INDEX TO

The Boiler Maker

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ARTICLES

COMMUNICATIONS

EDITORIALS

ENGINEERING SPECIALTIES

LAYING OUT PROBLEMS

PARAGRAPHS

TECHNICAL PUBLICATIONS

THE BOILER MAKER

JANUARY, 1915

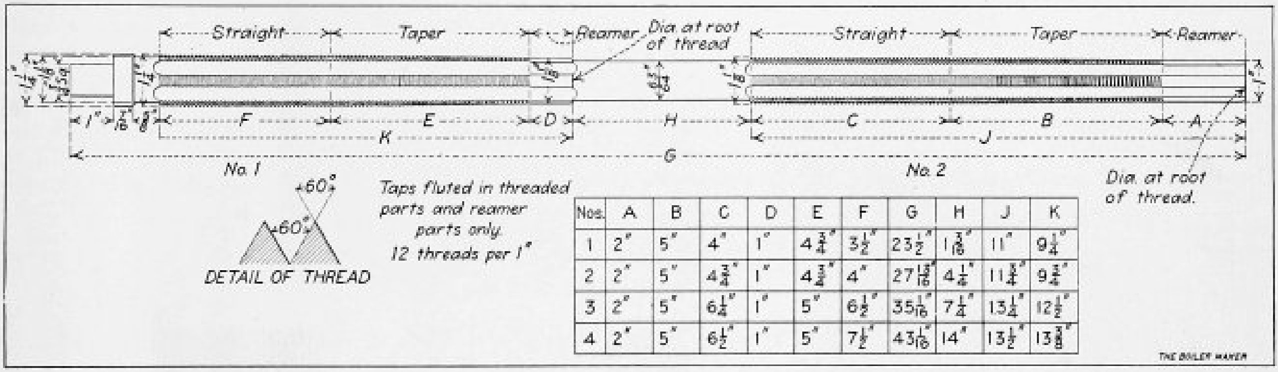
Applying Radial Stays in Locomotive Boilers

Successful Method Adopted on the Chicago, Milwaukee & St. Paul Railway for Applying Radial Stays in Radial Stayed Boilers

BY A. N. LUCAS *

For the past twenty-five years we have been using radial stays and our method of applying the stays on radial stayed boilers has proved to be good practice. We use a combination bolt. For small power the bolt is 1⅛-inch diameter at the top and 1 inch diameter at the lower end. For our heavy power we have been using radial staybolts 1¼ inches diameter at the top end and 1⅛ inches diameter at the bottom end. We use a sharp V thread, twelve threads per inch, with a straight fit in the crown sheet. We believe the sharp V thread is superior for this class of work over the United States standard.

carriage just back of the jaw, which is adjustable. Before cutting the thread on the smaller end of the stay, the different taps are placed in position in the head, with the larger end resting in the gage back of the jaw. When the thread is being cut on the smaller end of the radial stay, the larger end is placed in the gage just back of the jaw, which gives us a perfectly cut stay with the threads at all times in pitch with the tap. This makes it possible for us to apply our radial stays rapidly. In fact, the radial stay is applied in practically the same way as an ordinary staybolt, as we are practically sure that the bolt will enter the



Nos.	A	B	C	D	E	F	G	H	J	K
1	2"	5"	4"	1"	4¾"	3½"	23½"	1 3/16"	11"	9¼"
2	2"	5"	4¾"	1"	4¾"	4"	27 13/16"	4¼"	11¾"	9¾"
3	2"	5"	6¼"	1"	5"	6½"	35 1/16"	7¼"	13¼"	12½"
4	2"	5"	6½"	1"	5"	7½"	43 1/16"	14"	13½"	13⅜"

Fig. 1.—Radial Staybolt Taps

Our holes are tapped from the outside with a combination tap according to the size of bolts being appplied. The tapping is done very rapidly with an ordinary air drill, running the tap down through both sheets and then backing same out with the air drill.

In applying radial stays due to the variation in length, it is necessary to use taps of different lengths, and, with our method, we use four taps, designated as No. 1, No. 2, No. 3 and No. 4, as shown in Fig. 1. With No. 1 tap we apply the shorter radial stays from 8 inches up. With No. 2 tap we catch the next row or two, and with No. 3 tap the next longer length and with No. 4 tap we tap the longest radial stays.

Cutting the Threads

All our radial stays are threaded on a double head "Acme" bolt cutter. On one head we cut the thread on the large end of the radial stays, and on the other head we cut the thread on the small end of the radial stays. But, in order to have the threads on both ends in pitch with the tap, we have a small adjustment or gage placed on the

crown sheet without stripping, an important consideration.

Details of the gage for threading radial staybolts and keeping same in pitch with a tap are shown in Fig. 3. This can be applied on any bolt-cutting machine with very little expense.

Applying the Bolts

The eight center rows in the crown sheet extend down through the crown sheet long enough to receive thin copper gaskets and a ⅝-inch steel nut. The radial stays outside of the eight center rows are riveted over the same as ordinary staybolts. We believe in this method because we get the best results with it. The nut and gasket used is shown in Fig. 2.

We have several engines built as follows:

Class B-1. Engines built in 1896.
Class B-2. Engines built in 1897 and 1898.
Class B-3. Engines built in 1899 and 1900.
Class B-4. Engines built in 1899 and 1901.
Class A-1. Engines built in 1896 and 1898.
Class A-2. Engines built in 1901 and 1902.

Many of these engines have the original crown sheets and radial stays and are still in service and in good con-

* General Foreman, Boiler Work, Milwaukee Shops, Chicago, Milwaukee & St. Paul Railway.

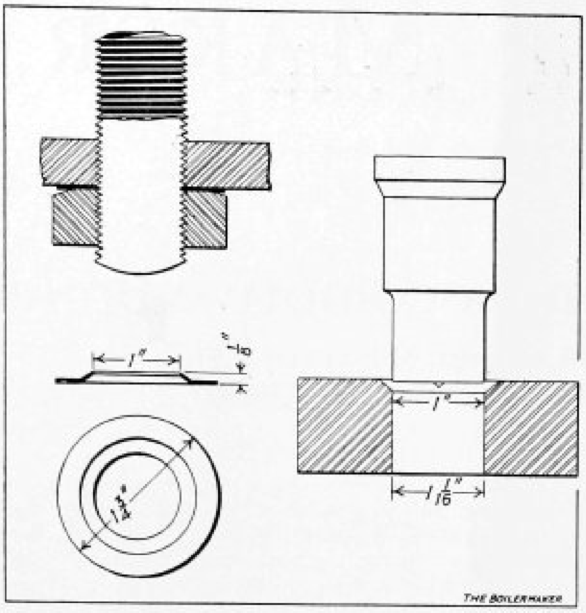


Fig. 2.—Nut and Copper Gasket

dition. We seldom have any trouble with our radial stays, except in cases of low water when the bolt is bound to loosen up in the sheet whether it be a straight fit, a taper fit or otherwise. What you want is a good fit in the crown sheet when the bolt is applied.

Holding Power of the Bolts

With our method we have holding power due to the thread in the sheet as well as the holding power of the nut placed on the bolt outside of the sheet. Where the bolts leak slightly, we can apply new gaskets and renew these nuts very readily and still have considerable holding power. We have an adjustable die nut whereby we can recut the thread on the end of the radial stay and then apply a new nut to fit same.

Another good point about our method is that when the bolt leaks you cannot locate it without taking off the nut, and then, if the bolts show that they are loose in the sheet to any extent, we apply new bolts and a new nut and gasket. Another good point is that we can always see whether or not the thread on the radial staybolt has been stripped when applied.

It will be noted from Fig. 2 that the copper gasket used is shown to be slightly dished. This we do when punching the gasket by having the corner of the die turned off, as shown in Fig. 2. For a 1-inch bolt we only punch a 1-inch hole, and then when the copper gasket is placed on the bolt and the nut is tightened up against the gasket, the gasket is straightened out, making a fit right into the thread of the bolt, which makes is impossible to get the gasket off without cutting it. A gasket with a larger hole would be of very little benefit in regards to making a joint. Twenty-pound copper is used for the gasket.

The steel nuts we use are punched out of scrap boiler plate ⅝-inch thick, and in putting these nuts on radial stays, the round side of the nut goes up against the crown sheet, as shown in Fig. 2. Due to the shape of the nut, we apply the bolt up against the crown sheet in a very good manner.

With the buttonhead, or the other method, the tapping of the holes as well as the applying of the bolt is done from the inside of the firebox, and you are not always sure of a good fit on the crown sheet, and you are unable to determine whether the thread has been stripped or not. Again, the buttonhead does not always go up against the crown sheet as it should, due to the radius, and many times the head is calked up against the sheet right from the beginning. When these bolts become loose in the sheet they may be quite loose, still they are calked up many times, and due to this fact they do not have the holding power and will not give the good results that we are getting from the method described above.

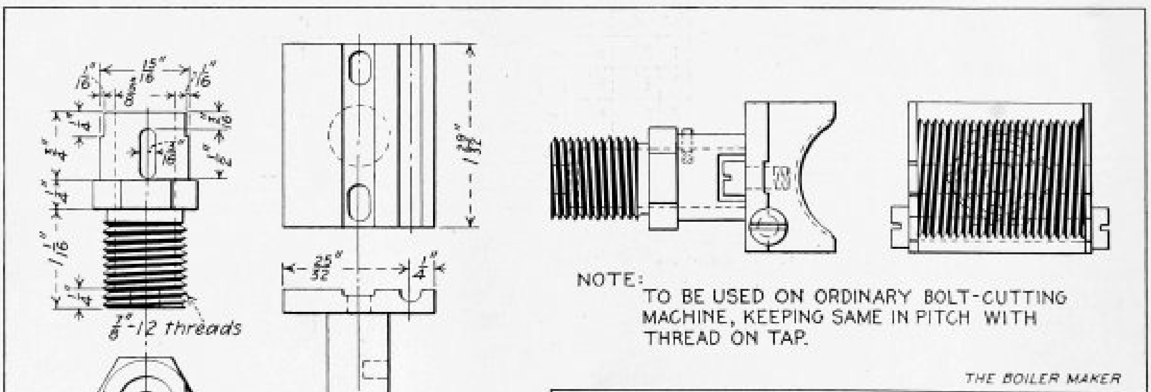
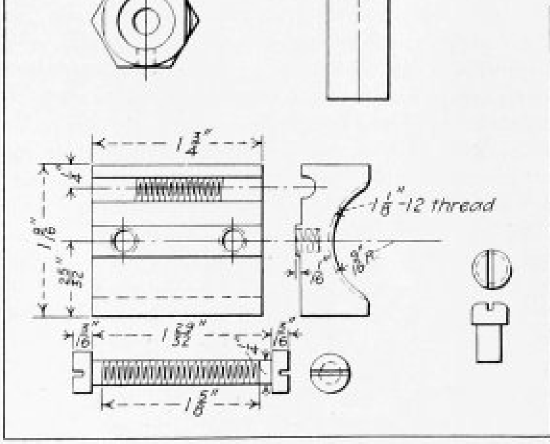



Fig. 3.—Gage for Threading Radial Staybolts

Personal

T. McClymont has been appointed foreman boiler maker of the Toronto, Hamilton & Buffalo railroad at Hamilton, Ont., vice F. Fell.

J. H. Stone has been appointed foreman boiler maker of the Erie Railroad at Marion, Ohio.

Prof. A. M. Greene, Jr., Prof. Wm. Kent, Frederick Sargent, F. H. Clark, Thos. E. Durban and H. G. Stott have been appointed an advisory committee of the A. S. M. E. Boiler Code committee to consider the questions of factor of safety and age limit of boilers.

The Modern Tube for Locomotive Service*

Development of the Boiler Tube—Process of Manufacture and Method of Testing—The Use of Steel for Safe Ending

BY P. J. CONRATH †

The modern boiler tube, as manufactured to-day, is made of a special grade of open hearth steel by either the lapweld or seamless process. The material selected for this purpose is kept up to the highest standard in chemical and physical properties in order to produce a strong and ductile tube which will successfully withstand the rigid requirements of service. The methods of manufacture are improved, the tests severe, and the inspection most careful, so that the finished tube will be adapted to meet not only all the demands of locomotive service, but also expanding, flanging and beading, and the exigencies of repair requirements from time to time.

Let us consider the development of the locomotive tube. In the building of the first locomotive, copper tubes were probably used, but the necessity for a less expensive material soon led to the use of welded charcoal iron. This tube was first made by the buttweld process of drawing the heated plates or skelp, as it is known to the trade, through a bell-shaped ring, which forced or butted the edges together.

Buttweld charcoal iron tubes were used for some time, but later, when the lapweld process of manufacture was invented, this improvement was applied to tubes for boiler service. The lapweld tube was, of course, better adapted to stand the manipulation required in turning over and beading and the increased steam pressure, and therefore gave improved service.

Charcoal iron, however, from the nature of its manufacture, is produced in comparatively small quantities, because the manual labor involved does not permit the handling of heats or lots larger than 500 pounds, and as a consequence does not produce the uniform product now required for locomotive service. Charcoal iron is only about half as strong as steel in the direction at right angles to the center line of the tube, and this is unfortunately just where strength is required.

When the Bessemer process of purifying pig iron was applied to the tube industry in 1886, the resultant metal was a mild, well-refined iron, purer than charcoal or wrought iron, but was classed as steel, because it was refined in the Bessemer converter. This steel is equally strong in all directions and marked a considerable improvement over charcoal iron.

Then in 1887 the seamless process for making tubes was introduced, and ten years later its value was shown by the fact that railroads were becoming rapidly interested in the development of its possibilities. Seamless tubes were made of soft basic open-hearth steel, Bessemer being unsuited to the process. Subsequent tests also proved open-hearth steel to be better adapted for lapwelded tubes, as it was found to be much less liable to become brittle while in service.

The improvements in the method of manufacture of this steel gave such gratifying results as to finally lead the largest manufacturers of tubular goods to abandon altogether the production of charcoal iron boiler tubes, devoting their attention to the manufacture of the special grade of steel which experience has proved to be the best material for the purpose.

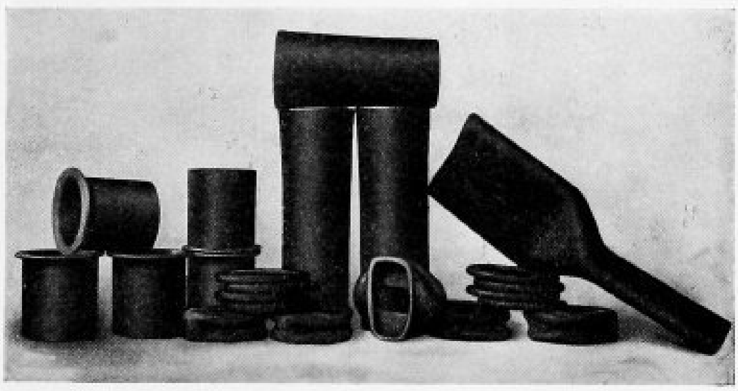


Fig. 1.—Standard Tests on Steel Boiler Tubes

The market now affords practically three classes of tubes for locomotive service: lapwelded charcoal iron, seamless (cold-drawn and hot-rolled), and lapwelded steel tubes. When the action of corrosion on the two metals, iron and steel, is compared, and the durability and economy in service are investigated, the conclusion that steel is equal to charcoal iron in this respect for tubes will be found to be fully confirmed.

Those interested in looking into this matter should examine the reports on the steel boiler tubes which have been submitted for several years past to the annual conventions of the Master Boiler Makers' Association. These reports all represent unbiased service tests and are authentic and reliable.

Besides the greater strength, ductility and uniformity obtained in making tubes of basic open-hearth steel, a special process of treating the metal, which better enables it to withstand corrosive action, has been successfully developed. This special process, known as Spellerizing, produces in the tube an exceptionally dense and uniform surface, which has been proved in service particularly

* A paper read before the St. Louis Railway Club on October 9.
† Tube Expert, National Tube Company, Pittsburg, Pa.

efficacious in resisting the effects of corrosion, especially in the form of pitting. In the manufacture of "Spellerized" lapweld tubes, the bottom surfaces of the steel blooms are alternately knobbled and smoothed down by passing the hot bloom first through a series of rolls which have a regular series of knobs cut on their working surfaces, and then through plain rolls which in turn smooth down the roughened or knobbled surface, the operation being repeated several times. This produces alternately a roll-knobbling or kneading and a smoothing down of the surfaces of the plate, rendering the texture more dense and uniform, strengthening the resistance of the tube against corrosion.

Spellerized Lapweld Tubes

It has also been found of advantage to devise a special test for "Spellerized" lapweld tubes intended for locomotive service. This test is made on each of the two crop ends cut from every boiler tube, and consists of a horizontal flattening, vertical crushing and flanging test, made on the cold tube in one operation, while held in a specially designed hydraulic machine. This test insures that the weld is as strong as other parts of the tube, and that the physical properties are uniformly up to the standard requirements. This is an eliminating test and is given in addition to the hydrostatic inspection and other tests to which these boiler tubes are subjected in the course of manufacture. It is an eliminating test because any tube is scrapped if, under the rigid conditions of the test, a trace of weakness or any other defect is developed.

Fig. 2.—The Rolling and Beading Test (Note that the material wears away evenly when rolled to destruction before the bead cracks)

The manufacturer has been hampered ever since the first tube was made by a variety of specifications. It has been our object to make the best tube possible for locomotive service. The American Railway Master Mechanics' Association Specifications of 1913 were adopted as the result of their committee's labors to reconcile the different specifications, and was a great step in advance. The manufacturer can make a better tube under this specification than under any of the older ones, and with more assurance of uniformity in quality as soon as this standard becomes universal.

It is rapidly becoming a well-known fact that soft basic open-hearth steel tubes, either seamless or lapwelded, withstand the severe treatment encountered in the process of expanding into the flue sheet better than charcoal iron. The steel, being more rigid than the iron, requires less attention while in service. The life of the tube to-day is governed by the number of times it can be worked without destroying the life of the material. The steel, being more dense and rigid, will stand more working and reduction without any ill effects to the tube, either in splitting or breaking off of beads, etc. Owing to its density, the steel has greater holding power than the iron, thus considerably reducing maintenance cost and giving increased mileage between settings of tubes, as well as reducing engine failures due to leaky tubes to a minimum. The steel beads are stronger than the charcoal iron, and are thus better able to resist the stresses incident to modern service, and eliminate the bulging of tube sheets.

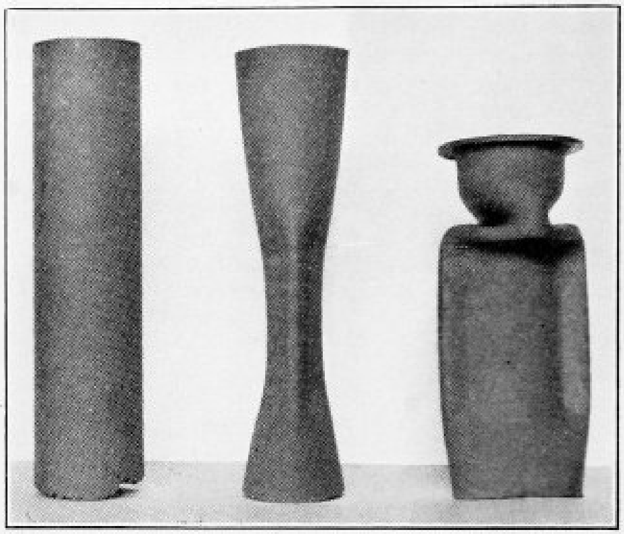


Fig. 3.—Special Test Applied to Spellerized Steel Locomotive Boiler Tubes. Combined Vertical Crushing, Horizontal Flattening and Flange Tests on One Pieece

Safe Ends

The practice in a large number of shops is to use steel almost exclusively for safe ending rather than to use iron and steel alternately. There seems to be no difficulty in welding steel safe ends on steel tubes under these conditions. In safe-ending, it is best to bring the body tube to a bright orange heat (1,750 degrees F.) for expanding to admit safe end, and allow it to cool to at least a blue heat before reheating for welding. Precautions should be taken not to overheat the metal near the weld, which may occur if there is much difference in thickness between the body tube and safe end.

The recent application of electric buttwelding to safe-ending is worthy of consideration. The important advantage is that the metal away from the weld is not so readily overheated. The process appears easy to control, is economical and should give a continuous, fine-grained structure throughout the weld. Some laboratory tests recently made show electric buttwelds made at the Norfolk & Western Railroad shops to have 90 percent of the strength of the material itself. This railroad has for some time past been using this method of welding on safe ends and with very satisfactory results, attracting the attention of the mechanical officials of a number of other railroads, who will in all probability soon adopt this method.

Nearly 90 percent of the locomotives in America are now equipped with steel safe ends, although some railroads adhere to the use of charcoal iron body tubes carrying steel safe ends. The reason for this apparent inconsistency is not plain, for it is the safe end that must endure the most severe service.

With respect to durability in the flue sheet, there is

Fig. 4.—Shelby Hot-Finished Seamless Steel Boiler Tube, After Being Crushed Together From the Ends

abundant evidence on record to show that the mileage made with steel tubes is considerably greater, under the same service conditions, than with charcoal iron. In the following tables are given some comparative figures on the corrosion of iron and steel tubes, and the mileage obtained in actual service of various railroads, which are indicated by letter. One of the most remarkable examples of unbroken service, probably the greatest tube mileage made in America, is shown by the Lehigh Valley Railroad in fast passenger service. Engine No. 2479, pulling an average 450-ton train, during 28 months completed in June, 1913, ran a distance of 245,675 miles on one set of lapweld "Spellerized" steel tubes.

After testing out, side by side in service, the two classes of tubes, charcoal iron and steel, the leading railroads now recognize the value of the steel tube in service, the saving in shop work, and the great economy in first cost and increased mileage.

In this paper it is the desire to present the facts, both from a theoretical and practical standpoint, pertaining to the relative value of iron and steel boiler tubes as gained from the experience of manufacturer and consumer, all of which points to the one conclusion that steel tubes will ultimately replace iron, just as this material has displaced iron in other parts of boiler construction.

Hot-Rolled Seamless Tubes

Many of you undoubtedly are familiar with the manufacture of cold-drawn, seamless steel tubes, but probably few have heard anything regarding the manufacture of hot-rolled seamless tubes, which is practically a new process, and I might devote a few minutes to explaining the manufacture of this tube, which, like the cold-drawn, is pierced hot, considerably larger than its finished size, then reduced by passing to a series of rolls, each roll reducing the tube both in size and thickness of wall. Small gas furnaces are placed alternately between rolls, which, as tubes pass through, keep up the temperature adaptable to the working of the metal, and the tube is, practically speaking, finished at the same degree of heat it was started with. Then it is allowed to cool gradually, and in this way is annealed throughout, which gives us a very soft and uniform material.

It is a well-known fact that hot metal will gather oxide from the air, which is beneficial to the material. In this case, while tubes are passing from one roll to the other, they are coated with oxide, which is worked into the surface of the metal by the rolls, and forms a protection to the tubes, whereas, when tubes are drawn cold, all of this oxide is removed while drawn through the die, or, in other words, the surface of the metal is removed, which in all cases is a protection to any material. In my opinion, the only reason a tube was ever drawn cold was to insure a uniform gage. The finishing of a seamless tube hot is, I might say, of recent date. The process has been perfected, however, so that we can finish a tube hot and get a uniform gage throughout. This being a fact, there is no good reason why the material should be worked cold, which cannot be of any benefit to the material. All of our tubes are made of basic open-hearth steel and will give equally good service.

A great deal of your tube troubles on the road are due principally to the water; it starts through the ingredients in the water, and that starts in turn the tubes to leaking. One of the most important things is proper care of the locomotive in service, such as washing, and in carefully cooling them off.

Another thing is misuse and abuse of the locomotive, as we term it, on the railroad. An engineer can be of the greatest help in the way of increasing tube mileage on a locomotive; in fact, after the tubes have been properly set, it is up to the engineer to help take care of the flues. I might say that I do not care how good a set of tubes may be installed in a boiler, without the engineer's assistance you will not get the expected mileage out of the tubes. I always lay great stress on the pumping engines, which should never be done while standing still, if it can be possibly avoided.

TABLE No. 1.

SERVICE CORROSION COMPARISONS.

Rail-road.	Material Installed.	Water Condi-tions.	Length of Service.	No. Discarded		Cause of Rejection.	Remarks.
				Steel.	Iron.		
A	Charcoal iron and lapweld steel tubes in opposite sides of same engine.	Not stated	14 months	14 out of 176	49 out of 176	Pitting	
B	Tests made on three engines using half-sets of lapwelded steel and charcoal iron tubes on each engine.	Bad	Three years (3 re-settings) Test continued	None	None		Steel tubes are in as good condition as iron. Tubes still in service.
C	Charcoal iron and lapweld steel.	Very bad	60,000 miles	25	75	Pitting	Engines in which iron and steel tubes were used were in same service under same conditions.
D	Tests made on one engine, using lapweld steel tubes on right side and charcoal iron on left side.	Bad	11 months (Test continued)	3	6	Pitting	Tubes removed and examined after 11 months. All put back in boiler except 9 which were discarded.
H	Ingot iron and lapweld steel tubes.	Bad	Iron—15,000 miles Steel—30,000 miles	3%	All scrapped	Pitting	
I	Swedish iron and lapweld steel in opposide sides of same engine.	Very bad	14 months (When examined)	None	All scrapped (One at end of eight months)	Pitting	They report that 18 to 24 months' service is obtained from steel; best service from charcoal iron was 12 to 14 months.
E	See "Remarks."	Extremely bad	See "Remarks"				Now using lapweld steel tubes on this division and obtain 25% more mileage and have less pitting than with charcoal iron.

TABLE No. 2.

MILEAGE—FLUE SHEET PRACTICE.

Rail-road.	Mileage.		Water Conditions.	Remarks.
	Steel.	Iron.		
A	101,000 (One engine)	50,000-60,000 Was considered good	Not stated	Test made on one engine equipped with lap-weld steel tube under same conditions as the charcoal-iron previously used.
C	95,000 (Average)	46,000 (Average)	Bad	Engines equipped with lap-weld steel tubes tested in comparison with engines equipped with charcoal-iron tubes under same conditions.
B	80,500 (Average)	40,000 (Average)	Probably most severe in country.	Tests made on engines equipped with lap-weld steel tubes under same conditions as the charcoal-iron previously used.
F	70,000 to 75,000 100,000 to 125,000*	Freight 20,000 to 25,000 Passenger 40,000 to 50,000	Not stated	About three years ago the use of charcoal-iron tubes on this railroad was abandoned in favor of steel tubes after comparative tests on these two materials.
G	78,000 (One engine)	40,000 to 50,000 (Average)	Not stated	Tests made on engine equipped with lap-weld steel tubes under same conditions as the charcoal-iron previously used. Tubes still good and in service.
H	Test on engine equipped with Swedish iron on one side and Shelby seamless tubes on the other side of same engine.		Not stated	After 13 months engine was shopped. Nearly all beads on Swedish iron tubes were in bad condition; those on Shelby seamless tubes were apparently as good as ever.

*One engine on this road in fast passenger service equipped with "Spellerized" lap-weld steel tubes made 245,675 miles before tubes were removed. This exceptional case is probably the largest tube-mileage ever made in America.

Another thing is where the engine is worked very hard with the injector shut off; that will have a tendency to bring boilers to a very high degree of heat, and then engines are allowed to stand on side track with the injector working. The cold water will rush to the bottom and cause a sudden contraction, and the sudden contraction is what loosens the tubes, and then you have them leaking.

Another thing is in connection with the engine going over the cinder-pit. If I were in authority, I would never allow an engine to be pumped, if it can be avoided, from the time it lands in the yard and is relieved from the train, until it is under steam again. If an engine is placed on the cinder-pit with three gages of water, it will not be necessary to again put water in the boiler until engine is fired up and again under steam.

The water is not in circulation when the engine stands still, and the cold water will rush to the bottom and strike the back flue sheet, where the boiler is hottest, and there is a sudden contraction, and that is what causes trouble.

Wisconsin Boiler Code

The steam boiler orders of the Industrial Commission of Wisconsin become effective January 18, 1915. The orders of the commission have the same effect as law and are printed in pamphlet form for free distribution.

The orders are arranged under two different headings, styled Parts I and II. Part I contains general orders which define terms and explain the method by which the orders will be made effective. Part II applies only to boilers installed prior to January 1, 1916, and contains rules to govern the inspector in his work. The orders affecting the construction and installation of boilers after January 1, 1916, will be issued previous to the time when they will be effective. The commission refrained from issuing orders at this time affecting future construction, as it wished to avail itself of the advice of the final report of the American Society of the Mechanical Engineers' Standard Boiler Code.

H. E. PRESSINGER,
Deputy in Charge, Department of Steam Boiler Inspection, Industrial Commission of Wisconsin.
Milwaukee, Wis.

Specifications for Lap-Welded and Seamless Boiler Tubes

On September 25 representatives of boiler tube manufacturers adopted a standard specification for lap-welded and seamless boiler tubes. It differs in only a few details from the corresponding specifications of the American Society for Testing Materials. The specification is important, however, in one point at least, that it stands for an agreement of those in direct competition, and for this the American Society of Mechanical Engineers is to be given the credit, through the activities of its committee, which has been engaged for over three years in establishing a steam boiler code covering construction and maintenance. It was out of the hearings and deliberations which this committee held that the manufacturers were brought together, and it is a commentary on the co-operative spirit of the manufacturers' representatives that they were quickly able to assist the mechanical engineers' committee in their joint recommendation. With the American Society for Testing Materials specifications as a base, the work of drawing the new specification was rendered doubtless easy. One of the main points, it may be said in passing, lies in the variation from gage allowed, which requires that all tubes be up to the gage specified at the thinnest point. The other important feature is the use of an impact test on lap-welded tubes while under pressure. The manufacturers whose representatives signed the specification were: Alleghany Steel Company, Monongahela Tube Company, National Tube Company, Parkesburg Iron Company, Pittsburg Steel Products Company, Reading Iron Company, Spang Chalfant & Co., Tyler Tube & Pipe Company and Worth Brothers Company.

The specification is in part as follows:

Process.—"Lap-welded tubes shall be made of open-hearth steel or knobbled hammered charcoal iron. Seamless tubes shall be made of open-hearth steel." (The A. S. T. M. specifications for steel and iron tubes are not combined and the new specification so far as it covers iron tubes is a departure from the A. S. T. M. iron tube specification.)

Chemical Properties and Tests.—The stipulations apply to the steel tubes and are the same as in the A. S. T. M. steel tube specifications.

Physical Properties and Tests.—"Flange test. A test specimen not less than 4 inches in length shall have a flange turned over at right angles to the body of the tube without showing cracks or flaws. This flange as measured from the outside of the tube shall be ⅜ inch wide." (There is no reference to diameter of tube as in the A. S. T. M. specification.) Flattening Tests.—A test specimen 3 inches in length shall stand hammering flat until the inside walls are brought parallel and separated by a distance equal to three times the wall thickness, without showing cracks or flaws. In the case of lapwelded tubes the test shall be made with the weld at the point of maximum bend. [A test specimen 4 inches in length shall stand hammering flat until the inside walls are in contact, without cracking at the edges or elsewhere. For lap-welded tubes care shall be taken that the weld is not located at the point of maximum bending.] (The portion in brackets is the A. S. T. M. specification. No crushing tests are provided for, as the A. S. T. M. specifications.) Hydrostatic Tests.—Tubes under 5 inches in diameter shall stand an internal hydrostatic pressure of 1,000 pounds per square inch and tubes 5 inches in diameter or over, an internal hydrostatic pressure of 800 pounds per square inch. *Lapwelded tubes shall be struck near both ends, while under pressure, with a two-pound hand hammer or the equivalent.* (The part in italics is new.)

The part of the new specification covering test specimens, number of tests and retests is substantially the same as the A. S. T. M. specification. A table of standard weights does not form a part of the new specification.

Workmanship and Finish.—The finished tubes shall be circular within 0.02 inch and the mean outside diameter shall not vary more than 0.015 inch from the size ordered. *All tubes shall be carefully gaged with a B. W. G. gage and shall not be less than the gage specified, except the tubes on which the standard slot gage, specified, will go on tightly at the thinnest point, will be accepted.* The length shall not be less, but may be 0.125 inch more than that ordered. (The part in italics is new.)

The remainder of the specification is not materially different from the A. S. T. M. specification. In marking, the name and brand of the brand of the manufacturer, the material from which it is made, whether steel or charcoal iron, and "Tested at 1,000 pounds" for tubes under 5 inches in diameter, or "Tested at 800 pounds" for tubes 5 inches in diameter or over, shall be legibly stenciled on each tube.—*The Iron Age.*

Boiler Explosions in Great Britain

The annual report for the year ending June 30, 1913, on the working of the Boiler Explosions Acts, 1882 and 1890, has just been issued by the Board of Trade. During the period named, 66 preliminary inquiries and 14 formal investigations were held under the provisions of the acts. The 80 explosions thus dealt with caused the death of 31 persons and injury to 42 others. The 31 deaths were caused by 20 explosions, of which 11 occurred on land and 9 on ships. The number of persons killed is above the average (26.5) for the thirty-one years since the act came into force, but the number of injured is considerably below the average. There was a drop in the number of explosions which occurred during the year, though this is still slightly above the average (72.9).

On analysis of the complete summary of the explosions for the year, it appears that 22 boilers, etc., were under boiler insurance or accident insurance companies; 12 were under the Board of Trade or Lloyd's Survey; 5 were under mutual marine insurance companies, etc.; 3 were under the inspection of the makers; while in the remaining 38 cases the boilers, etc., were apparently under no system of periodical inspection.

The 80 explosions occurred in the following types of boilers or vessels, etc.: 13 horizontal multitubular boilers; 5 vertical boilers; 3 Lancashire or Cornish boilers; 3 locomotive boilers; 8 watertube boilers; 9 tubes in steam ovens; 4 heating opparatus; 18 steam pipes, stop valve chests, etc.; 3 hot plates, etc.; 6 calenders, drying cylinders, etc.; 3 economizers; 1 steam-jecketed pan; 4 miscellaneous.

The causes of the 80 explosions were as follows: 24 deterioration or corrosion; 13 defective design or undue working pressure; 11 water hammer action; 16 defective workmanship, material, or construction; 7 ignorance or neglect of attendants; 9 miscellaneous.

The average figures for each year for the thirty-one year period (1882-1913) were 72.9 explosions, resulting in the loss of 26.5 lives and injuries to 58.2 persons.

In the investigations of some of the explosions during the past year important recommendations were made by the Commissioners. In one case they recommended that the attention of the users of small boilers should be called to the neglect of periodic "thorough" examination of their boilers. In two others they made recommendations dealing with the construction and management of the boilers of heating apparatus and cylinders of drying machines respectively. In a fourth case the Commissioners recommended that all owners of steam-trawlers should be warned of the danger attending the use of loose-fitting valve-seatings unless they are under the control of a master valve interposed between the check valve and the boiler.

It may be pointed out that many of the explosions reported upon were of a comparatively trivial character, such as those due to the failure of tubes in steam-ovens, etc., but inasmuch as such occurrences endanger life, it is reported that they should be investigated by the Board of Trade in the hope that by the spread of information on the subject greater care will be taken both by those who make and those who use any vessel liable to give rise to an explosion of a more or less serious nature.

Hydraulic Pressing—VIII*

BY C. W. R. EICHHOFF

In my previous articles I have described some of the operations in flanging and forging which can be performed on the sectional flanging machine. There are many articles which can be pressed and forged on this machine, as, for instance, pipe flanges, manhole saddles, nozzles, and so on. The boiler manufacturer can fabricate these steel products in his shop if he chooses, but it is a question if it is advisable to do so. In most cases it is cheaper to buy these articles from a concern which makes a specialty of this kind of work. There is always occasion for more profitable work on this machine. In fact, a sectional flanger can always be worked continuously on regular boiler work. To manufacture small articles in small quantities, however, is not economical, considering the steam consumption and labor involved.

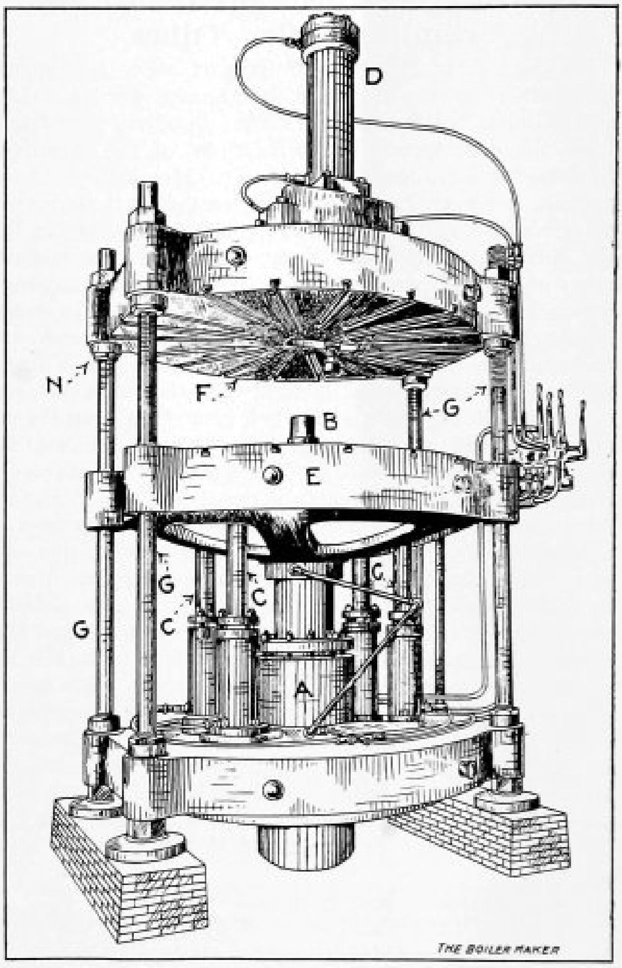
As stated in a previous article, the sectional flanging machine is of more general use than a four column press, but for more rapid work on large pieces which have to be produced in quantities, the latter machine is preferable.

FOUR COLUMN PRESS

A four column press of modern design is shown in the sketch. This machine has a main cylinder with a main ram *A* fastened to and moving the platen *E*. In the ram *A* is contained a smaller ram *B*. This can be used on small work which does not require the force of the large ram. It is also used in some operations in addition to ram *A*.

I wish to call attention to the fact that every time any one of the rams is operated the water has to fill the cylinder which contains the ram for the required length of stroke. To do this it requires every time a certain amount of power or steam to operate the pumps which supply the necessary amount of water. For this reason the designer should be careful to get out dies and formers in such proportions to each other that the travel of the rams is as short as possible. On the other hand, the flanger operating the machine can do very much to economize in this respect.

In the flanging machine shown are four auxiliary rams, *C, C, C, C*. These rams can be moved and adjusted in a radial direction. There is also shown an auxiliary cylinder, *D*, on top of the machine. In the table *E* and cap *F* are T-slots in which the filler castings and dies are fastened by heavy bolts and nuts. The fillers are used to give the necessary clearance. The table *E* slides along the four bolts *G*. The ends of these bolts are threaded



Sketch of Four-Column Press

with a square thread to hold the adjustable cap *F* in place by means of the nuts *N*. It can be seen that there is considerable more clearance between the platen and the cap in this machine when comparing the same with the sectional flanging machine.

FLANGING ROUND HEADS

In the following I shall take up some of the work that has been done on the four column press. The simplest work and the work mostly done in the boiler shop is the flanging of round heads for boiler and tank work. The operation is shown in Fig. 1. The unfinished plate is shown in black and the flanged product by dotted lines. In Fig. 2 the male and female dies are shown in detail. Such dies were used originally for flanging round heads and are found to-day in many a boiler shop. Of late the dies shown in Figs. 3 and 4 are replacing the old style mentioned. The male block is cast in three sections, which can be adjusted by liners between the same to serve for the different thicknesses of plate. The cone is for

* Continued from the November, 1914, issue.

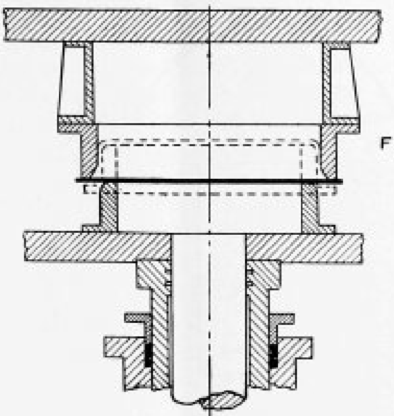


FIG. 1

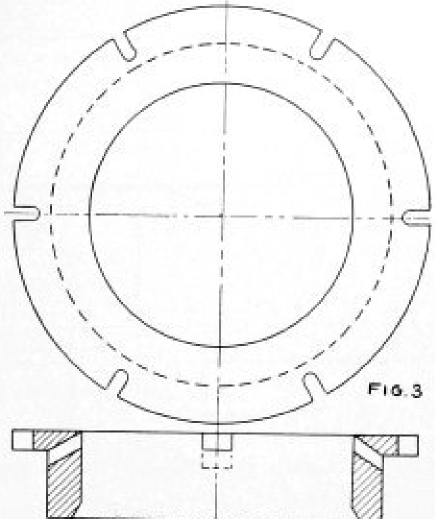


FIG. 3

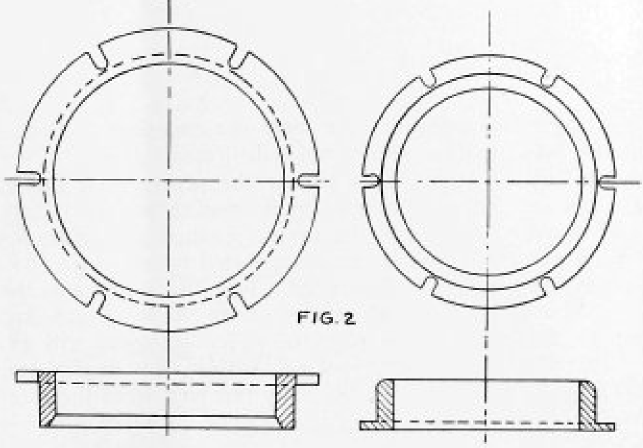


FIG. 2

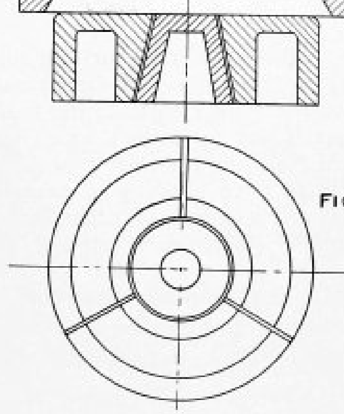


FIG. 4

releasing purposes. A more complete description of the use of such sectional dies will be given in the following example.

In Figs. 5 and 6 the flanging of a dished head is shown by means of sectional blocks and a gripping female block. Fig. 5 shows the position of the dies before the plate *P* is flanged and formed. To the cap *A* are fastened the distance blocks *B* and the female die *C*. To the movable table *H* is fastened the grip block *L*; the sectional male block rests on plate *G*, which is attached to the auxiliary plunger *K*. The table *H* is fastened to the main ram *M*.

By referring to our cut, we see that the grip block *L*, resting on the table *H*, is run against the female die *C*. Where these blocks touch each other the surface should be finished—in fact, all surfaces in direct touch with the plate or any part of the machine should be smooth and finished. This is essential for adjustment and alinement.

Between the female block *C* and the grip block *L* is left a space 1/16 inch or more deeper than the thickness of the head. This clearance is governed by the thickness

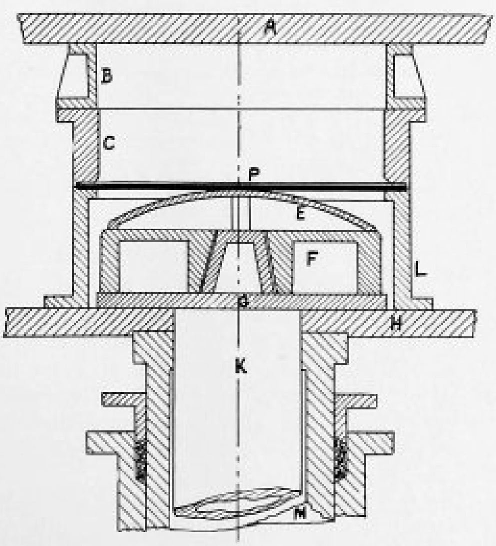


Fig. 5

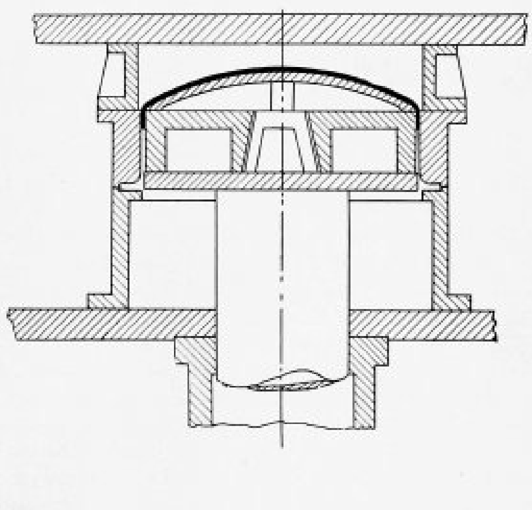


Fig. 6

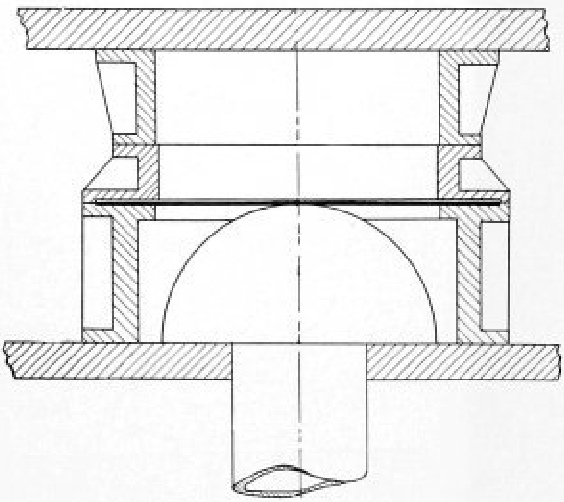


Fig. 7

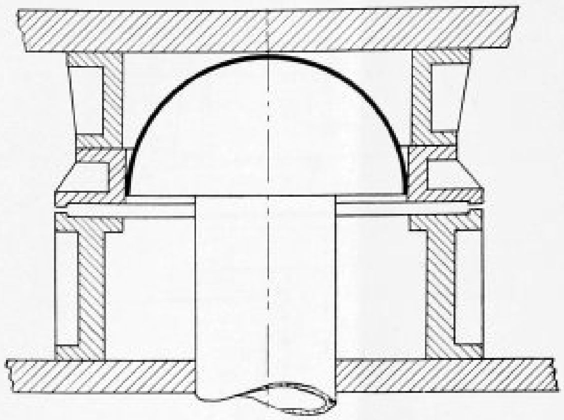


Fig. 8

of the head. It should be small for thin sheets and larger for heavy plates. The object of the clearance is the following: When the plate *P* to form the head is pushed up by the plunger *K* and the male block *F*, the plate has an opportunity to slide out from between the die and block, keeping the plate from buckling or crimping. With the old style blocks it happens too often that the heads are buckled, especially when thin sheets are used.

Flanging and Dishing

Now the flanging and dishing with these dies is done in the following manner: Before beginning the work, see that everything is adjusted properly and in good alinement. I cannot warn too often that this precaution should be taken. Have the moving table *H* in its resting position, then place the heated sheet *P* on the grip block *L*. The space left in this block is of great assistance in centering this plate. Run the table *H*, to which the grip block is fastened, up against the female block *C*. In this position hold the table with the full pressure on the main ram *M* until the whole operation is completed—i. e., the head dished and flanged. Apply the pressure to the center plunger *K*. This ram will push the male block, dish and heated plate up. The dishing will then begin and the space left between *C* and *L* allows the head to drag out, and while following the sectional block there is just enough space to avoid the tendency of the edge of head to buckle.

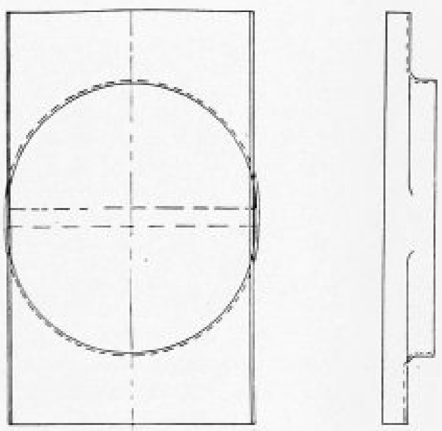


Fig. 9.—Double Throat Sheet

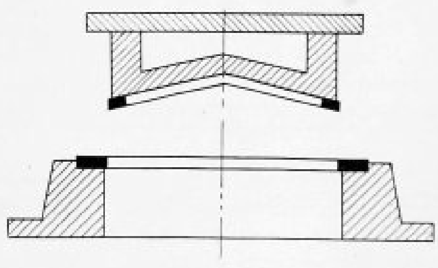


Fig. 10

By pushing the male die and dish further, the head is flanged and completed.

Afterwards release the pressure on the main plunger *M* and lower *H* to its resting position; then release the pressure on the auxiliary ram *K*, bringing down the male die with its cone supported by plate *G*. As soon as the cone has descended a little the sections of the male block will clear themselves from the head and drop down, following the plate *G*. The hot head will remain in the female die, cool off, shrink, and finally drop out, after which it can be easily removed from the machine.

Fig. 6 shows the position of every part when the head has just been dished and flanged before the pressures are released on the different rams.

Pressing Spherical Forms

In Figs. 7 and 8 I have shown how spherical forms can be pressed with a similar arrangement. The operation is practically the same as in the previous case, only it might become necessary to release the pressure on the platen *H* earlier, as indicated in Fig. 8. The final releasing of the grip block can also be accomplished by means of wedges shown in the cut of forming spherical heads with the sectional flanging machine.

The few operations mentioned are all performed in one operation—i. e., while the head is only heated once. There are many parts of tanks and boilers which can be formed in one heat, as throat sheets, front heads with flanged fire doors, heads with flanged openings and flat surfaces. Such a form I have shown in Fig. 9. There is no limit to the possibilities in this respect.

In Fig. 10 I have shown how dies for punching holes can be made and used on the flanging machine. To be successful, however, in punching holes, the capacity of the machine should be considered carefully. Here, as in many other cases, experiments will show better than any calculations how far one must go to get satisfactory results.

To calculate the net pressure exerted by a ram or plunger of a hydraulic press, the following formula might be used:

$$P = .7854 \times D^2 \times p \times \left(1 - \frac{f}{100}\right) - w.$$

where,

D = diameter of ram or plunger.
P = net pressure exerted by the ram.
p = pressure in pounds per square inch on system.
f = coefficient of friction in percentage.
w = weight of ram and attached dies.

The friction coefficient depends on the diameter of ram, conditions of packing and varies from 3 to 25 percent. The smaller the diameter the higher is the friction.

Federal Locomotive Boiler Inspection Report

In the third annual report of the work of the Division of Locomotive Boiler Inspection of the Interstate Commerce Commission, signed by Frank McManamy, chief inspector, a comparative summary is given of the work performed, the conditions found, and the results accomplished during the three-year period, because it is believed that sufficient time has elapsed since the law has been in force to permit the benefits which may reasonably be accredited to its operation to be fairly shown.

The following table shows in concrete form the inspection work performed each year since the passage of the law; and the decrease in the percentage of locomotives reported defective indicates in a measure the improvement in conditions.

	1914	1913	1912
Number of locomotives inspected	92,716	90,346	74,234
Number found defective	49,137	54,522	48,768
Percentage found defective	52.9	60.3	65.7
Number ordered out of service	3,365	4,676	3,377

It does not, however, fully show the improved conditions resulting from the operation of the law, because, as pointed out in our 1913 report, our attention was first concentrated on the more serious defects, so that the number of fatalities might be reduced; therefore, the improvement is more accurately indicated by the reduction in the number of casualties, as shown by the following table:

	1914	1913	1912
Number of accidents	555	820	856
Decrease from previous year ...... percent	32.3	4.2	.....
Decrease from 1912 "	35.1	....	.....
Number killed	23	36	91
Decrease from previous year ...... percent	36.1	60.4	.....
Decrease from 1912 "	74.7	....	.....
Number injured	614	911	1,005
Decrease from previous year ...... percent	32.6	9.3	.....
Decrease from 1912 "	38.9	....	.....

The facts shown in the above tables are so conclusive that nothing further that might be said could add to or take from their weight; therefore, it is not necessary to enlarge on the information contained therein.

INVESTIGATION OF ACCIDENTS

In addition to the inspection work above shown, a careful investigation has been made of every accident reported in accordance with the provisions of the locomotive boiler inspection law. In each case active steps were taken to remedy any conditions or practices which could be shown to have caused or contributed to the cause of the accident, and this action has materially assisted in reducing the accident list.

Four hundred and six applications for extension of time for removal of flues, in accordance with the provisions of rule 10, were filed, of which number 67 were withdrawn by the railroad companies before an investigation was made. An investigation was made in each of the remaining 339 cases, in 264 of which the full extension asked for was granted, in 21 an extension for a portion of the time asked for was allowed, and 54 applications, or 16 percent of the total number, were refused after an investigation.

FACTOR OF SAFETY

Rule No. 2 of the locomotive boiler inspection rules provided that:

"The lowest factor of safety to be used for all locomotives in service or under construction on or before January 1, 1912, will be fixed after investigation and hearing and after the expiration of the time allowed for filing specification cards.

In accordance therewith a careful investigation, extending over the two-year period allowed for filing specification cards, was conducted by this division. This investigation showed that 11,153 locomotives, or about 17 percent of the total number for which specification cards were filed, had a factor of safety below four, being divided as follows: 4,407 with a factor between 3¾ and 4; 2,531 with a factor between 3½ and 3¾; 2,039 with a factor between 3¼ and 3½; 1,082 with a factor between 3 and 3¼; 1,094 with a factor below 3, on some of which the factor was found to be below 2.

This factor is based on the ultimate tensile strength of the material; the elastic limit, at which point the metal takes a permanent set and never recovers, is usually about one-half of the ultimate tensile strength; therefore, the imperative need of increasing the factor to a point which might reasonably be expected to provide adequate protection against flaws or hidden defects in the material, poor workmanship, and undiscovered deterioration becomes apparent.

All of these points were carefully considered at a conference held at the office of the Chief Inspector of Locomotive Boilers on April 28 and 29, 1914, at which the railroad companies and their employees were represented; and suitable amendments to the rules, providing for improved methods of construction and increased safety of operation, were agreed upon, to be submitted to the Commission for its approval

STRESSES ON STAYS AND BRACES

It was also found that there were many locomotives in service with excessive stresses on stays and braces; therefore, a maximum allowable stress for stays and braces was included in the amendments to the rules.

In preparing these amendments the practice established by the Commission in previous cases of a similar character was followed, and a series of time limits was provided for the making of the necessary changes, so arranged as to require the more serious conditions to be promptly remedied and allow more time for other necessary improvements in cases where the conditions, while improper, were not so likely to cause accidents. Therefore, the amended rules as approved by the Commission on June 9, 1914, will not materially add to the expense of maintenance, as the required improvements can in most instances be made when the locomotives are shopped for regular repairs.

In the following table is shown the total number of persons killed and injured in locomotive boiler accidents during the past three years, classified in accordance with their occupations:

	Year ended June 30—					
	1914		1913		1912	
	Killed	Injured	Killed	Injured	Killed	Injured
Members of train crews:						
Engineers	8	187	12	268	22	310
Firemen	8	290	12	478	19	491
Brakemen	....	46	6	79	8	79
Conductors	1	6	2	7	4	16
Switchmen	....	1	....	2	....	7
Roundhouse and shop employees:						
Boiler makers	1	18	....	10	2	3
Machinists	2	5	....	11	7	11
Foremen	1	6	....	4	1	4
Inspectors	....	3	....	3	1	2
Watchmen	1	7	....	8	3	6
Boiler washers	....	8	....	4	1	4
Hostlers	....	9	1	6	....	5
Other roundhouse and shop employees	1	17	1	24	14	62
Other employees	....	10	....	4	3	3
Non-employees	....	1	2	3	6	2
Total	23	614	36	911	91	1,005

A check of the above table shows that 86 percent of the total number of killed and injured were engine and train men, and that the accidents were caused by failure of some part of the boiler or appurtenances thereof while in service. Thirteen percent of these casualties were caused by failures due to low water where no contributory cause could be shown to exist.

Causes of Accidents

Three percent of the total number killed and injured were boiler makers who were engaged in making repairs to boilers under pressure; about 50 percent of these casualties were due to plugs, studs, or rivets blowing out or being driven into the boiler while being calked with pressure on the boiler. To reduce the number of accidents from this source, we are requiring all plugs more than 1¼ inches in diameter in firebox sheets, excepting fusible plugs, to be secured by a staybolt. Approximately 16 percent of the injuries to boiler makers occurred while trying to tighten washout or arch-tube plugs while there was pressure on the boiler, which under no circumstances should be required or permitted.

The remaining 11 percent of the total number killed and injured were from the various classes of employees engaged in the work of caring for and repairing locomotives at terminals.

Two formal appeals from the decision of inspectors, as provided in section 6 of the law, were filed during the year, in both of which a subsequent investigation resulted in the decision of the inspector being sustained.

No prosecutions for violations have been filed during the year, as the beneficial effect of the law and rules is being generally recognized by railroad officials, most of whom show a disposition to comply with the very reasonable requirements and to co-operate with us in bringing about improved conditions. On two or three of the larger roads, however, and on several smaller ones, conditions

Accidents and casualties resulting from failures of locomotive boilers and their appurtenances.

Nature of failure or defect.	Year ended June 30—								
	1914			1913			1912		
	Accidents.	Killed.	Injured.	Accidents.	Killed.	Injured.	Accidents.	Killed.	Injured.
Arch-tube failures	13	....	19	20	8	27	18	....	23
Ash-pan blowers defective	5	....	5	14	1	14	3	....	3
Blowers defective	11	....	11	13	....	13	11	....	12
Blow-off cocks defective	15	1	15	16	....	18	23	2	22
Boiler checks defective	14	....	14	11	....	12	11	1	11
Boiler explosions:									
A. Shell explosions	1	....	1	....	....	....	3	27	41
B. Crown sheet failures due to low water where no contributory causes were found	36	13	59	44	23	67	69	35	129
C. Crown sheet failures due to low water where contributory causes or defects were found	13	3	18	28	6	50	23	15	38
D. Fire-box failures due to defective staybolts, crown stays, or sheets	4	1	7	5	....	8	1	1	1
E. Fire-box failures due to water foaming	1	....	2	1	2	....	1	3	....
Cross stays defective	....	....	....	1	....	3	....	....	....
Crown stays defective	....	....	....	1	....	1	....	....	....
Dome caps defective	....	....	....	2	....	2	2	....	2
Draft appliances defective	1	....	1	4	....	4	3	....	4
Exhaust nozzle breaking	....	....	....	1	....	1	....	....	....
Fire doors defective	....	....	....	2	....	2	....	....	....
Fire-hose failures	3	....	3	....	....	....	....	....	....
Flue failures	51	....	56	54	1	63	56	1	62
Flue-plug failures	....	....	....	....	....	....	7	....	8
Flue pockets defective	3	....	4	2	....	2	3	....	4
Flue sheets defective	....	....	....	1	....	1	2	....	2
Gauge cocks defective	3	....	3	2	....	2	4	....	4
Grates defective	....	....	....	1	....	1	....	....	....
Handhole plates defective	1	....	1	....	....	....	1	....	1
Injectors and connections defective (not including injector steam pipes)	33	....	33	28	....	28	47	....	48
Injector steam-pipe failures	11	....	13	36	....	47	31	....	39
Lubricators defective	14	....	14	11	....	12	11	....	13
Lubricator glasses bursting	20	....	20	45	....	45	49	....	49
Lubricator piping defective	8	....	9	4	....	5	....	....	....
Mud-drum failures	1	2	2	....	....	....	....	....	....
Mud ring defective	....	....	....	....	....	....	1	....	1
Patch bolts defective	....	....	....	....	....	....	1	....	1
Plugs (arch-tube) defective	4	1	5	....	....	....	2	....	4
Plugs in fire-box sheet defective	6	....	7	5	....	6	1	....	1
Plugs (fusible) defective	2	....	2	1	....	1	1	....	1
Plugs in steam chest defective	....	....	....	1	....	1	....	....	....
Plugs (washout) defective	17	1	17	20	....	23	11	2	14
Rivets defective	4	....	5	3	....	3	....	....	....
Safety valves defective	1	....	1	1	....	1	....	....	....
Squirt-hose failures	139	....	140	266	....	267	243	....	245
Stay bolts defective	6	....	5	2	....	3	9	....	11
Steam-heat hose defective	....	....	....	1	....	1	....	....	....
Studs defective	18	....	21	20	....	21	14	....	16
Steam piping defective	14	....	16	5	....	6	11	2	11
Superheater-tube failures	....	....	....	1	....	2	1	....	1
Tank hose defective	2	....	3	3	....	3	....	....	....
Throttle glands defective	2	....	3	3	....	4	....	....	....
Throttle leaking	1	1	....	....	....	....	....	....	....
Valves defective (not including safety valves)	3	....	3	6	....	6	5	....	5
Water-bar failures	2	....	3	1	....	1	3	....	4
Water glass bursting	60	....	60	128	....	128	165	1	168
Water-glass fittings defective	10	....	10	7	....	7	8	....	8
Miscellaneous	....	....	....	....	....	....	1	1	....
Total	555	23	614	820	36	911	856	91	1,005

and practices appear to indicate that we may be unable to obtain a full compliance with the requirements of the law without resorting to the courts.

Defects Not Attributable to Boilers

During the year 2,141 defects to locomotives for which the present laws do not provide a remedy, 1,155 of which were defective wheels, were reported to this division by inspectors and directed to the attention of the proper railroad officials. In most instances locomotives with defects of this character were held for repairs by the local officials when their attention was directed to the defective conditions. In some cases it has been necessary to wire the president of the road in order to get the repairs made, and even that has not always brought about the desired result.

In one instance inspectors objected to the use of a locomotive in passenger service which had sharp flanges on both engine-truck wheels, three driving wheels, and one trailer wheel, and also one loose driving-wheel tire, and were assured by the local officials that the locomotive would not again be used until repaired. Instead of holding the locomotive for repairs, however, the local officials sent it light to a point a few miles from the terminal, sent a passenger train out to that point with another locomotive and changed locomotives, sending the defective one through with the passenger train.

If a freight car with similar defects were offered to this carrier in interchange by a connecting line, it would be refused under their own rules as unsafe to handle; yet this defective locomotive was sent out on a passenger train by the officials after their attention had been directed to its condition, and existing laws provide no remedy.

Our records contain other instances of a similar character; therefore, the recommendation made in our report for the year 1913, that the provisions of the boiler inspection law be extended to cover the entire locomotive is respectfully renewed.

In this connection it seems appropriate to state that the inspectors now in the service are men of wide experience in railroad work, who were selected after passing a competitive civil service examination, and their three-years' training as inspectors, in addition to their previous experience and training, has eminently fitted them to perform the additional duties that such a law would impose in as satisfactory a manner as they do their present ones, and, it is not unreasonable to say, with equally good results.

Taking Care of the "Kicks" in a Boiler Shop

Changes in Specifications the Main Cause of Complaints from Customers—Minor Faults for Which the Manufacturer is Not Responsible

BY JAMES FRANCIS

It isn't the most pleasant position in the world—that of "Kick Master" in a boiler shop—but it is a very necessary position, for somebody must receive and take care of the "kicks" which come from customers—kicks some of which are well warranted, while others are as unwarranted as the high prices because of the European war. And when you run down the cause of a "kick," it will almost always be found on account of a change in specification from what the customer was to receive or expected to receive. And right here is the grand reason: He *expected* to receive a certain thing, and it's human nature to kick when you don't get what you expect is coming to you, even though you do get something just as good, or perhaps just a little better.

But to come right down to cases: Here is a letter from Mr. Leeds, who is "up in the air" on account of a 60-inch by 16-foot boiler which he has just received from us, and the kick is because the specifications called for 44 4-inch tubes and the boiler he received contained 54 3½-inch tubes. And what Mr. Leeds doesn't say in his letter isn't worth saying; but that is neither here nor there. What we want to get at is: had we a right to make the change in specification, and has Mr. Leeds any moral or material right to "kick" regarding the change? Are the 44 4-inch tubes any better or worse than the 54 smaller tubes? That's the question; and as it is up to the "Kick Master" to decide that point before he can deal with Mr. Leeds, we might as well help out the K. M. by deciding the tube business right here and now—or by leaving it to readers of THE BOILER MAKER to decide.

CHANGE IN NUMBER AND SIZE OF TUBES

Let the editor hear from you all, my friends, regarding this matter. I will try and state the matter as plainly as possible, also such of the evidence as comes to hand at this writing, and "you alls" shall be judge and jury in deciding the matter. Does Mr. Leeds get as much for his money in the 54 small as in the 44 large tubes? For evidence in this direction we will use the table in Kent's Mechanical Engineers' Pocket Book, and extract therefrom the figures pertaining to 4-inch and to 3½-inch tubes.

The first two lines of Table I are taken bodily from Kent—probably the same table may be found in other reference books as well—but the third line was calculated from the other lines and represents the equivalent number of 3½-inch tubes required to replace 4-inch tubes. A separate calculation is required to find each quantity in the third line, and slide rule calculations were used to find those given.

To find the several quantities, let those given in the first line be represented by A, those in the second line by B, and we can use the equation:

$$\text{Equivalent} = \frac{44 \times B}{A}.$$

In the case of the internal diameters of the two tubes, make the equation:

$$\text{Equivalent} = \frac{44 \times 3.732}{3.26} = 50.3,$$

meaning that 50 tubes, each 3½ inches in diameter, will be required to equal 44 4-inch tubes. And by substituting values of A and B in each of the ten other columns of the table, the quantities given in the third line of the table are worked out.

In the three quantities relating to the length of tube per square foot of heating surface, it will be necessary to reverse the position of A and B in the equations, because of the fact that these are inverse ratio quantities. And furthermore, they don't really have much bearing upon the problem. What we are concerned with more is the area of one foot of tube and the weight per foot.

The table shows that the internal areas of one foot

TABLE I—EQUIVALENTS OF 3½-INCH TUBES IN PLACE OF 4-INCH TUBES

Tube.	Internal Diameter.	Standard Thickness.	Circumference.		Area in Square Feet.		Length of Tube Per Square Foot of Heating Surface.			Weight Per Foot.
			Internal.	External.	Internal.	External.	Internal.	External.	Mean.	
3½"	3.26	.120	10.242	10.996	.058	.0668	1.172	1.091	1.1315	4.28
4"	3.732	.134	11.724	12.566	.076	.0873	1.024	0.955	.9895	5.47
Equivalent	50	49	50	50	57.5	57.5	50	50.5	50	56.2

length of tube are .058 and .076 square feet respectively. Substituting these quantities for A and B in the equation, we find that 57.5 3½-inch tubes are required to replace 44 4-inch tubes, and in the external area of the tubes it is also found that 57.5 tubes will be required. In the weight per foot, it is found that 56.2 small tubes are required to replace the 44 larger ones.

A glance at the tube diameter equivalents, also at the circumferences and length of tube per square foot equivalents, shows that about 49 to 50 tubes would be required to give the customer value received for his money, but the heating surface items and the tube weights don't say so, and seem to indicate that the customer is warranted in his "kick," in fact as well as according to boiler shop ethics. And we would like to hear stated in THE BOILER MAKER why the boiler manufacturer should make the change in specifications after the customer had placed his order for the boiler—why the change was made, and by what right, reason or license such change was necessary or permissible.

Variation in Plate Thickness

In the matter of minor changes, there are some things which the manufacturer is not to blame for, and cannot very well be helped by him except at considerable expense. Among these things is the slight variation in plate thickness from the specified gage. There are very few sheets rolled which are not thicker in the middle than at the edges, and this extra thickness may be carried by the manufacturer at his expense, and to the benefit of the customer, but the manufacturer must not put in a sheet which runs a little under gage, although he can put in a sheet which runs thicker.

The boiler is "no stronger than its weakest part," and no shell has a strength greater than that of its thinnest plate, therefore the manufacturer is *not* warranted in using thinner plates than those specified, but is welcome to use those which run over gage. As this is not a profitable thing for the boiler manufacturer to do, it stands him in good stead to look pretty sharp after what he buys from the rolling mill and to procure good plates which do not run under gage at all, or much over gage.

Slight changes in the pitch of rivets are permissible and are necessary, but the boiler manufacturer has no right to, and usually will not, vary the rivet pitch enough to sensibly affect the plate or rivet-section value. He will hear from the boiler inspector if this be done. The diameter of rivets should never be varied from the specifications except in the case of a few larger rivets to fill holes, which have been reamed over-size to correct some error in the holes in question.

There are a great many changes in specifications which are caused by poor workmanship, and it is the business of the manufacturer to detect and root out these changes and their causes—that is what the shop manager, superintendent and foremen are for. But any poor workmanship or material cannot exist without making a change in the specifications, or rather a departure therefrom, which is understood as a change in this writing. A departure from the specifications, if not a change of them, entitles the customer to a "kick," whether it be for poor riveting, poor tube expanding, bad flanging or slouchy calking. All these, of course, come under the head of poor workmanship, but nevertheless they are one and all departures from the specifications.

Finding the Tensile Stamp

No boiler shop can afford to use sheets which do not bear the tensile stamp, but it is often an almost hopeless job to find that stamp after the boiler has been set up and painted. Then it is some job to locate the stamps on the head and on the shell, especially the latter, when the impress of the stamp is very faint and imperfect, as is many times the case.

To obviate this difficulty, and to make the stamps easy of location, until the boiler is actually placed in its setting, it is only necessary to send a man with a pot of white paint and let him smear a small circle about 4 inches in diameter around each stamp mark. A brush about ¼ inch wide may be used for this work, and the white ring around each mark is a guide to the painter as well as to the customer, for the brush artist may then daub right up to the white circle and then stop, leaving the number clean and prominent. There will be a small area of black steel left uncovered around each stamp impression, but that matters very little. Indeed, I question very much whether it pays, in many instances, to load the customer with seven or eight dollars for time and material for painting boilers at the shop. The paint is utterly worthless after the boiler has been set, and, where the shell is shipped direct a comparatively short distance to the customer, I see no benefit whatever that may be derived from painting.

Painting Boiler Shells

When boilers are to be shipped long distances, they should be painted. Likewise when held in the yard for a long time, a coat of so-called "paint" should be applied, but the daubing of boiler shells at the shop, when they are to be sent 100 miles or less to the customer, seems useless expense. The boiler maker may claim that it makes the shell "look nice" and appear more like a finished product, but that is about the only argument which can be brought to support the indiscriminate painting of boilers at the shop.

Second-hand boilers are painted for several reasons. The paint adds from 100 percent to 300 percent to their value to the dealer, for customers will not consider shells which are rusty and fire-stained. Such shells are in condition to be closely examined by the agents of the customer, who, it seems, had rather take a chance with a doubtful bit of boiler plate if it be thickly covered with black paint on top of the rust. Personally, I have scraped off an acre or so of black or brown paint when inspecting old boilers for customers, and while the paint may protect the shell an infinitesimal part from the weather, it doesn't fool the true inspector a bit and only adds to the expense of the inspection.

I am rather against the matter of painting new boilers, except for distant shipment as stated above, and I surely am dead set against the painting of second-hand boilers under any circumstances, except when they are to be used as water tanks, columns, or for some other purpose than steam vessels. There should be no painting of second-hand boilers, for there should be no use for them as boilers again. There is a State law in Ohio or Indiana, or perhaps in each State, which forbids the sale and use of second-hand boilers for steam-making purposes—and a right good law it is, too, both for the boiler maker and for the customer. The best is none too good for any boiler, and inferior shells should never be tolerated in any instance. There are a few instances where a second-hand boiler may be "just as good as new," but such cases are few. Sometimes a good boiler is displaced for a larger one, and again a brand new shell is thrown out by the failure of a plant through commercial reasons.

I was up against a case of this kind a short time ago. A trip to Chicago was made to inspect a couple of boilers for the customer of a dealer in second-hand machinery. Arriving at the plant, I found that the boilers had been discarded on account of the installation of electric power throughout the factory. But somehow the entire plant seemed to have a very familiar appearance, although I was never in it, and had never seen it before. However, very soon after I was inside the familiarity was explained, for I found that the entire plant was of my own design. I had made, a very few years since, plans for the entire plant, and the two boilers were built from my own specifications. As the boilers had been in use only a year and tallied with the specifications and showed no signs of corrosion from the two years they had been laid up on account of electric power, I was able to certify to the customer who bought the boilers that they were O. K., and I shipped these boilers to the customer without even painting or cleaning them, except to brush with a broom the worst dusty portions. Here is one instance where the second-hand boiler should have a hearing and could be used with safety.

Maintenance and Care of Locomotive Boilers*

Causes of Engine Failures—Work on Flues on Running Repairs—Cooling and Washing Boilers

BY J. F. RAPS †

As we are on the verge of another winter, it might not be amiss this time to take up the maintenance and care of the locomotive boilers, as during this season of the year the number of engine failures due to no steam and flues leaking is greatly increased, aggravated by three distinct causes, namely, improper work at the round-house, improper firing and improper handling of the feed water.

In these days of long hauls, increased tonnage and high speed, the locomotive boiler is a very important item in railroad economy, and there is no part of the locomotive which requires more careful and painstaking care than the boiler, and each one, from the engineer to the cinder-pit man, should contribute his share toward keeping it in a serviceable condition and in the highest state of efficiency, which can only be accomplished by the hearty co-operation of all concerned with the handling and operating of the locomotive.

Let us first deal with the shop organization, as a great deal depends upon the proper method of handling the work on running repairs. After the locomotive has been turned out of the shop and before being placed into active service, the roundhouse inspectors should make a thorough inspection of the front end appliances, ash pan and grates, in order to ascertain if they have been properly applied and are in perfect condition. This is very essential in order to avoid engine failures, due to being improperly drafted or having some defect develop in the newly applied front end rigging or grates, but more especially to overcome the setting of fires on bridges or along the right of way. A like inspection should be made after each trip and a report made on regular form showing condition. Any defect reported should be repaired immediately.

The cleaning of flues is a very important factor in locomotive performance, as stopped-up flues will cause a poor steaming engine. Whenever an engineer reports steam pipes leaking, engine not steaming or hot at door, examine the flues first to make sure that they are clean, as invariably the above conditions are due to stopped-up flues. The proper method of cleaning flues is with the auger and compressed air. Flues should be thoroughly blown out with air at the termination of each trip. When flues are stopped up they should be bored with an auger of sufficient length to reach from end to end and then blown out thoroughly with air. Special attention should be given flues in superheated locomotives. In locomotives with brick arches the bottom flues must be maintained in clean condition and no locomotive should be allowed to go into service with any flues stopped up. This work should be done previous to boiler makers entering the fire box in order that they may check the work to see that it has been properly performed.

The brick arch, which has gained such a prominent part in the economical operation of the locomotive, should receive a great deal of care and consideration. By its use the trouble experienced by leaky flues is very materially decreased and their life greatly increased. Care should be taken to see that the arch is properly cleaned off after each trip and is maintained in perfect condition, and engine should not be allowed to go into service with holes in the arch or with part of the arch missing, as trouble is likely to be experienced either with the flues leaking or a poor steaming engine.

The work on flues on running repairs should be performed in the following manner: Flues showing cinder-pit leak, to be calked by hand with standard beading tool. Flues blowing or leaking enough to allow water to run down sheet, should be expanded with a straight sectional expander; the use of the roller is not permissible. Special attention should be given to flues when the boiler is washed out. All leaks should be stopped with a sectional expander while the boiler is hot and a "V" of flues in lower part of sheet should be beaded with a light air hammer and the standard beading tool, while the boiler is empty. The flues should be inspected after the boiler is refilled and any leaks tightened up. This is especially important, because the inequalities in temperature occasioned by the cooling and washing have a tendency to break the joint of the flues in the flue sheet.

Now we are about to take up one of the most important operations performed at the roundhouse: The washing of the boiler. This subject is so extensive and the methods used so conducive of good or bad results, that I will give a few concise rules governing the proper method of preparing and washing the boiler.

1. Locomotive boilers are required to be washed as often as may be necessary to keep them clean and free from scale and sediment.

COOLING BOILERS

2. Boilers should be thoroughly cooled before being washed at all points excepting where improved hot water washing systems are installed.

3. When there is sufficient steam pressure to work it,

* From the *Illinois Central Magazine*.

† General Boiler Inspector, Illinois Central Railroad.

start the injector and fill the boiler with water until the steam pressure will no longer work the injector. Then connect water hose to feed pipe and fill boiler full, allowing the remaining steam pressure to blow through siphon cock or some other outlet at top of the boiler. Open blow-off cock and allow water to escape, but not faster than it is forced in through the check, so as to keep the boiler completely filled until the temperature of the steel in the firebox is reduced to about 90 degrees, then open all blow-off cocks and allow boiler to empty itself as quickly as possible.

4. While the boiler is cooling the boiler washer is to loosen all wash-out plugs. All wash-out plugs and arch tube plugs must be removed at every washing.

5. Removing the plugs or opening the blow-off cocks is forbidden until the water coming from the boiler is cooled to 90 degrees. The object of this method is to cool the boiler equally.

6. The crown sheet shall then be washed, starting on sides and then washing through holes in back head.

7. The door ring to be washed next.

8. Wash arch tubes next. It is very essential that the pneumatic or other cleaner be used every time boiler is washed and all concerned are instructed to strictly comply with these instructions.

9. Then wash through plug holes in barrel of boiler just ahead of firebox, using bent nozzle in order to thoroughly wash down flues. Wash flues through plug holes at front of barrel, using bent nozzle.

10. Wash belly of boiler, starting at front end, using bent nozzle, washing scale toward firebox.

11. Wash legs of boiler through plug holes in side and corner of firebox, using straight nozzle in corner holes and bent nozzle through side holes, revolving same to clean the side sheets. Rods to be used to dislodge any accumulation that water pressure will not move.

12. After boiler is washed out it should be thoroughly inspected through all plug holes before plugs are replaced, to see that no accumulation is left, the work of inspecting to be taken care of by foreman boiler maker or inspector.

13. The removal of all plugs is imperative. The plugs should be put back with a coating of graphite and oil made to a paste. This enables the plugs to be removed readily.

14. Boilers should be washed out with a minimum of 100 pounds pressure.

It must be remembered by those in charge that, when orders are issued to boiler washers to slight the washing of any boiler in order to get the locomotive ready for a certain run, they are storing up trouble for the future. Although it might not be in evidence at that time, the day of reckoning is sure to come. Blowing out can be resorted to in some instances to save washouts, with either incrusting or alkali water, but care must be taken to see that the fire is in proper condition—that is, clean and bright.

The prevention of engine failures due to leaky flues does not rest entirely with the roundhouse boiler makers, regardless of the fact that they are compelled to assume the responsibility in most instances. One may take a locomotive with practically a new set of flues and by the improper use of the injector cause most of the flues to leak. This can be demonstrated by getting into the firebox after the fire has been drawn and the locomotive placed in the roundhouse with a perfectly dry set of flues, then start either the right or left injector and watch the results caused by the change in temperature of the water around the flues. The engineer and fireman should carefully examine the firebox sheets and flues as soon as they take charge of the locomotive, reporting any leaks or defects to the roundhouse foreman.

If the flues are all open, in good condition, and there is no mud on the flue sheet, there is absolutely no reason for a failure due to flues leaking, yet there are cases where tonnage is reduced or trains set out, and on making an inspection of the flues, they are found to be in good condition, but loose in the sheet, which is prima facie evidence of the improper use of the injector.

After the cause and effect of the inequalities of temperature in the boiler is thoroughly understood by the enginemen and hostlers, it should not be difficult for them to fully appreciate the damage done to the flues and firebox sheets by the injection of water at a temperature of about 200 degrees lower than the water in the boiler. It is a common practice to fill the boiler at terminals while the blower is on and the fire door standing open, in order to eliminate the black smoke. Whenever it becomes necessary to fill the boilers while standing at stations or on sidings, a bright fire should be maintained, using the blower and applying fresh coal if necessary. The fire door should be closed while the injector is working.

The successful maintenance of the locomotive boiler in service is summed up in just one word, "Co-operation"; first, by the foreman and mechanics turning out a perfectly tight boiler from the locomotive works or the company shop. Second, the careful inspection and work of the roundhouse organization in keeping boiler tight and free from mud and scale. Third, in the careful handling by the enginemen. The best care and workmanship will be of no avail, however, if the boiler does not receive intelligent treatment while in service.

$100 Dollars for a Name

Prizes of $100 in gold, $125 in one hundred loose-leaf leather reference books and $100 in two hundred bound reference books, making a total of $325, are offered by Joseph T. Ryerson & Son, Chicago, for the best trade name for the complete line of tool steel which this company manufactures.

This contest is open to all readers of this notice.

The first prize of $100 in gold will be given to the one who submits the winning name.

To those who send in the one hundred next best names, the company will give one of their new reference books of steel and engineering data in loose-leaf leather binders.

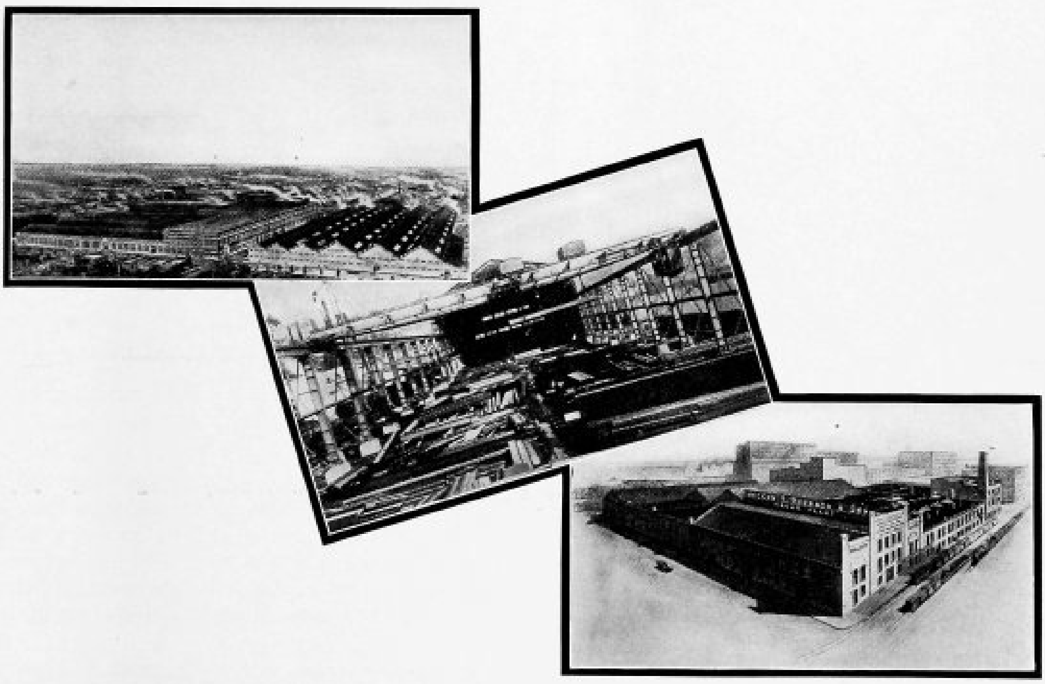
For the next best two hundred names submitted, bound volumes of the same book will be given.

The names of those submitting the best one hundred and one names and letters will be placed in the "Contest Roll of Honor," which will be published in *Ryerson's Monthly Journal* and in trade papers.

It is desirable, but not absolutely necessary, that the name bear some relation to the steel or its qualities, or to the manufacturer's firm name. A name which can be trade marked is also preferable.

The contest closes April 15, 1915, at 12 o'clock noon, Central time, and each contestant may send in as many names as he desires. When selecting a name, however, give your reasons for its use. If any good ideas are entered which can be used to advantage, the manufacturers will pay for them aside from the prizes. All names should be sent to Joseph T. Ryerson & Son, Chicago, and the officials of this concern will be the judges.

For further information regarding this contest write to Joseph T. Ryerson & Son, Chicago.



Development of Ninety-Degree Elbow

Method of Laying Out the Elbow Whereby Only One Templet is Needed, with Consequent Saving of Time and Money

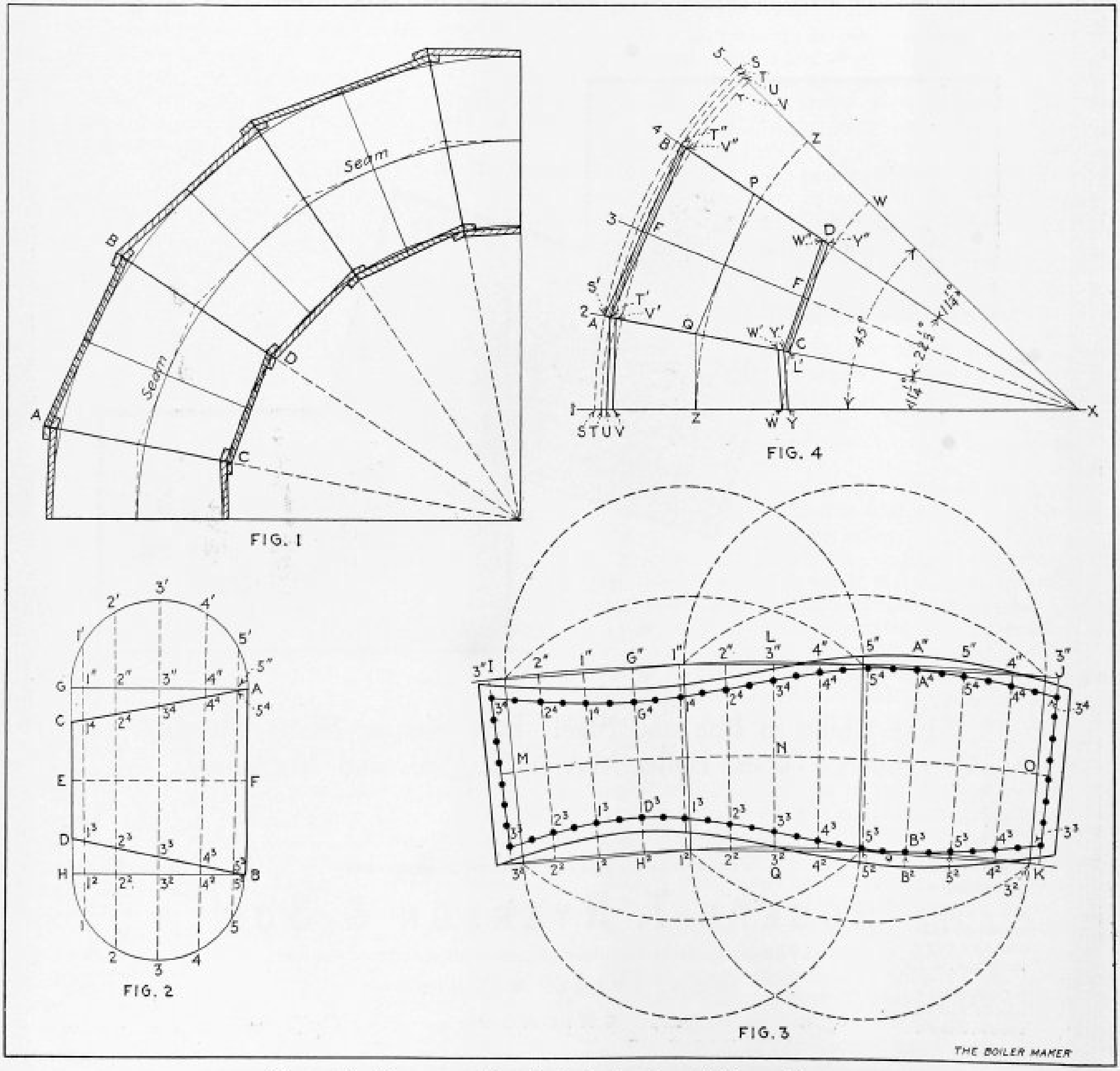
BY JOSEPH WILLIAM ROSS

Many of the approximate methods of laying out a 90-degree cylindrical elbow, constructed of heavy plates in several courses, require in the fitting up of the courses a good deal of lining up with unfair and very often "blind" holes. All of this would have been obviated if a good layout had been made in the first place, with the result of a material saving in time, temper and money.

Each layer out has his own method of laying out elbows—some prefer the approximate method, while others prefer triangulation. The layout described in this article, however, involves some marked advantages and has been used with great success.

Fig. 1 shows a sectional elevation of an elbow constructed with five courses. If the end courses of this elbow were butted together they would form a course of exactly the same shape in every way as the intermediate courses. Therefore, one templet will be all that will be required to be developed.

It is not necessary to draw a full-sized elevation view, as in Fig. 1, to obtain the construction lines. In elbows built up of several courses the end courses are each counted as one, and the intermediate courses as two each, so that in an elbow of five courses the total sum will be eight. As this is a 90-degree elbow, the miter lines will



Construction Diagrams and Templet for Laying Out a 90-Degree Elbow form angles of $90 \div 8$, or $11\frac{1}{4}$ degrees. Now each end piece is cut on an angle of $11\frac{1}{4}$ degrees, while the intermediate courses will cut angles of $22\frac{1}{2}$ degrees each.

THE CONSTRUCTION DIAGRAM

With this information construct the outline shown in Fig. 4. With *X* as a center and *X-Z*, the distance to the center line of the elbow, as a radius, construct the arc *ZZ*. Mark off the inside diameter as *VW* with *Z* as a center. On the base line 1-*X* make *VU*, *UT* and *TS* each equal to one thickness of the plate. With *X* as a center and the distance to the points *V*, *U*, *T*, and *S* as radii, strike the arcs *VV*, *UU*, *TT* and *SS* to an angle of 45 degrees.

Divide the arc *SS* into four equal parts and connect the points of division to *X*. Draw in the radial lines 2, 3, 4 and 5. With *X* as a center and *X W* as a radius, draw in the arc *WW* to the radial line 5-*X*. Connect by straight lines the point *V* to *V′* and *U* to *T′* and similarly connect points *T′* to *V″* and *S′* to *T″*, thus showing the plate thickness.

At right angles to the base line 1-*X* and tangent to the arc *ZZ*, draw in the straight line *Z-Q*. Also draw in *Q-P* tangent to the arc *ZZ*. Mark off *W-Y* equal to the plate thickness. With *Q* as a center make *QW′* equal to *QV′*, *QY′* equal to *QT′* and *QL′* equal to *QS′*. Also on the radial line 4-*X* with *P* as a center and distances *PV″* and *PT″*, mark off the distances *PW″* and *PY″* respectively. Draw in the straight lines *A-B* and *C-D*.

Now transfer the neutral lines *A-B* and *C-D* over to Fig. 2. On Fig. 2 draw in the lines *G-A* and *H-B* parallel to the horizontal line *E-F*. Extend the line *C-D* to *G* and *H*. Bisect the line *G-A* and describe the half sectional view *G-3′-A*. Divide this semicircle into a number of equal parts—in this case eight is chosen to save confusion of the lines. Project these points to the diameter line *G-A*.

Proceed in a similar manner with the smaller diameter. Connect by straight lines the numbered location points, as 1″ to 1^2, 2″ to 2^2, 3″ to 3^2, and so on as shown. Where these lines intersect the inclined lines *C-A* and *D-B* number accordingly.

LAYOUT OF THE TEMPLET

Transfer the outline *G A B H*, Fig. 2, over to *G A B H*, Fig. 3. With the trams set to *B* as a center, Fig. 3, and with *B-G* as a radius, strike the arc *GJ*. With *H-A* as a radius and *H* as a center, strike the arc *AI*. Also with *G* and *A* as centers and *G-A* and *A-G* as radii, respectively, strike the intersecting arcs at *I* and *J*. With a flexible batten draw a curve through these four points thus located.

In a similar manner obtain the lower curve through the points *P*, *H*, *B*, *K*. Make the curve *I-G-A-J* equal in length to the neutral stretchout of the diameter *G-A* in Fig. 2. Also make the curve *P-H-B-K* equal to the stretchout of the neutral diameter *B-H*, Fig. 2.

Divide *I-G-A-J* into sixteen equal parts, which is twice the number of parts in the half view, Fig. 2, and also divide *P-H-B-K* into sixteen equal parts. Connect these division points, as shown, from 3″ to 3^2, 2″ to 2^2, 1″ to 1^2, 4″ to 4^2, and so on. Now with dividers set to the distance 3″ 3^4, Fig. 2; transfer that distance to 3″ 3^4, Fig. 3. It will be noticed that there are three lines with this number—the center line and also the two rivet lines.

Now reset the dividers to the distance 2″ 2^4, Fig. 2, and transfer it over to its correspondingly numbered line on Fig. 3. Also transfer over from Fig. 2 to Fig. 3 the distances 1″ 1^4, G″ G^4, 4″ 4^4 and 5″ 5^4. A fair curve drawn through all these points locates the rivet line and also each point may be used as a rivet center, and, if desired, extra rivets may be pitched equally between these points.

The lower curved rivet line is located in exactly the same way, the measurements D^3 H^2, 1^3 1^2, 2^3 2^2, 3^3 3^2, 4^3 4^2 and 5^3 5^2, on Fig. 2, being transferred over to their correspondingly numbered lines on Fig. 3. The points thus located will be used as rivet centers, and also the extra ones will be marked to correspond with the top curve.

If the above construction is done correctly, every hole will be fair and very little lining up will be required in the fitting up. Mark in the rivet centers for the longitudinal seam at each end of the templet and add on the laps. Of course the opposite corners will require scarfing for a close-fitting job at these points.

The curve *M-N-O* is marked off equidistant from the curves *I-G-A-J* and *P-A-B-K*, locating the line of demarcation for the end course.

Locomotive Injectors and Safety Valves

BY GEORGE SHERWOOD HODGINS *

When a locomotive boiler is in place and the "iron horse" is ready for the road, it is important to know that the machine has been fitted with adequate means of keeping up the supply of water. Some instructive data may be had by glancing over the record of a brake test made several years ago on the New Jersey & Seashore Division of the Pennsylvania Railroad.

In those experiments a large Atlantic type engine was run over a good roadbed for a distance of twenty-eight miles. A measured mile of track was fitted with electrical recording apparatus, and tests were conducted with the engine hauling eight coaches. Eighty miles an hour was made with this train, and the fastest speed attained was just a little under ninety miles an hour. The light engine alone was able to run ninety-five miles an hour.

The consumption of water at high speeds is always large, and in this case two No. 11 Simplex injectors were used. A cubic foot of water contains 7.48 U. S. gallons of water, and in this instance about sixteen cubic feet, or nearly 120 gallons of water, was put into the boiler and turned to steam at 205 pounds pressure. An idea of the consumption of water by this engine at high speed, on the trial with eight coaches behind it, may be gained by comparing its performance with what we know of and use in daily life.

An ordinary bath tub in a house holds on a fair average about ten cubic feet of water. This engine, therefore, took an amount equal to about one-and-a-half such bath tubs every minute. This is at a rate faster than the ordinary faucet will fill it, or the waste pipe take it away.

The earliest, and indeed the usual, way of determining the size of injectors for locomotive boilers was empirical; that is, it amounted to the results of good practice, observed and compared. It was not based upon theory or calculation, nor did it follow any well defined or accurate rule. The heating surface of the boiler formed a standard upon which the so-called rule stood, and according to good practice the following figures were very frequently used:

No. 6 injector for total heating surface of from 625 to 825 square feet, 1,230 gallons per hour.

No. 7 injector for total heating surface of from 825 to 1,125 square feet, 1,920 gallons per hour.

No. 8 injector for total heating surface of from 1,125 to 1,650 square feet, 2,340 gallons per hour.

* Member American Society of Mechanical Engineers. Formerly Consulting Mechanical Engineer, National Transcontinental Railway.

No. 9 injector for total heating surface of from 1,650 to 2,350 square feet, 2,940 gallons per hour.

No. 10 injector for total heating surface of from 2,350 to 3,200 square feet, 3,750 gallons per hour.

No. 11 injector for total heating surface of from 3,200 to 4,100 square feet, 4,150 gallons per hour.

More recent practice, according to the American Locomotive Company's standard system of boiler proportions, gives interesting results. A cylinder 27 inches in diameter, using superheated steam at 185 pounds pressure, produces a cylinder horsepower of 2,427. One cylinder horsepower requires the evaporation of 20.8 pounds of steam per hour. To develop full cylinder horsepower for such an engine, 50,480 pounds of steam per hour is required. The heating surface provided for an engine will, of course, do something better than this, if there is to be any margin.

An engine recently built by the American Locomotive Company for the Chesapeake & Ohio, of the Atlantic type, has a heating surface of 4,448 square feet. This is made up of tubes, 2,933; flues (for superheating), 1,263; firebox, 225; and arch tubes, 27 square feet. The evaporative efficiency of the different portions of the heating surface have been worked out by this company, and their results give the tubes at 8.69 pounds of steam per square foot, the flues at 9.86, and the firebox and the arch tubes at 55, each portion thus having its specific value.

From this it appears that the evaporative efficiency of the tubes, at their value, is 25,487, the flues taken at their appropriate figure give 12,493, and the firebox and arch tubes together at 55 give 15,554 pounds of steam per square foot. These various evaporative efficiencies added together give 53,534 pounds of steam per square foot per hour. This is a more scientific way of arriving at the evaporative efficiency of the boiler than the empirical method, and it is readily seen that the firebox must deliver much more heat to the water than the ends of the tubes next to the "round head."

There is, therefore, in this boiler 53,534 pounds of water which must be evaporated each hour if the engine is to be worked to its full capacity, and this heavy demand for water must be adequately met. One gallon of water weighs 8.335 pounds, so that in 53,534 pounds there is 6,423 gallons. This amount of water has to be turned into steam in one hour. To do this two injectors are usually employed, and each has to supply its share, viz.; 3,211 gallons per hour. Two No. 11 injectors, each delivering 2,350 gallons per hour minimum and 4,100 gallons maximum capacity, give an average of 3,600 gallons per hour. As each injector is only called upon to deliver 3,211 gallons when the engine is worked very hard, the two No. 11 of this capacity would allow a little necessary margin. All this is on the assumption that the engine was worked to develop full power, at other times one injector might be able to keep up the lighter demand.

In the question which has come up regarding the size of injectors for a locomotive boiler having 48 square feet of grate surface and 3,250 square feet of heating surface, it is fair to suppose that the boiler has 250 square feet of firebox heating surface and 3,000 square feet of heating surface in the tubes. The grate area is not taken into consideration, because it does not actually boil the water, though it holds the fire in place. The horsepower figures given above are not directly necessary in the calculation, though they form a valuable check, but the values for evaporative efficiency are important.

The evaporative figures when applied here become $250 \times 55 = 13,750$, and the 3,000 square feet of tube surface gives, at 8.69 pounds, 26,070. Both together amount to 39,820 pounds. One gallon of water weighs, as before, 8.335 pounds, so that the equivalent in gallons of 39,820 pounds is 4,777.4 gallons of water to be evaporated per hour.

Taking this engine, with properly designed cylinders, and using saturated steam, and now applying the same reasoning that the American Locomotive Company uses, we find that 39,820 pounds of water, or 4,765 gallons, have to be turned into steam in the hour. If the consumption is supplied by two injectors, one of them must put 2,383 gallons of water into the boiler in an hour. By reference to the table given above, it will be found that two No. 10 injectors would do the work.

Coming to the relief of steam from the boiler, we approach the safety valve problem. In 1908 a report was made on the size and capacity of safety valves for locomotives. This report was presented to the American Railway Master Mechanics' Association. The report stated that "no uniform practice seems to have prevailed in the past in proportioning safety valves to the work they have to perform." It has been very largely left to private firms to further investigate the matter.

Mr. Philip G. Darling read a paper some years ago on this subject before the American Society of Mechanical Engineers, in which he gave the results of some practical experiments which have been incorporated into the practice of the Consolidated Safety Valve Company, New York, from whom the report may be obtained. This company gives a formula from which the nominal diameter of the valve, in inches, can be worked out.

The formula is

$$D = .055 \frac{H}{l \times P}$$

where

D is the diameter of the valve in inches.
l is the vertical lift of the valve in decimals of an inch.
P is the pressure in pounds per square inch (absolute).
H is the heating surface (total) in square feet.

The constant .055 was found after a large number of tests, carefully conducted by this company to be accurate for their make of locomotive safety valves having bevel face and seat. This does not say that another and equally accurate constant may not obtain with other designs. This company, however, experimented exclusively with their own product and found this constant to be the correct one to apply to their work.

The heating surface in terms of square feet refers to the total heating surface of the whole boiler. The pressure, in pounds per square inch, is the absolute pressure, and is 15 pounds greater than that shown on the steam gage. It is 14.7 pounds, to be strictly accurate.

Applying this formula to an engine with 4,400 total square feet of heating surface, 200 pounds gage pressure, and a valve lift of 13/64 inch, we have

$$D = .055 \frac{4,400}{.2031 \times 215}.$$

This works out giving a safety valve opening of 5.538 inches in diameter. Referring to any table giving diameters, circumferences and areas, we find that this diameter would give an area of about 23.758 square inches and that the large aperture could be replaced by two valves 4 inches in diameter or three safety valves of 3 inches in diameter. The safety valve is the intentionally weak spot in the boiler, designed to give way at a certain pressure, and governed by appropriate mechanism so that it is under control and can open and shut without injury and with minimum wear, and its well-known reliability on hundreds of boilers all over the country attests to the correctness of its principle and the careful thought bestowed on its design.

Determining the Number and Size of Boilers for a Shop Power Plant

BY W. D. FORBES

A problem has been presented for solution in which a boiler maker is called in and asked to supply a boiler or boilers to meet the following conditions: A machine shop having 75 tools which are now run electrically is obtaining its current from an outside source, and it is desired to substitute an independent plant to supply this current. The building is to be heated by the exhaust steam, and a feed water heater is to be supplied. The size of the building is not given. The inquirer wants to know how to proceed to arrive at the proper size of boiler or boilers to give an up-to-date plant.

Here the whole problem lies in finding out how much power it will take to run the machine tools. Fortunately, the fact that current is now being supplied places the inquirer in a position to obtain easily this all-important figure. The style of the boiler which is to be used is the well-known B. & W. watertube type. The concern having obtained the electric current from outside has been paying for so many kilowatts per month. This amount, therefore, must be devided by the number of working days to get the kilowatts used per day. This amount, or number of kilowatts, must be multiplied by 1.34 to obtain the horsepower which will be needed to drive the plant under working conditions. If a single month is taken it is quite possible to make a serious blunder in the calculation, as that month might be one in which the machinery was not used to its full extent. Therefore the power might be underestimated. Again, if the machine shop was a jobbing shop a large percentage of the tools is likely to remain idle for considerable periods, and it is hardly probable that all the machine tools have often been worked at their full capacity at the time, while if the plant is a manufacturing one this condition is probable. It is therefore wise to investigate this important matter carefully.

Next, knowing the horsepower, the type of engine has to be selected. It may be a single cylinder, horizontal engine of moderate speed, or it may be a compound. These engines may be fitted either for belt or direct drive. Or the engine may be of the vertical type, single or compound. Again, a steam turbine, direct connected, might be considered. If the horizontal type is deemed more suitable the style of valve must be determined on. It may be single or four valve. The single valve may be assumed as not as economical as the four-valve type, but is lower in first cost, and is simpler. A belted type of plant is not to be recommended unless there is a great deal of space available, but it has some advantages in the fact that the generator first cost will be less than in the direct connected type.

The water consumption of the engine selected must then be found. It is difficult without knowing just the make of engine to say what this will be, but for a single-valve engine of the single cylinder type the water con-consumption can be assumed as 20 pounds per horsepower per hour, and this may be taken as fair for either the horizontal or vertical type of engine. As the engine is to be run without a condenser, the economy of the compound type will not be as pronounced as if run with one, but if the compound type is selected, a considerable saving under some circumstances could be made in water consumption. Just what economy is effected by a feed water heater under the circumstances of using the exhaust steam for heating purposes is open to considerable debate, but it would be safer to assume that it would not affect the boiler size, or rather its economy during the winter months, but it would make some saving, and in the summer months a very decided saving, in fuel.

After having found how much water has to be evaporated in order to furnish the horsepower, the question would come up whether it was wise to have a single unit or to have the required horsepower in two boilers. The type of boiler selected is one which is very easy to repair, and, if handled properly, requires little attention beyond cleaning, and this will depend largely on the quality of the water which is available. One large boiler would be run a little more economically than two smaller ones, yet there is an advantage at times in having the two smaller units, as, for instance, if overtime has to be done, only part of the machine shop would be in operation and one unit could then be used with better economy. If a single cylinder engine is used, the steam pressure should be from 80 to 100 pounds, and 125-150 pounds if a compound is selected.

The inquirer states that either alternating or direct current could be used, but as he says that the plant is now being operated, it must have its motors already in place, of one of the two styles named. Alternating generators and motors are somewhat more expensive for first cost, but this is offset by their being less liable to get out of order. Let us assume something in the concrete. Say that the 75 machines use 3 horsepower each. This will give 225 kilowatts, which, according to the previous statement, will be 225×1.34, or 300 horsepower. Now as the kilowatt consumption of power is taken from actual conditions, friction and drop, if any, are all taken into consideration.

Assuming that our engine is of a type using 20 pounds of water per horsepower per hour, we would have to multiply our 300 horsepower by 20, getting 6,000 pounds, which would have to be evaporated to produce this horsepower. One square foot of heating surface in a well designed boiler should evaporate 3 pounds of water per hour. Therefore, dividing our 6,000 pounds of water, which has to be evaporated per hour, by 3, we would have to provide 2,000 square feet of heating surface, and this, it must be particularly noted, must be effective heating surface.

The next thing to be determined is the necessary grate surface for the heating surface, and this, of course, will depend on the kind of coal and the draft. But assuming good soft coal as the fuel, and a natural draft, it would be fair to say that ¼ square foot of grate surface per horsepower should be allowed. Now as we require 300 horsepower, we divide this by 4, and we have 75 square feet of grate surface. This is not too large an area to have under one boiler, if two furnace doors are used. It is assumed in the above calculation that 15 pounds of soft coal will be burned per square foot of grate per hour; this would give us a consumption of 1,125 pounds per hour, or about 3.75 pounds per horsepower per hour. The B. & W. type of boiler which has been selected has been shown to give a lower figure than this—that is, 2.35 pounds per horsepower. It must be borne in mind, however, that the quality of coal is very variable, and that the temperature of the feed water has considerable bearing on the evaporation.

The plant on which these figures are based is to be heated by the exhaust of the engines. This means that during the cold months a certain amount of back pressure will be put upon the engine, and this must be remembered in determining its size. This could be cared for by setting the valves during the cold months with a long cut-off, and in the summer months with a short one. It is, of course, evident that whatever steam comes from the exhaust can only be used to the extent of its volume, and if the building is so large that more than this volume is needed, a larger engine could be supplied, which would act as a sort of reducing pressure valve, but this idea might be carried to an absurdity. In heating a building it is safe to supply one square foot of radiating surface—that is, one square foot of pipe surface for every 100 cubic feet of space in the building. Of course the exhaust steam from an engine would be higher in temperature than steam from an ordinary heating boiler, and if the leads and piping were not too large and crooked, one-half the above radiating surface per 100 cubic feet would probably be satisfactory in all but the coldest weather.

Now as to the smokestack or chimney. The height will have to be governed by that of surrounding buildings, but the draft power of the chimney will vary as the square root of the height. It is quite common to allow one-fifth the grate area for the area of the smokestack, and in the case we have taken the area of the stack will be one-fifth of 75, or 15 square feet. This is equivalent to a diameter of 52 inches, if the chimney is round.

It is to be remembered that if these general outlines are to be made minute and exact they would have to be modified by an expert after he had obtained precise information. It is self-evident that other conditions than those named might have to be considered, as, for instance, the probability of more power having to be furnished shortly for added tools, etc., but, as a general warning, err on the safe side and provide more boiler power than calculations show is necessary. If the boilers are too small it will be quickly found out and will be a great annoyance, while if they are too large it will be a satisfaction to the owners if they find it out when an unexpected demand for additional power is made.

Efficient Lighting in a Boiler Shop

Application of Electricity to Shop Lighting—Methods of Installation—Location of the Lights and Choice of Reflectors

BY J. E. BULLARD *

Increased cost of labor and material without a proportionate increase in price of the output is causing manufacturers to analyze carefully their expenses. They are constantly cutting out wastes, stopping leaks, and increasing general plant efficiency.

One means of increasing efficiency which ordinarily does not receive the attention it merits is efficient lighting. Of all the expense items connected with manufacturing, probably this is the smallest—a reason why it has received no more attention. Nevertheless, there is scarcely anything which so directly affects the efficiency of labor. The better the light, the more efficiently the worker can complete the tasks set for him. The cost of the best lighting rarely, if ever, exceeds one percent or two percent of the cost of labor, but it has a marked influence on its effectiveness, and improved lighting may produce results far outweighing the small expense involved.

What is Good Lighting?

Efficient lighting may be defined as that quantity and quality of lighting, either natural or artificial, which enables the worker to do the best and the most rapid work, with the least effort, over the longest period of years.

Advantages of Good Lighting

Such lighting affects the net profits of the business in the five following ways:

1. It reduces the number of accidents and thereby reduces the operating costs. A great many accidents result in expensive litigation ending with a substantial cash settlement with the injured party. Even though the accident is slight and does not prevent the worker returning to his post of duty the following morning, it upsets his fellow workers and the rate of output is lowered for the remainder of the day. It, therefore, is self-evident that it pays to reduce the number of accidents.

2. It increases the quantity of output. The better the worker can see, the faster he will work and the less his work will cost the concern.

3. It improves the quality of production. Just as a first-class workman cannot do the highest grade work on an old, worn out machine, he cannot do his best work unless the lighting is of the best. The better the work the higher the selling price and the greater the demand for the output.

4. It decreases the percentage of defective work. The better a man can see what he is doing the less likely he is to let defects escape him and fewer imperfections will show up in the testing department.

5. In many instances the cost of good lighting is actually lower than the cost of unsatisfactory lighting. Change in and relocation of the lighting units frequently results in much more effective lighting and a smaller consumption of electricity.

Light Sources

There are three general classes of electric lamps: the arc lamp, the tube lamp and the incandescent lamp.

The arc lamp, depending for its light on the intense heat of the electric arc, is manufactured in types ranging from the enclosed carbon arc to the modern high candle-power flaming arcs.

Tube lamps, depending for their light upon causing gases or vapors contained in transparent tubes to become incandescent by passing an electric current through them, are manufactured in widely varying types.

Incandescent lamps, depending for their light upon heating to incandescence a filament contained in a bulb from which all air has been exhausted, or which is filled with a non-combustible gas, are manufactured in all sizes and with carbon or metal filaments. The best example of the incandescent lamp is the modern metallic filament lamp, such as the Mazda.

For outdoor lighting and for indoor lighting in factories having high ceilings and traveling cranes running on tracks elevated high above the floor, necessitating the hanging of high power units at high altitudes, arc and tube lighting is extensively used.

For indoor lighting where the lamps do not have to be

* Of the Society of Electrical Development.

hung an undue height above the floor, tube and incandescent lamps are used. For this purpose the modern high efficiency Mazda lamp serves admirably. These lamps are made in all sizes from those giving only a few candlepower to large units giving several thousand candlepower. This makes it possible to select the size which will best meet the requirements under consideration.

All electric lamps have been greatly improved in efficiency and durability. The modern Mazda lamp gives more than four times the light, for the same current consumption, given by the lamps manufactured by Edison thirty-five years ago. This means that even at the electric rates prevalent a generation ago, lighting would now be only one-fourth as expensive as then.

Electric lighting companies, however, have immensely increased the efficiencies of their plants and transmission systems. The corresponding decrease in the cost of generation and delivery of the current has been shared with light users through rate reductions. As a result the cost of electric lighting has been tremendously reduced, and it is practically the only item in the cost of manufacture which has steadily decreased, instead of increased, during the past twenty-five years.

Reflectors

Reflectors are made in three different types—direct, semi-direct and indirect. Since it directs all the light on the surfaces to be lighted, and is very little affected by dirt and dust, the direct type is used almost universally for industrial lighting. The semi-indirect type is an attempt to give daylight effects by directing part of the light upward and part downward, uniformly illuminating the whole space to be lighted. The indirect type directs all the light to the ceiling, which in turn reflects it to the floor. The success of this reflector depends upon the reflecting powers of the ceiling. It, therefore, can be used only where the ceilings are of a light color and can be easily kept clean.

It is apparent from the foregoing that neither of the last two types mentioned would be at all suitable for boiler shop lighting. For this reason only the direct type need be considered. These reflectors are made in glass, metal and enamel-lined metal. Glass reflectors have many advantages, but are hardly suited to the rough usage to which they would be subjected in the lighting under consideration. For this class of lighting the enamel-lined steel reflector is very satisfactory.

Methods of Installation

The methods of installing lights may be roughly divided into three classes—local, group and general.

Local, or the placing of a light over each machine or piece of work, was used almost exclusively in the old days of high electric rates and inefficient lamps. With the wonderful increase in lamp efficiency and the steady decrease in electric lighting rates, this method is rapidly giving way to the other methods of lighting. In fact, changing over an old installation to the more up-to-date methods may result in economies which will materially reduce the cost of lighting and at the same time greatly improve its effectiveness and quality.

Group lighting is used extensively in works where there are groups of machinery requiring a comparatively high intensity of lighting separated by groups, or stores of material, requiring less light. In this method each group of machinery or section of the factory is considered by itself, and the intensity of lighting required for each group provided. The units are usually hung at a convenient height above the floor and spaced sufficiently close together to make the units selected give the intensity of light required on the illuminated surfaces.

The general method of lighting is the cheapest to install and gives the most pleasing appearance. In this method, if the building is of the modern mill type construction, a unit is installed in each bay. Otherwise, the area to be lighted is divided into as many rectangles as there are lighting units, and a unit equipped with the proper reflector hung at the correct height in the center of each rectangle. This results in a uniform illumination over the whole floor.

Frequently all the varying requirements existing in a plant cannot be met with any one method of lighting. For example, a factory having good general lighting may have a group of machines requiring more light than is required in the rest of the factory. This necessitates supplementary group lighting for that section. Where either group or general lighting is installed, some local lighting may be required. This supplementary local lighting can be provided by lamps suspended on drop cords and by hand lamps equipped with cords of sufficient length which are either permanently attached to the ceiling or wall or provided with plugs for insertion in receptacles distributed along the wall, floor and ceiling.

All lamps, whether fixed or portable, should be equipped with suitable reflectors. There are reflectors made for every requirement. These reflectors are carefully designed and should be used only on those lamps and for those purposes for which they are intended. All hand lamps should be protected by wire guards, and no workman should be allowed to use one without a suitable reflector. The effectiveness of the lamp is lost if used bare. It requires the keenest eyesight to see, with any degree of distinctness, work lighted by a bare lamp. The light shining directly into his eyes blinds the workman and causes him to do his work slowly and poorly. Too much stress cannot be laid upon the importance of the proper reflector. Reflectors pay for themselves many times over during one lighting season.

Along with the development of the electric lamp has grown up a new profession. Illuminating engineers specialize in planning and supervising the installation of the most efficient lighting systems. Their competent counsel can be sought and secured in practically every large city and the results obtained from following their advice always more than repay the fees they receive.

Should the Paid Employees of Boiler Owners Be Authorized to Make Their Own Inspections?

At one of the hearings before the A. S. M. E. committee on uniform boiler inspection laws a question arose concerning the right of, or the advisability of permitting, locomotive boiler inspectors employed by railroads to make inspections of the stationary boilers owned by such roads.

It is generally understood that a fundamental principle of all State laws for the compulsory inspection of steam boilers is that such inspections should be made by outside, impartial inspectors and not by paid employees of the boiler owner. The real object of such laws is to safeguard human life, and the reluctance that paid employees feel in asking their employers to effect needed repairs or to expend money for any purpose whatever is well known. Thus an employee who discovered a defect might, for one reason or another, hold back his report and an explosion might occur as the result. This would be against the best interests of the employer, because it would mean serious financial loss, protracted shut-down, and possibly the death or serious injury of a great many persons employed about the plant.

For this reason boiler owners in general do not want these inspections to be made by their own employees. Engineers do not want to be charged with the responsibility of making their own inspections, and States considering the adoption of a compulsory boiler inspection law would not permit any paid employee of the boiler owner to make such inspections. Neither the Massachusetts, nor the Ohio, nor any other boiler-inspection law now in force grants such privilege. Inspections made by the licensed inspectors of boiler insurance companies are accepted in lieu of State inspections, in order to save the boiler owner the expense and inconvenience of having to shut down for both State and insurance inspections. Such inspections, however, are made by impartial experts, who devote their life work to the safeguarding of these vessels from explosion, and they conform to the general principle involved, since insurance inspectors are neither directly nor indirectly in the employ of the boiler owner.

Laws providing for the inspection of steam boilers are enacted under the police power of the State, and should, of course, go no further than is necessary to protect the public against the evil anticipated. Whatever class of boilers the Legislature sees fit to exempt from the operation of the law may be properly excluded if the classification is based upon reason. Steam-boiler insurance companies are incorporated and authorized by the State to inspect boilers and to insure them against explosion; and the State, through its insurance department, supervises the operations of the companies and sees that they are and continue to be solvent and wisely managed. The State knows that the explosion of a steam boiler means heavy financial loss to the company which insures it, and that hence the company has a strong financial inetrest to do its inspection work thoroughly. This being the case, it is manifestly entirely reasonable that the State should except from the operation of its general steam boiler inspection law, boilers insured in and inspected by duly authorized steam boiler insurance and inspection companies. To require a boiler owner who has provided for insurance and inspection by highly trained experts in the employ of a State-authorized and supervised insurance and inspection company, which will be required to pay for the damage done in case of an explosion, to also submit to and pay for an inspection by State inspectors, is manifestly casting upon such a person a wholly unnecessary burden. The exclusion of boilers inspected by the owner is quite a different thing. The State has very great knowledge of and supervisory control over insurance companies, while it has no such knowledge of or control over the owner. Moreover, the expense incident to the repair or condemnation of a boiler and other considerations might easily influence the owner or his employee to continue to use the boiler after it should be shut down, whereas the insurance company would not be subject to any such influence, and its interests would naturally lead it to require a very strict adherence to good practices.

It would be transgressing a fundamental principle to extend to railways a privilege not granted to other employers; and so it is to be presumed that the railways themselves, acting in their own best interest, will not resist upon having their stationary boilers inspected by their own locomotive boiler inspectors.—*Monthly Bulletin of the Fidelity and Casualty Company of New York.*

BOILERS FOR PEAK LOAD CONDITIONS.—In plants that are to be worked at high rates of evaporation it is important to select only those types of boilers which are free from stress due to temperature changes and which permit of easy renewal of tubes. It has been pointed out by engineers who have given this subject close study that when boilers are to be worked during peak-load periods at from 7 pounds to 10 pounds of water per square foot of heating surface—that is, from two to three times the rating—the total cost of the boiler plant will be so greatly reduced that the very best boiler structure for the purpose can be selected without greatly increasing the cost of the plant. The cross-drum type of boiler offers advantages for high rates of working as the discharge from the upward circulation of steam and water is near the center of the cross drum and therefore near the normal water level, thus liberating the steam near the surface of the water, which permits of freer and more rapid circulation. —*Electrical World.*

How to Tell if a Crown Sheet Has Been Hot

Low water, however caused, always produces excessive heating, and if the temperature rises sufficiently to weaken the material, failure may occur by stripping of the staybolts or rupture of the sheets by bulging between them, or otherwise. If the temperature has raised the material to a low or bright red color, this can be readily determined by superficial inspection. While the fire side will show red rust or a black color, the water or steam side will invariably show a typical steel-blue scale, which will not disappear even after years, as it is a so-called rustless coating. If this be once oiled it will always be distinguishable, even if the plates had been exposed to moisture and gases for years. The color of this scale will depend somewhat upon the temperature at which it was produced, being brightest at those points where temperature was the highest. Carefully made tests, with autographic diagrams of such material, will again demonstrate changes of properties which are very characteristic.

The yield point will be found very low, while the diagram will show a material drop of curve just after the yield point. The elongation will, however, as a rule, be materially increased, with a diminution of tenacity. Nicked and quenched bending tests will again show marked difference between strips cut from the sheet at points which in one case were overheated or were above the low-water line, and in others were taken from a part below this line. The fracture will also be materially different. To demonstrate the temperature at which the plates happened to be at the instant of explosion, it is necessary to cut strips from points of the overheated plate below the water level. These strips polished on the edges are then held in a clear fire so that one end remains cold while the other is heated to a dull yellow or a very bright red. This temperature being reached, the bars are withdrawn, and while one is rapidly plunged with one end into a pot of boiling water, the other is allowed to cool in air, but not in contact with wet metal or stone. When the piece which had been immersed in boiling water about one inch deep has become nearly cold, below blue heat, it is plunged into cold water.

On the polished edges of both bars will be found scale and heat colors, the temperatures producing them being well established. These bars are then carefully nicked at points opposite every change of color and then broken off at these nicks. By comparing these fractures and their scale and color with those obtained from pieces cut from the overheated plates, the temperatures at which they were at the instant of explosion can be determined with great accuracy. Having thus determined the temperature at which the sheets were during operation, it is also known whether the metal was sufficiently soft to bulge off or strip from the staybolts; examination of plates and bolts will verify the conclusion.—*Railway and Locomotive Engineering.*

The Boiler Maker

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NOTICE TO ADVERTISERS.

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

Elsewhere in this issue is an article showing how to determine the number and size of the boilers to supply steam for a given shop. From the data given there would be required to answer the inquiry properly a thorough knowledge of steam engineering, electric drive, and heating. Now is it fair to expect this knowledge in a manufacturer of boilers, or even if he possessed it, is it wise to accept his calculations? In the United States, and it is the only country where the procedure is found, if a man comes ino the office of a boiler making establishment and intimates that he wishes a boiler for a certain purpose, he would be plied with questions, and some sort of a boiler with its price would be offered him. Some large boiler concerns will be willing to send an expert to look over the situation, write a specification, and give prices. Quite commonly the specification will be copied by the prospective customer, and sent to rival boiler concerns for their bid, and the lowest is accepted.

This is totally unfair, to say the best about it. The action borders on dishonesty. In other countries a customer desiring a boiler will be first asked whether he is an engineer. If he says no, he will be diplomatically and politely informed that not being one he is not likely to know his requirements, and they, the boiler people, cannot guess what is wanted. The prospective customer will probably be informed that "Messrs. Wilson, Jones, or Robinson are all recognized engineers, and if any one of them will undertake the investigation and write a specification of what is required in the boiler line, we shall be very much pleased to bid." Of course there are consulting engineers and consulting engineers. Often they are prone to recommend a sweeping out of everything, which would incur too heavy an expense to be considered. Is it not wise, however, to place the selection of anything so important as a boiler in the hands of a thoroughly competent man who is unbiased and unhampered?

The American system has, however, its advantages. Under it boiler makers are jealous of their reputations. Consequently they would be inclined to give something satisfactory, but there is always the inclination, which is natural, to sell a particular product in which one is interested, rather than the product of someone else. But the great point in selling anything, and particularly a boiler, is to have it satisfactory, and have it stay sold. It would seem that all that could be fairly asked of a boiler manufacturer is that he provide first-class materials and workmanship, and sufficient grate and heating surfaces to evaporate a given amount of water in a given time under clearly specified conditions.

Some indication of the recent unprofitable condition of the boiler-making industry is shown by the following abstract from bids which were opened at Tompkinsville, N. Y., on November 10, 1914, for two Scotch type marine boilers for the United States lighthouse tender *Larkspur*:

A. D. Granger Company, New York...	$11,917.00	(135 days)
S. J. Waterman	16,942.00	(130 days)
Springfield B. & M. Co. (Illinois)....	11,350.00	(120 days)
P. Delaney, Newburgh, N. Y..........	14,450.00	(150 days)
Ellicott Machine Corporation, Baltimore, Md.	13,236.35	(160 days)
New York Shipbuilding Company, Camden, N. J....................	12,500.00	(125 days)
Harlan & Hollingsworth Corporation, Wilmington, Del.	13,315.00	(118 days)
Kingsford Foundry & Machine Works, Oswego, N. Y....................	15,465.00	(126 days)
John Baizley, Philadelphia, Pa........	10,756.00	(120 days)
Valk & Murdock, Charleston, S. C.....	11,170.00	(170 days)
Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa.	15,185.00	(145 days)
W. T. Cahill, Baltimore, Md..........	13,700.00	(100 days)

Under ordinary conditions it would be quite unlikely that competitive bids for only two boilers would vary as much as 57.5 percent, as was the case above, especially when the estimates were made from carefully drawn government specifications. Whatever the reason may be in this particular case for the wide divergence in quotations, it is to be hoped that a careful study of these figures and of the specifications covering the work to which they apply will be beneficial to the trade.

Engineering Specialties for Boiler Making

Automatic Spacing Table for Punching Plates—Air Compressor Equipment for Field Work and High-Pressure Hydraulic Pump

Thomas Automatic Spacing Table

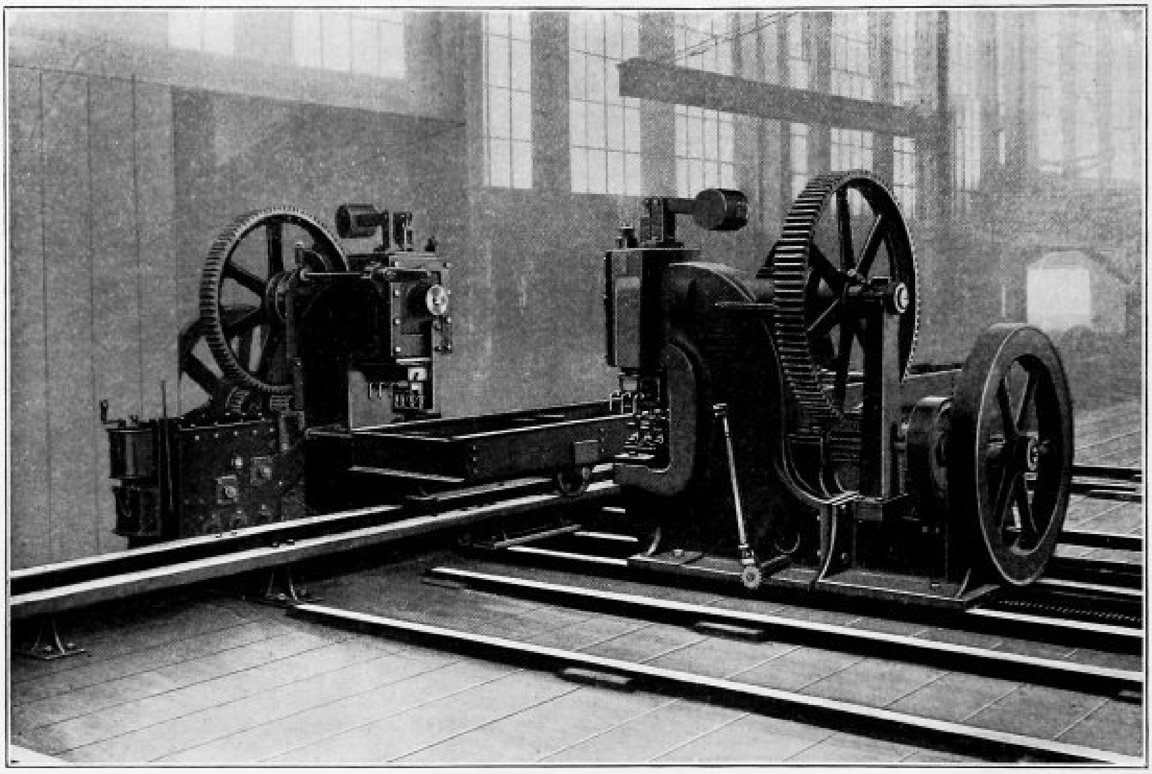
The Standard Bridge Tool Company, Pittsburg, Pa., has placed on the market a new and improved type of spacing table which is designed for punching plates of all kinds. The machine illustrated was built for one of the leading tank manufacturers, and is designed to punch two edges of a plate at one pass, either sidewise or endwise. One of the punches is fixed on the base and the other is adjustable to the width or length of the plate.

For punching very wide plates or the holes in the ends of plates, auxiliary rolls are provided to avoid sagging. These rolls are carried on separate bases located on each side of the movable punch and are set to suit the size of the plates. The tops of the bases are planed and are set in concrete foundations.

The spacing is obtained from full-size templets. On work where close spacing of holes is not essential a wooden strip can be used. If great accuracy is desired a steel templet must be provided. It is claimed that the machine will respond to the templet and that the wear of parts or lost motion will not affect its accuracy.

One of the particular features of these machines is that regular or irregular spacing may be obtained. Also on boiler work or tank work the inner or outer course sheets may be punched without changes or resetting. The movement of the carriage is automatic, deriving its motion when spacing from the main shaft of the punch. The return movement is effected by means of motor. The table proper, the tracks, and the base of the punches are all steel and practically unbreakable. The carriage runs on cast steel rollers fitted with hard steel roller bearings.

These machines can be modified for punching all classes of plate work, either light or heavy material. The spacing table can be used in connection with a single punch for punching only one edge of a plate at a time or in connection with large multiple punches for punching all holes at one single pass.

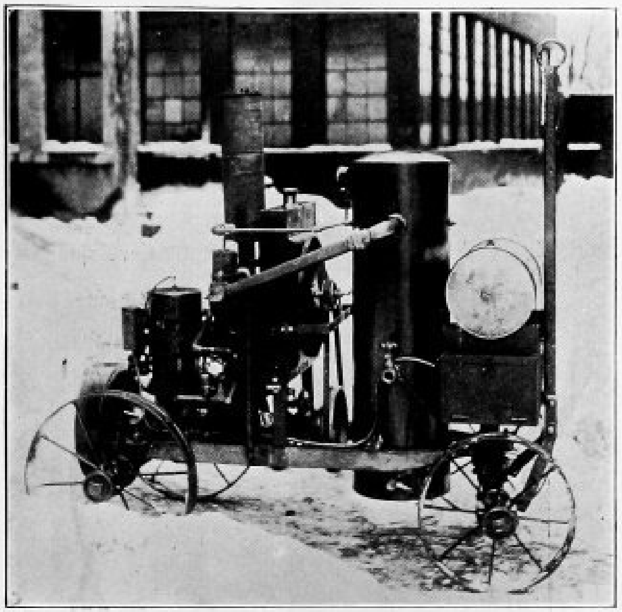


Thomas Automatic Spacing Table for Punching Boiler and Tank Sheets

A Small, Portable Air Compressor

The small gasoline (petrol) engine driven portable air compressor illustrated has been developed by the Ingersoll-Rand Company, New York, to meet the needs of the contractor doing work of a temporary character requiring compressed air in small quantities. The compressor is operated by a simple single-cylinder gasoline (petrol) engine, which is coupled directly to the compressor, both pistons working on the same crank shaft. The engine is of the single-acting, two-cycle type, closely following the well-known marine designs. The air compressor, which is one of the company's standard types known as "Imperial XII," has a capacity of 45 cubic feet per minute at a pressure of 90 pounds. It is fitted with an air unloader and the engine with a centrifugal governor. Cooling is provided for by a gear-driven pump and an automobile type radiator, with large tank capacity, serving both the compressor and engine. The radiator is assisted by a large fan.

The frame, axles and wheels are of steel, the front axle is arranged with swivel connection to the frame, permitting horizontal rotation for turning corners and sufficient vertical movement to accommodate the wheels to inequalities of the road without strain on the frame. An air receiver tested to 300 pounds water pressure and fitted with safety valve, pressure gage, necessary piping, outlets, etc., is hung at one end of the frame, and a gasoline (petrol) tank of 15 gallons capacity is supported on

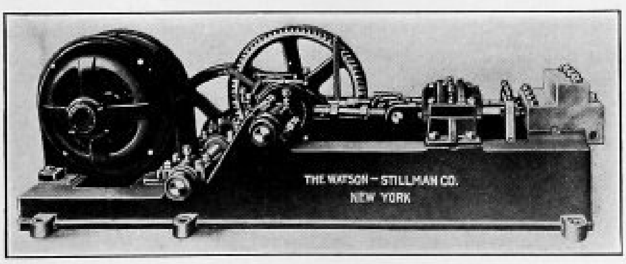


Gasolene-Driven Portable Air Compressor

a large tool box, as shown in the illustration. The outfit complete weighs 1,600 pounds and is designed for hand transportation, but can be fitted with tongue and single tree if desired.

Watson Stillman Triplex Hydraulic Pump

The Watson-Stillman Company, New York, has added to its line of high-pressure hydraulic pumps a new type of motor-driven geared triplex single acting pump, which embodies some features of special merit. While primarily



Motor-Driven Hydraulic Pump

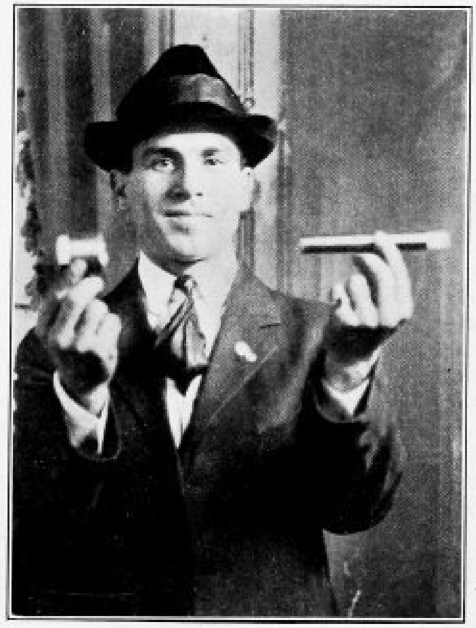
designed to meet the severe demands of tunnel service, it will be equally appreciated for other conditions.

To secure unusual compactness and rigidity, and also to insure perfect alinement of all the working parts when under severe service, the motor is mounted on an extension of a heavy cast iron base. The driving shaft and bearings are large and are amply provided with lubricating cups. The gears are of the heavy cut tooth type. The drive from the shaft is by eccentrics set at 120 degrees and are cast in one piece and keyed with one key to the driving shaft. The eccentric straps are heavy and the plungers are of tool steel and are guided in a rigid crosshead guide, which is keyed and bolted to the base.

The pump body is a machine steel forging with bronze valves and bonnets, and designed to eliminate and aid spaces. The passageways are made large to reduce friction of the water to a minimum. The pump as shown is operated by a 10 horsepower motor running at 600 revolutions per minute and delivers 100 cubic inches per minute at 3,500 pounds pressure, with a speed of the crankshaft of 100 revolutions per minute. Other sizes are built to suit operating conditions.

Boiler Inspector Invents New Flexible Staybolt

H. A. Lacerda, assistant boiler inspector at the West Albany shops of the New York Central Railroad, has invented a new type of flexible staybolt so constructed that an ordinary staybolt with telltale hole can be applied and



New Flexible Staybolt, Presented for Inspection by the Inventor

driven at both ends. In the outside sheet the bolt is headed up in a corrugated sleeve which provides for the expansion and contraction of the bolt and makes a flexible connection. The bolt can be tested by the hammer test in the same manner as an ordinary solid staybolt.

Technical Publication

STEAM BOILERS. Third edition. By C. H. Peabody and E. F. Miller. Size, 6 by 9¼ inches. Pages, 543. Illustrations, 229. Folding plates, 5. New York and London, 1912: John Wiley & Sons and Chapman & Hall, Ltd. Price, $4; 17s. net.

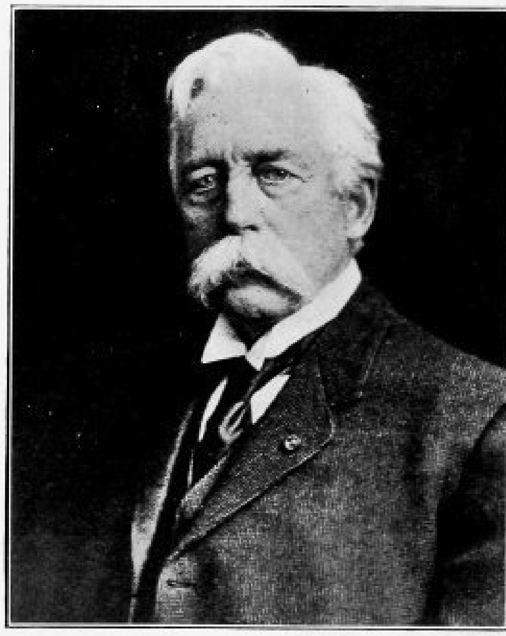
Authoritative books on steam boilers are not very plentiful. What few there are, either deal directly with the thermodynamics of the generation of steam or with the mechanical details of boiler construction. In this book, which was primarily intended for the use of students in technical schools and colleges, theory and practice each have an equal share in the explanation of the construction and operation of steam boilers. The subject is thoroughly covered by giving only clear and concise statements of facts concerning boilers. No preference has been given to any one particular type, each type being described in detail. Following a description of various types of boilers, a chapter is devoted to superheaters and this includes a short discussion of superheated steam. The chapter on combustion has been extended in this edition to cover oil burning and to include the most recent analyses of American coal, together with a detailed description of coal calorimetry as applied to the determination of the heating value of coal purchased on a heat unit basis. This chapter alone would make a very interesting book, as the matter has been presented in the careful and thorough manner which is characteristic of the authors. Corrosion and incrustation are discussed in great detail, and the subjects of mechanical stokers, economizers and steam piping have been treated at considerable length. The new edition also includes new material on chimney draft and a chapter on coal handling and coal-handling machinery. The subjects of riveted joints, boiler testing and staying flat surfaces have also been extended and are very complete. The design of the horizontal return tubular boiler is the only one taken up in detail as the principles in the design of different types of boilers are the same throughout.

Obituary

Col. Edward Daniel Meier, president and chief engineer of the Heine Safety Boiler Company, and past president of both the American Society of Mechanical Engineers and the American Boiler Manufacturers' Association, died in New York December 15 at the age of seventy-four from hardening of the arteries and heart. Col. Meier was a veteran of the Civil War and one of the most eminent mechanical engineers of the country. To boiler makers he is probably best known from his lifelong activities in the movement to better the standard of steam boiler construction. From many years' service as president of the American Boiler Manufacturers' Association and as chairman of its committee on uniform boiler specifications, and also as chairman of the committee on uniform boiler specifications of the American Society for Testing Materials, Col. Meier through his personal efforts exerted a marked influence on the progress towards better and safer boiler construction in this country. What will be recognized, however, as his greatest achievement in this field of endeavor was the inauguration of the movement for a standard boiler code by his appointment, soon after his elction as president of the American Society of Mechanical Engineers, of a committee of eminent authorities on boiler work to compile a standard A. S. M. E. boiler code which can be used as a basis for uniform boiler legislation and practice throughout the country, a work which is now still under way but which will probably soon be brought to completion.

Col. Meier was born in St. Louis, Mo., May 30, 1841. At the close of a scientific course at Washington University, St. Louis, in 1858, he spent four years in Germany at the Royal Polytechnic College in Hanover, this being followed by an apprenticeship at Mason's Locomotive Works, Taunton, N. J. In 1863 he enlisted in the Gray Reserves, the Thirty-Second Pennsylvania, which was attached to the army of the Potomac until after the battle of Gettysburg. He subsequently served in the Second Massachusetts Battery, also in the United States Engineer Corps, and finally became lieutenant in the First Louisiana Cavalry, seeing much active service, and on May 30, 1865, receiving the surrender of Lieutenant-General John B. Hood and staff.

At the close of the war he entered the Rogers Locomotive Works, at Paterson, N. J., remaining one year. From 1867 to 1870 he was associated with the Kansas Pacific Railway, first as assistant superintendent of machinery, keeping open its Western communications when the bridges were swept away, designing, building and operating a mill for sawing, planing and turning the soft magnesian limestones by machinery, designing machine and car shops, etc., and subsequently becoming superintendent of machinery. He resigned to become chief engineer of the Illinois Patent Coke Company, leaving there in 1872 to assume the secretaryship of the Meier Iron Company and to build its blast furnaces. From 1873 to 1875 he directed the machinery department of the St. Louis Interstate Fair. During this time he became actively interested in the St. Louis cotton industry and was associated with the St. Louis Cotton Factory and with the Peper Hydraulic Cotton Press, for both of which he designed machinery for compressing cotton. In 1884 he organized the Heine Safety Boiler Company for the development in



Col. Edward D. Meier

the United States of the watertube boiler of that name, and has been its president and chief engineer ever since. He has also been responsible for the introduction of the Diesel motor into the United States, and until 1908 was engineer-in-chief and treasurer of the American Diesel Engine Company.

Col. Meier was lieutenant-colonel and later colonel of the First Regiment of the Missouri National Guard, serving about ten years, and is a member of the Grand Army of the Republic and of the Loyal Legion. He has been active in a number of professional organizations, serving in 1881-1884 as treasurer of the St. Louis Engineers' Club, in 1889-1890 as its president and as secretary of the American Boiler Manufacturers' Association. It was in the latter capacity that he drew up the Uniform American Boiler Specifications of 1898. He has been president of that organization and also of the Machinery and Metal Trades Association since 1908.

In the American Society of Mechanical Engineers he has been active on many committees, was one of its managers from 1895 to 1898, and has twice been elected vice-president, serving his first term from 1898 to 1900, and beginning the second in 1910, but resigning in the same year to assume the presidency.

Letters from Practical Boiler Makers

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

A Boiler Failure

A boiler, about fifteen years old, on a river tug developed several bad leaks in the back sheet. After laying up the tug all night, the engineer found no water in the glass or gage cocks. This had happened on previous occasions, however, due to the leaks in the back flue sheet.

The steam pressure was low and the engineer turned on the steam jet to blow the fire, but neglected to bring the water level up. When the fire became hot, the tubes above the three lower rows drew away from the sheets, front and back, showing that the level of the water must have been down to the top of the third row of tubes from the bottom.

This was clearly a case of neglect on the part of the engineer. In the first place, when there is no water in the gage glass and, especially, in the gage cocks, it should be attended to immediately. In the second place, the leaks in the tube sheet should never have been neglected for so long a time. No doubt the failure would have occurred in as short a time if only the first condition obtained that of a low-water level. G. T. C.

Method of Boiler Construction Advocated to Overcome Leaky Flues

On page 370 of the December number of THE BOILER MAKER I read the discussion on welding tubes in back flue sheets of locomotive boilers. This strikes me as a last resort and an expensive way to overcome tube leakage, especially when the tube sheet deteriorates with every weld that is made, to say nothing of the cost of retubing, which would be added to by the Federal requirements of removing tubes every three years. On some of the Eastern railroads where bad water exists this retubing must be done every nine months.

Just so long as the same principle of construction is adhered to, over which the master boiler makers have puzzled their brains for the past sixty years, there can be no way out of the difficulty, and yet they show no inclination to try a new and more scientific construction which from experience and test, I, with other well-known engineers, can confidently recommend to them as being a far less expensive way of overcoming leaky flues and flue failures on the roads. The welding in of tubes does only one thing, and you are not sure of the exact amount of good resulting, but the shallow corrugated construction accomplished many things, among others the prevention of tube and mud ring leakage and staybolt breakage, and we are exactly sure of the amount of resultant good.

I have had a boiler working for the past three years with superheater tubes which has given the greatest satisfaction in every respect, including the tubes. And in closing I might state that the scale, which one might almost say was the foundation of tube troubles, is broken up and entirely dispersed in the shallow corrugations, owing to the constant expansion and contraction allowable in this flexible form of boiler, and therefore there can be practically no scale burn and no leakage.

My working experience with boilers and boiler making has been of forty-five years' duration, and the past eight years I have devoted a great deal of time to this particular and important subject of locomotive boilers, and I say that it is now time to try the new construction.

WILLIAM H. WOOD,
Mechanical and Constructing Engineer.
Media, Delaware County, Pa.

Rolling Boiler Tubes

In relation to "rolling" boiler tubes, I quite agree with N. G. Near in his statements, which appear in the December issue of the paper. I have used the Dudgeon expander on marine and stationary boilers, both with new tubes and with old tubes that had begun to leak at the ends. Of course more care is required with old tubes, for not only are the ends thinner from having been expanded before, but the metal seems to be more brittle than when new. The continued heating and cooling with the consequent expansion and contraction, fatigues the metal, and so re-expanding must be done cautiously. It is quite possible to ruin a tube end by expanding it too much, for then the holding power is impaired permanently.

In the case of old tubes that have been expanded several times at intervals, and still leak upon the least provocation, the least possible expanding that is done the better it will be. In such a case it would not be wise even to make the track of the rollers pronounced, but only to the extent of showing that the rollers have lightly pressed the tube all round. With new tubes, the track made by the rollers should be well pronounced, as referred to by Mr. Near, for when new the tubes can stand it better than at any later period. The holes in the tube sheets, or headers, as the case may be, should be cleaned out and the sharp edges "broken" with a half round file before putting in a new tube. I have found that by painting the tube ends and the holes in which they are to be expanded with thick red paint, a good job can be made that will last. CHARLES J. MASON.

Scranton, Pa.

An Amateur Boiler Maker's Views

I am not an authority on the manufacture of steam boilers "by a long shot," but I am interested in them, and therefore went to the meeting of the American Society of Mechanical Engineers to watch them as they put the kibosh on future failures. It will be pretty hard to squeeze in any more failures after their proposition is put through broadcast over the United States. The committee has evidently worked pretty hard at their new code, and I notice that all engineering journals, and even the daily papers, join hands in wishing the perpetrators "God speed." One prominent engineering journal in particular states that the new boiler code is "the most important subject the American Society of Mechanical Engineers has ever tackled," and I guess that paper is about right. Boilers *are* important. It would be hard to name anything more important in the mechanical world.

There were some *big men* at that meeting, such as Andrew Carnegie, Mayor Mitchel, etc. I didn't speak to any of them personally, and they didn't make an effort to speak to me. You see, as long as I am an amateur and just a junior member of the A. S. M. E., I keep out of the way of the big fellows. I just stand around and watch them and wish that I, too, were an *authority*.

I noticed that most of the *big men* smoked cigars, and so I smoked a "toofer" also, but even that didn't put me in the limelight. I can smoke just as many and just as black cigars as the next man, but it doesn't seem to do much more good than to just help make the atmosphere of the desired kind in the Engineering Building. They are a jolly bunch. The *big men* laugh and shout at each other and call each other by their boy names, such as Joe, Jim and Mike, and between them all they somehow or other manage to make the mechanical world sit up and take notice.

There seems to be a little sentiment among the older men against the younger members—so I have been told. The big engineers don't always like to associate with men of smaller caliber, and I don't blame them exactly. But how are we going to learn if we are not allowed to associate with them once in a year, and thus be prepared in a few years to take hold of the work where they—the *big men*—left off?

It's a great thing to go to a meeting where great men discuss the greatest subjects. I kept out of it, of course, because, as I have already said, I am not an authority.

Here's wishing the new code the greatest success.

New York. N. G. NEAR.

A Criticism of the A. S. M. E. Boiler Code

As a subscriber to your valued paper, and one who takes great interest in all things pertaining to boiler construction and the rules governing the same, I have read with pleasure your article on the efforts of the A. S. M. E. committee on standard boiler rules, and wish to make the following statement regarding their work:

It would appear to the layman, far removed from the center of activities, that the gentlemen appointed by the A. S. M. E. as a committee on standard boiler rules had taken the State of Massachusetts' boiler code as their guide in all things. In the first place, the committee forwarded copies of their proposed rules to the various persons throughout the United States that they had reason to suppose would be interested. I, among others, received a copy with a letter asking for a criticism of the rules as drawn. I have no doubt but that this was the action taken with hundreds of other men throughout the country, and I have no doubt but that each and every one of the gentlemen invited to criticise the work faithfully performed his duty to the best of his ability, so that no doubt the committee received several hundred various criticisms on various points in the rules as drafted. No doubt the committee gave to each letter received all the attention that it was possible to give to such a large number of answers.

Probably you are aware that Mr. Thomas Durban, as the chairman of the boiler manufacturers' committee, called a meeting to be held in Pittsburgh, Pa., in the early part of November, 1913. At that time there were present many representatives of the Boiler Manufacturers' Association, also many of the inspectors of boilers from the various States and cities that have laws governing the inspection of steam boilers, also the representatives of the steel manufacturers. The matter of "standard rules" for the manufacture of boilers was taken up and received a great deal of attention from the various interests represented, including Mr. George Luck, as the representative of the Commonwealth of Massachusetts; Mr. H. A. Baumhart, representing the Board of Boiler Rules of the State of Ohio; Mr. Robert Wilcox, representing the city of Chicago, and various persons representing interested parties in the discussion of this vital matter. At this meeting I had the pleasure of representing the city of Seattle, and in the course of the meeting I was called upon to discuss several matters pertaining to the rules as adopted by the city of Seattle, and I had the pleasure of having the same receive the approval of that meeting.

The same items that were discussed in Pittsburgh were again taken up by me with the committee appointed by the A. S. M. E., but I do not see wherein there has been any attempt to adopt the same; therefore I submit them to the boiler makers and boiler inspectors through the columns of your valued paper. The following is a copy of my answer to the A. S. M. E. committee on standard boiler rules:

"To the American Society of Mechanical Engineers:

"Gentlemen: I am in receipt of your valued favor of the 26th inst., enclosing a copy of the recommendations of your committee appointed to draft a suitable standard specification for the manufacture of steam boilers, and kindly inviting me to critisise or suggest any changes. I am pleased to be allowed to give my views on this important matter, and taking it for granted that you desire a fair, impartial criticism from the various interested parties, I feel at liberty to take up the following subjects:

"First. Method of determining net area of segment of a head (Page 199, Section 4, Article 32), in which you give as follows: 'The area of a segment of a head to be stayed shall be the area enclosed by lines drawn 3 inches from the shell and 2 inches from the tubes (as shown in Figs. 22, 23).' This rule I do not believe to be based upon good mechanical judgment. True, it has been the rule for many years, and apparently, in order to follow the line of least resistance, it has been decided not to change it. I do not believe that this rule is right, for as the conditions change, so should the allowance change. Taking into consideration the thickness of the metal and the pressure carried, it would look as though this allowance could be graduated to meet the conditions. It does not seem right that the same allowance should be made where the thickness of the head is 7/16 inch and the pressure carried is 150 pounds, and again where the thickness of the head is ⅝ inch and the pressure carried is 100 pounds. That there is a way of arriving at the proper allowance, based upon the data given, is shown by the rules in use in various places. In the city of Seattle I have based this allowance upon the rule that covers the greatest allowable pitch of brace or stay, and by taking one-half of that allowance I believe that it will be much nearer a solution of the problem than to allow 3 inches for the holding power of the flange. As to the allowance of 2 inches for the holding power of the tubes, although I feel that it could be determined definitely what the value of that power actually is, still I feel that an allowance of 2 inches is a very conservative estimate, and on account of the unknown quantity of the workmanship I believe that this allowance should not be changed.

"Second. 'Determination of net area of a segment of a head containing a manhole opening' (Page 201, Section 4, Article 35, Fig. 24). 'An area 2 inches wide all around the manhole opening may be deducted from the total area of the head, including manhole opening to be stayed.' I do not believe that this deduction should be made. I am of the opinion that it is not warranted by conditions. True, the sheet has been flanged in for a distance of not less than twice the thickness of the head, and by so doing a certain stiffening effect has been given, but I believe that this stiffening effect has only been for the purpose of forming a beam, and is used for the purpose of transferring the load from the manhole cover to the other part of the segment that we are able to brace. I cannot see wherein we have in any way lowered the total load to be sustained by the brace or through-rod. We have already given the flange and the tubes their full allowance, and I believe that the area to be braced in the front head should be the same as if no manhole were used.

"Three. Section 4, Article 7, Page 193. 'The longitudinal joints of a boiler, the shell or drum of which does not exceed 36 inches in diameter, may be of lap riveted construction, but the maximum pressure shall not exceed 100 pounds per square inch.' I believe that this ruling is wrong, my contention being that the smaller the diameter the more aggravated the fault, as the angle will be greater. In fact, I am of the opinion that all longitudinal joints should be of the butt (double strapped) type, as this form of joint is just as cheap to manufacture as the lap type. I base this assertion upon the following reasons: Taking into consideration the diameter of the boiler and the pressure to be carried, the higher efficiency of the butt type of joint will allow of the use of lighter plates and will offset the difference in the cost.

"Fourth. Section 4, Article 17, Page 195. 'Bumped heads.' I believe this form of construction to be not only wrong, but also absolutely dangerous. I believe that the head should be a true hemisphere. In the 'bumped head,' so-called, we have a condition that allows of an abrupt change of angle. At the point where the departure is made from the straight line to the curvature, there is a condition set up that I believe has been the cause of many disastrous failures. I have noted on at least three occasions where a disastrous failure has occurred, that the failure has taken place at this point, and I am of the opinion that it is caused by this form of construction. If the hemispherical type were used it would allow of the use of a thinner plate, and this in turn would compensate for the added expense, and I believe that it would give much better service and I am sure that it would be a great deal safer.

"Fifth. I believe the rule making it necessary to consider a plain internally fired boiler with a furnace over 38 inches in diameter as a flat surface, is wrong. Apparently it is considered that the limit is reached immediately at this point. I do not believe that to be a fact. I believe that a plain furnace with a diameter greater than 38 inches should be given some allowance for the strength of the cylinder.

"Sixth. Article 50. Calking. 'The calking edges of plates should be beveled.' I believe that at this time your society should go on record as being opposed to the use of the 'rotary bevel shear,' as I believe that the use of this machine sets up a condition whereby the metal is distorted to a greater degree than it is by the use of a punch in punching holes for the riveted joints. I believe that this work should be done on a planer.

"In submitting the above, I have been actuated only with the motive of trying to help to the best of my ability in your splendid work. Wishing you every success in this matter, I am, very respectfully,

"(Signed) WILLIAM E. MURRAY,
"Inspector of Steam Boilers for the City of Seattle."

In answer to the above I received an acknowledgment of the receipt of the same and assuring me that the committee would give it the fullest consideration. Now I am very doubtful as to whether that consideration has been given. If so, then it is apparent that my suggestions or criticisms were not considered to have sufficient weight to be incorporated in their next draft, as the next copy of the proposed regulations did not incorporate any of the suggestions given the foregoing letter, or it may be that the committee, after careful deliberation, came to the conclusion that I was entirely wrong in the ideas advanced. Be that as it may, I am submitting the above for the careful perusal of the readers of your valued paper, and I respectfully invite a thorough discussion of the above.

This letter was prompted by the article appearing in the December issue of THE BOILER MAKER under the heading of "How and Why I Taught Boiler Design," which I believe contains a great deal of truth, although apparently written as a humorous article, and I feel that the task of drawing up a set of standard boiler rules should be the task of a committee composed of boiler inspectors, for the reason that they are not in any way biased, and only have the one object in view, viz., safety.

WILLIAM E. MURRAY,
Inspector of Steam Boilers.

Seattle, Wash.

Does Quantity Make Quality?

There is no question but that in the manufacture of a great many products, such as engines, boxes, wagons, automobiles, etc., quality has much to do with quantity. The manufacturer can either make a better product at the same price when he makes it in large numbers, or he can undersell his competitor. Henry Ford is now demonstrating to the world the great value of quantity, production and efficiency in shop methods. It is evident that if he should choose to do so he could sell his car at a much lower price by reducing the wages of his employees to nearly what it was before. His employees are thankful that he is continuing his present policy.

In the manufacture of boilers, however, quantity does not figure so strongly because of the great amount of hand work that must be performed on each and every boiler. True, the factory that turns out ten boilers per week to another factory's one boiler per week would logically have better or more machinery for quick production, but since all factories make boilers of all sizes and types, the chances are that the big house, after all, will not be able to make a given boiler much more quickly than the smaller factory, anyway. This rings true when we consider that the small factories seem to be successfully competing with the larger ones right along.

The big manufacturer has one important advantage in the purchase of his materials: the more boilers built the greater the amount of materials required, and the lower the prices at which these materials can be obtained. This is a common and well-known practice among all industries. Thus the larger boiler manufacturer may be able to purchase a slightly better grade of materials at the same price that his smaller competitor must pay for a lesser quality and quantity.

Besides, the big producer is often able to employ a force of workmen consisting almost entirely of specialists. Each is given his own peculiar task, in which constant application has enabled him to become highly proficient.

As far as I have been able to observe, though, the small factories also are provided with experts who seem able to hold their own very well, and although they may not receive the same high salary, their lower salary tends to equalize the profits between the large and small shop.

Truly, it is rather a complex question. The large factory has a higher overhead cost usually. Smallness is often more desirable than bigness. In boiler manufacture both have their advantages and disadvantages.

Building a boiler is much like building a house: one man in ten days can often do as much work as ten men can do in one day. If the one man is particularly skillful he can build a better house alone than the ten could should there be two or three unskillful men in the gang.

I therefore declare myself neutral. It all depends upon circumstances as to whether or not quantity makes quality.

New York. N. G. NEAR.

Selected Boiler Patents

Compiled by

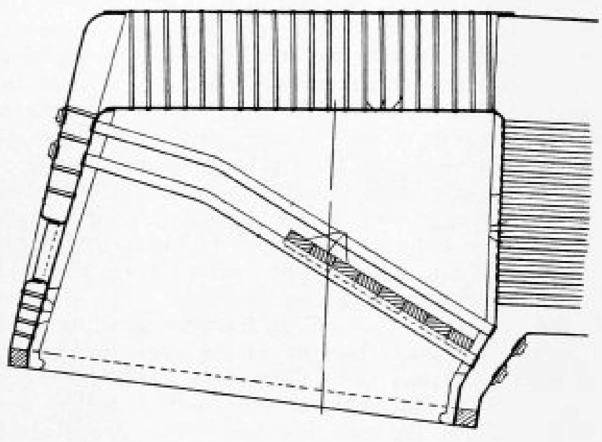
DELBERT H. DECKER, ESQ., Patent Attorney,

Millerton, N. Y.

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

1,110,815. LOCOMOTIVE FIRE-BOX CONSTRUCTION. LE GRAND PARISH, OF NEW YORK, N. Y.

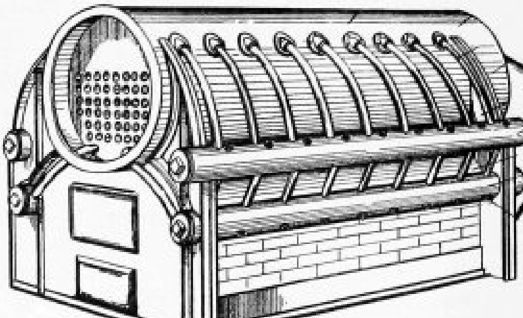
Claim 2.—A locomotive firebox comprising in combination with water spaces, a plurality of circulating tubes extending rearwardly and upwardly from one water space to another and arranged in two rows, one above the other, and an arch wall supported on the tubes of the lower row and extending rearwardly from a point adjacent the forward end



of the tubes a portion of the distance to the rear water space, the said wall protecting the tubes of the upper row from direct contact with the intense heat, but subjecting said tubes to the action of the hot gases passing from the rear of the wall forwardly above the wall. Three claims.

1,111,176. STEAM GENERATORS. MAXIMILIAN VON PAGENHARDT, OF KANSAS CITY, MISS.

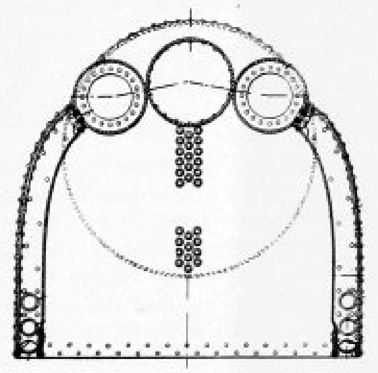
Claim 1.—The combination with a furnace, of a shell, headers at opposite sides of the shell, inclined conduits leading through the furnace and connected with the headers at opposite sides of the furnace, with



the lower end of one conduit communicating with the upper end of the other conduit through the headers whereby circulation is provided between the headers independently of the shell, conduits leading from the lower portions of the headers, and conduits leading from upper portions of the headers to upper portions of the shell, for the purpose set forth. Twelve claims.

1,111,266. FIREBOX FOR BOILERS. JAMES M. McCLELLON, OF EVERETT, MASS.

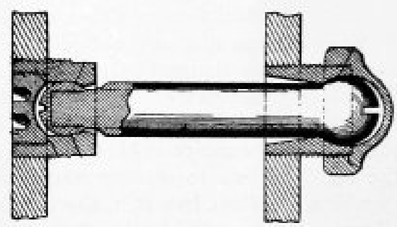
Claim 1.—In a boiler the combination of a series of upright, unitary flexion sections, each having an open side; a chamber at their upper ends with which said sections communicate and are connected; cover means secured to said sections and closing their open sides; and secur-



ing means for holding adjacent sides of said sections against distortion movement in the direction of the length of the series thereby to localize the expansion to individual sections. Thirty-five claims.

1,111,691. FLEXIBLE STAYBOLT FOR BOILERS. JOHN ROGERS FLANNERY, OF PITTSBURG, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

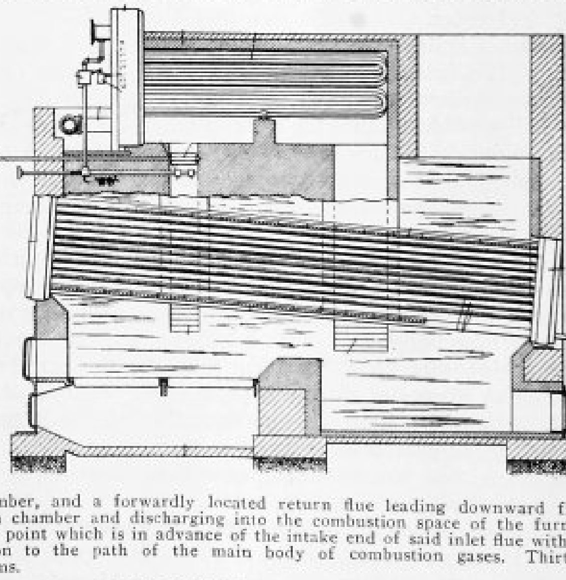
Claim 1.—In a staybolt for boilers, the combination of a pair of oppositely disposed sleeves each open at its ends, and each provided with



an integral infernal curved seat, a staybolt having two approximately spherical heads, one of which is detachably secured to the bolt, the said heads resting against the curved seats in the sleeves, and caps for the sleeves, the inner faces of the caps being curved to conform to the contour of the heads and approximately concentric therewith. One claim.

1,114,785. SUPERHEATER FOR BOILERS. EDWARD D. MEIER, OF RIDGEFIELD, CONN.

Claim 1.—The combination with a steam-boiler furnace, of a superheater chamber above the same having a hot gas inlet flue in the rear of the furnace leading hot gases upwardly and discharging them into such



chamber, and a forwardly located return flue leading downward from such chamber and discharging into the combustion space of the furnace at a point which is in advance of the intake end of said inlet flue with relation to the path of the main body of combustion gases. Thirteen claims.

1,114,812. SUPERHEATER FOR LOCOMOTIVE BOILERS. WILHELM SCHMIDT AND PETER THOMSEN, OF CASSEL-WILHELMSHOEHE, GERMANY, ASSIGNORS TO SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT M. B. H., OF CASSEL-WILHELMSHÖHE, GERMANY, A CORPORATION OF GERMANY.

Claim 1.—In combination with a locomotive boiler provided with smoke tubes, a superheater comprising a plurality of units constituted of loops arranged in said tubes all the ends of said units belonging to a plurality of smoke tube rows being bent into a common plane and, in said plane, the saturated steam ends and the superheated steam ends being arranged in two separate groups. Eight claims.

THE BOILER MAKER

FEBRUARY, 1915

Electric Arc Welding in Boiler Shops

Benefits Gained by Electric Welding—Description of the Process—The Strength and Cost of the Welds

BY GEO. W. CRAVENS*

The art of boiler making is a very old one, as old as the use of steam by man for power purposes, and yet boilers are made with riveted joints in practically the same way as from the beginning. To be sure, there have been great strides made in many of the details of construction, strength of materials, disposition of tubes and heating surfaces, forms of grates, etc., and the modern boiler is a much finer and more reliable piece of apparatus than ever before. Nevertheless, the limit of structural improvement for boilers with riveted shells and sheets has about been reached, whether of the internally or externally fired types and of whatever variety, with the result that practice has become pretty well standardized.

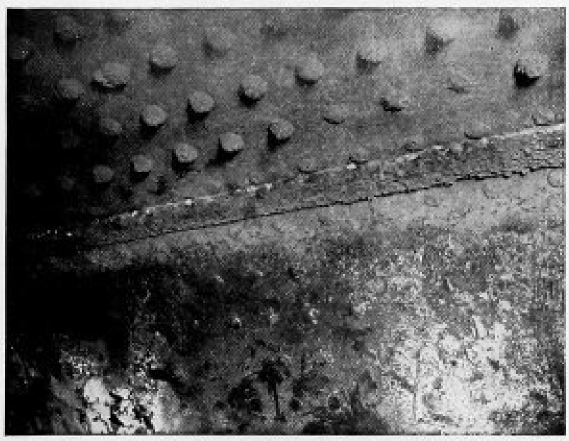


Fig. 1.—Corroded Seam After Having Been Repaired by Electric Welding

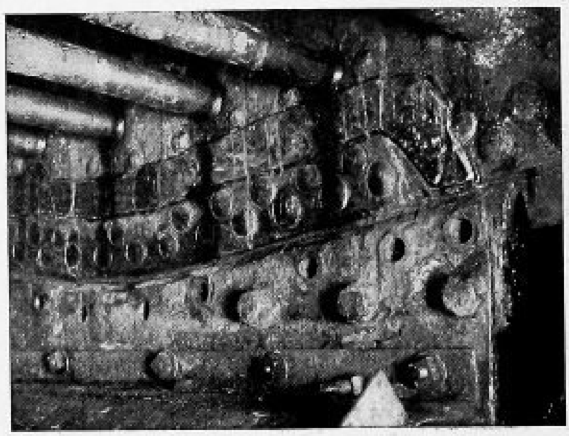


Fig. 2.—Patch in Locomotive Boiler Welded to Plate

It is because of this very standardization of practice that recent advances and developments in the application of electric arc welding to the manufacture and repair of boilers is so important. In fact, this application of the art of welding is so revolutionary and has been adopted so gradually and quietly that a large majority of boiler makers and repair men are not fully informed as to either the details or possibilities of the system. For instance, there are over 2,000 steam locomotives running in the United States alone to-day with more or less extensive arc-welding repairs made to their boilers; several hundred marine boilers with patches and cracks welded electrically; hundreds of contract boilers of all kinds repaired and thousands of low-pressure house-heating boilers made with arc welded joints. So gradual has been the adoption of electric arc welding in this field that many of the boiler inspectors and insurance companies are just beginning to appreciate the situation and to investigate the process.

Hence an article on this subject in THE BOILER MAKER at this time should prove of intense interest and benefit to all in this line of business. The benefits to be gained through the use of arc welding are so real and so numerous that it is hard to say which is the most important. Aside from the inconvenience of the process, it is a better, quicker and cheaper one than any other method of making permanent joints of great strength. This may sound like a strangely broad statement to many, but wait until you get the whole story. Another advantage in this process lies in getting joints of the same thickness as the plates, if desired, and eliminating the necessity for calking in order to get tight seams.

ELECTRIC ARC WELDING PROCESS

Electric arc welding is one of the oldest applications of the heat developed by the electric arc, but was not developed to a commercially practical point until within a comparatively few years. Several ways of using the arc for welding purposes have been devised, but only two of them are in general use for boiler making and repair work, so we will consider them only. Both of them have been developed to their highest degree by the C. & C.

* Manager, Welding Apparatus Department, C. & C. Electric and Manufacturing Company, Garwood, N. J.

Electric and Manufacturing Company, but we will deal with them under the names of the men who did the most originally to develop these processes to a practical point and apply them commercially. These are known as the Benardos and Slavianoff processes and are similar in principle but differ as to the method of applying the heat of the arc to the filling material and to the joint to be welded.

The Benardos or "carbon" welding process is the oldest form of practical arc welding, having been in commercial use for over 25 years, and is the process used for cutting and for certain kinds of welding. It consists in attaching one side of the current supply to the object to be welded and the other line to a suitable holder for the carbon or graphite pencil or electrode. The arc is then drawn between the job and the carbon, and the pieces melted together or the filling material fused into place by the heat of the arc, in a similar manner to using a gas flame. Cutting is done by allowing the arc to play upon one spot until the metal fuses and runs out, and the operation is very rapid and economical.

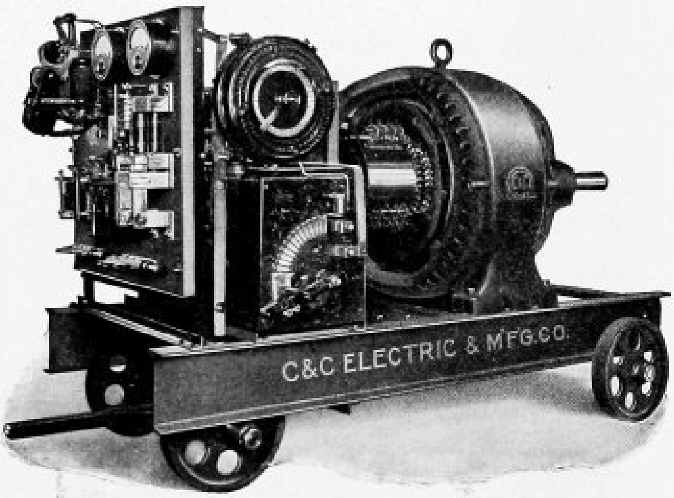


Fig. 3.—Portable Arc Outfit for Use in Shops and Yards

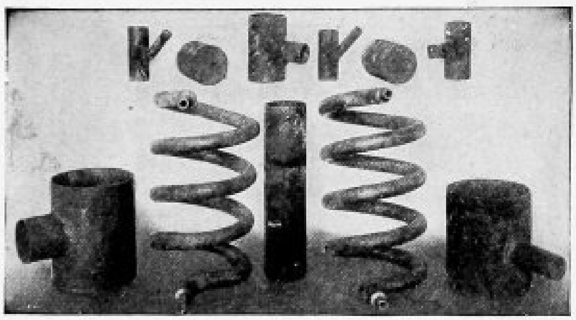


Fig. 4.—Thin Metal Pieces Welded with Metallic Electrodes

The Slavianoff or "metallic" welding process is the latest form of arc welding and was developed especially for use on steel plates and to give a more nearly universal method of welding than when using the carbon electrode. It also consists in attaching one side of the power supply to the job and the other to a suitable holder, but a piece of the filling material in the form of wire is used in the holder instead of the carbon pencil. The arc is struck in the same way, by touching the electrode to the job and withdrawing, but with this process the heat of the arc melts the metal electrode directly into place on the job and fills the joint. This is the process used almost exclusively for boiler work, and suitable apparatus for such work is now on the market. Those equipments comprising the most complete control systems are able to show advantages over the others, of course, and eliminate the personal equation to the greatest extent. Direct current at about 70 volts is used for both of the processes described, and the positive line is carried to the job and the negative line to the electrode holder for the best results.

Joints are of various kinds, depending upon the thickness of plates, location of joint, strength required, function of piece, etc. For low-pressure work the plates may be brought together edge to edge to form a butt joint, whereas it is better to make a lap joint for high pressures. The edges of the plates should be bevel-sheared for butt joints in order to allow the filler to give a joint full thickness of the plates, but lap joints may be made with either square- or bevel-edged plates, because the weld is made between the edges of the plates and the sides of the sheets. Butt joints are good for pressures up to 80 percent of the strength of the plates and lap joints up to 95 percent. Where full strength is demanded it is best to use a butt strap and a butt joint, welding the joint and along both edges of the strap. This is especially important for the longitudinal seams of heavy boilers, but lap joints will do for the girth seams. For medium and light boilers the girth seams may be butt welded and the side seams lap welded without butt straps.

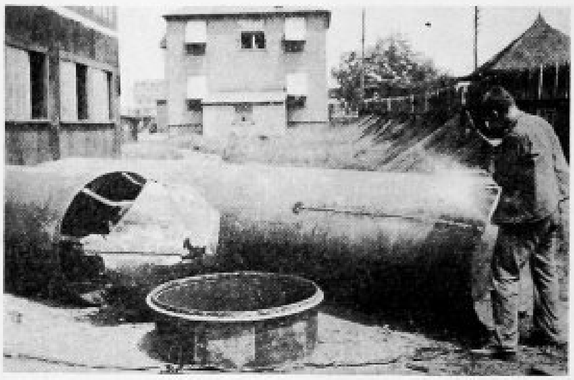


Fig. 5.—Cutting Scrap with Graphite Electrode

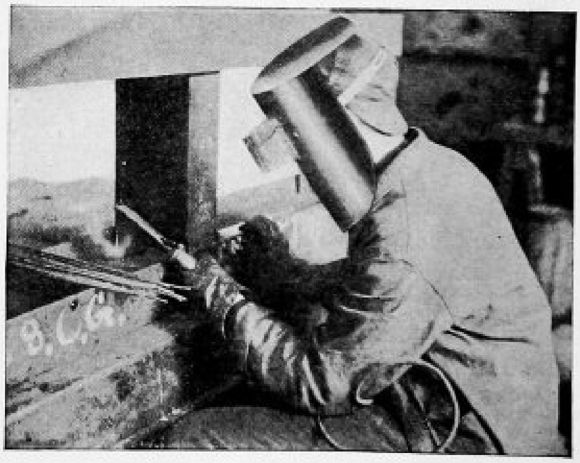


Fig. 6.—Operator Using Metallic Electrode. The Electrode Itself Is Melted and Supplies the Extra Metal Necessary for Welding or Building Up

The welding operation consists in setting the plates in the desired position, attaching the positive cable to them, drawing the arc and filling in the joint with the metallic electrode or melt-bar and arc. For plates up to about ⅝ inch thick the work is done by working entirely from one side, but for heavier work it is sometimes desirable to work from both sides of the plates if they are accessible. In this case, the joint is beveled from both sides to the center instead of from one side only. Owing to the peculiar action of the electric arc it is possible to work against a vertical wall or overhead almost as readily as down-handed, thus making this a much more convenient and universal process than any other. This also saves the expense of moving the boiler in many instances, thus

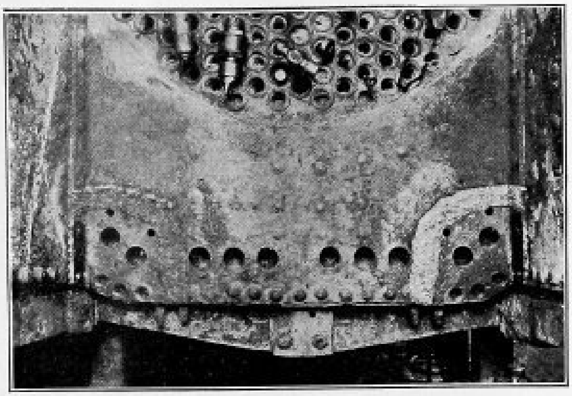


Fig. 7.—Shows Pieces of the Flue Sheet Welded in Position Ready to Rivet

reducing the cost very materially and saving valuable time. The filling material should be of about the same composition as that of the boiler, and the work is done with from 100 to 200 amperes, according to the thickness of plates, etc.

Aside from the beveling of the edges of the plates, the operation of preparing them for welding is similar to that for riveting except there is no laying out and punching or drilling rivet holes. This is another big item of saving. For convenience in assembling, it is sometimes desirable to insert bolts every 18 or 24 inches along the

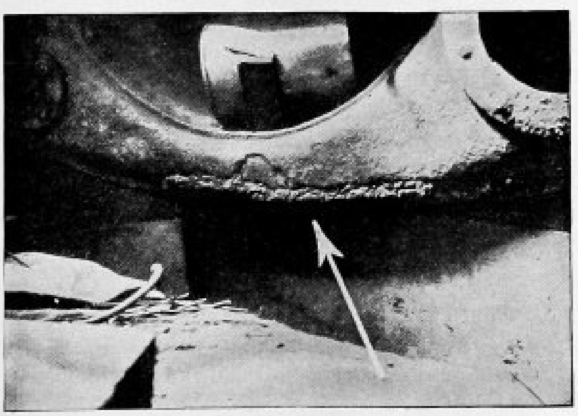


Fig. 8.—Boiler of *Sarnia* After Welding with Metallic Electrode

seams to hold the plates in position ready for welding, and this is especially easy when making lap joints. After the seams are welded the bolts may be removed and the holes welded tight with a metallic electrode. Where butt joints are to be made the sheets must be held in proper relation by means of suitable clamps, and any boiler maker will soon devise ways of handling such jobs easily. The heads, flue and throat sheets, domes, etc., for boilers should also be formed somewhat the same as for riveted boilers and bolted temporarily in place, then welded in. Most boiler shops are equipped with the necessary apparatus for handling plates and other boiler parts to good advantage, so it will not be necessary to enlarge upon that here, but, in general, it may be said that such labor as is necessary for handling the plates will be about the same for either process of boiler making.

Application to Boiler Building and Repair

Turning now to the specific applications of electric arc welding to the various parts and operations of boiler build-

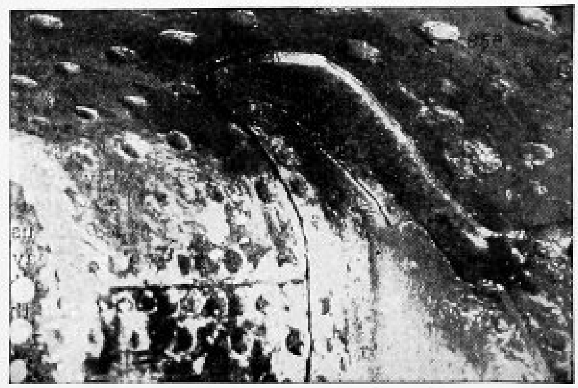


Fig. 9.—Ear of Throat Sheet Welded; Work Done Overhead with the Metallic Electrode

ing and maintenance, we find that all of the joints in practically every variety of boilers have been welded individually, but so far as the writer knows there has never been a completely welded boiler put into service. This is due to the virtual impossibility of getting any inspector to pass such a boiler on account of the existing rules. And yet it is possible to build boilers with electric arc-welded joints that will withstand pressures of 5,000 pounds per square inch, and parts of boilers have been so built and tested. In fairness to certain progressive boiler inspectors, it must be said that a number of them are highly in favor of electric arc welding, but have been unable to convince their respective home offices of the great value of this method of forming joints. But the good work is going on and it will only be a question of a short time before practically all who have to do with boilers will see the light, and then riveted boilers will gradually follow the wooden passenger cars and sailing vessels. Progress has always been a matter of finances and demand, and boilers cannot indefinitely resist the action of this law of business.

Boiler shells should be made by forming the sheets in the usual manner for butt or lap joints, depending upon the thickness of sheets and pressure of operation, and then welded as described. Boiler heads, flue sheets, firebox sheets, throat sheets and corrugated furnaces should be flanged as usual and then welded in place all the way around the edges of the flanges. In some cases it is desirable to weld along both sides, while in others the flanges may be omitted and the flat sheets welded in place in the shell by going around the edge of the sheet on both sides, depositing a fair-sized fillet with the metallic electrode. The ease with which the most irregular corners may be welded absolutely tight, regardless of position or location in the boiler, and the consequent freedom from leaks is not the least of the advantages of this system of boiler making.

Flue welding has been carried farther and in more kinds and types of boilers than any other welding operation, with the possible exception of welding cracks, and has cured an almost incalculable amount of trouble. In firetube boilers of all kinds, and watertube boilers with steel drums or headers, this operation has been done successfully, but in watertube boilers with cast iron headers it cannot be done because the tubes cannot be welded to the iron castings. For other kinds of boilers the work is done by expanding and beading the tubes and welding around the edge of the bead with a metallic electrode to tie it to the sheet. This makes a tight joint because the tube, sheet and filler become one piece. Safe ends are also being welded on old tubes and cracked or corroded tubes are being reclaimed, such work also being done with the metallic electrode.

Mud rings that have cracked or been badly corroded are also being repaired in place, thus saving the time and expense of removing and replacing. Cast steel doors and manholes can be welded in place because they and the sheets are both steel, and this saves making holes in the sheets for rivets, with the consequent liability of leaks. Domes and fittings of all kinds can also be welded on, and changes or additions may be easily made. By using the graphite electrode for cutting openings, these may be made after the main body of the boiler has been assembled instead of laying them out on the sheets and cutting them first, thus making it possible to save an appreciable amount of time when starting a rush job. This is also of value when making up boilers of new types, because it allows many attachments to be located and applied after the rest of the work has been started without danger of error and extra expense.

The marine boiler departments of both the United States and Canadian Governments approve electric arc welding for most all sorts of repairs, and now allow considerable leeway for applying patches, welding cracks, building up corroded plates, calking seams and numerous other sorts of work. Arc welders are in use in several of our navy yards and in numerous shipbuilding and repair yards and nearly 50 railroad shops continuously.

Strength and Cost of Welds

Something has already been said about the strength of welded joints, but this matter is worthy of further consideration because of the very unwarranted opposition to electric arc welding in some quarters. Joints can be made much stronger than the plates welded by using high-strength fillers or by reinforcing the joint, when making butt joints, or by making lap joints and welding on both sides of the plates. Under average operating conditions, in a number of shops that have come under the observation of the writer, it has been found that joints averaging from 80 percent to over 90 percent of the strength of the sheet are the rule. In order to test the relative merits of riveted, arc-welded and acetylene-welded joints, when made by workmen of average skill, the following pieces were made up and tested, with the results indicated:

Samples and Preparation	Breaking Strain.	Percent Efficiency.	Breakage.
Original piece of steel plate...	58,600 pounds	100.00	Near end of piece.
Lap joint, arc welded........	54,800 pounds	93.52	Outside weld.
Lap joint, riveted and welded.	54,200 pounds	92.50	Outside joint.
Butted joint, arc welded.....	47,800 pounds	81.57	Through weld.
Butted joint, acetylene welded	36,800 pounds	62.79	Through weld.
Lapped joint, riveted only....	35,000 pounds	59.72	In rivet holes.

The pieces of steel plate were all 3/8 inch thick and the tests were made by pulling the pieces in a tension testing machine and showed the relative merits of the various kinds of joints quite clearly. Another test made by a locomotive builder showed the following results:

Plate Thickness.	Elast. Lim. Lbs. Sq. In.	Tens. Strength Lbs. Sq. In.	Elongation Percent in 8 In.	Percent Effic.
1/4 inch	40,920	54,650	4.5	97.6
3/8 inch	40,930	53,020	5.75	94.7
1/2 inch	40,160	51,280	4.75	91.6

The elongation in the weld is less than in the plate because it is less fibrous, but its ductility can be improved by hammering while still hot when welding, and this is sometimes done on heavy plates. When the low efficiency of riveted joints is considered, the high efficiency of arc-welded joints shows what great advantages can be realized through using this system in place of riveting.

Welds for High-Pressure

Several of the illustrations herewith show high-pressure work and a number of boiler welds made by electric arc welding. In all cases the joints were both tight and strong and required no calking. The receiver, which was tested to 3,600 pounds per square inch by hydraulic pressure, is not an isolated example, but one of a number of jobs requiring great strength. Another example of high-strength welding is the work done in making Foster superheater flues by the Power Specialty Company. These tubes are tested to 5,500 pounds per square inch without fracture, and various other joints in these superheaters are also arc welded. These figures are absolutely reliable and prove beyond reasonable doubt that arc welding for boiler making is a perfectly practical operation, and it is bound to come.

The cost of boiler repairs with the electric arc shows such great economies that the figures are almost unbelievable, and yet the records of a large number of users of such apparatus made by the writer's company are very clear and complete, so we will give some of the figures. Take the very common trouble of a broken mud ring in a locomotive boiler and see what the comparative costs are between the old and the new methods of repair. This example was cracked in both corners:

Old Method—Stripping engine, removing mud ring, welding ring at the blacksmith shop, preparing for resetting, riveting in place, reassembling engine parts, and miscellaneous items of labor and material required, at usual prices..................$118.06

Arc Welding—Cutting out corners of plate, welding ring without removing and with no dismantling of engine, welding back in same pieces of plates and driving a few rivets......................$32.07

Showing a saving of $86.00 by using the newer method for this work. Another case is that of making general repairs to an old firebox instead of replacing it with a new one. The repairs cost $22.00 and a new box would have cost $800.00, thus saving $778.00 and several weeks' time. New work can also be done rapidly, economically and conveniently by welding instead of riveting, and locomotive, marine and contract boiler makers are slowly but surely using this method whenever the specifications will allow, and profiting greatly thereby.

Personal

T. C. O'Brien, general boiler inspector of the Baltimore & Ohio Southwestern Railroad and Cincinnati, Hamilton & Dayton Railway, at Cincinnati, Ohio, has been appointed general foreman at Lima, Ohio. Martin Murphy has been appointed general boiler inspector at Cincinnati.

Joseph F. Wangler, president Joseph F. Wangler Boiler & Sheet Iron Works, St. Louis, died recently of heart disease, aged seventy-eight years. He had been in business in St. Louis fifty-five years, and for many years was treasurer of the American Boiler Manufacturers' Association. One of his sons, Joseph A. Wangler, will continue in charge of the business, having been the active manager for some time.

Common Uses of Electric Welding Machines

In our issue of July, 1914, we illustrated and described an electric-resistance welding machine for safe-ending boiler tubes. This machine is used in railroad repair shops, by manufacturers of pipe coils, and for other like purposes.

There is a good deal of misinformation with regard to the fields in which various welding processes are employed. There is a process in which the electric arc is used with advantage, in the same field and for the same kind of work for which the oxy-acetylene process is employed; in cutting, filling up blow-holes in castings, building-up material in fractured castings, and in some forms of welding. This process, however, is quite distinct and the apparatus entirely different from that of the electric-resistance process, which is not suitable for repairing defective and broken castings, or in welding castings.

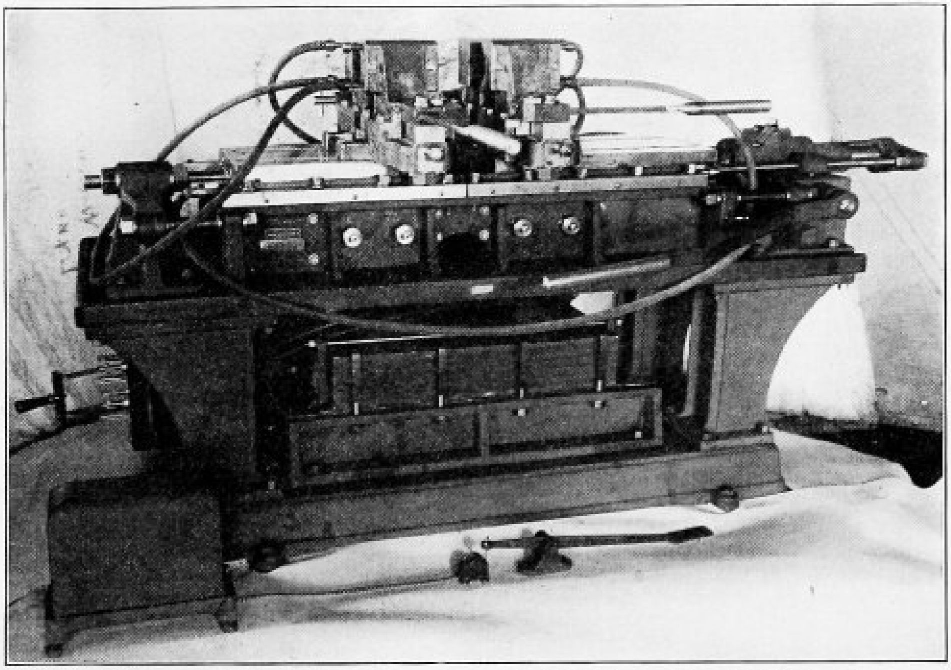
By the electric-resistance process heat is developed in the material where the joint is to be made and is not applied from the outside, like the arc weld and all other welding processes. This fact necessarily requires that the pieces to be welded together be held in electrodes conforming to the shape and size of these pieces, so that the current can be caused to pass through the material at the joint, and in order to do this these electrodes are made in the form of dies.

It will therefore be seen that a machine fitted with dies for welding a certain size and shape of material would not be suitable at all for welding some entirely different size and shape. The machines, therefore, are usually employed in duplicate work and are not blacksmiths' tools or machines for general repair work.

The machines are used in places where a large output is required and where the machine can be started up in the morning and employed all day in welding one thing; like safe-ending boiler tubes; welding pipe for coils; hub bands for farm wagons; carriage tires; shaft irons; fifth wheels; dash and fender frames; parts of bicycles; many kinds of tools; wire in all sizes and for all purposes, rings and hoops as well as in straight lengths; automobile rims; break levers; connecting rods; transmission shafts; axles; springs; propeller, crank and cam shafts; braces; brake bands, etc., and a great variety of special articles; like printers' chases, tramway rails in streets, spokes in hubs for agricultural wheels, seam-welding tubing, wire fencing and wire mesh for concrete reinforcement.

In all of the above articles it will be noted that it is duplicate work where an output is required.

There is, in electric-resistance welding machines, an opportunity for some variation in the work, provision being made in the machines to regulate the current for various sizes of stock; for instance, a machine with a normal capacity of 1½ inches round stock can be used, with the same dies, for welding ¼-inch round stock, and by a change in the dies, flat stock of any thickness from 1/32 inch 1 inch wide to 4 inches wide ⅜ inch thick, or any thickness when the sectional area is not increased beyond the capacity of the machine; and this material can be welded in lengths or in the form of rings or bands.



Electric-Resistance Welding Machine, Manufactured by the Thomson Electric Welding Company

A comparatively late-used branch of the electric-resistance method is what is known as "spot" welding. This method is entirely distinct and different from the older form, commonly known as "butt" welding, and is the subject of U. S. Patents owned by the Thompson Electric Welding Company, of Lynn, Mass. This method is employed in welding plate and sheet material in iron and steel, and the process will finally probably be developed to include this material in aluminum, brass and other metals. It is yet confined practically to the lighter gages under ¼ inch.

The electric-resistance welding machine for this spot-welding process is an entirely different machine from that used for butt-welding work. There are two ways of making this spot weld. One is to punch projections or bosses on the sheet, which makes points, to which the electric current is directed in passing from sheet to sheet, a flat electrode die being used. The other way is to confine the current by a pointed rod or pencil electrode to one point, without punching the sheet.

Boiler makers, however, are more interested in a machine for welding pipe and tubes, and a welder with a capacity for 5½-inch boiler flues and superheater tubes, ordinary pipe up to 4 inches, extra heavy pipe up to 3 inches, and double extra heavy pipe up to 2 inches, is shown in the accompanying illustration. This machine will also weld solid rounds up to 2 inches, thick flats, and the like, of equivalent section.

There are sometimes sections and shapes to be welded for which the clamping device shown on the machine is not suitable; that is to say, the pieces cannot be put into the device on account of their shape. This clamping device can then be removed and the pieces strapped directly on the gun metal platens or table by any simple device, which could be made in the shop in which the machine is used. A more elaborate form of clamping device could also be made and fitted on these platens, if required.

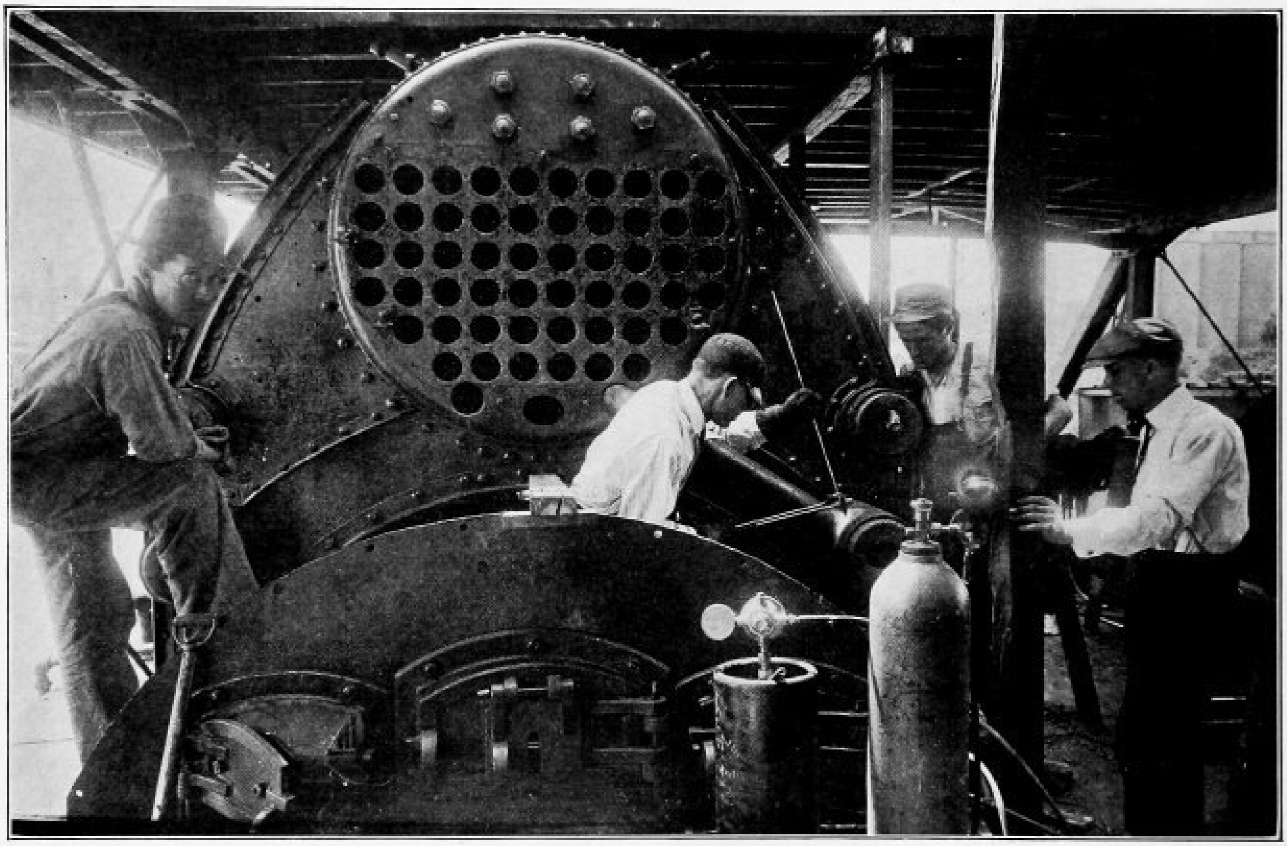
The pressure required to push the ends of the contacting pipe or other material together is effected by a 12-ton double-acting oil jack, operated by the lever at the front of the machine. In order to keep these electrode dies cool, water is caused to circulate through them, as shown by the hose.

To operate the machine to its full capacity a 60-kilowatt (90 K. V. A.) alternating current, single-phase or one-phase of a multi-phase circuit must be used, preferably from 40 to 60 cycles, and the machine can be adapted to any voltage between 100 and 600 most convenient for the operator. It takes about 30 seconds to heat a 4-inch tube and 50 welds can be made per hour. Small tubes, of course, take less power and less time to heat. The machine is complete in itself, and it is necessary only to run two wires from it through a wall switch to the source of power.

The machine illustrated is 94 × 60 × 47 inches high, and weighs about 8,000 pounds. It is manufactured by the Thomson Electric Welding Company, Lynn, Mass.

Marine Boilers with Tubes Welded by the Oxy-Acetylene Process

Two marine boilers rated at 150 horsepower and built for a working pressure of 250 pounds per square inch, were built recently by the Fowler-Wolff Sheet Metal Works, Paducah, Ky., for installation on the river towboat *Advance*, of the Kansas City Missouri River Navigation Company, Kansas City, Mo. As the specifications for these boilers called for welding the fire tubes into both the front and rear heads, and also the downflow supply pipes connecting the main boiler shell with the lower drums on each side, the builders of the boilers purchased from the Economy Welding Machine Company, Kansas City, Mo., one of their "Outfit A" oxy-acetylene welding plants, which is shown in the illustration in operation.



Welding the "Downflow" Pipes on High-Pressure Boiler of Western River Towboat

The boilers were required by the rules and regulations of the United States Steamboat Inspection Service to stand a hydrostatic pressure of 500 pounds per square inch. All of the welding was done at the boiler shop in Paducah with the exception of welding the downflow supply pipes, which was done after the boilers had been placed on the towboat at the Kansas City Missouri River Navigation Company's docks in Kansas City.

PERSONAL.—John Wood, president John Wood Iron Works, Portland, Ore., died January 12, having been in poor health for about a year. He was born in Wales and came to the United States in 1880. It was largely due to his efforts that the Columbia Engineering Works made the first steel manufactured on the Pacific Coast.

Electric Arc Welding; Its Use in the Shop

Description of Electric Welding Apparatus Manufactured by the General Electric Company—Its Possibility as an All Around Shop Tool

BY J. A. SEEDE *

Although arc welding equipments have been in use for several years, there are many prospective users who are ignorant of the possibilities of such equipments, the apparatus they consist of and their operation. As all-around shop tools for quick and thoroughly serviceable repairs on all kinds of machines, they have no equal, and their capacity is only exceeded by their wide range.

Disregarding the many arrangements that have been proposed but are not used commercially, it can be said that electric arc welding is divided into carbon or graphite electrode welding and metallic electrode welding. Carbon electrode welding includes the very light work on thin metal using ¼-inch diameter electrodes carrying 40-80 amperes, all average conditions using ¾-inch diameter electrodes carrying 300-500 amperes and up to 1½-inch electrodes carrying 600-1,000 amperes for very heavy work including cutting. Metallic electrode welding varies from 30 amperes for very light work to 130 amperes for all ordinary work up to 200 amperes for rough, heavy work.

In both classes of welding a large part of the operator's success depends upon the ability of the generating equipment to maintain a steady voltage under the rapidly varying current conditions. The construction shown in Fig. 1 is especially adapted for such service and the correctness of the design is demonstrated by the satisfactory service of these equipments. The quality of the electrodes is of great importance, the carbon electrode requiring fine texture, freedom from cracks and irregularities; and the metal electrodes, freedom from scale, slag, cracks, etc.

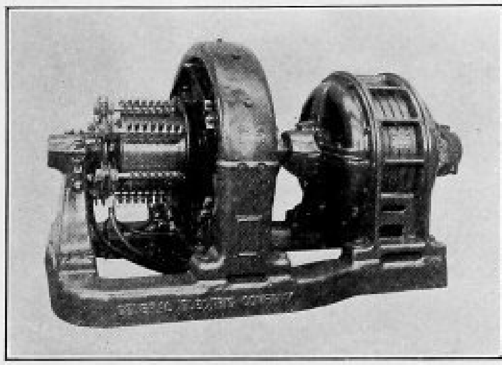


Fig. 1.—800-Ampere Arc Welding Set, Consisting of Generator Driven by Induction Motor

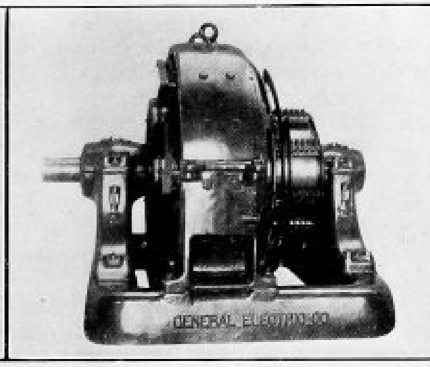


Fig. 2.—200-Ampere Portable Arc Welding equipment

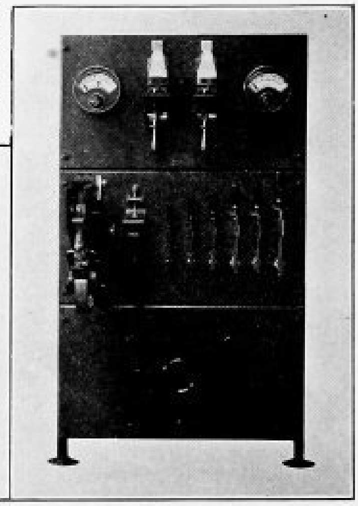


Fig. 3.—800-Ampere Arc Welding Generator Panel

A modern arc welding equipment usually consists of a suitably driven compound-wound direct-current generator designed to operate at a constant voltage between the limits of 60 to 75 volts, with control panel having automatic protection in addition to customary rheostats, switches, etc. Stationary equipments have been standardized in capacities of 200, 300, 400, 500, 600, 800, 1,000 and 1,250 amperes, with portable equipments of 200 and 300 amperes.

In the smallest sizes each equipment is only good for one operator, unless very light work is being done; while, as the capacities are increased, more operators can work from one equipment, until with the largest sizes the number of operators is only limited by the relation of the capacity of the equipment to the kind of welding being done.

To vary the current supplied the arc, a rheostat is connected in series and sections cut in or out by means of a dial switch. A high-resistance low-current section, normally short-circuited by the contactor, serves as a preventative resistance.

There are several advantages to be derived from the slightly increased complexity caused by adding automatic protection. As long as operators are human, mistakes

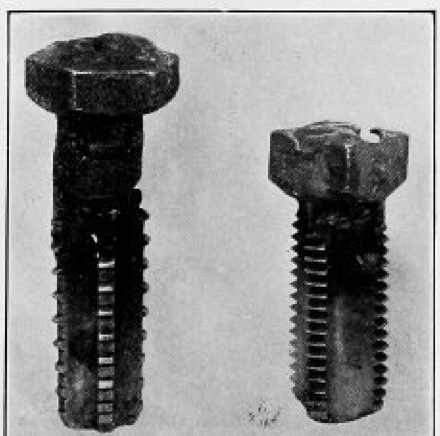


Fig. 4.—Broken Taps, Removed by Arc Welding Equipment

* Power & Mining Engineering Department, General Electric Company, Schenectady, N. Y.

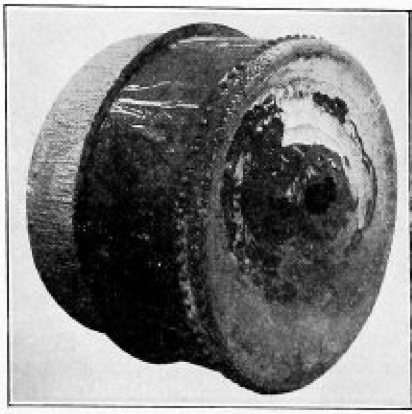


Fig. 5.—Compound Kettle, With Hole Burned in Bottom Plate

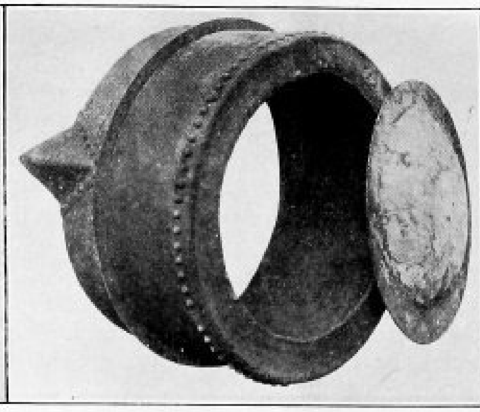


Fig. 6.—Compound Kettle, With New Plate Ready for Welding

Fig. 7.—Compound Kettle Repaired and Practically as Good as New

will occur and a distinct loss in working efficiency occurs every time the operator leaves his work to walk to the panel to close a circuit breaker, or what may occasionally happen, to have several operators wait for someone to go to the main panel in the case of a severe short-circuit that blows the main circuit-breaker. With the equipment previously referred to, as soon as the operator takes too much current for a short time the series relay breaks the exciting circuit of the contactor, throwing the preventative resistance in circuit, which warns the operator that he has taken too much current. Immediately on breaking the arc, the relay closes the exciting circuit and the contactor short-circuits the resisance, leaving the circuits in their normal operating condition.

These relays and contactors are clearly shown in Figs. 2 and 3. In Fig. 2 is shown the arrangement of the 200- and 300-ampere portable equipments. This is a very compact equipment for metallic electrode welding and other light work, and is designed to stand up under the somewhat rough treatment these equipments meet when dragged around the ordinary shop. In Figs. 3 and 1 are shown the control-panel and the motor-generator set respectively for the 800-ampere equipment. This differs in arrangement from the smaller sizes only in supplying knife-blade switches in place of the dial switch, on account of the increased capacity.

In Fig. 4 are shown taps, broken in work, which were removed by welding up to and through a nut. On being allowed to cool, the tap was backed out, the total time required being 4 to 8 minutes. One-inch taps broken off 2½ inches below the surface have been removed without injury to the thread by putting a piece of gas pipe in the hole before starting to weld.

In Figs. 5, 6 and 7 is shown a kettle used for heating insulating compounds. After a time the bottom plate

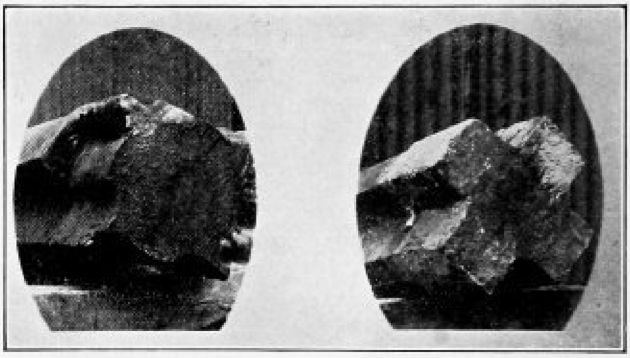


Fig. 10.—Steel Roll Wobbler Worn and Repaired by Arc Welding

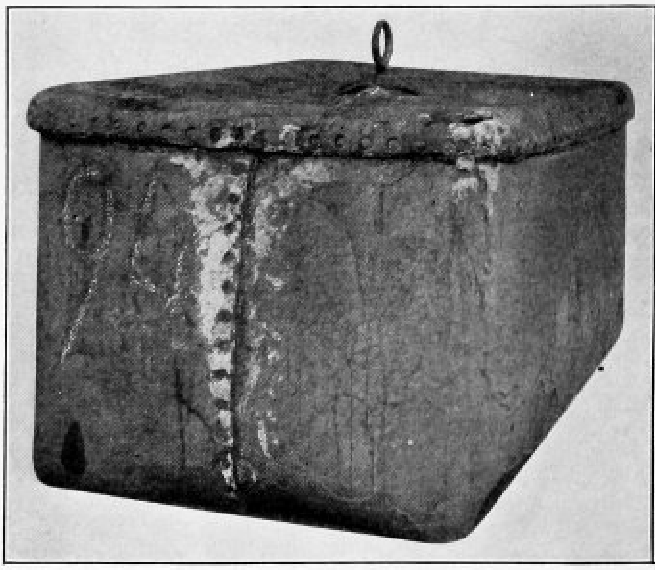


Fig. 8.—Annealing Box With Hole Burned in Corner, Rivet Heads Burned Off and Plates Sprung at Joints

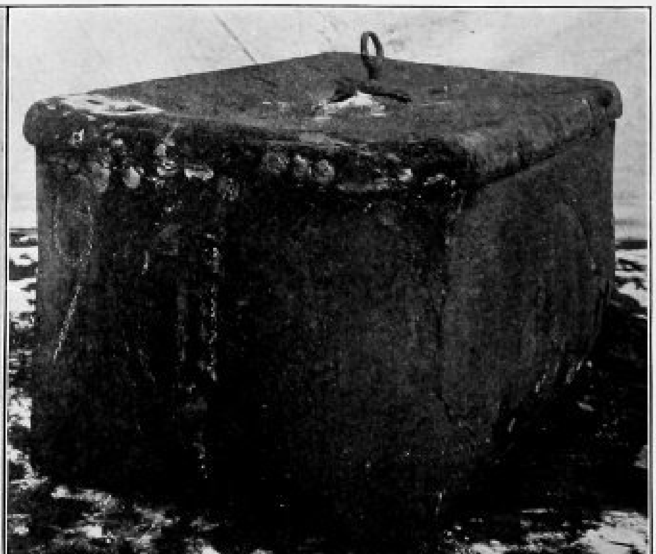


Fig. 9.—Annealing Box, With Hole Welded in Corner, Rivets Built Up and Plates Welded and Filled in at Joints

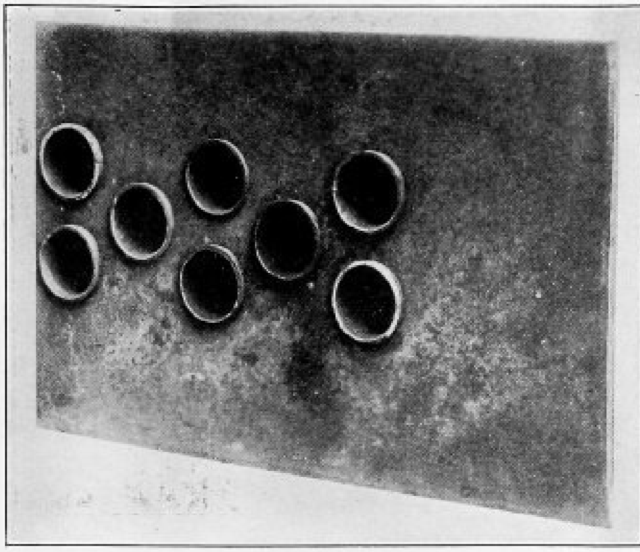


Fig. 11.—Small Section of Locomotive Flue Sheet, Tubes in Place and Ready for Welding

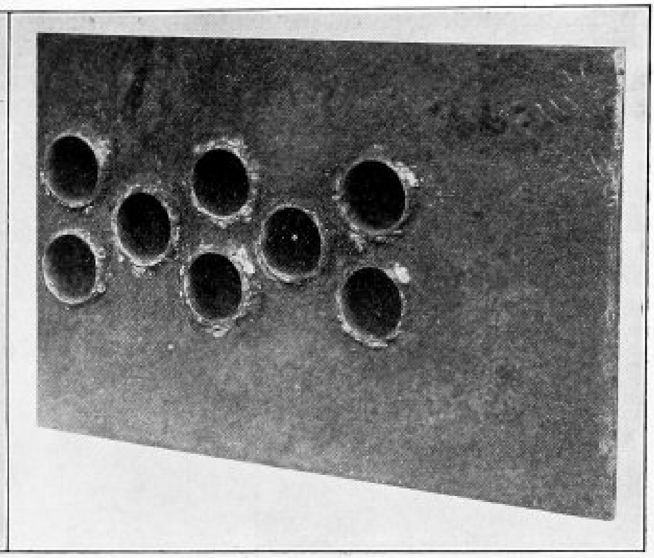


Fig. 12.—Small Section of Locomotive Flue Sheet, Tubes, Welded

bags and burns out. It is then cut out with the electric arc, on account of rust and dirt on the metal and a prepared plate is welded in, after which we have a practically new kettle.

A similar class of work is shown in Figs. 8 and 9, where a box for holding laminations during annealing is shown with a hole burned in the corner, the rivet-heads burned off and the plates sprung apart at the joints. The operator soon filled up the hole, built up the rivets and welded the plates together.

In Fig. 10 we have a sample of heavy work, in which a steel roll wobbler is shown very much worn and useless without considerable repairing. After the worn parts had been built up by arc welding, the wobbler was as good as new, and a considerable saving in time and money had been effected.

In Figs. 11 and 12 we have a section of a standard locomotive flue sheet with tubes before and after welding. This is one of the most important applications of arc welding and one of the many in which it is showing up very satisfactorily.

In Figs. 13 and 14 we have a gear case with hole ready for welding, and the same gear case ready for service. Such holes are occasionally met with and the photographs show the satisfactory way in which they can be repaired.

These illustrations exhibit only a few of the many possibilities of repair work that is being done every day by these equipments and indicate losses in every plant that does not possess such an equipment.

In addition to repair work, many of these equipments are being used in welding small structural steel shapes for various purposes, where the speed and flexibility of these equipments are particularly desirable. While electricity has been put to many and varied uses, it is doubtful if there are any that are more useful and interesting than the various forms of electric arc welding.

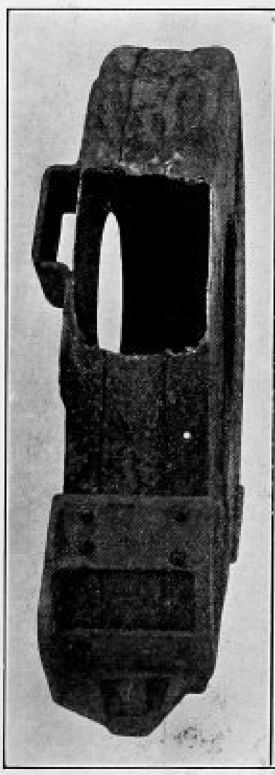


Fig. 13.—Hole in Gear Case, Cleaned Up and Ready for Welding

Fig. 14.—Patch Welded Over Hole in Gear Case

Oxy-Acetylene Welding and Cutting on the Frisco.—During the past eighteen months the Frisco has installed and put in operation nine oxy-acetylene welding plants supplied by the Oxweld Railroad Service Company. The largest is at the new shops at Springfield, Mo., where twenty operators are regularly employed. The oxygen and acetylene gases are piped to the different shop departments from a central generating plant. Accurate and thorough records have been kept of the comparative costs of doing similar work with the oxy-acetylene apparatus and by former methods. At the Springfield new shops from July 1, 1913, to June 30, 1914, savings amounting to $83,191.60 were made by the oxy-acetylene process, while the savings for the nine plants from April 1, 1913, to August 31, 1914, were estimated at $181,364. The greatest use of the oxy-acetylene process so far has been in connection with boiler repairs. The Frisco now has in operation more than 400 locomotives in which firebox sheets and patches have been welded, and the welding of tubes into the tube sheet has proved most successful, increasing the life of both tubes and tube sheets, possibly 50 percent.—*Railway Age Gazette*.

Application of the Mahr Portable Torch for Boiler Shop Use

One of the handiest tools in the boiler shop is a portable oil-burning torch for use in pre-heating metal before welding, and also for laying up riveted seams, corners of plates and flanges preparatory to either riveting or welding. The torch manufactured for this purpose by the Mahr Manufacturing Company, Minneapolis, Minn., illustrated in Fig. 1, is so constructed that the oil vapor from either kerosene or crude oil is discharged from an atomizer into an inner chamber, where it is ignited. This burning vapor in passing through a choked nozzle into a second chamber draws in free air through auxiliary air openings, causing, it is claimed, a perfect burning mixture and a steady, compact flame.

Fig. 1

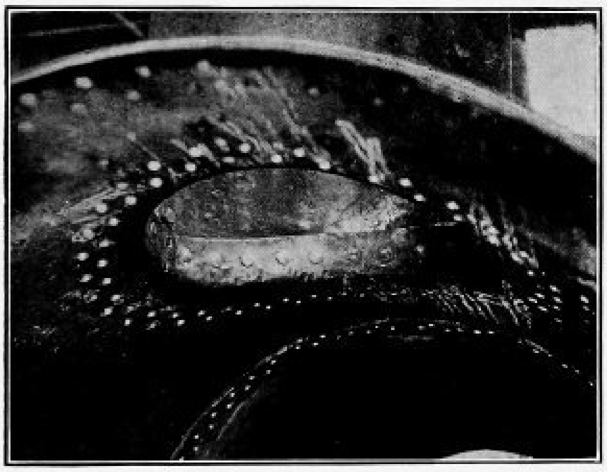


Fig. 2

Fig. 2 shows the inside of a boiler where the sheet has been flanged for connecting to a dome. No welding is done in connection with this job, but the portable oil-burning torch is taken into the boiler and the lap around the dome connection is heated and laid up to a perfect fit.

In Fig. 3 the torch is shown in operation pre-heating the thick metal on a part of a steam shovel which has been broken off. The piece broken off was part of a very large casting, and it would have been almost impossible to pre-heat this part by any other method except by using a portable torch. The work was done in a railroad boiler shop where the torch is in common use for many purposes.

Fig. 4 shows a fire door opening partly welded. The inside sheet is brought through the fire door opening of the back head, and then heated with a portable torch and made to fit before welding. Fig. 5 shows another fire door opening where an asbestos sheet has been placed against the opening on the inside to deflect the flame from the portable torch to the sides. In this way the entire lap around the door hole is laid up with one heat, so that the job is completed in fifteen minutes.

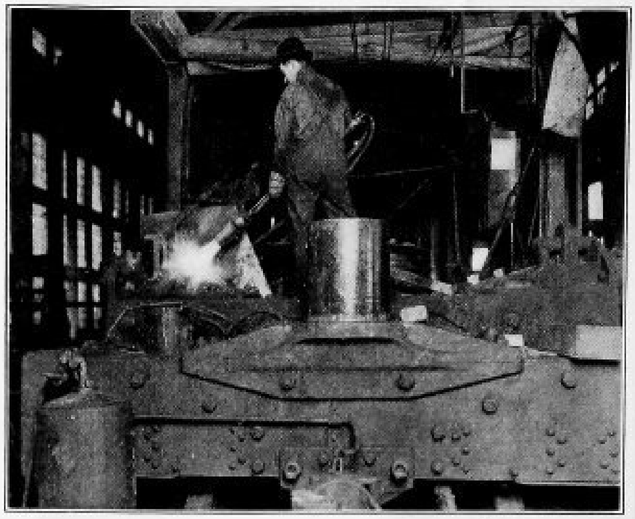


Fig. 3

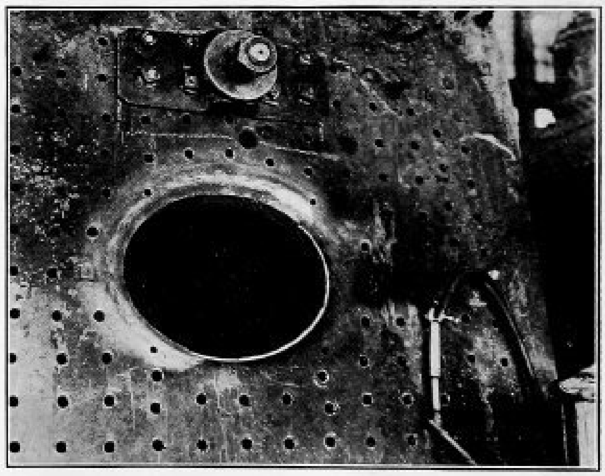


Fig. 4

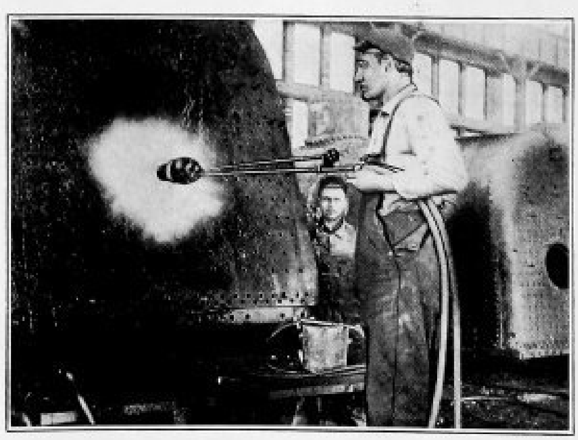


Fig. 5

Fig. 6 shows a broken mudring being pre-heated for welding. A V-shaped notch is cut in the mudring where broken, or a V is cut from each side and built up with the welding torch. After the part of the mudring which is to be welded has been brought to the proper temperature, the oil-burner is regulated so as to produce a small pointed flame just sufficient to keep the mudring well heated while the welding is being done with the welding torch.

Similar work is shown in Fig. 7, where a broken casting is being welded by the oxy-acetylene process. The

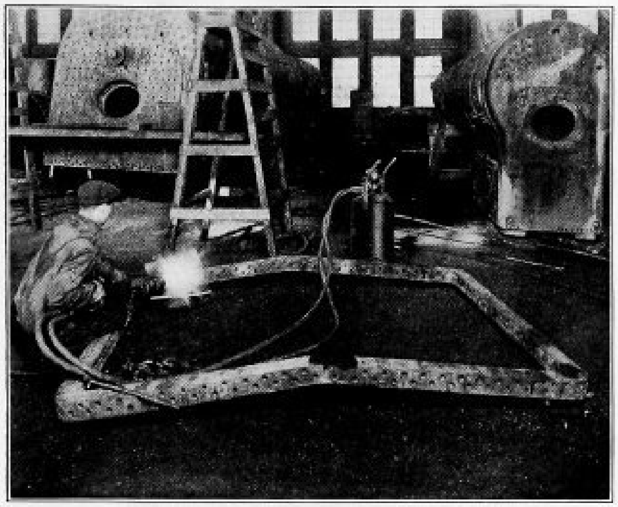


Fig. 6

casting is heated to the proper heat and maintained in this condition during the welding operation. Pre-heating and annealing when properly done in this manner, it is claimed, take care of all expansion and contraction of the metal welded, and work done in this manner is found to be entirely satisfactory. The use of the pre-heating torch in

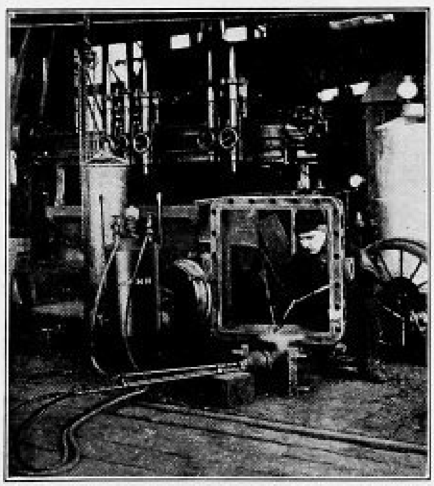


Fig. 7

this manner saves both time and money, for when the metal is brought to a red heat a smaller amount of welding gases is used and the work is done more rapidly.

Engineering Foundation Established.—Ambrose Swasey, president of the Warner & Swasey Company, Cleveland, Ohio, and a past president of the American Society of Mechanical Engineers, has given $200,000 to the engineering profession as a fund for research.

Special Oxy-Acetylene Welding Jobs

Figs. 1 and 2 show two special jobs of welding carried out with oxy-acetylene welding apparatus manufactured by Messer & Co., Philadelphia, Pa. The steel cylinder

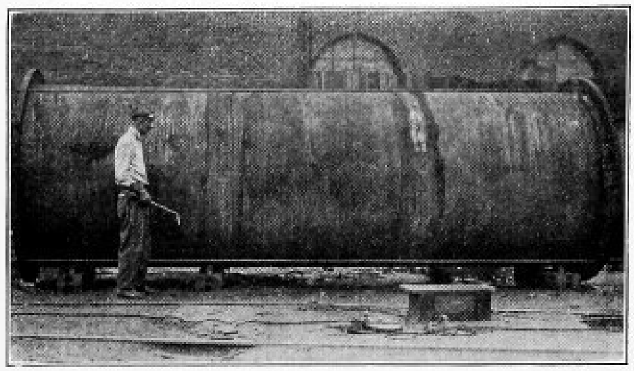


Fig. 1.—Steel Cylinder, With Seams and Flanges Welded

shown in Fig. 1 is 24 feet 6 inches long and 72 inches inside diameter. It is constructed in three sections of 9/16-inch plate, and at the ends flanges 2½ inches outside diameter are welded on.

Fig. 2 shows an irregular section of twisted pipe, which

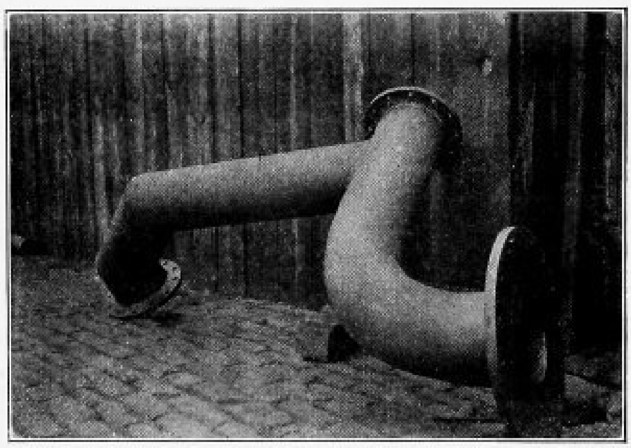


Fig 2.—Twisted Pipe, With Joints Welded

has been made up with all the joints welded. The pipe is 10 inches diameter, made of ⅜-inch metal.

Difficult Cast Iron Welding

Cast iron welding is always more difficult than steel welding, on account of the character of the metal. However, temperature effects may be much more important than the composition or structure of the metal. This is especially true in castings that have ribs or other parts that make equal cooling and heating impossible.

The welding of cast iron in most instances depends upon the skill of the welder in laying out the work. Especially must he take into account heating and cooling, so that dangerous strains are not developed which may easily wreck the work.

One of the most difficult jobs of this type was done by The Electric Welding Company, 220 West Forty-second street, New York, on an old-fashioned walking beam engine with a cast iron jet condenser directly underneath the cylinder. This condenser was cylindrical in form and supported the cylinder upon its upper flange. On each side there was cast an L-shaped lug to which was fastened one of the legs of the wooden A-frame which supported the main shaft.

The condenser casting had gradually corroded and wasted away until it was no longer strong enough to carry the strains put upon it by the A-frame through the lugs on the sides. The effect of this was to cause cracks around the lugs. In front there was a crack about three feet long. Another one just above it and one below it were also found.

To take out the condenser and renew the foundation of the engine would have required at least six weeks during the busiest season, therefore the owners decided to take a chance on welding and the Electric Welding Company, which specializes in cast iron work, was called in to do the job.

In doing the work the wooden beams of the A-frame were removed, the cracks chipped open and the walls of the cylinder braced in position. To avoid temperature strains the large difference in mass and radiation capacity between the lugs and the cylinder proper, it was necessary carefully to preheat the whole working area so as to maintain the uniform distribution of temperature.

On account of the general weakness of the metal it was necessary to do the welding in installments. First a thin weld was made both from the inside and outside, then the surface of the welding was chipped off and rewelded, and finally the reinforcement was added. The mechanical finishing of the welds was done with air tools, then the whole area was packed in sand and allowed to cool. By preventing sudden cooling dangerous strains were avoided.

This job occupied only three days of time and the boat ran until the end of the season. There is every reason to believe that it will also run through the coming season without further trouble.

Repair of a Steam Road Roller After Collision with a Wall

An interesting example of the application of the oxy-acetylene process for the repair of heavy machinery is found in the case of a steam road roller, illustrated in Figs. 1 and 2, which was put out of service by running into a wall. The shock of the collision broke the main-head casting around the fore-truck swivel pin, and also broke the 6-inch swivel pin squarely in two. Fig. 2 shows the detail of the break in the head casting, a large piece being knocked out completely. The metal was about ½ inch thick. The swivel pin may be seen lying on the floor with the broken end pointing outward.

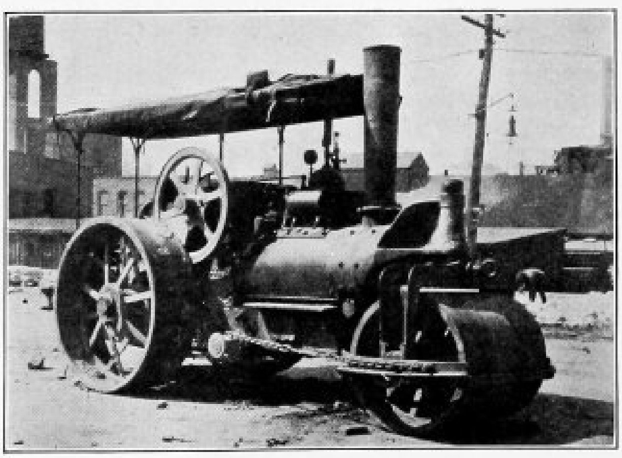


Fig. 1.—Road Roller; Damaged by Collision

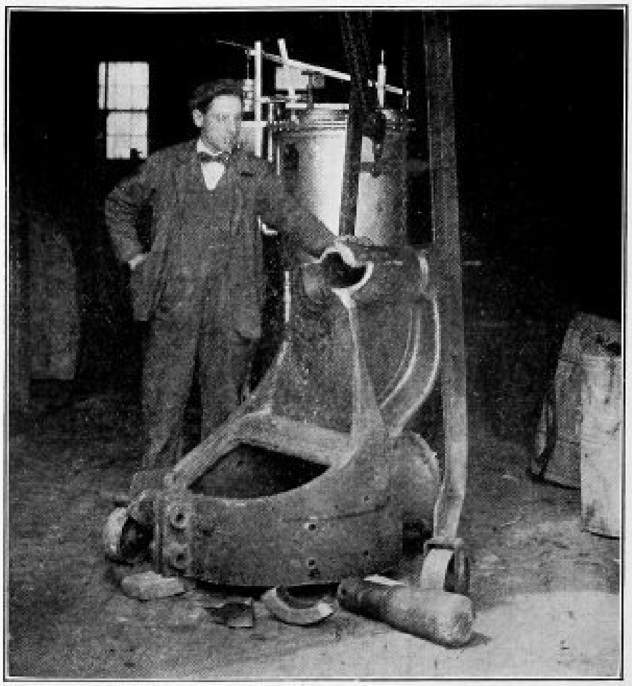


Fig. 2.—Broken Head Casting

Such an accident as this, of course, put the roller entirely out of service. In order to make a quick, efficient repair and to return the roller to service as soon as possible, the head casting was unbolted from the end of the boiler and was sent, together with the pin, to the shop for an oxy-acetylene repair. Both the break in the head and the heavy pin were welded in a few hours' time from their delivery to the shop and were returned to the roller for re-erection on the road. The two welds restored the roller to service in as good condition as new, and the great delay and expense of securing new parts were avoided.

This repair was made with a Milburn oxy-acetylene plant, manufactured by the Alexander Milburn Company, of Baltimore, Md.

Bill Extending Boiler Inspection to Entire Locomotive

The house of representatives passed on January 4 a bill supplementing the federal inspection of locomotive boilers, which will extend the federal supervision to all parts of the locomotive and tender. The bill went to the senate, and on January 6 was read twice and referred to the committee on interstate commerce.

Sections 2, 3 and 4 of the bill read as follows:

Sec. 2. That the chief inspector and the two assistant chief inspectors, together with all the district inspectors, appointed under the act of February seventeenth, nineteen hundred and eleven, shall inspect and shall have the same powers and duties with respect to all the parts and appurtenances of the locomotive and tender that they now have with respect to the boiler of a locomotive and the appurtenances thereof, and the said act of February seventeenth, nineteen hundred and eleven, shall apply to and include the entire locomotive and tender and all their parts with the same force and effect as it now applies to locomotive boilers and their appurtenances. That upon the passage of this act all inspectors and applicants for the position of inspector shall be examined touching their qualifications and fitness with respect to the additional duties imposed by this act.

Sec. 3. That nothing in this act shall be held to alter, amend, change, repeal or modify any other act of congress than the said act of February seventeenth, nineteen hundred and eleven, to which reference is herein specifically made or any order of the Interstate Commerce Commission promulgated under the safety appliance act of March second, eighteen hundred and ninety-three, and supplemental acts, except that for a violation of the act of February seventeenth, nineteen hundred and eleven, as hereby amended, or of any rule or regulation made under its provisions, or of any lawful order of any inspector acting thereunder, the offender shall be subject to prosecution by the United States for a penalty under said act, as hereby amended, only: Provided, That the passage of this act shall not affect any suit pending or offense committed prior to the passage hereof.

Sec. 4. That this act shall take effect six months after its passage, except as otherwise herein provided.

Heavy Work Welded by the Oxy-Acetylene Process

Two representative instances of successful welding of heavy metal are shown in Figs. 1 and 2. Fig. 1 shows a large steel tank on which the angle iron ring at the base was cracked in the course of construction. This crack was welded up with oxy-acetylene apparatus.

Fig. 2 shows the broken head of a bull dozer bedplate, weighing 24,000 pounds. In this photograph one head of the bedplate is shown intact while the other is broken. The head shown intact was brazed eighteen months before, and when the casting received the strain which broke the other head, it was clearly demonstrated that the head which had been brazed on was stronger than the original casting, as the casting broke through the opposite side.

Fig. 3 shows the same casting after being repaired with both heads brazed on. This work was done by the Pittsburgh Reinforced Brazing & Machine Company, Pittsburg, Pa.

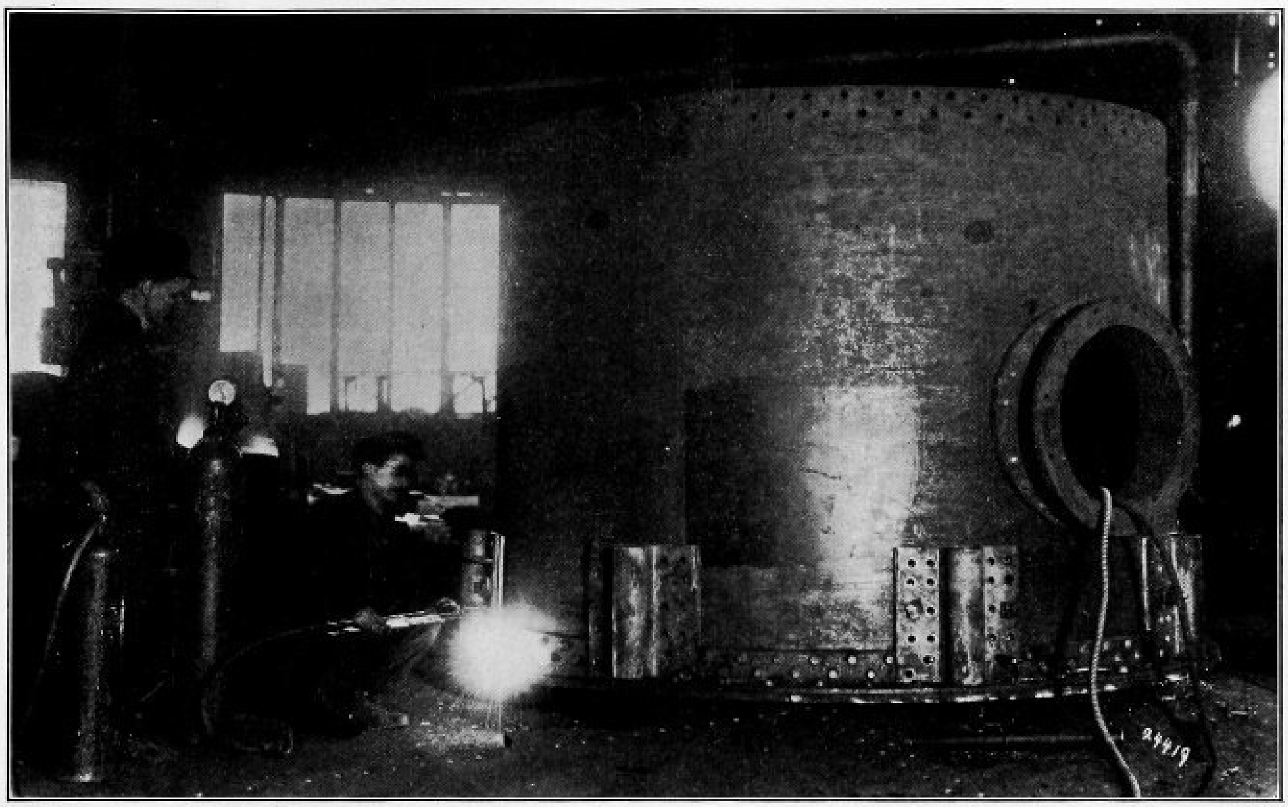


Fig. 1.—Welding Up Crack in Heavy Angle Iron Ring

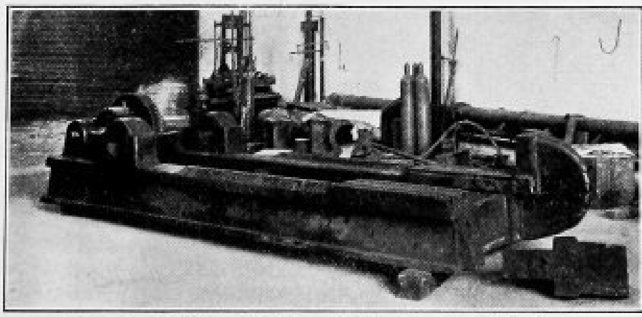


Fig. 2.—Bulldozer Bedplate, With Fractured Head

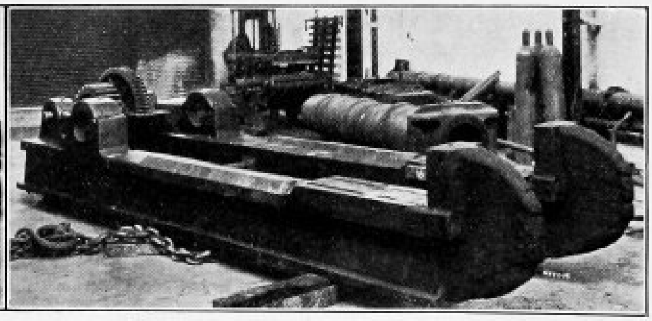


Fig. 3.—Bulldozer Bedplate After Repairs

Electric Arc Welding*

Carbon and Metal Electrode Processes of Electric Welding—Apparatus Required and Method of Operation

BY J. H. BRYAN †

The art of welding, which may be broadly defined as the joining together of metals into intimate and permanent union, dates back to the early days of history. Until within the last half-century the only practicable method of making a weld was by a process with which we are familiar, namely, that of heating the pieces to be joined at the point where the union was to be made, then, when they were almost at fusing point, placing them in their proper relation and completing the weld by hammering.

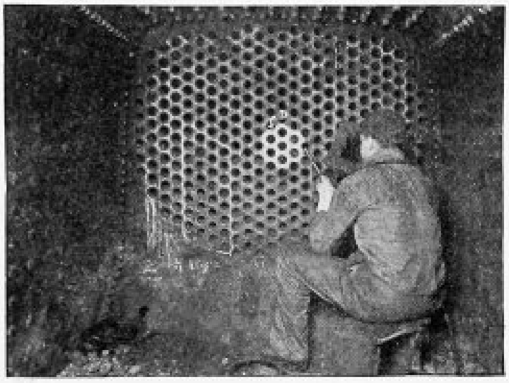


Fig. 1

This is a comparatively simple operation, and one which is carried out daily in every cross-road blacksmith's shop. There are, however, limitations to the score of this class of work, and until the introduction of the process which we are considering, these limitations were insurmountable. The introduction of the electric are welding process and the kindred ones of incandescent electric welding and gas welding has, however, very greatly increased the field of possibilities, and we are now able to produce results which were previously impossible to obtain.

The method of joining the metals by the use of the electric arc is one branch of what is known as autogenous welding. This term may be defined as the fusing together of two metals without pressure, by causing them to melt, then mix and unite as they cool. It differs from older methods in that successful results may be produced without hammering or pressure.

Coming now to a consideration of electric arc welding or, more briefly, arc welding as a commercial process, it may be divided into two general classes as follows:

First—Benardos or carbon electrode process in which the arc is drawn between the metal to be welded and a carbon electrode.

Second—Slavianoff or metal electrode process in which the arc is drawn between the metal to be welded and a metal electrode.

These two processes are generally spoken of as carbon electrode and metal electrode welding, respectively.

In addition to these there is the Zerener process, in which the arc is drawn between two carbon electrodes, as in the arc lamp, and the metal to be welded is placed in contact with the arc. This is, however, not considered as a commercial proposition in this country at least, as its field of application is limited, and the apparatus itself is unwieldy.

Carbon Electrode Process

"In carbon electrode welding the metal to be welded is made one terminal of a direct-current circuit, the other terminal being a carbon electrode. Upon closing the circuit by bringing the carbon electrode into contact with the metal and then withdrawing it to a distance, an arc is drawn between the two terminals. Through the medium of the arc, which is the hottest flame known (having a temperature between 3,500 and 4,000 degrees C.—6,300 to 7,200 degrees F.), the metal may be either entirely melted away, molded into a different shape or fused to another piece of metal as desired.

"In the first attempts to weld by this process the carbon electrode was made the positive side of the circuit and the metal to be welded the negative. Practice, however, shows that it is better to reverse these conditions, for, if not, since the flow of current is from positive to negative, particles of carbon will find their way into the welds, thus tending to make them exceedingly hard and consequently difficult to machine. A further very important advantage is gained by making the metal to be welded the positive terminal. It is a well-known fact that in a direct-current arc the highest energy consumption—about 75 percent of the total—and therefore the highest temperature occurs at the positive terminal, and, while no very extended data are available regarding the behavior of arcs having either or both electrodes of metal, there is considerable information regarding arcs, and it is fair to assume that, with reference to this particular point, there is not a wide difference between them. Since the positive is at the highest temperature, the greatest amount of heat is at the point to be welded and therefore where most needed." (C. B. Auel, *American Machinist,* 1911.)

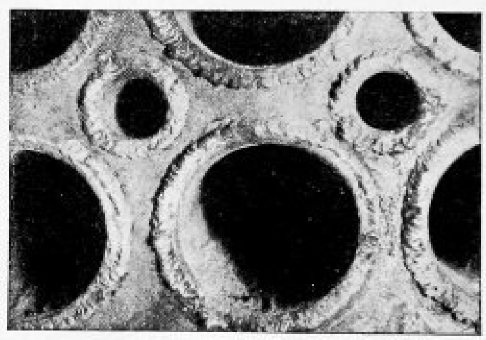


Fig. 2

Metal Electrode Process

The metal electrode process of welding is a somewhat later development than the carbon electrode method, and as has already been indicated, it differs from the latter in that a metallic electrode is substituted for the carbon.

* A paper read before the Western Railway Club, Chicago, Ill., November 17, 1914.

† Westinghouse Electric and Manufacturing Company.

Apparatus Required

The essential requirements for arc welding are:

First—A suitable source of direct-current supply.

Second—A steadying resistance to be placed in series with the arc, together with means for adjusting same, i.e., suitable control equipment.

Third—A means of holding the electrode so that it can be properly manipulated by the operator.

Fourth—Protective covering for operator.

Fifth—Suitable filling material.

Sixth—Miscellaneous material, such as flux, fire-clay or carbon blocks for making molds, etc.

Direct-Current Supply

Taking up this equipment in order, the direct-current supply can be obtained in any one of several different ways. If direct current is available from a shop or commercial circuit, welding can be done directly from this source of supply, but this method has been found to be very wasteful of power and should not be resorted to except where welding is only to be done at very infrequent intervals. An additional disadvantage of the use of the shop circuit as a source lies in the fact that, unless arrangements are made for insulating the work from ground, the shop circuit is grounded, with attendant danger to other employees in the shop, as well as to the welding operators. A much more economical method is that of using a motor-generator set, the motor being constructed with characteristics suitable for operation on the shop or other circuit, and used to drive a low-voltage generator. In case electric power is not available, the generator may, of course, be driven by belts from a steam or gas engine or from a line shaft.

The generator may be either shunt or compound-wound, the shunt-wound machine being satisfactory where only one arc is to be operated, while the compound-wound machine is preferable if several are to be supplied from the same unit. Experience has shown that generators giving a potential of 75 volts or thereabouts will enable satisfactory results to be produced.

Control Apparatus

As different welds require different strengths of current, it is at once evident that there must be some means of regulating the current supply. This is usually effected by inserting resistance in the welding circuit connecting it in series with the arc. Without this resistance a condition of practical short-circuit would occur at the moment the electrode was touched to the work when striking the arc, and even after the arc is drawn and normal operation begun, the series resistance is necessary for the purpose of steadying the arc, much as is the case in the ordinary arc lamp.

Electrode Holders

A suitable electrode holder must be provided for both carbon electrode and metal electrode welding. There are a number of forms of these in use at the present time, all of which are arranged with either a spring or positive clamp for holding the electrode, the construction of the holder being such that the electrode may be removed in a minimum of time. The metal electrode holder differs from that for the carbon electrode in that it is lighter and more compact. The carbon electrode holder has a disc shield on the handle to protect the hand of the operator from the heat of the arc, which when heavy currents are used would cause discomfort. This shield is not necessary for metal electrode, as the gloves of the operator constitute ample protection.

Protective equipment is necessary for the operator on account of the fact that the exposure to the rays of the arc causes an irritation and subsequent peeling of the skin if the exposure has been sufficiently long, say several minutes. The irritation is very similar to sunburn and is uncomfortable, but no serious consequences ensue, and at the end of a few days all traces of the burn disappear. The clothing has been found to be ample for the protection of the body. For the eyes and face of the operator a hood or shield is provided, both of these being arranged with windows of thick colored glass through which the welding is observed. Experience has shown that where carbon electrode work is being done, especially when the work is being carried on in an enclosure, the hood is preferable to the shield or mask, as it gives entire protection from reflected light, which is not the case with either of the latter devices. The hands and wrists of the operator should be shielded by gauntleted gloves, which are preferably of leather, although canvas gloves have been found to be satisfactory. The window of the hood or shield should be provided with several pieces of glass in layers, one or more of red and one or more of blue or green, the combination of these colors being much more satisfactory than any one of them used alone.

In addition to the protective covering for the operator himself, arrangements should be made for a suitable enclosure around the work and operator so that the intense

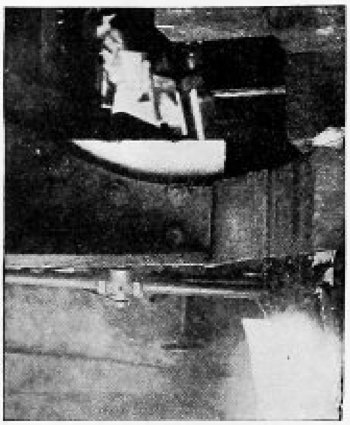


Fig. 3

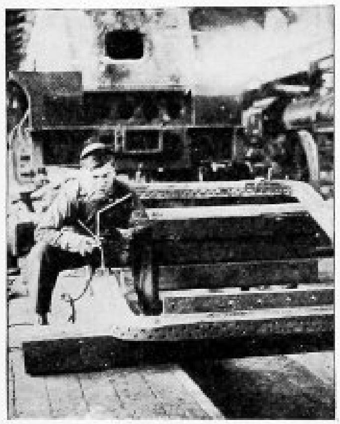


Fig. 4

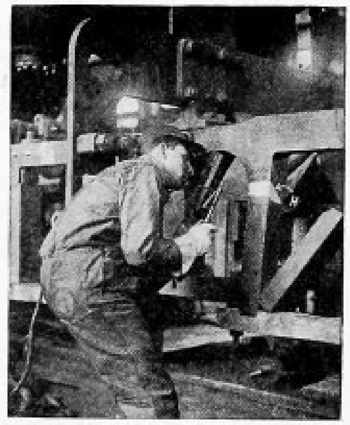


Fig. 5

brilliancy of the arc will not interfere with other workmen in the vicinity.

Filling Material

When the carbon electrode is used, the filling material is usually of the same metal as that being worked upon and may be used in any convenient form. For instance, when welding steel and iron, filling material may be in the form of rods, clippings from boiler plate, steel chippings, etc. For cast and malleable iron, soft iron rods, punched iron scrap or special cast-iron filler may be used.

Fig. 6

These filling materials are fed into the welds and fused into place much as solder is applied with a blow-torch.

When metal electrodes are used for welding iron and steel they should be of best quality of soft iron or steel wire and may range in diameter from 1/8 to 1/4 inch. The length most generally used is about 12 inches. Copper, bronzes and brasses with a low percentage of zinc may also be welded by this process, in which case the electrodes should be of the same material as that being welded. Where the zinc content of brasses is high, it volatilizes to such an extent as to make the work porous and brittle.

Procedure

In making a weld by the carbon electrode process, the work is connected to one terminal of the machine, usually the positive, the electrode holder being connected to the opposite terminal. The work, if small, may be laid upon a metallic table which forms the positive terminal. The resistance of the circuit having been adjusted to what is considered the proper value for the work in hand and the circuit-breaker and the main switch being closed, the operator assumes his position in front of the piece to be welded, taking the electrode holder in one hand and having flux (if same is used) and filling material within easy reach. He finally closes the window of the hood, touches the carbon electrode to the metal to be welded and instantly withdraws it to a distance of 2 inches or more, thus striking the arc. Experience has indicated that with a long arc there is less opportunity for carbon particles to enter the metal and in this way produce a hard weld; the heating effect is also more regular and more evenly distributed. For these reasons the arc should be as long as possible, about 3 inches to 4 inches being the usual length. If the arc is found to be too fierce or to go out due to insufficient current, the resistance in circuit may be increased or decreased accordingly.

After the arc is drawn it is allowed to play upon the work, being given a rotary motion by hand. The object of this motion is to heat a comparatively large area of the surface about the weld so that the consequent cooling will take place more slowly and there will be less danger of cracking the work or of making a hard weld. When the metal flows, the flux (if used) and the filling material should be added a little at a time, the arc, of course, being continued until the metal is thoroughly melted and the weld made. As soon as the metal commences to cool it should be hammered thoroughly in order to prevent sponginess and give the metal a finer grain. All oxide and other impurities must be kept out of the weld. It is advisable, therefore, to make, if possible, one continuous application of the arc. When, however, more than a single application is necessary, care should be taken to remove all the scale. This may readily be done in most cases by means of a stiff wire brush. Similarly, the metal should be cleaned before commencing the weld. To accomplish this, chipping may be resorted to or the piece may be tilted, the arc applied and the impurities allowed to run off by gravity as fast as melted.

The current required for carbon electrode welding varies from a minimum of about 200 amperes to a maximum of around 700 amperes, or even more in very heavy work. In general, however, 300 or 400 amperes have been found to be sufficient for ordinary carbon electrode work.

As is indicated in the foregoing, carbon electrode welding is more or less of a puddling process. A considerable amount of heat is generated, and this is, in many cases, objectionable on account of the expansion of the work, in which strains may be set up on subsequent cooling and shrinking. In work where trouble of this nature is liable to be experienced, pre-heating may often be used to advantage. On small work this may be done by the use of the carbon electrode. The arc is drawn just as in welding, but it is moved about over the piece without being held in any one place long enough to cause fusion. With larger pieces, a temporary furnace may be made by laying fire-brick together loosely to form an enclosure around the casting and over it. Heating may be done in any convenient manner either by the use of oil, gas or

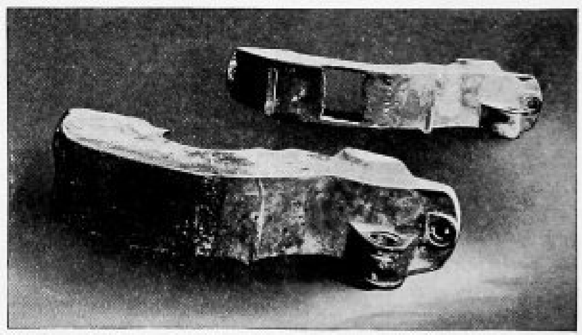


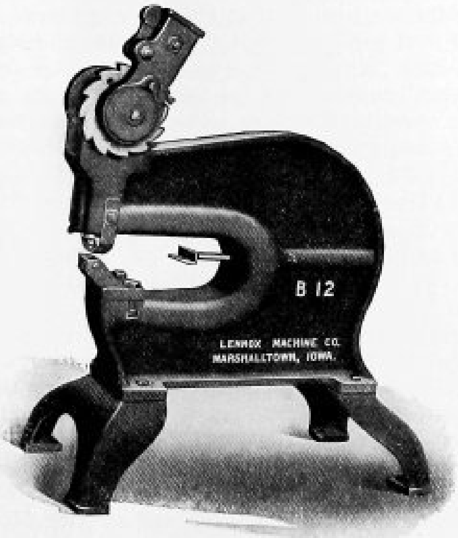
Fig. 7

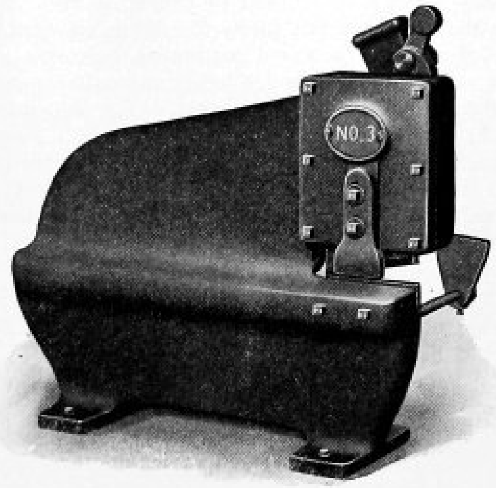
coal. When the work has reached a red heat, the cover is removed and the welding done without taking the piece from the furnace. After the welding has been completed, the cover is replaced and the work allowed to cool slowly, either with or without a second application of heat.

Metal Electrode Process

The metal electrode process, though a considerably later development than the carbon electrode method, has a field of application very distinct in many cases from the older process. A principal advantage of its use is in work where it is desirable to localize the heat to the greatest extent possible, thus minimizing strains due to expansion and subsequent contraction. An example of this is in the welding of sheet metal or of a broken bridge in a flue sheet. Another advantage of this process is that it enables

Small Punches and Shears



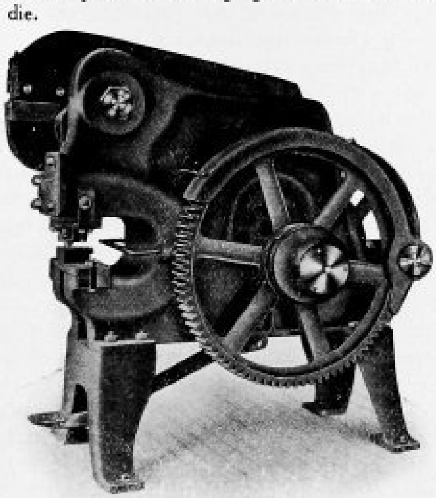


Hand Lever Punch

THESE Punches are built in capacities ranging from 1/4 through 1/4 inch to 1 inch through 3/4 inch, or their equivalents. The throats vary in depth from 4 to 18 inches. Each machine is furnished with a stripping attachment, an improved adjustable throat gauge, a hand lever, a punch and die.

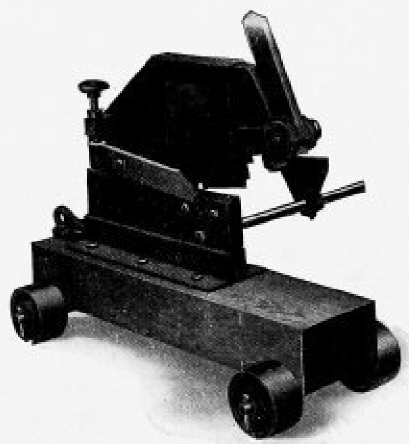
Hand Lever Splitting Shears

WE build Hand Lever Shears to handle plates from 1/8 to 1/2 inch in thickness. The frames are offset so that sheets of any width may be split. The leverage is so arranged that these machines can be easily handled by one operator.



Power Combined Punches and Shears

THESE Power Combined Punches and Shears are built with punching capacity up to 1 inch hole through 3/4 inch material, shearing up to 1 x 8 inches flats, 2 1/4 inches rounds, and 4 x 4 x 1/2 inches angles. The frame is built in one piece, making a much more rigid machine than if built in parts and bolted together.



Universal Steel Frame Hand-Lever Shear

THIS shear is built of forged steel plates planed to size, then pinned and riveted together. This makes it much stronger and lighter than the cast iron type. It is especially suited for heavy outside work, where portable machines are necessary. The machines are mounted on trucks, but can be furnished with or without as desired.

The machine will split plates up to 3/8 inch, will shear flat bars, 1 inch rounds and 3/4 inch squares. Weight without truck 350, with truck 450.

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welding to be done in a vertical plane or even from the underside of the piece to be repaired. This class of work is done daily in railroad shops in repairs to the side sheets and crown sheets of locomotive fireboxes.

The method of using the metal electrode differs from that of the carbon electrode in the fact that a much shorter arc, generally 1/8 inch to 1/4 inch in length, is used, and and also in that the electrode forms the filling material as it melts and flows into the fused portion of the work.

With the metal electrodes much lower currents are used than in the carbon electrode process. The maximum value hardly ever exceeds 150 to 175 amperes. For a greater portion of the work a current of about 100 to 130 amperes is found satisfactory, although the amount of current required will vary with the size of the electrode and the class of work being done.

Cutting by Use of Carbon Electrodes

The carbon electrode process is also well adapted for cutting of metals. In cutting, the arc is drawn just as in welding and is played along the line to be cut, provision being made for the melted metal to run off. Very rapid work of this sort can be done, especially if heavy currents are used. The heat generated varies approximately as the square of the current, so that a comparatively small increase in current will give a considerable increase in the rapidity with which work may be done. This process of cutting is used to advantage in work such as cutting off risers and sink heads from castings in a steel foundry, cutting up scrap, and the like, where rapidity and cheapness are of more importance than absolutely smooth finish and accurate work.

Application

In spite of the fact that arc welding as a commercial process is of comparatively recent origin, it has been found to have a considerable and ever-widening field of applicability. It has shown itself to have a distinct range of usefulness, in which it is unsurpassed either by blacksmith welding or by any of the systems of gas welding.

In the repair work of steam-railroad shops arc-welding equipment has shown itself to be an exceedingly valuable adjunct. The present high standard of maintenance involves constant attention to rolling stock to keep it in first-class condition; reductions in the expenditures for this maintenance have been necessitated by present-day financial conditions in the railroad field. This combination has been an important factor in the introduction of electric-welding equipment as a valuable agent in repair work. Among the principal uses of arc-welding equipment in steam-railroad shops are the following:

Flue welding,
Firebox repairs,
Frame repairs,
Building up of worn parts.

Besides these there are innumerable minor uses for the equipment.

Flue welding is being done by practically every large railroad shop in the country at the present time, and this welding is, almost without exception, being done by the electric-arc process using the metal electrodes. The advantages of welded flues lie in the fact that the results obtained are practically permanent, since the flue and sheet are bonded together without a joint. A welded flue in which scale or other troubles do not develop could remain in place indefinitely were it not for the federal limitation of three years. The elimination of leaky flues means, not only that road failures due to this cause will be entirely eliminated with attendant delays and expense, but also that maintenance expense on this account is reduced to a minimum. In this connection, I would like to quote from the proceedings of the International Railway General Foremen's Association, the quotation in question being a part of the report of the committee on autogenous welding and covering the experience of one road (C. of G.):

"A field in which electric welding has proved very successful and profitable is that of welding flues to back flue sheets. We have in service to-day over 90 locomotives with flues welded to back flue sheets, making a total of about 27,000 flues. Out of this number of locomotives in service with flues welded, we have our first engine to fail on line of road with flues. We have, however, had some few flues to leak after being in service a short time, but this was due to bad beads on flues when welded in. If part of the bead is off, exposing the copper (ferrule), it is very difficult to get a good weld.

"Our first experience on flue welding was tried out on a Pacific type engine. This engine was shopped for a new back flue sheet. The old sheet was so badly worn and buckled that it was impossible to keep flues tight. We had just installed our electric-welding plant and we were anxious to see what could be done along this line. Flue beads and sheets were thoroughly cleaned with sand blast, given a light working and welded in. The engine was put back into service June 1, 1913, and to date (July, 1914) has given no trouble by leaking. During this time hydrostatic test was applied and no leaks developed. This job was done at a cost of $14.68, where a new flue sheet would cost about $150 and the engine held out of service at least 30 days."

This report was made by one of the members of the association, and serves to indicate some of the work that is being done along these lines.

General practice varies as regards the best method of welding flues. In most cases, however, the flues are applied in the usual manner with copper ferrules and rolled, beaded and pressed. The head is then welded to the flue sheet, leaving a fairly rough finish which has not been found to be objectionable. The time of welding flues will probably average 15 per hour, although as high as 25 per hour have been reported. This time is for 2-inch flues. Five-inch superheater flues are being welded at about one-fourth this rate.

It is interesting to note that the flue sheet is found to be in better condition upon removal of flues than is the case where flues have not been previously welded in. This is due to the fact that the welding builds up the sheet around the flue holes to about the original thickness. Where welded flues are to be removed it only requires a few hours longer to cut down the beads, and by the use of a special tool for facing off the rough surface after the flues are removed a good, clean sheet is left.

Flue welding has not been entirely satistactory in every case, but it is believed that the difficulties which have been experienced have been due to methods used and not to the process itself, and these difficulties seem to be diminishing with the increasing experience which is being obtained on this class of work.

Firebox Repairs

Closely related to flue welding is the subject of firebox repairs. The defects to be repaired include cracks in the side, flue, door and crown sheets, leaky staybolts, leaky seams, etc. Also sheets will often be found to be in such condition that repairs are impossible, and it is necessary to put in patches. All of this class of work can be done very satisfactorily by the use of the arc-welding equipment. In the case of cracks, etc., it is necessary that the sheet be cut along the crack into a notch, or V-shape, so as to enable the weld to extend through the whole thickness of the sheet. The V is cut either by the use of the carbon electrode or, preferably, by a chisel. It is then filled in, using the metal electrode and a slight reinforcement built over the outside of the weld.

Where a sheet has gotten into such shape that it is necessary to replace it, it may be cut out by the use of the carbon electrode and a new section welded in. Half side sheets, door sheets, etc., are being welded in without difficulty.

In this connection the repairing of mud rings might also be mentioned. A mud ring is often found to be badly corroded at the corners of the firebox, due to bad water. Where this is found to be the case, the sheet can, in many cases, be cut out at the corners of the firebox, thus giving access to the corroded portions of the mud ring, which may then be built up. The section of the sheet that has been cut out is then put back and welded into place. The same method may often be used in the repair of a cracked mud ring.

Broken locomotive frames are very satisfactorily repaired by the use of the electric arc. The frame is prepared by notching either from one side or from both sides, preferably the latter; the notch is then filled in by the use of the metal electrode. A reinforcement is also built up around the frame at the place where the weld is made, so as to give extra strength at this point. The electric-arc process of welding is probably cheaper than any other for this class of work and is found to be just as permanent as can be obtained by any other means. An additional advantage of its use lies in the expedition with which the work may be completed, as no dismantling of the locomotive is necessary beyond that required to allow the welder to secure access to the broken parts. Cases have been known where a frame has been welded without drawing the fire. One railroad (R., F. & P. R. R.) reports that it has in service at the present time 65 welded locomotive frames and has had only one failure; this failure was attributed to the fact that the arc weld was in close proximity to one made by another process. In work of this sort it is often found desirable to pre-heat the member of the frame opposite the one which is being welded in order to insure the absence of strains upon cooling.

Tender tank repairs can also be easily made, the methods used being similar to those applied to boiler work.

Savings Effected by Arc Welding in Railroad Shops

The following figures were taken from records of actual repairs made in a large railroad shop in the Middle West at various times, the figures given being a comparison between the actual cost of welding and that of putting the apparatus back into service by methods previously used, either by replacement or by repair of the old parts. The arc welding costs were based on a power cost of 51 cents per hour for the carbon electrode and 17 cents per hour for the metal electrode, together with cost of labor and an overhead charge of 40 percent. It might be mentioned, in passing, that the power costs used are slightly higher than those usually obtaining in shops of this nature:

	Cost of Welding.	Cost by Other Methods.
Plugging 51 holes in expansion plate, holes 1 inch diameter by ½ inch deep	$2.75	$10.15
Repairing mud ring	6.50	34.57
Cutting four 6-inch holes in tender deck sheet ½ inch thick	1.08	8.35
Welding eccentric strap, broken through neck	1.08	41.28
Repairing mud rings	6.50	24.57
Welding two spokes in driving wheel center	7.98	99.98
Welding cracks in bulkhead in tender tank	2.33	8.00
Welding cracks in side sheets	26.15	31.79
Repairing firebox	134.89	869.58
Building up flat spots on locomotive driver	.40	225.00

Numerous other figures could be presented showing similar savings.

With reference to the last item given above, namely, that of building up flat spots on locomotive drivers, the repair in this case is effected by welding at the roundhouse without withdrawing the locomotive from service. The tire is simply built up at the flat spot and filed to shape, using a templet. Against this the cost of repair by other methods would include the sending of the locomotive to the shop and having the entire set of drivers turned down, which usually means putting the locomotive out of service for at least a week or ten days, as well as the loss of at least one year's wear on the tires. Taking the loss of revenue from the idle engine, the cost of the older method might easily be $500 or more.

Marine Repair Work

An industry of comparatively recent origin is that of the repair of marine boilers. Practically every large harbor now contains one or more repair barges. These barges are equipped with an arc-welding equipment and a compressor for furnishing air for sand blast and pneumatic tools; they are employed in the repair of the boiler equipment of vessels that may arrive in the harbor in need of such repairs. The barge is brought alongside the vessel while the latter lies at the dock; cables and air hose are carried through convenient port-holes to the point where work is to be done, thus enabling the necessary repair work to be accomplished without any loss of time on the part of the steamer.

General Repair Work

There are a number of minor applications of arc-welding equipment, among which may be classed general repair work in large shops, work in steel plants, cutting up scrap, etc.

Industrial plants employing a large number of machines will oftentimes be able to reduce their maintenance expense very considerably by the use of arc-welding equipment. Repairs to be taken care of in these shops consist of broken shafts, worn journals and keyways, broken gear-teeth, worn rolls, etc. The welding equipment may be installed permanently and wiring carried to different sections of the shop where welding is likely to be required, or the repair equipment may be made portable and suitable connections arranged for the motor end of the equipment. Still another method is that of installing the motor-generator and wiring permanently, and using a portable welding control panel, which is connected to the circuit by plugging in at the point where work is to be done.

Installations

The earlier installations of arc-welding equipment employed a motor-generator for each operator, but this method was soon found to have several disadvantages in shops where two or more operators were to be employed. In the first place, electric-arc welding is essentially an intermittent process, and experience has shown that the arc will be in actual use not more than 50 percent of the total time in most cases. From this it can be seen that the load factor of the motor-generator would be below and that the cost of power would be correspondingly higher. In the second place, such an installation is necessarily more expensive than one employing a motor-generator of sufficient capacity to supply all operators within a reasonable range, and it would also be more expensive as far as regards maintenance. Again, the efficiency of the smaller equipment will necessarily be lower than that of the large unit. The general practice now followed is that of installing a motor-generator of sufficient capacity to supply all operators within a range of 500 to 600 feet of the set, permanent wiring being installed and panel outlet for the individual operators located at points where it is desired to do welding.

A word as to the size of outfit required may not be amiss.

No hard and fast rules can be laid down, as no two installations will be alike in their requirements, and the matter of selection of apparatus of proper capacity is largely one of judgment and experience. It may be said, however, that in general for miscellaneous repair work around large industrial plants a 300-ampere equipment, which is of sufficient capacity to take care of two operators on metal electrode work, or to do, when necessary, light carbon electrode work, is usually satisfactory. For electric railways for track work, a 200- or 300-ampere outfit will be found to be about the proper size. In the repair shop the track-repair outfit may be used or a separate outfit may be installed if conditions justify it.

In steam-railroad shops installations are usually made of sufficient capacity to take care of not less than four to six operators, and the larger shops can occasionally use even greater capacities to advantage. Where a greater number of operators are to be supplied, however, it is generally found to be more economical to install additional outfits in other sections of the shop where welding is to be done, rather than to put in one large central plant. This is on account of the fact that as this work is usually more or less scattered the cost of line copper becomes an item for consideration.

In steel foundries and steel mills outfits of 800 to 1,000 amperes capacity are usually installed. These are large enough to take care of six or eight operators on metal electrode work, respectively, but most of the operations found in these industries will be performed with the carbon electrode, and the large capacity will be found advantageous in that it will enable more than one operator to be employed using the carbon electrode, or, when necessary, the full capacity of the machine can be concentrated at a single arc, thus enabling extremely rapid work to be done.

In conclusion, it should be noted that arc welding is not to be considered as a panacea for all the ills that the metal worker is heir to. There are many classes of work for which it is entirely unsuitable, but its range of usefulness is so wide that it has long since fully justified its existence.

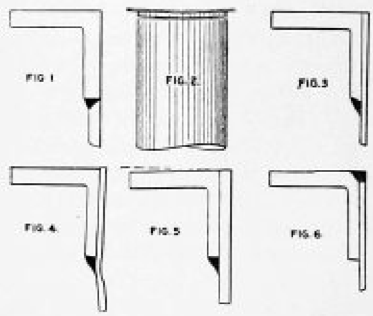
Precautions in Welding Angle-Iron Rings

The autogenous welding of angle-iron rings to cylindrical shells often leads to failure if proper precautions are not taken; the shell is apt to be distorted and the ring warped, making the work unfit for use.

Usually the shells are butt-welded to the leg of the flange, as shown in Fig. 1, says a writer in the *American Machinist*. When heat is applied to this leg, this part expands more than the upper leg, forcing the sides of the ring away from the shell, as shown in Fig. 2. Some welders try to overcome this by clamping a heavy casting to the face of the ring. This is bad practice, as when the flange is released after finishing the weld, the stresses set up by the welding will be transferred to the ring, the weld and the shell. With a thin shell the ring will not be straight and the shell will be distorted; with a heavy shell the ring tends to pull away from the shell, and often does so after cooling.

Good results are obtained if the ring is first heated all over, tacked well and the welding finished with a pre-heating torch. This makes the expansion of both legs practically the same and eliminates excessive stresses that would otherwise occur.

It is sometimes desirable to have the shell extend through to the face of the ring. In that case the weld is



Good and Bad Results in Welding Angle-Iron Rings to Cylindrical Shells

made as in Fig. 3. The commercial spiral riveted pipe flange is not well adapted for this unless bored out, as the diameter of the bore is usually larger at the bottom than at the face. This causes thin shells to be drawn up and pushed ahead, as shown in Fig. 4. On heavy shells the flanges usually turn down, as shown in Fig. 5.

If a tight-fitting flange is used with a straight bore and the edge of the lower leg chamfered, good work should be obtained, provided the pre-heating torch is used to heat the top of the flange.

Whenever faced rings are used and the flange must be true, none of the above-described methods will answer.

To insure the desired accuracy in welding these rings the methods shown in Fig. 6 give good results. The shell is welded to the inside edge of the flange; the corner built up with the flame and the top of the weld left slightly below the face of the flange, this to reduce cost of trimming. A good welder can finish this weld so that only the line where the weld runs into the original metal need be filed.

The heat applied to the inside edge of the flange affects both legs alike and the ring remains in the same position; therefore, no stresses remain in the weld and the weld is as strong, if not stronger, than the butt weld. The ring should, after placing in the proper position, be heated all over; then tacked well on opposite sides; then 45 degrees from this, also opposite. The number of tacks depends on the diameter of the ring; up to 30 inches four tacks are sufficient. The weld is then started between tacks and carried on alternately on opposite sides until finished. The use of the pre-heating torch is not necessary except on heavy rings of large diameter to save gas. A ring welded in this manner, of any thickness or size, will then be straight.

A Mile of Cutting

The value of an efficient portable oxy-acetylene cutting outfit and its facility of operation is well shown in the accompanying illustrations. A steel pipe line of the Northern Canada Power Company, in the Cobalt disirtct, 47 miles north of Timmins, Ontario, was put out of commission by shifting sand and resulting buckling of the pipe. An auxiliary wooden pipe line had been constructed, and it was decided to cut the steel pipe line in two half-sections, replacing the buckled lower half with the upper half to form a sort of trough for a new wooden stave line.

The steel pipe was 12 feet in diameter, 1,480 feet long, with 7½-foot riveted sections. The amount of cutting necessary, and the time required, with the difficulty of cutting by older methods, would have been prohibitive, especially as time and the placing of responsibility on a single pipe line for the power requirements of many large industries within a considerable area, were of the greatest consideration.

Fig. 1

Fig. 2

Fig. 3

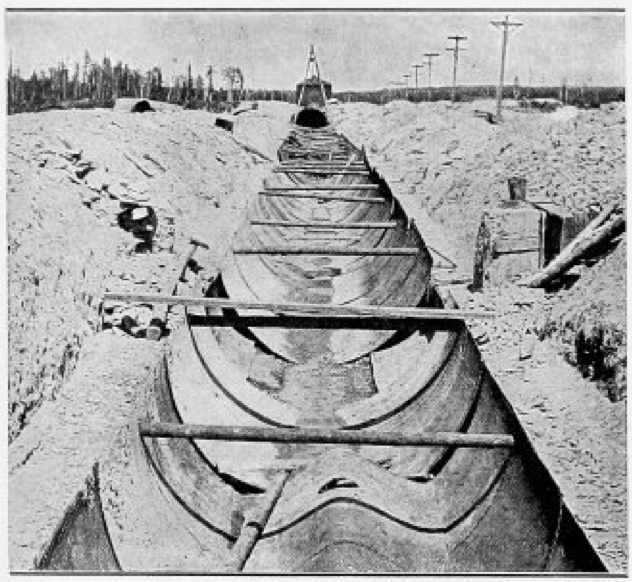


Fig. 4

The oxy-acetylene cutting process greatly simplified the problem. The Davis-Bournonville Company of New York was called upon, and they sent a single operator, "Jack" Saunders, from their Jersey City shops, with one of their portable cutting outfits. The operator went by train to Timmins, thence by motor boat up the river to Wawaitin Falls, with his outfit, oxygen and acetylene gases being shipped in portable tanks from Toronto. The complete equipment was thus immediately available.

Longitudinal cuts were made on both sides of the entire length of the pipe line (Fig. 1) cutting the pipe into two halves. Lateral cuts (Fig. 2) were made every three riveted sections, and a hole cut in the middle of each half-section for the hook with which the 22½-foot half section was hoisted out of place with a derrick (Fig. 3). Fig. 4 shows the damaged under-half section of the pipe line, after the upper half had been cut and removed, and the buckling of the plates, causing the damage, is plainly seen.

In all there was 5,097 lineal feet, or nearly one mile, of cutting of 5/16-inch steel plate. Five tanks of compressed acetylene, 1,125 cubic feet, and 66¼ tanks of oxygen, 8,285 cubic feet, were used. Necessarily the cutting could not be done continuously, owing to other labor involved and some bad weather during the seventeen 8-hour days on the job, but the operator accomplished from 258 to 393 lineal feet of cutting each day after the first day, generally averaging 350 feet, and the last 85 lineal feet of cutting was done in 65 minutes.

Welding in Gas Main Construction

It has been demonstrated in many of the large cities in this country and through widespread practice abroad that oxy-acetylene welding is not only the most economical method of making joints in steel and wrought iron mains, but that a welded main entirely eliminates the joint leakage and subsequent maintenance cost due to insecure joints. It has been found that with skilled operators the strength of the welded joints ranges from 80 to 95 per cent of the strength of the pipe itself. By building up the section at the weld the strength of the joint is readily increased beyond that of the pipe, if so desired.

Fig. 1.—Welding Gas Main with Oxy-Acetylene Torch

In welding gas mains with the apparatus developed by the Oxweld Acetylene Company, Chicago, Ill., two or more lengths of pipe are butted together and welded by the operator. Where the pipes are cut off straight the two sections are butted up to within 1/16 inch or ¼ inch of each other, according to the size of the pipe and the weld is made by heating the metal on each side of the joint to the fusion point with the oxy-acetylene flame when pure Norway iron wire is fused into the molten metal, forming a true fusion weld. The pipe may be obtained at no increased cost from the mills cut at a bevel, in which case the two pipes are butted together, forming a V-shaped opening of about 60 degrees. It is desirable to have the pipe prepared in this manner, as the weld can be made quicker at less cost and with the use of less filling material.

Fig. 2.—Twenty-Four Lengths of 10-Inch Pipe, Each 20 Feet Long, Welded Into One Section

Among the advantages derived from welding gas mains is the fact that on account of the great strength of the welded joint it is possible to use pipe 40 feet long in main construction instead of the 20-foot lengths commonly used with other methods. Much lighter pipe is also feasible, as no allowance need be made in its thickness to permit threading. It is reported that in some parts of Europe, where welded joints have been in widespread use for a much longer time than in this country, pipe of 40

Fig. 3.—Welded Joint in 12-Inch Gas Main. Entire Joint Welded in the Trench

percent less thickness is being used instead of the size necessary where the ends are threaded.

In city streets the number of lengths of pipe that can be put together outside of the trench is usually limited, but in the open country it is not unusual to weld up 1,000 feet of pipe at a time and one case is reported where 4,000 feet of 8-inch pipe was welded into one section before being lowered into the trench. As fast as a section of welded pipe is finished it is capped at both ends and tested for leaks under any desired pressure. As soon as it has been placed in the trench it is welded to the pipe already laid by digging around the joint a bell hole of sufficient size to allow the operator to weld entirely around the joint.

In practice it has been demonstrated that welded joints can be made at a cost of from 25 to 40 percent less than the cost of producing and connecting recessed screw coupling while the economy is considerably greater in comparison with the cost of insulated coupling.

The following costs are given as representative of joints of steel pipe, butt welded, made with the Oxweld process by competent operators:

4-inch pipe	$0.435
6-inch pipe	.57
8-inch pipe	1.055
12-inch pipe	1.57
16-inch pipe	2.21

One of the great values of the Oxweld process in gas main work is the cutting of holes for branch pipes and the welding in of the branches at any angle. In this way it is possible to cut and construct fittings of any type desired. Samples of this kind of work are shown in Figs. 4 and 5. The Y shown in Fig. 5 is formed of 6-inch pipes cut and welded at a 60-degree angle. The cost of cutting was 33 cents and of welding $1.815, making the total $2.145. The total cost of cutting and welding two pieces of 6-inch pipe to form a 45-degree angle, as shown in Fig. 5, was only $.765, the cutting amounting to $0.095 and the welding to $0.67. In forming and welding the 6-inch and 4-inch reducer, illustrated in Fig. 5, the flange is cut out of ½-inch plate welded to a piece of 6-inch pipe, a similar piece of plate is cut and rolled to form a reducer, one end of which is welded to the 6-inch and the other to the 4-inch pipe. The total cost of this work is $0.245 for cutting, $1.605 for welding the flange, and $1.495 for welding the reducer, making a total of $3.345.

Fig. 4.—Emergency Welding and Cutting Job

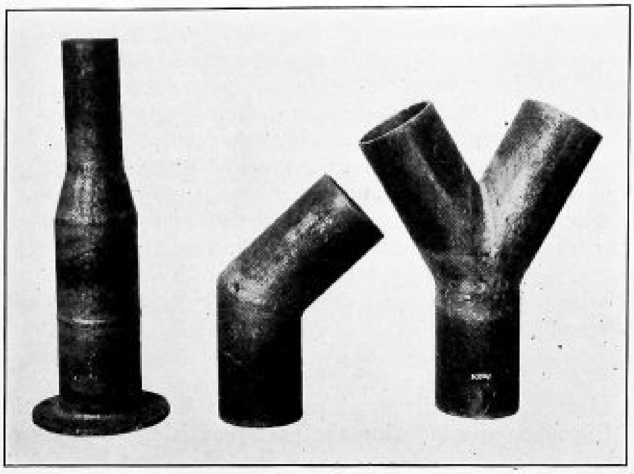


Fig. 5.—Branch Pipes with Welded Joints

In considering the utility of this work, not only the low cost of preparation, but the fact that these welded fittings are absolutely gas-tight and as strong as the pipe itself should be borne in mind.

Oxy-Acetyene Welding at the Milwaukee Shops of the Chicago, Milwaukee and St. Paul Railway

BY A. N. LUCAS*

The Chicago, Milwaukee & St. Paul Railway Company at Milwaukee, Wis., put their first acetylene welding outfit to work in September, 1913, and it has been in service now for about fifteen months. Since this outfit was installed no locomotive tires have been taken off on account of flat spots. All flat spots have been welded up in a first-class manner with the oxy-acetylene apparatus and only two cases occurred where it was necessary to reweld on account of "shelling out." During the past year flat spots have been welded up on the tires in sixty-five locomotives and the saving on any one of these locomotives would buy a complete welding outfit.

On the machine side, considerable work has been done on frames. Some good welds have been made and also a few have failed, due, however, to not loosening the frame and getting the proper contraction and expansion. Many short cracks were welded up on frames and also worn spots were filled up on frames.

Cracked cylinders have been welded up and patches put on some. It has been found that this can be done successfully, if the cylinder is warmed up in a proper manner. The method by which this is done is to take off the steam chest, valve and piston, and then warm up the cylinder with charcoal, and then weld. When the welding is completed the cylinder is covered up with asbestos paper and allowed to cool down gradually.

A great many parts, such as cast steel driving boxes, trailer boxes, which show cracks above the crown, and shoe and wedges when cracked in the corner of the flange have been reclaimed by welding up with the oxy-acetylene apparatus. Other work which is welded includes cracked driving-wheel spokes and all kinds of worn forgings, such as link hangers, transmission bars, radius bars, rocker arms, tumbling shafts, throttle levers, throttle ratchets,

* General foreman, boiler work, Chicago, Milwaukee & St. Paul Railway.

new ends on armature shafts, guide yokes, brake shoe hangers and broken castings; also parts of large shafting are filled in so that a bearing can be turned and a new fit made, thus reclaiming a worn piece of shafting.

A lot of work also comes into the railroad shop from outside parties and various classes of work, such as the following, are carried out:

Reclaiming electric headlight castings, car wheels, lawn mowers, water pumps, vises, water jackets for motor cars, stand pipes, dry pipes, "nigger heads," frames for gas engines, journal boxes, cylinder castings, cracked cases and exhaust pipes.

Boiler Work

Among the boiler work which has been done at the Milwaukee shops during the past year is the welding of sixty-five door collars. Welding door sheet flanges to the back head does away with the laying out, punching and applying rivets or patch bolts and subsequent calking and makes a saving of $15 per door ring. This kind of work is giving the best of results. This method gives more expansion to the door sheet and it is believed that the door sheet will not crack as readily. In renewing, all that is necessary is to take the air hammer and cut the door sheet flanges loose from the back head, which can be done very readily and which leaves the back head in its original condition, so that if at any time a patch would have to be applied, the same could be done as heretofore.

Full door patches have also been welded inside on to the door sheet. A couple of these, however, gave trouble on account of opening up after being in service three or four months.

Other welding work which has been done in the boiler shop includes welding up short cracks in the door ring. We have also welded in two three-quarter door sheets; three half side sheets and thirty-five patches on side sheets. We have also reclaimed several back flue sheets by welding up cracks in the top flange and in the bridges. A large number of cracks have also been welded up from staybolts and cross-seams. Worn spots in sheets above the mud ring have been welded, and also cracked mud rings have been filled in where worn.

As a matter of fact, there is practically no limit to the work which can be done with the oxy-acetylene torch, for we have welded in all corner patches; welded up short cracks in the throat sheet; welded patches on cracks in the front flue sheet; welded bottoms and patches in smoke arches, and also welded up pitted flues.

Oxy-Acetylene Cutting

Practically all of the cutting is done with the torch, such as cutting out old fireboxes, half side sheets, patches of all kinds, and also cutting frames which makes a big saving at all times.

One special piece of work which should be mentioned is that we have found that we can burn out a broken staybolt in the outside sheet or inside sheet much quicker than we can drill same out. This we can do nicely, where we are renewing broken staybolts or radial stays, without damaging the thread in the hole.

In cast steel we have been reclaiming all back plates for swing head couplers, welding up cracks in openings, as well as welding on new rests for coupler heads, resulting in a big saving. We have also welded up coupler heads, broken spots on the side as well as cracks in the face, also cast steel bolsters for tender trucks and where worn badly at the center we have welded pieces of boiler plate on top, making same as good as new.

At the present time we have two welders on the locomotive side and are asking for more. Only recently the general storekeeper has placed a welder in the scrap yard to reclaim all broken or defective castings and forgings and do other welding or cutting that may come to him. In car work we now have three welders and they are reclaiming truck sides, draft arms, Bettendorf truck bolsters, barber bolsters, spring planks, spring leafs, etc. Welding is done on different jobs that cost from 18 cents to $3.65 and make a saving on each one of anywhere from $1.20 up to $22.21 each. All repairs to steel cars are made with the oxy-acetylene apparatus, and forgings and castings are reclaimed.

Cost of Operation and Savings

In fact, the oxy-acetylene welding outfit is a money-saver from the start. We figure that a welder costs us for labor and material, including a helper, about $1.50 per hour. We also figure that a welding outfit can average a saving of $4 and over per hour for every hour it works. It is just a matter of getting an outfit, getting your welder broken in and getting accustomed to the work when the results will follow.

It is very necessary, of course, to have the proper material for the different jobs. When welding up flat spots in the tires we straighten out and use chips from the tire lathe. When welding up steel castings, we shear up tank steel in narrow strips. In welding up ordinary cast iron castings, we use small bars of cast iron that we get from our foundry. In cylinder jobs and other work where particular care must be taken, we use the best cast iron welding rods that we can buy. We also use a flux that helps to keep the casting soft, so that when the job is finished it can be machined readily. In welding up firebox work we are using good Swedish iron welding rods.

Ten Miles of Autogenous Welding

At the Washoe Reduction Works of the Anaconda Copper Mining Company, located on the Butte, Anaconda Pacific Railroad, between Butte and Anaconda, Mont., is the largest copper smelter in the world. A striking feature of this plant, to the uninitiated, is a brick-sided, metal-roofed structure running from the base of an adjoining hill to the top, where its terminus is surmounted by an unusually tall brick stack.

This structure branches at its lower end into numerous ramifications leading to all parts of the smelting works, and serves as a common flue carrying off noxious or gaseous vapors and fumes of all descriptions produced in the smelting and refining operations. The top of the hill on which the stack is located is approximately 400 feet above the smelter, while the stack towers 300 feet above the hill-top.

From the view of the flue and stack shown in Fig. 1, beginning at the point where the overhead trusses end, can be seen an expanse of metal-roofed flue 120 feet wide for the most part and approximately 850 feet long. The roof was composed of steel plates, 20 inches by 240 inches, riveted to supporting 7-inch I-beams. For several years this roof gave no trouble, but, owing to the riveted construction, it was impossible to make the joints in the plates absolutely tight, so that rain or melted snow leaking through the riveted joints brought moisture in contact with flue dust containing sulphur fumes and this formed sulphuric acid, which in time corroded the sheets badly and resulted in reducing the flue draft to such an extent as to seriously curtail the entire works' production.

Fig. 2 shows the appearance of a section of the plates attached to the I-beams in which the honeycomb effect is quite noticeable. After an investigation which showed that roof sections which remained watertight were not deteriorated, the company decided to adopt means whereby the roof would shed water over its entire surface. The 7-inch I-beams were drilled and tapped

Fig. 1.—Welded Metal Roofed Flue, 120 Feet Wide, 850 Feet Long

for ⅝-inch bolts, and to these new plates were fastened by 1-inch bolts and washers. The plates were spaced ⅛ inch apart for clearance, and, as evidence of the care taken to allow for strains due to temperature changes, V-shaped bolt holes were provided.

Autogenous welding by oxy-acetylene apparatus sup-

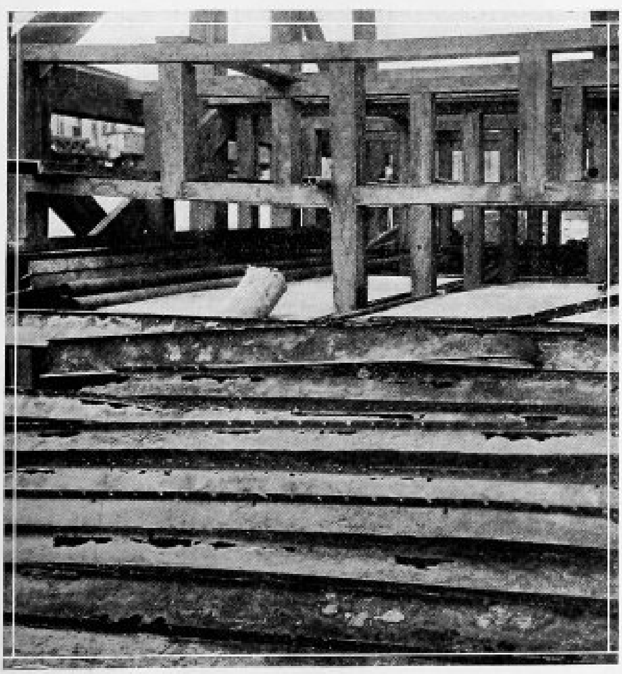


Fig. 2.—Honeycombed Roof Plates Resulting from Riveted Construction and Leaky Joints

plied by the Davis-Bournonville Company, Jersey City, N. J., was adopted as the means to close the plate joints and to attach the washers to the plates. For the acetylene supply two Davis pressure generators, each having a capacity of 200 pounds of lump carbide per charge, were employed, the acetylene being conveyed by flexible hose to the operators, of whom an average number of eleven were employed for a continuous twelve-months' period. Standard Davis-Bournonville welding torches were employed throughout the work. The oxygen was stored in portable cylinders at 300 pounds pressure.

It is believed that this is the largest work planned and carried to a successful conclusion in the history of oxy-acetylene welding. Covering a period of twelve months with an average of eleven Davis-Bournonville welding torches in use, there was employed 330,000 cubic feet of oxygen; acetylene production from 20 tons of lump carbide; 9,200 pounds of 3/16 inch round welding rods. Six hundred and ninety thousand pounds of No. 9 gage plates, 40 inches by 240 inches, were welded together, with the periphery of 16,000 washers 2 inches to 3½ inches in diameter welded to the plates, making in all 53,365 lineal feet, or 10.1 miles of welding!

Some Queries Answered

BY GEORGE SHERWOOD HODGINS *

A question which has recently arisen in boiler practice and which includes some practical considerations in construction, may be stated as follows: "Give the rule to find the working pressure on a boiler flue 5/16 inch thick, 20 inches inside diameter and 12 feet long. The flue to be made in two sections, with longitudinal seams single-riveted."

It is evident here that the thickness of the flue sheet, i.e., 5/16 inch, and the total length of the flue, are the determining factors. The fact that the flue is made in two sections and probably double-riveted in the circumferential seam really has a tendency to strengthen it in the center, so that in finding out what is the fair working pressure under which such a flue should be operated, one may disregard the central circumferential seam.

The rule which has been adopted by the British Board of Trade is a very safe one and a very practical method of ascertaining what is a safe working pressure. The formula is as follows:

$$P = \frac{60{,}000\, t^2}{(L + 1)d}$$

where

P is the safe working pressure in pounds per square inch.
t is the thickness of the plate in fractions of an inch.
L is the length of the flue in feet.
d is the diameter of the flue in inches.

The 60,000 pounds given as a constant in the numerator of the fraction is that used where the longitudinal seam is single-riveted, or where the workmanship is not of the highest quality.

The formula works out:

$$P = \frac{60{,}000\,(5/16)^2}{(12 + 1)\,20} = \frac{5859.375}{260}$$

$$5859.375 \div 260 = 22.536 \text{ pounds.}$$

This 22½ pounds is the safe working pressure, and with a factor of safety of 4, the collapsing pressure would be 90 pounds per square inch.

Another question involving somewhat similar conditions

* Member of American Society of Mechanical Engineers.

but extending a little further, may be stated as follows: "Give the rule to find the number and size of staybolts required for a circular firebox 5/16 inch thick; 36 inches inside diameter and 36 inches high, to carry 125 pounds pressure." Here we may suppose that the circular firebox is vertical. The top is stayed by the tubes, and the bottom by a mud ring or equivalent means. The problem, therefore, narrows down to the staying of a circular surface 36 inches long and 36 inches in diameter so as to safely sustain a working pressure of 125 pounds per square inch.

The circular, or rather the tubular, shape of this firebox has some stiffness due to its form, and this can be ascertained by means of the formula used above, viz.:

$$P = \frac{60{,}000\, t^2}{(L+1)\, d} = \frac{5859.375}{144}$$

$$5859.375 \div 144 = 40.69.$$

The pressure, therefore, which may be safely used upon this firebox is 40 pounds per square inch. The working pressure of the whole was to be 125 pounds per square inch, so that staying, capable of supporting a pressure of 125 — 40 = 85 pounds to the square inch, has yet to be provided.

The area of the firebox, when unrolled and laid out flat, is 36 × 3.1416 × 36 = 4,071½ square inches; so that on this surface a pressure of 85 pounds per square inch has to be sustained. This amounts to 4,071.5 × 85 = 346,077.5 pounds. A staybolt ¾ inch in diameter has a sectional area of .4418 square inch, and taking the tensile strength of the bolt iron at 50,000 pounds per square inch, we find that our ¾ inch staybolt will support 22,090 pounds pressure per square inch.

In order to sustain the pressure on the total firebox surface, viz.: 346,077 pounds, we divide the one by the other, thus: 346,077 ÷ 22,090 = 15.66, so that we may say that each area of 16 square inches requires a staybolt, or 255 such staybolts in all are required. As each one of these bolts supports an area of 16 square inches, it follows that when each is placed in the center of a square of these dimensions, adjacent bolts will be spaced 4 inches apart, and the firebox will be able to sustain the prescribed working pressure of 125 pounds to the square inch.

A question involving boiler feed by means of a pump, is stated as follows: "Give the rule to determine the size of a pump capable of supplying a boiler rated at 250 horsepower, assuming that 30 pounds of water are evaporated per horsepower hour with a speed of pump 47.5 feet per minute."

One rule to ascertain the gallons per minute which would pass through the required pump, is to multiply the horsepower given by .06, this gives 250 × .06 = 15 gallons per minute. This result can be verified by converting pounds per hour, given in the question, into gallons, viz.: 30 × 250 (the horsepower) = 7,500 pounds per hour, and by dividing by 60, ascertaining the pounds per minute, 7,500 ÷ 60 = 125. Each gallon of water contains 8.335 pounds by weight, and if 125 pounds per minute is pumped, we find that 125 ÷ 8.335 = 14.99 gallons of water, or say 15 gallons.

The pump which will perform the service designated and deliver 15 gallons of water a minute can readily be found by turning to the pages of a pump maker's catalogue. This is done because it is not customary to design a special pump for each boiler which is built. A pump maker supplies a standard article in which parts are interchangeable and can be readily duplicated.

Looking at, say, the Worthington Pump catalogue (115 Broadway, New York), we find a 6 × 4 × 6 pump to be the most suitable. This pump has a speed very close to that specified in our question and its capacity is approximately the same. Our pump, if it has a 6-inch stroke and a piston speed of 47½ feet per minute will give 7.91 strokes per minute, and the delivery set down in the catalogue is 1.25 gallons per stroke. This gives the gallons per minute as follows: 47.5 ÷ 6 = 9.8875, and for the duplex pump, such as those made by Henry R. Worthington, the total capacity is twice this amount, or 19.77 gallons. Our pump was required to supply 15 gallons, and this one, giving 19¾ gallons, is capable of being run slightly more slowly and has a very desirable margin of power to draw on in case of emergency.

Oxy-Acetylene Welding and Cutting With Portable Apparatus

Much boiler and sheet metal work, both in the shop and in the field, can be welded to advantage with oxy-acetylene apparatus when the apparatus is portable and can be brought to the work. With the Prest-O-Lite apparatus, which is supplied by the Prest-O-Lite Company, Inc., Indianapolis, Ind., the equipment consists of one cylinder of acetylene gas, one cylinder of oxygen, one oxygen regulator, one acetylene regulator, one welding blowpipe with interchangeable heads and one cutting torch. The welding blow-pipe has a series of tips suitable for all classes and thicknesses of work, and the welding tips range in capacity from 1.5 to 35 cubic feet of free acetylene per hour, the consumption of oxygen being approximately 1.2 parts to one of acetylene.

The acetylene cylinder consists of a steel tank packed with a porous material which is saturated with a chemical which has the property of dissolving and holding many times its own volume of acetylene. It is only in this way, the manufacturers claim, that large quantities of acetylene can be held in a small cylinder and stored safely under a comparatively low-pressure. The porous substance, it is claimed, not only acts as a sponge for absorbing the solvent, but also makes it impossible for an explosion to be propagated through the cylinder.

The entire equipment is mounted on an ordinary two-wheel truck, and one man can easily take it to any part of the shop or to the work in the field. The extreme portability of this type of apparatus is one of its many advantages to which the manufacturers call particular attention. It is pointed out that in general shop and field use the cost of making repairs will be reduced considerably if a portable apparatus is employed. Then the apparatus can be wheeled to the work for much less cost than that required for transporting heavy work to or about the shop.

One advantageous feature in connection with the blowpipe welding using the oxy-acetylene flame is that it does not affect the skin of the operator. The glare, of course, is injurious to the eyes unless tinted glasses are worn, but it is unnecessary to protect the face and hands as in electric arc welding, where the injurious rays affect the skin.

Oxy-acetylene welding has found a wide application in the construction of various articles made of both light and heavy plates. Many of these articles, such as tanks, air vessels and domestic boilers, are subject to comparatively high-pressure and other conditions which require extreme strength and durability.

Some specific uses for the process in this connection are the welding of mild steel plates employed in the manufacture of steel barrels and drums, steel tanks of all sizes

Fig. 1.—Prest-O-Lite Portable Welder

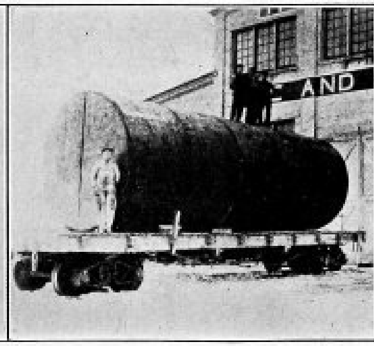


Fig. 2.—Welded Oil Storage Tank

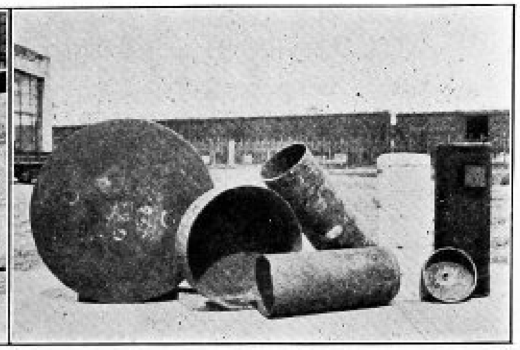


Fig. 3.—Steel Welded Cylinders

and shapes, compressed air receivers, pipe and pipe fittings, smoke stacks, angle, channel and tee iron, and also the welding of flanges or bosses on to vessels.

Welded receptacles for highly inflammable and searching liquid chemicals are capable of withstanding high-pressure, allowing no leakage or evaporation, and are capable of withstanding excessive vibration and rough handling. Cylinders for gases under pressure are being welded to withstand necessary rough usage and rigid tests. The shells are welded longitudinally, the ends welded in and the necessary spuds for valves and fittings welded to the tanks. Cylinders so welded are to-day approved by the Interstate Commerce Commission for the transportation of various gases.

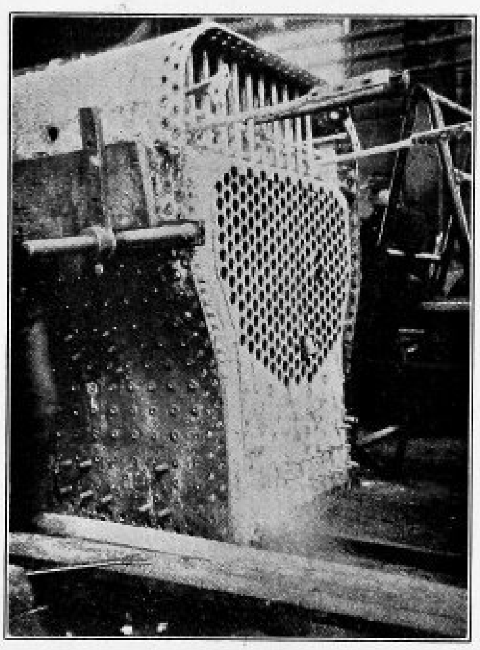


Fig. 4.—Cutting Out Flue Sheet with Oxygen-Acetylene Torch

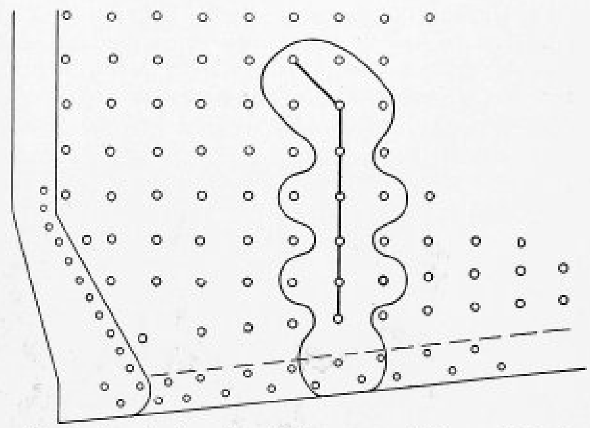
An angle elbow is easily welded to a smoke stack by the oxy-acetylene process, whereas by any other process it is an exceedingly difficult and expensive operation.

The elbows at times make acute angles with the stack. The turning of a flange on the elbow at such angles would be likely to cause the flange to fracture and it would be difficult to get at the riveting from both sides and then do the necessary calking.

The welded joint can be easily made and is even stronger than the riveted joint. In this process the hole in the stack to take the elbow or branch is cut out by means of the cutting blow-pipe. This part of the work alone effects enormous savings as compared with the old methods of cutting.

Irregular Patch Welded in Side Sheet with Electrical Welder

In the accompanying sketch is shown a section of the side sheet and leg of a back flue sheet of a wide firebox boiler of a freight locomotive. A fracture developed on the side sheet, as shown, extending from the first row of staybolts above the mudring and running vertically over five staybolts. Then the fracture traveled forward and upward one row of staybolts, as shown. On account of the fact that the fracture extended up towards the front of the firebox, it was not thought advisable to apply a V-shaped patch and therefore the method shown in the sketch was employed.



Sketch Showing Location of Fracture and Shape of Patch

Starting above the staybolt at the top of the fracture, the section was laid off with circular arcs on each side of the staybolts along the fracture to the mudring, as shown in the sketch. After having marked off this section, the side sheet was V-ed out along the lines shown. The staybolts were drilled on the outside wrapper sheet, the rivets backed out and the piece removed from the side sheet. A duplicate was marked off from this piece for a patch and punched out. Rivet and staybolt holes were drilled and the patch trimmed off and beveled all around. It was then bolted up securely in place and welded in by the electrical process. Finally, the rivets were driven and the staybolts applied.

This patch has now been in service for three months without requiring any attention from the boiler maker.

W. J. GILLESPIE,
Boiler Inspector, Pittsburg & Lake Erie Railroad.
McKees Rocks, Pa.

Lead Furnace Water Jackets Welded with Oxy-Acetylene Torch

In fabricating steel water jackets for the lead furnaces at the plant of the International Smelting Company, Tooele, Utah, extensive use is made of the oxy-acetylene torch in welding the sheets together. This job is of special interest to smelter boiler makers on account of the size of the jackets, some of them being 9 feet in height and 8 feet 3 inches wide. The plates are of the best flange steel, the fire sheets being ½ inch thick and the back sheets ⅜ inch thick, strengthened by having ⅜-inch by 4-inch by 5-inch tees riveted to the back sheets. The plates are flanged, the stays and fittings riveted on, and then they are fitted together with a water space of 5 inches and welded up with an oxy-acetylene torch. The discharge pockets are flanged of ½ inch steel and are also welded up and welded to the back sheet with a torch, making in all about 1,050 lineal feet of welding. An idea of the size and construction of these jackets is shown in Figs. 1 and 2.

The tools and equipment usually used in large contract boiler shops for such work are not provided at the plant where these jackets were fabricated. There were no hydraulic clamps or presses to flange the plates with, but a set of blocks was rigged up under a large power punch which did the flanging very nicely.

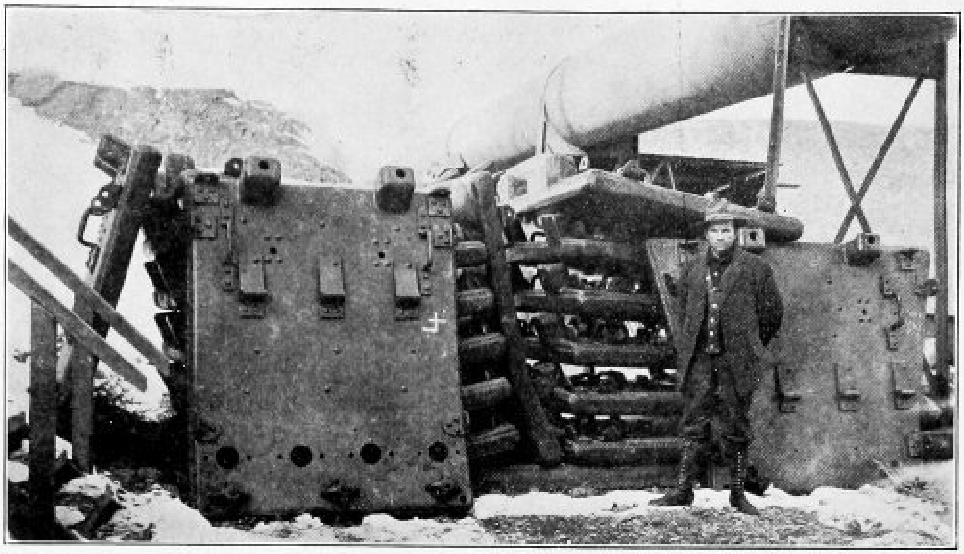


Fig. 1

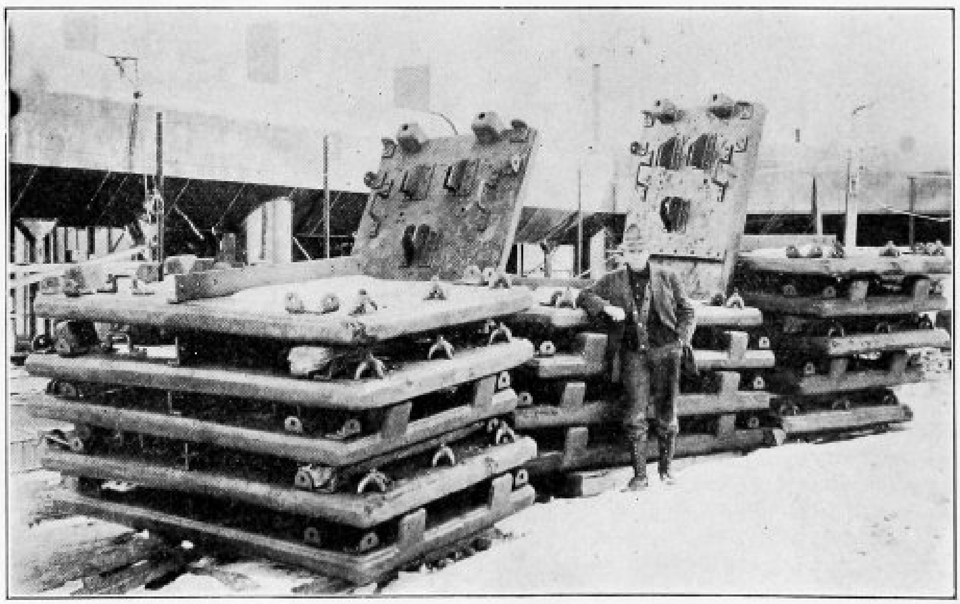


Fig. 2

While these jackets when completed weighed about 75,000 pounds, this work is only one of a large number of interesting steel jobs that are turned out by the shops of this modern copper and lead smelting plant.

WILLIAM T. CLEMO,
Foreman Boiler Maker, International Smelting Co.
Tooele, Utah.

Electric Drive for the Boiler Shop

Advantages of Electricity for Power Transmission —Its Reliability and Safety—Speed Regulation

BY J. E. BULLARD

In any industry every reason for the use of power can be reduced to one of the following: The power is used either to decrease the labor cost or to increase the production. If we realize either or both of these ends we reduce the cost of production. The first power-driven machines were only crude affairs. The first mechanical power producers were windmills and water wheels. From these small beginnings the use of power has developed till now we find in mills and factories the wonderfully complicated machines of the present day, and scattered throughout the country enormous electric power generating stations, some of which contain gigantic steam turbines, each one more powerful than a team of 25,000 heavy draft horses, and some of which send power to points hundreds of miles distant.

The power from these great electric power generating stations is communicated to the machinery in the shop not by means of ropes, belts, line shafting, etc., as power was transmitted in the days of yore, but through the medium of small, flexible copper wires. These wires can be strung on poles, buried in the ground, or carried under the water. After these wires reach the factory they can be carried along the walls, ceilings or floor to the machines to be driven. They always deliver as much or as little power as may be desired.

The modern great electric power generating station might be likened to the large insurance companies. Just as the insurance company is a pooling of funds to reduce the burden of any possible loss, the large electric power generating station is a pooling of the individual shop power plants into one large central plant. This co-operative or specialized system of doing business is being adopted in all branches of industry. It is a product of evolution and the result of competition. It has been found the most satisfactory and the most economical method of producing big results. Factories are coming more and more to use central station service for the same reason that they pay insurance companies to carry their insurance. They find it cheaper and more satisfactory.

Specialization in the production of power has resulted in a reduction in both the cost of power and the cost of the manufacturing operations. This is true in spite of the fact that most mechanics now work only eight hours a day with Saturday afternoon off and receive each week as wages considerably more money than did their grandfathers, who worked twelve hours per day and did all their work by hand.

In order to make labor more productive, machines must be placed in the most convenient locations. To do this some flexible method of transmitting the power to the machines must be adopted. If the machine is to be placed where the material is located, instead of the material being conveyed to the machine, we find that it cannot be driven by any of the old methods of transmitted power. A punch press is needed in one location, an emery wheel in another. And scattered throughout the shop in such a way that they could hardly be belted to line shafts, will be milling machines, bending rolls, compressors, lathes, drills, shears, hoists, cranes, pumps, etc. Electricity, thus far, has proven by far the most flexible method of transmitting power. It is the only method which permits of the placing of the driven machine anywhere—indoors or out —with no regard for the location of line shafting.

The adoption of electricity as a means of transmitting power always resulted in an increase in production. This increase in production has been brought about by the possibility of installing additional machinery in the space saved by the elimination of belting and line shafting, the relocation of the machinery in such a way that no time is wasted in conveying the material back and forth from one machine to another, the better speed regulation obtained, etc. The increase in production resulting from the adoption of electric drive has varied in different factories all the way from five percent to a hundred percent.

From all the many advantages which may be enjoyed through the use of electric power generated in large stations by means of large units distributed to many and varied industries, we will select only four for consideration here. There advantages are:

1. Reliability of service.
2. Better speed regulation.
3. Greater safety.
4. Better lighting.

Reliability of Service

Night and day, holidays and Sundays, hard times and good times, the electric motor is always ready for use. Where a motor is installed on each machine, a rush job requiring the use of only one or two machines can be finished at night or on a holiday at small cost. For instance, a job of shearing can be run off by operating only the shearing machines required to do the work without operating any other part of the shop, starting up the engine, or turning over any line shafting. All that is necessary to secure the power needed is the closing of a switch. No engineers or firemen need be called on to work overtime. Where steam power is used the services of these men would be required and their wages would make the cost of the comparatively few horsepower hours required to complete the rush job very high. Where central station electric power is used the cost of a unit of power need be no greater when one machine is being operated and very little power consumed, than when the whole shop is in operation and a great deal of power is being consumed.

Where electricity is used from large power plants, shutdowns due to power troubles are less frequent and of shorter duration than where the old systems of small plants, line shafting, and belting is used. If there is trouble with or an accident to any of the machinery in the factory only the machines affected need be out of commission. The rest can keep on operating. They will not have to wait till the trouble is remedied, a line shaft is repaired, a bearing babbitted or a belt mended.

Speed

Modern machines require much closer speed regulation than was required by the older and cruder machines of bygone days. There is always a correct speed for each machine. The speed may vary with different jobs. For

* Of the Society of Electrical Development.

a given piece of work, however, if the best results are to be obtained, a definite rate of speed must be maintained. If the machine is driven at a higher rate of speed disaster follows. If at a lower rate output suffers.

An ordinary belt-driven engine lathe depends for its speed control on counter shafting carrying cone pulleys matching pulleys mounted on the head end of the lathe and on back gears in the head of the lathe. At best this system permits of very limited control. Often, though, the speed may be too slow with the belt on one cone; it will be too high if the belt is shifted to the next step. Electric motors are now on the market having a very wide range in speed. These can be mounted directly on the lathe and geared to it. All belts, exposed gears, etc., are eliminated, and the speed variation is not only very wide, but under complete control. This perfect speed control results in more and better work being turned out by the machinist operating the machine.

On account of the ease, quickness and positiveness of their control, electric-driven cranes are now more and more displacing cranes driven by any other form of power.

Safety

There is a movement now going over the country with the slogan, "Safety First." In order that a shop may be as safe as possible, it is almost necessary that individual electric motor drive—that is, an electric motor mounted on and used to drive each machine—be used. There is hardly a mechanic who has worked around machinery for any length of time who has not seen some fellow workman caught by a protruding set screw in some rapidly revolving shaft and either killed or severely injured. Possibly he himself has had his clothing caught in exposed gears or by the belting on his machine and been painfully injured. Where individual motor drive is used this need never occur. There is no line shafting, belts are short and small, if not entirely eliminated, and all gears used can readily be encased and made harmless.

Light

There is no one thing of greater importance both to the owners of, and the workers in a factory, than good and sufficient light. If there is not enough light the owners suffer because production falls off, more material is wasted, and the work is not up to standard. The workman suffers because he is working under a constant eye strain which will in time permanently weaken his sense of sight and bring on more or less eye trouble. Because of his impaired eyesight he will never again be able to do as good work as he did before, working under poor light.

In order to secure good lighting it is usually necessary to eliminate all line shafting and belting. Line shafting and belting traveling at high rates of speed throw dirt, oil, etc., on the walls and surroundings and soon blackens them to such an extent that they reflect little, if any, light thrown on them. Belting and shafting cast shadows which make the problem of lighting very difficult.

Where each machine is driven by an individual motor, a clear space is left above the machine with no obstructions between it and the spot where the lighting unit can be placed. This makes it possible to install large and efficient lights which will brilliantly light the whole factory and do away with the necessity of each mechanic working with a bare light shining directly into his eyes and with the rest of the room in darkness.

Efficient lighting is of the greatest importance, for the results are better work and more of it.

Factor of Safety in Compulsory Boiler Inspection Laws

The factor of safety employed in engineering construction is made to vary not only with the character of the material used, but also with the nature of the loading to which the structure is subjected. The greater the variation in the strength of different test specimens of the material, the higher is the factor of safety employed for that material. Thus for a homogeneous and ductile material, such as mild steel, a factor of safety of five might be employed, while for a material lacking in homogeneity and in ductility and for test specimens which show wide variations in strength, such as cast iron, a factor of safety of ten might be employed. Again, for a structure such as a railroad bridge subjected to live loads varying between wide limits—that is, from no load, excepting the dead load, to maximum load—a factor of safety of five might be employed; whereas in the case of a roof truss not subject to a live load, a factor of safety of three might be employed.

For an engineering structure built in the form of a boiler and carrying extreme pressures, a factor of safety of five is not too great. It should be remembered that the term "factor of safety" is composed of two parts—one part a true factor of safety, the other a real factor of ignorance. The factor of ignorance takes care of differences in strength that often occur in the same piece of material, takes care of necessary abuse of the material while it is being punched and worked to form, and takes care of varying qualities of workmanship. The true factor of safety is, therefore, all that is left to take care of any overload to which the boiler may be accidentally subjected in service. Moreover, this particular factor is based upon the ultimate strength of the material, whereas the yield point of such material is only about one-half the ultimate strength. Consequently this true factor of safety is cut in half. For example, if the assumed factor of safety were five, and the factor of ignorance happened to be one, then the true factor of safety based on ultimate strength would be four, and the factor of safety based on the yield point would be only two.

Now, if a factor of safety of five is good engineering practice for new construction, it also is good engineering practice for boilers already in service. Certainly there would be no consistency in using a lower factor of safety for old boilers than for new boilers. Boilers in service are subjected to serious intermittent stresses due to expansion and contraction brought about by an alternate heating and cooling.

As a matter of fact, however, many boilers in service have a theoretical factor of safety of only four or even less. Insurance companies in general demand a factor of safety of not less than five. But not all boilers in service are insured, and it is well understood that if a law were passed affecting boilers in operation at the time, and if a factor of safety of five were required, it would seriously affect a great many industries; and would mean cutting down the pressure of a great number of boilers and the discontinuance from service of many more.

For this reason, although a factor of safety of five is desirable and is adopted in virtually all compulsory boiler inspection laws for new construction, it is usual to permit a factor of safety of four and one-half in boilers in service at the time of the enactment of the law. This is probably the best that can be done, and it means, of course, that eventually the desired factor of safety of five will be attained.—*Monthly Bulletin of the Fidelity and Casualty Company of New York.*

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NOTICE TO ADVERTISERS.

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

Few recent developments in the boiler-making field have made greater progress than the application of autogenous welding to repair work, particularly in railroad shops. Ten years ago autogenous welding had hardly approached a successful commercial development. The possibilities for the utilization of such methods were by no means fully realized by boiler makers, and it has been due very largely to the vigorous efforts of the manufacturers of welding equipment, during the last five years, that autogenous welding has become such an important factor in boiler work to-day.

Both the electric and oxy-acetylene processes of welding have passed far beyond the experimental stage, and such a fund of valuable data and experience has been gained that the factor of uncertainty regarding the results that may be expected is rapidly disappearing. Furthermore, the remarkable economies made with autogenous welding methods in repair work are becoming fully recognized. Not only is the cost of repairs very materially reduced, but with the present methods locomotives are kept out of service for repairs for a much less length of time than was the case with former methods.

Experience has shown that the two principal methods of autogenous welding, the electric and the oxy-acetylene, have advantages over each other in different operations. According to a report presented before the last convention of the International Railway General Foremen's Association, the electric process is recognized as particularly suited for welding flues to back flue sheets, filling in on calking edges, reinforcing small corroded parts and for use wherever it is important to confine the high temperature to as small an area as possible. On the other hand, for large boiler patch work, new half or whole side sheets, long cracks and work where suitable provision for contraction can be readily provided and in cutting or removing defective parts of old sheets, the oxy-acetylene excels. In any case, both electric and oxy-acetylene welding equipments have been found to be paying investments. One report states that the electric welding outfit would pay for itself by just welding flues alone, while, in another case, it is estimated that with an oxy-acetylene outfit an average saving of $4 and over is made for every hour that the welding outfit is at work. The cost of labor and material, including a helper, was only about $1.50 per hour.

The uses to which both electric and oxy-acetylene processes can be put are almost infinite. It is interesting to note, however, that in welding flues to the back flue sheets by the electric process it is found that the flue sheet is kept in better condition than it was before the flues were welded in. As a matter of fact, it requires only a few hours longer to remove welded flues than it does to remove flues applied in the ordinary manner. Flue leakage, however, is practically almost eliminated with welded flues, and cases are cited where an engine with an entire set of tubes welded in has been in continuous service for eleven months with the tubes in excellent condition and with no occasion for repairs. In view of such excellent results, it is now becoming the standard practice on some roads to weld all of the tubes to the back flue sheet, either by the electric or oxy-acetylene process.

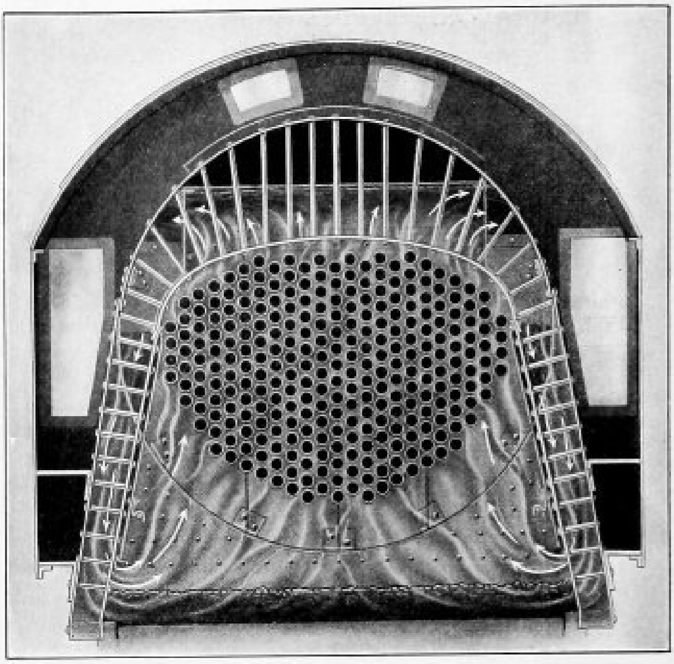
From two hundred to two hundred and fifty papers and reports, covering all phases of engineering work and contributed by authors representing some eighteen different countries, have been assured for the forthcoming International Engineering Congress to be held September 20-25 in connection with the Panama-Pacific Exposition at San Francisco, Cal. In spite of the fact that the number of representatives from the countries involved in the European war will naturally be less than originally planned, the Congress, nevertheless, will be thoroughly international in scope and character. According to a report from the Secretary of the Congress, the papers are now rapidly coming in, and their character gives full assurance that the proceedings will form a most important collection of engineering data and a broad and detailed review of the progress of engineering art during the past decade. Invitations are now being issued by the Committee of Management to all important engineering societies of this country and abroad to appoint official delegates to attend the sessions of the Congress, and the presence of a considerable body of such delegates is well assured. Membership in the congress with the privilege of purchasing any or all of the volumes of the Proceedings is open to all interested in engineering work.

Engineering Specialties for Boiler Making

Water Circulating System for Locomotive Boilers—Useful Safety Device for the Shop—Meter for Measuring the Flow of Fluids

Ross Schofield System for Circulating Water in Locomotive Boilers

The Ross Schofield system for the circulation of water in fire-tube boilers, which for some time has been in successful use in stationary and marine boiler practice, is now being applied to locomotive boilers. On locomotives the device is made up of three parts. A baffle plate, which loosely surrounds the tube and separates the barrel of the boiler from the firebox portion, is secured to the shell of the boiler at the throat sheet. This extends to a height level with the highest point of the crown sheet, and openings are provided at the sides below the center line of the boiler. The space between the baffle plate and the firebox side sheet is closed by side plates which extend downward to a point about 10 inches above the mudring. A water column is thus formed which is enclosed by the flue sheet, the baffle plate and the two side plates. All circulation from the barrel of the boiler must pass through the openings in the baffle plate, downward through the water leg to the bottom of the side plates and thence upward over the rear flue sheet and the rear ends of the tubes. Supported to the top of the baffle plate is a curved hood extending up to the normal water line, which directs the circulation over the crown sheet toward the back of the firebox. The water about the firebox thus moves in a circuit; upward across the flue sheet, backward and downward along the crown sheets, side sheet and door sheet, and forward near the bottom of the water legs. As the water in the firebox space is evaporated, more flows in from the barrel of the boiler through the openings in the baffle plate.



Cross Section, Showing the Direction of Flow from the Barrel of of the Boiler

From the above it will be seen that a space is confined around the hottest portion of the heating surface by means of baffle plates, communication with the body of water in the boiler being provided at the top and bottom only. The generation of steam within the water column thus

Section of Locomotive Boiler Fitted with Ross-Schofield System of Circulation, Showing the Direction of Currents Over the Crown Sheet formed produces a rapid circulation of the water, provision being made at the surface of the water to properly guide the current thus formed.

It is claimed that this device increases the rapidity of evaporation due to the constant freeing of the heating surface from the steam bubbles by the sweeping action of the water. Priming which is caused by the violent separation of the steam from the water is overcome by means of the hood which directs the rush of the rising steam and water in a horizontal direction, thus making available the entire surface of the water over the crown sheet for the separation of steam, with a consequent decrease in violence of ebullition at any one point The rapid circulation of the water prevents the formation of stagnant pockets of cold water near the corners of the firebox and produces a uniform temperature at all points around the firebox, thus in a measure reducing the effects of unequal expansion and contraction. It is also claimed that the formation of scale is largely prevented by the rapidity of the circulation, which causes the particles of scale-forming material to collect at the mudring, where they may be disposed of through the blow-off cock. This is borne out by the result of experience with the system in stationary service.

This device may be readily applied to old boilers whenever the tubes are removed for repairs. The baffle plates may be made in sections of any size suitable to be taken into the boiler through the dome, the parts being assembled inside the boiler before the tubes are applied.

The Q. & C. Company, with offices at 90 West street, New York, and in Chicago, are the sole selling agents for this system in the United States and Canada for locomotives.

Buffalo Machine Guards

The Buffalo Wire Works Company, Buffalo, N. Y., has on the market wire machine guards to be placed around exposed moving parts of machinery, such as belts, flywheels, pulleys, etc. The guards are made to fit almost any arrangement of machinery. They are constructed with 1½-inch diamond mesh of No. 9, 10 or 12 gage wire with

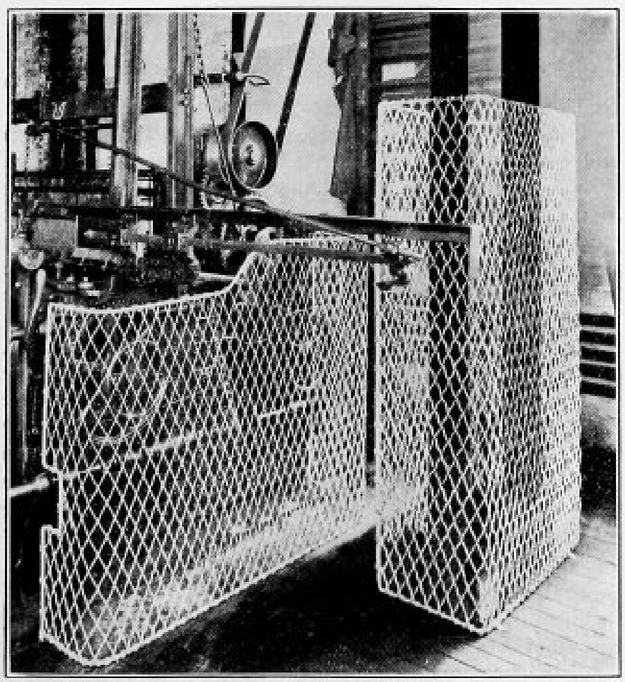


Fig. 1

either channel iron frames (as shown in Fig. 2) or round iron frames (as shown in Fig. 1). Means are provided for fastening the guards to the floor, or either type can be made with legs that can be fitted into holes in the floor

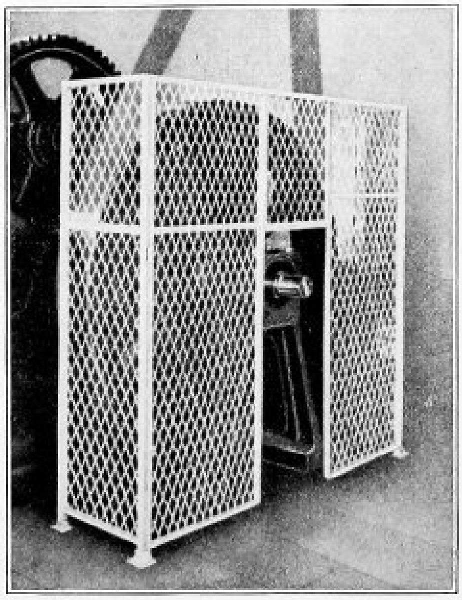


Fig. 2

and thereby allow the guards to be removed when necessary.

Machine guards of this type are one of the most important safety appliances that can be installed in a shop. They not only save life and limb, but also decrease insurance rates and the costs for damages from accidents.

Kreutzberg Volumetric and Velocity Meter

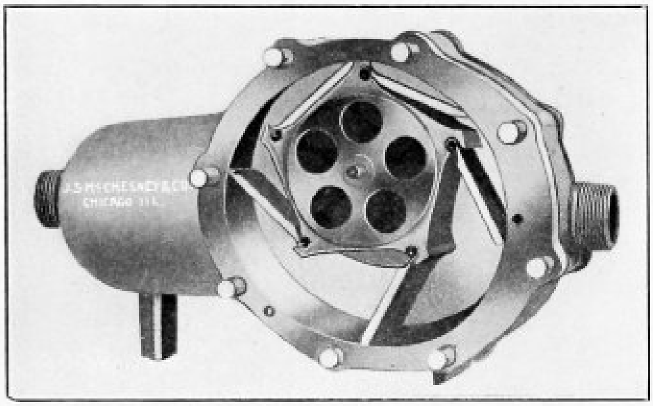
J. S. McChesney & Co., Chicago, Ill., has placed on the market a meter, known as the Kreutzberg meter, which is designed to measure accurately the volume and velocity of any fluids passing through it. The meter consists of a casing in which a drum fitted with hinged vanes is mounted eccentrically. As the drum rotates a certain definite volume of the fluid passing through the meter is confined between two adjacent vanes, and in this way the fluid is mechanically divided into sections of definite volume, so that the number of revolutions of the drum, recorded on a register, gives by direct readings the amount and velocity of the flow of the fluid.

The fluid enters the meter through a screened chamber, so that any solid matter will be removed. The fluid then passes into the meter and impinges against the vanes, causing the drum to rotate. When a vane passes the cut-off point on the inlet a section of fixed volume of the fluid is contained between the cut-off vane and the next vane ahead. The fluid is discharged as the vane passes the outlet opening at the opposite side of the meter.

It is claimed that the Kreutzberg meter makes possible the rapid and accurate measurement of commercial quantities of any fluid, such as oil, alcohol, turpentine, etc., and also gas, steam and air under high pressure. Since the function of the vanes is to divide the flow into sections, the pressure on each side is theoretically the same, and in practice differs only by the energy required to rotate the drum which in pressures greater than five pounds is negligible. The wear on the vanes is at the end, and this, it is claimed, is automatically taken up.

With compressed air and pneumatic tools in general use, the loss of air, whether through faulty tools or by line leakage, frequently assumes serious proportions. To detect this loss and accurately measure the amount of air required to secure maximum efficiency, the Kreutzberg meter has been found most useful, especially to the user of pneumatic tools seeking absolute information as to air consumption in the shop or the efficiency of tools offered for sale.

It is stated by the manufacturers that several railroads and factories are using the meter in compressed air and steam lines to determine proportions of total supply delivered to different departments, thus affording figures upon which to base operative and manufacturing costs. Comparative tests are also made as to the air consumption of a tool when new and after a period of service. In this latter case, if the consumption has increased excessively, the tool may be subject to inspection to determine where the leakage occurs and how this can be reduced so that the tool will regain its original efficiency for a longer period. Further, tools may be tested periodically and sent to the tool room for repair when excessive air consumption is required to work them at full efficiency.



Kreutzberg Meter with Side Removed, Showing Drum and Vanes

The New Wilson Safety Goggle

In the May, 1914, issue of THE BOILER MAKER was published an illustrated description of the Willson safety glasses, manufactured by T. A. Willson & Co., Inc., Reading, Pa., for protecting the eyes of chippers and men doing heavy work where they are liable to be struck by large slugs of metal. These glasses, it will be recalled, are of an extra strong construction, having a patented safety flange which extends ⅛ inch over the back of the glass to prevent broken glass going through and injuring the workman's eye. The side shields are made of strong wire screen. The temples are inside the shields and fold back of the glass.

Such heavy protection glasses, however, are unsatisfactory for grinders, machinists and men doing light work, so a short time ago the manufacturers perfected a new Willson goggle especially designed to meet the requirements of grinders and machinists. The new goggle is very light in weight and at the same time substantial enough to withstand the hardest knocks to which it would be likely to be subjected. The safety flange used in the previous heavy chippers' glasses has been eliminated, as there is no danger of the glass being broken. Protection is only necessary from flying bits of emery, dust and grit. The rim of the new goggle which replaces the flanged frame of the safety glass is amply strong. The lenses are of good quality glass. The side shields are much lighter and of finer mesh. The temples are on the outside of the shields and fold over the front of the glasses. The new goggles are supplied in a strong steel case, protecting them when carried by the men.

The manufacturers of the above specialties were awarded the grand prize at the Second International Exposition of Safety and Sanitation, held at the Grand Central Palace, New York, December 12 to 19, 1914, in acknowledgment of the merits of the Willson safety glass, the new Willson goggle and the Albex eye protector.

Worth Brothers-Coatesville Rolling Mill Company to Manufacture Basic Open Hearth Steel Tubes

The Worth Brothers-Coatesville Rolling Mill Company, Coatesville, Pa., which holds the unique position of being the only tube manufacturer that can supply itself with basic open hearth steel skelp for tube manufacture, has decided to take advantage of this opportunity to manufacture basic open hearth steel tubes. The value of Worth Brothers' well-known quality of locomotive boiler and firebox steel for equipment and repairs is well recognized throughout the United States. This same quality, it is claimed, will be used in making basic open hearth steel tubes.

The Coatesville Rolling Mill Company claims that for many years it has been the largest producer of charcoal iron locomotive tubes, and that it will continue to maintain this position, at the same time having the distinction of being the only tube manufacturer that can supply the trade with both charcoal iron and basic open hearth steel tubes manufactured from the ore to the finished product.

Technical Publications

OIL FUEL FOR STEAM BOILERS. By Rufus I. Strohm. Size, 5 by 7 inches. Pages, 140. Illustrations, 63. New York and London. 1914: McGraw-Hill Book Company, Inc. Price, $1 net; 4/2 net.

This book is one of the series, called the Power Handbooks, which is frequently referred to as the "Best Library for the Engineer and the Man Who Hopes to be One." The purpose of the volume is to describe the underlying principles in the use of oil as a fuel for steam boiler practice. The construction and operation of various types of burners, together with their arrangement in different boilers and the operation of pumps, heaters, etc., are described clearly and in many cases by excellent drawings. No special reference is made to marine practice, as the subject matter is confined to stationary boilers.

STEAM BOILERS. By E. M. Shealy. Size, 6¼ by 9⅜ inches. Pages, 350. Illustrations, 184. New York and London, 1912: McGraw-Hill Book Company, Inc. Price, $2.50 net.

As this book is intended for the use of firemen and others who are in responsible charge of boiler rooms, it is given over almost wholly to the subject of the operation of boilers rather than to their design. Chapters on the chemistry of combustion and fuels form a basis for the study of the proper burning of fuels. These are followed by descriptions of firing and smokeless combustion of coal. Chapters are also included on the care and inspection of boilers and boiler testing. As a text-book for correspondence students, for which it was primarily written, it is excellent for practical study, and although it does not refer especially to marine practice, nevertheless it should be a valuable asset to those operating any type of boiler.

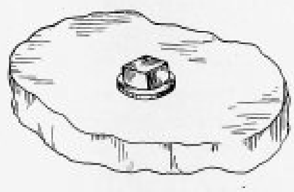
Letters from Practical Boiler Makers

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

The Safety Plug Variety of Fusible Plug

After a boiler explosion we hunted around for the pieces, and about a mile away we found a patch of the boiler that contained a plug—the safety plug. The piece we found looked something like the sketch indicated herewith.

We removed the plug after some severe labor and put it through the test. It was hard—very hard. It was not



"The Safety Plug"

very easy to chip it with a chisel nor was it easily filed with a file. It seemed quite unlike fusible metal. We hammered it hard with a heavy sledge and finally managed to fracture it. Its crystalline structure was identical with the structure of a high grade of cast iron. We diagnosed the plug as being pure cast iron.

The plug was a good one—perfectly safe. Hence we derive its name—SAFETY PLUG!

New York. N. G. Near.

Size of Tubes for Return Tubular Boilers

In the January, 1915, issue of The Boiler Maker, under the title "Taking Care of Kicks in a Boiler Shop," Mr. Francis asks the question: "Are 44 — 4-inch boiler tubes any better or worse than 54 — 3½-inch tubes?" These tubes are 16 feet long and are placed in a 60-inch diameter return tubular boiler.

The internal heating surface in

54 — 3½-inch tubes = 737 square feet, and in
44 — 4-inch tubes = 687 square feet.

Therefore, from the standpoint of heating surface alone, the 3½-inch tubes have about 50 square feet to their credit over and above that in the 4-inch tubes. This would be equivalent to about 5 horsepower.

A still greater item in favor of the 3½-inch tubes, and one which is usually overlooked, except by boiler designers well versed in the art, is the resulting higher velocity of the flue gas in passing through the smaller tubes. Actual practice with locomotive boilers and various experiments with other forms of boilers have proven that an increase in the velocity of the gases passing over the heating surface means a direct increase in the heat transmitted to the water in the boiler. The tubes in a locomotive boiler are smaller in diameter than those in a stationary type boiler, which accounts to some extent for the higher efficiency of the former type of boiler. In general, a boiler with long tubes of small diameter will be more efficient than a boiler with short tubes of large diameter. Kreisinger and Ray, in "The Transmission of Heat into Steam Boilers," state: "If the same weights of gas at the same initial temperature are passed through a 2-inch and a 4-inch tube, both tubes having the same length, the 2-inch tube will absorb *more* heat than the 4-inch tube, although the 4-inch tube has twice as much heating surface as the 2-inch tube."

In the case under consideration, the 44 — 4-inch tubes have an internal cross-sectional area = 44 × .076 = 3.35 square feet, and the 54 — 3½-inch tubes have an internal cross-sectional area = 54 × .058 = 3.13 square feet, from which it will be seen that where all other conditions are the same, for each 3.13 feet per minute flue-gas velocity through the 4-inch tube there would be a corresponding flue-gas velocity of 3.35 feet per minute through the 3½-inch tubes. This is an increase in velocity of nearly 7 percent in favor of the smaller tubes, which when added to the additional 50 square feet of heating surface in these tubes would make the boiler containing the 54 — 3½-inch tubes about 10 percent greater steaming capacity than the boiler with the 44 — 4-inch tubes. For the same conditions of operation, the boiler with the 3½-inch tubes would be the more efficient.

It is the writer's opinion that return tubular boilers less than 18 feet long should always have 3-inch tubes, and above this length 3½-inch tubes may be used, if necessary, where the draft is poor. As regards 4-inch tubes for return tubular boilers, there seems to be no good excuse for their use.

Syracuse, N. Y. G. M. K.

Approximate Methods of Laying Out

It seems to the writer that there is a great deal of unnecessary quibbling over approximate methods of laying out. I have yet to see the method of laying out riveted pipe which is not approximate. Even with this handicap it is not good policy for a layer out to have blind or even unfair holes in an elbow of tapered courses, as Mr. Ross suggests we do, by using approximate methods. In fact, such a policy, if persistently followed, might have a tendency to make said layer out a unit in the army of unemployed.

A capable layer out ought to be able to take any one of several methods and make an elbow which can be fitted together with bolts the same diameter as the rivets which are to be used. However, careless preparations for assembling can make the best layout fit up only after much trouble.

In an elbow of 90 degrees, made in five courses, the end of each course must be bent in the back and throat 22½ degrees, and the bend tapered to nothing on the other quarters. If there is trouble in assembling, that bend is often a good place to look for it.

To get back to approximate methods, let us consider Mr. Ross' method. He uses what he decries. In his Fig. 4, section $V\ W\ W''\ V''$, is the frustum of a scalene cone, yet he does not develop it as such, but uses a rather cumbersome method of finding the camber for a right cone, and proceeds to lay out his plate on that line. I have no doubt but that his elbow will fit up O.K., however.

One thing I do doubt, though, is the advisability of making both ends of the elbow the same diameter, yet different from the intermediate courses at either end. Seems to me that is wasting any pipe that connects to the elbow.

Ensley, Ala. C. G. Reem.

Rolling Boiler Flues

In the December issue of THE BOILER MAKER, under the heading of "Letters from Practical Boiler Makers," I notice an article from N. G. Near relative to the rolling of flues.

In my opinion, his method is very slow, and then not sure, as a flue is liable to be perfectly smooth after the rolls have been turned completely around four or five times, and no boiler maker can say that a flue is rolled tight if it is smooth to the touch. Taking out the rolls to feel the flue, and upon finding it is not, in his opinion, rolled enough, to have to put the rolls back again is very tedious work. In an up-to-date shop this would not be tolerated five minutes. I am a boiler maker working for the Southern Railway Company, and I will try to give an idea of how we work things here:

In the first place, most all flue rolling is done with the air motor and an extension rod to reach from the outside of the smoke box to the flue sheet, and after the same principle in the firebox. In most cases the flues have a full eighth of an inch clearance in the flue sheet, and must, of course, stand the strain of being rolled out that much, and after that as much as the boiler maker thinks enough to make it tight. By watching the flue carefully, the boiler maker will notice the end of the flue that is sticking out of the front flue sheet stretch the least bit, and the air motor will pull harder, until it almost stops; but before it does that the ordinary practical boiler maker will have it reversed and draw the pin and move the rolls to the next flue.

With a little practice and a steady air pressure, say about 90 pounds, we can tell to a certainty when the flue is rolled and able to stand from 250 to 300 pounds to the square inch water pressure, which we always put on before the steam test.

In the case of rolling a flue with hand rolls, which undoubtedly Mr. Near refers to, my experience has taught me, and any boiler maker who has served an apprenticeship and worked at marine or railroad work will say the same, that the best method to determine when a flue is rolled is when the pin drives solid and the rolls turn evenly around in the flue, so that no slackening or tightening of the pin is felt by the boiler maker. In no case have I ever known a flue to leak if the above method is used; but in the case of self-feeding rolls, which are used in the majority of boiler shops to-day, the judgment of the boiler maker, after he has rolled one or two flues to his satisfaction, the size of rolls he is using and how far the pin goes in the rolls, will act as a guide for him in the other flues, without having to take the rolls out of the flue. Afterwards, by feeling around the flue inside, a ridge can be felt, and coupled with the smoothness of which Mr. Near speaks, is a very good indication that the flue is rolled successfully.

I hope the above remarks will be to the interest of THE BOILER MAKER readers in general, and I also hope they will give their views on this question.

Salisbury, N. C. D. G. YOUNG.

A Defense of the A. S. M. E. Boiler Code

I note that William E. Murray wrote "A Criticism of the A. S. M. E. Boiler Code" in the January issue of BOILER MAKER as a result of reading my letter in the December issue, entitled "How and Why I Taught Boiler Design." He says my article was "apparently written as a humorous article," but not so. I told the plain, unvarnished truth about myself. Perhaps he can hardly believe that anybody would do such a thing, but I did it, and I did it for the same reason that Mr. Murray wrote his code criticism on the A. S. M. E. code. He says that *safety* is his objective, and that is his reason why boiler inspectors should have a hand in framing the new code along with the A. S. M. E. committee. The committee certainly should have considered what he wrote, and perhaps they did.

From my viewpoint, which I do not claim is absolutely authoritative, I will give the probable reasons why the committee did not follow Mr. Murray's suggestions. My ideas are just those of an "Ex-Professor," and therefore my mind may be steeped too much in a combination of bluff, guesswork and theory. I would therefore wish to shake hands with Mr. Murray before I start and wish that I knew as much about the inspection end of the business as he does.

First.—Who knows just where the area of the segment begins that should be stayed? Why should it be 3 inches from the shell and 2 inches from the tubes? The only way it can be arrived at in my mind is by experience, test and judgment. I have made no tests, but my experience and judgment tell me that 3 inches and 2 inches, respectively, are all right. The head is certainly more securely held by the shell than by the tubes, because the head and shell are virtually one piece. If the tubes could be riveted in, I can see no reason why 3 inches from the tubes would not hold as well as 3 inches from the shell. Conditions as to thickness and pressure change, true enough, and it would be possible to use varying distances; but why do it when 2 and 3 inches are sufficient in all standard cases? It is a good thing to have set rules like this as long as they are always safe. As to the holding power of tubes, I am sure it is a settled matter that we cannot state their definite strength. The holding power in one boiler might be quite different from the holding power in another. In some cases, where we have had tubes merely rolled in without beading over, results have been disastrous.

Second.—Right here I will have to "crawl." Mr. Murray's argument is powerful and sways me in his direction. I can see no reason why the pressure on the manhole should not be considered and braces next to the manhole made stronger than the others. His argument is so good that I will repeat it here:

"True, the sheet has been flanged in for a distance of not less than twice the thickness of the head, and by so doing a certain stiffening effect has been given, but I believe that this stiffening effect has only been for the purpose of forming a beam, and is used for the purpose of transferring the load from the manhole cover to the other part of the segment that we are able to brace. I cannot see wherein we have in any way lowered the total load to be sustained by the brace or through-rod. We have already given the flange and the tubes their full allowance, and I believe that the area to be braced in the front head should be the same as if no manhole were used."

However, the beam effect must not be forgotten. We have the tubes on one side holding up one end of the "beam" and the boiler shell holding up the other end of the "beam" which takes care of a good share of the manhole area. Perhaps the A. S. M. E. committee considers that the manhole area is thus ENTIRELY cared for. Nevertheless, I believe extra caution should be observed with the braces adjacent to the manhole.

Third.—Whether the longitudinal joints of small boilers should be lap joints or butt joints is largely a matter of experience with explosions or semi-serious ruptures. That the lap joint is a ticklish proposition is well known by all, and what Mr. Murray says about the fault being more aggravated in small boilers than in large is doubtless true, but small boilers are not so liable to explode. The factor of safety of small boilers is generally greater than in large boilers, hence designers are allowed to be more shiftless. Besides, the committee doubtless possessed a large array of figures on explosions, from which they deducted the conclusion that lap joints are O. K. in sizes smaller than a certain diameter. Nevertheless, I take my hat off to Mr. Murray in specifying the butt joint throughout. His arguments are sound and certainly worthy of an ear of the committee.

Fourth.—The hemispherical head is an ideal shape, without question, but it is almost impractical constructionally. It does not permit interchangeability of tubes, is difficult to make, is less mechanical in appearance, and even if used would perhaps be just as dangerous as the present types. With a large radius of curvature at the flange and sufficiently thick metal the faults of the bumped head are obviated. It is common in nearly all walks of life for us to use things that are more easily made than to use those that are made with difficulty. We just make the simple thing a little stronger and heavier. The head, of course, is invariably lighter.

Fifth.—It is well to always be on the side of safety. A plain furnace with a diameter greater than 38 inches has some strength to resist collapse, without doubt, but why not consider it as a flat surface and thus be absolutely safe? The committee certainly knows that a limit is not reached at a certain point—38 inches—but it is best to place the limit somewhere, and why not right there?

Sixth.—The rotary bevel shear distorts metal, I admit, but the metal that is distorted is not so imporant in the ultimate strength of the boiler as is the metal right around the punched or drilled holes; it is not subject to so great unit stress.

The time will come, perhaps, when our methods of manufacture will be advanced to the extent that we can make a "perfect" boiler at about the same cost at which our present boilers are made. With automatic manufacture and other improvements machining costs are growing less every day. The Ford automobile factory is an excellent example. But until that time comes in boiler-making rules will be made that will meet our most economic conditions.

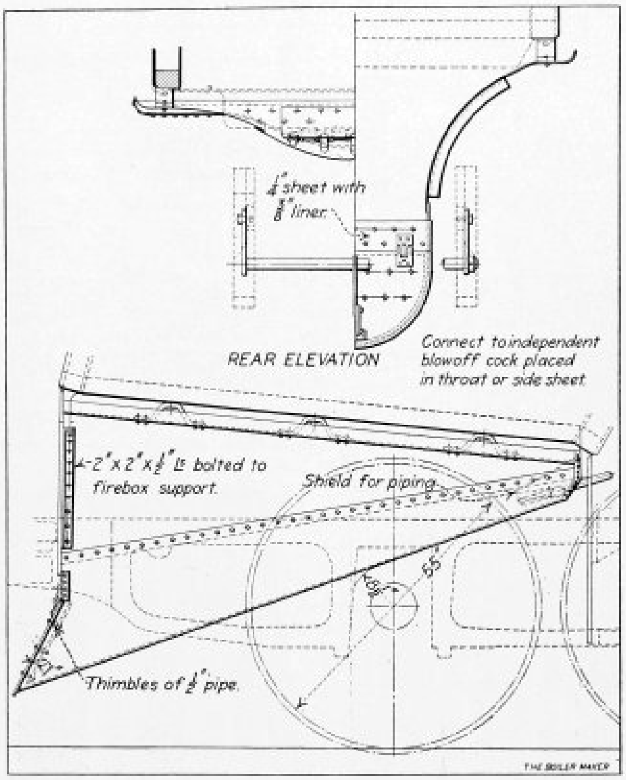
It would be easy to say, for instance, "Boilers must have no seams, and no rivets," but who is going to make the boilers? Maybe, some day, we will have such boilers. As soon as they can be made at small cost they will doubtless be specified.

New York, N. Y. "EX-PROFESSOR."

Improved Locomotive Ash Pan

Mr. T. P. Madden, traveling boiler inspector of the mechanical department of the Missouri-Pacific Iron Mountain Railroad, St. Louis, Mo., has recently patented some new and useful improvements in locomotive ash pans. The objects of the invention are to construct a comparatively simple, strong and durable ash pan which will effectively prevent the dropping of live coals on to the right-of-way, thereby meeting the requirements of the safety-appliance laws, and also to construct an ash pan in such shape that it will resist a tendency to buckle or become distorted as the result of unequal expansion and contraction, due to the variation of the heat of the ashes deposited in the ash pan. Means are provided in the form of a series of jet nozzles adapted to deliver water into the ash pan to quench any fire in the live coals in the ash pan and also to flush all ashes from the pan whenever desired.

The improved ash pan is constructed of metal in the form of a chute which gradually becomes narrower and deeper from the front to the rear end. By constructing the pan in the form of a tapered chute which slopes from one end to the other, all ashes falling into the ash pan will, by gravity, tend to pass to the lower end of the pan. The upper end of the pan is closed by a fixed plate and the lower end is normally closed by a hinged door, which is operated by toggle links actuated by a lever



Details of Improved Ash Pan

extending to the locomotive cab, so that the door can be locked in its closed position or opened from the cab whenever desired.

At the upper end of the pan is a tubular head into which is fitted a series of short nipples which project downward toward the inclined curved bottom of the pan. The ends of these nipples are cut off at an angle so that the jets of water issuing from them will be deflected down on the surfaces of the bottom of the pan.

The shape of the pan, it is claimed, materially stiffens the pan against any tendencies to warp and become distorted on account of unequal expansion or contraction, due to the varying temperature of the ashes in the pan. The shape of the pan also causes the ashes to gravitate toward the lower end and by means of the jets of water the contents of the pan can be flushed out or any fire in the ashes put out.

ELECTRIC WELDING OF FLUES.—According to statements by C. L. Dickert, assistant master mechanic of the Central of Georgia Railroad, over 90 locomotives with flues welded to the back flue sheets by the electric process, making about 27,000 flues, are now in service on the Central of Georgia without a flue failure on the road.

Selected Boiler Patents

Compiled by

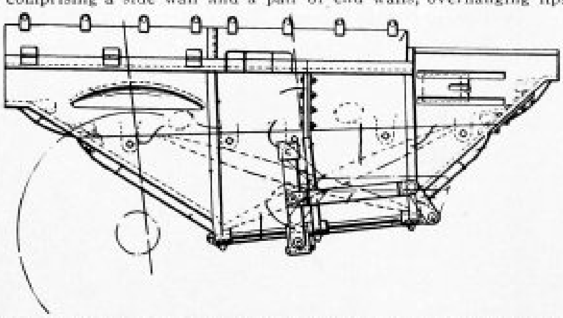
DELBERT H. DECKER, ESQ., Patent Attorney,

Millerton, N. Y.

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

1,114,196. LOCOMOTIVE ASH-PAN. ALFRED H. SMITH, OF NEW YORK, AND HARRY WANAMAKER, OF ALBANY, N. Y.

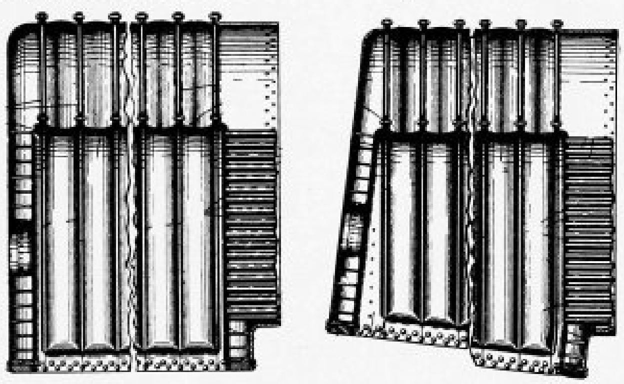
Claim 1.—The combination wiith a locomotive firebox of a hopper connected to and depending from said fire-box, flanges on the lower portions of the side walls of the hopper, an ash-pan formed in two parts, each comprising a side wall and a pair of end walls, overhanging lips on



the upper edges of the side walls of the ash pan, which lips engage the flanges on the lower portions of the side walls of the hopper, and diagonally disposed intersecting strengthening ribs formed on the inner faces of the side walls of the ash-pan. Fourteen claims.

1,115,156. BOILER. ARCHIE M. BAIRD, OF TOPEKA, KAN., ASSIGNOR OF ONE-HALF TO HENRY W. JACOBS, OF TOPEKA, KAN.

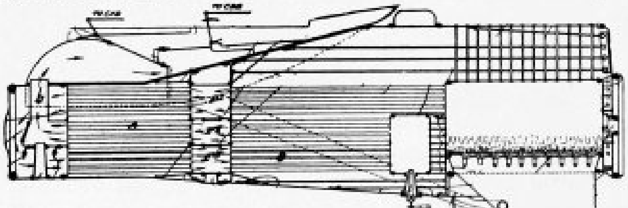
Claim 1.—A boiler provided with a sectional fire-box, the door-sheet and flue-sheet whereof are secured to the adjacent sections of the fire-box and independent of the outer boilr-shell, said sheets being com-



posed of sheet metal formed so as to provide off-set flanges extending substantially parallel with the main or body portions thereof whereby the sheets are secured to the flanges of the fire-box sections so as to permit expansion and contraction in the fire-box without transmitting the stresses to adjacent portions of the boiler and to the flues of the boiler. Five claims.

1,115,787. STEAM BOILER. CHARLES W. CROWELL, OF SALISBURY, N. C.

Claim 2.—A steam boiler having heating flues and a combustion chamber and having its heating flues divided into upper, lower and intermediate series, a smoke box in advance of the boiler and receiving the



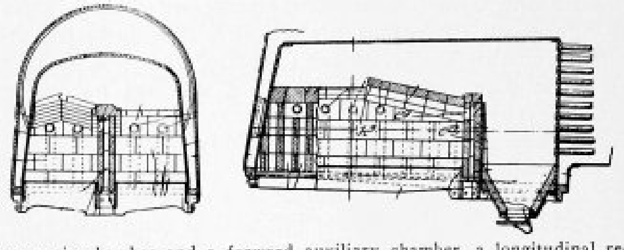
products discharged by the upper series of flues and delivering the same to the lower series of flues with the latter discharging into the combustion chamber and the intermediate flues extending forwardly from the combustion chamber, a smoke chamber to which the intermediate flues discharge, an exhaust nozzle discharging into such chamber and a stack leading from the chamber, substantially as set forth. Thirty-four claims.

1,110,319. TUBE CLEANER. ALBERT F. FROUSSARD, OF ST. LOUIS, MISS.

Claim 1.—In a tube-cleaning device, the combination with an outer rotary member, of an inner stationary member, a plurality of shafts carried by said inner member and arranged to simultaneously enter a plurality of tubes, tube-cleaning tools carried by said shafts, and means for communicating motion from said outer member to said tool shafts. Sixteen claims.

1,115,801. LOCOMOTIVE FIREBOX. FREDERICK F. GAINES, OF SAVANNAH, GA., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

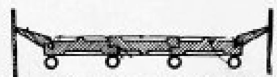
Claim.—In a locomotive boiler fire-box a refractory cross wall rising from the level of the grate extending from side sheet to side sheet and spaced from the flue sheet and dividing the combustion chamber into a



rear main chamber and a forward auxiliary chamber, a longitudinal refractory wall also rising from the level of the grate and dividing the main combustion chamber into two parallel subsidiary chambers, each of said walls being adapted to discharge heated air into the fire-box from discharge openings arranged near their upper edges, rearwardly and upwardly inclined refractory baffle walls covering the forward ends of said subsidiary combustion chambers, and a hoppered bottom in said auxiliary chamber for the collection of cinders and unburned fuel particles carried over by the gases of combustion. One claim.

1,115,955. LOCOMOTIVE-BOILER FURNACE. CHARLES B. MOORE, OF EVANSTON, ILL., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

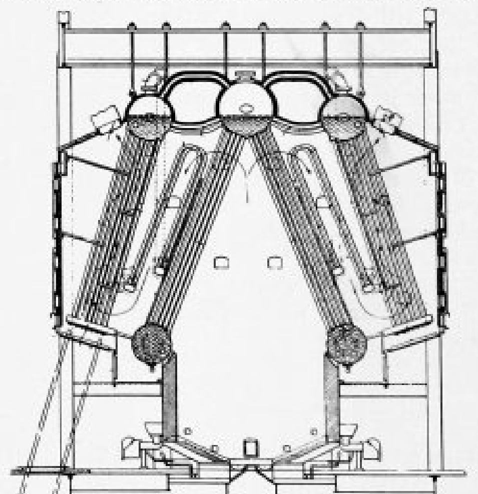
Claim 1.—A locomotive-boiler firebox having a plurality of arch supporting tubes, in combination with a refractory front arch therein resting on said tubes, said arch comprising a plurality of individual refractory arch bricks laid upon and supported by said tubes, and locking



bricks interposed between the edges of said arch body and adjacent side sheets of the firebox resting at their inner ends upon said arch body, the arch body and said bricks being formed with mutually interlocking projections and sockets and said locking bricks being thereby retained against movement relatively to the arch body. Five claims.

1,117,391. WATER-TUBE BOILER. DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—In a water-tube boiler, two inner banks of generating tubes inclined toward each other so as to form two sides of an A-shaped combustion chamber, a steam and water drum into which the upper ends of



the tubes of both of said banks are expanded, two mud drums into which the lower ends of the tubes of the respective banks are expanded, two outer banks of tubes, one on each side of the inner banks, steam and water drums and headers into which the tubes of the outer banks are expanded, steam and water circulators connecting the intermediate steam and water drum with the outer steam and water drums, and connections between the mud drums and said headers. Ten claims.

1,117,249. GRATE. JOSEPH F. ROTHE, OF GREEN BAY, WIS.

Claim 1.—The grate bar comprising a sinuous web provided along its upper margin with integral laterally projecting flanges constituting teeth, and having the upper portion of said web extended at each end and provided with depending rocker bearing projections adapted to support said bar. Two claims.

The Boiler Maker

MARCH 1915

A. S. M. E. Boiler Code Completed

Rules for the Construction and Allowable Working Pressures of Stationary Boilers Approved by A. S. M. E. Council

A signal event for the boiler industry and one that means much to the field of power production in general, was the completion of the report of the Committee to Formulate Standard Specifications for the Construction of Steam Boilers and Other Pressure Vessels and for Care of Same in Service, and its presentation to the Council of the Society on February 13, 1915. Its approval by the Council—the governing body of the Society—and the authorization granted for immediate printing of the report as a Boiler Construction Code mark a new era in the manufacture of steam boilers, and it is hoped will prove the inauguration of a movement of considerable importance for the protection of human life and property. The benefits that will accrue from an economical standpoint, when the rules for construction embodied in the new code are generally put into effect, are far-reaching, and will affect alike the manufacturer and the user of boilers.

The work involved in the final revision of the Code was one of the most strenuous and trying committee undertakings ever carried out in the history of the Society. The significance of this will be realized from the following account of the work taken from the current issue of the *Journal* of the American Society of Mechanical Engineers. The work of revision began on December 15, 1914, and was carried on continuously without interruption until February 3, 1915, covering a period of nearly eight weeks of the most exacting and painstaking work. The Boiler Code Committee worked constantly in conference with the Advisory Committee which had been appointed in December and the sessions, which were both investigative and judicial in character, were marked by a peculiarly intense interest of the committee members and the most unusual display of energy. The daily sessions lasted usually throughout the day and until midnight, and the attendance was usually a majority, which is a matter worthy of note when it is considered that the committee members came from all parts of the country and some of whom were in constant attendance for the entire seven weeks. A notable feature of the final revision was the amount of research work involved, several series of tests having been carried out by members of the committee to check and establish the authenticity of the rules and formulæ embodied in the Code.

The work of the Committee was confined to rules for construction of steam boilers only, all references to "other pressure vessels" and to laws and matters of legislation having been omitted. The result of the work of revision of the construction rules was the division into two parts, one for new installations and the other for existing installations, and following this was provided an appendix in which were placed the rules, examples, illustrations, references, and data that were in nature supplementary to the rules. As now laid out, the rules for existing installations (Part I) cover all details of construction of new steam boilers and the rules for allowable working pressures upon them, the details being referred to in the following order: Materials of construction, including the material specifications, maximum allowable working pressures, boiler joints, braced and stayed surfaces, combustion chambers, tubes, riveting and calking, manholes and handholes, safety valves, water and steam gages, and fittings and appliances. At the end of Part I is a section devoted to heating boilers, in which the above order of subjects is also adhered to. In Part II, which is devoted to existing installations, the same order of subjects is followed, although less complete and exacting in details.

The text of the Code in its revised form was printed in the form of printer's galley proof and sent to each member of the Council of the Society, as well as to each member of the Boiler Committee and the Advisory Committee for final proof-reading, on February 3, ten days before the Council meeting on February 13. At the Council meeting on this latter date at which the whole Boiler Committee was invited into conference, the report was approved by the Council in full, as finally revised, and was ordered to be printed as soon as possible for general distribution, and pamphlet copies are being issued as a preprint of the Transactions of the Society. Following the acceptance of the report, action was taken by the Council commending the Boiler Committee and the Advisory Committee for the heroic work that it had carried out in such a painstaking and careful manner and expressing the gratitude and appreciation of the Society to the Committee for the great work it had done for mankind.

The next step taken by the Committee was a careful proof-reading of the entire report for typographical errors and the preparation of the Code for final printing. It is now being issued in pamphlet form as above mentioned at $1 per copy to members and $1.50 to non-members. Later the Code will be distributed to the entire membership.

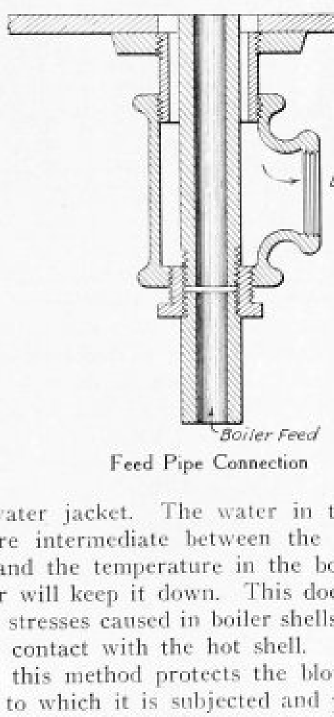
It is pleasing to find that the Code is finding immediate application. The State of Indiana is at this time considering the matter, and it is very probable that an amendment will be passed by the legislature rendering the former Indiana boiler code optional, with the proviso that the A. S. M. E. Code may be used for boiler construction in place of the present State code if desired. The Ohio State Boiler Board has the new code under consideration, and it is possible that it will be adopted in place of the boiler code now in force in that State. In Wisconsin the code will probably take immediate effect as a result of an action of the Industrial Commission of Wisconsin taken last year looking forward to the A. S. M. E. Code before it was completed; while a preliminary set of boiler rules were put into effect in that State the first of this year, provision was made for their replacement by the A. S. M. E. Code as soon as finished.

With the completion of this great work, considerable interest attaches to the originators of the movement, the committee of seven members, appointed in 1911. The original members represent the exceptional wisdom and foresight of the officials of the Society in their concern that all the various branches of the industry should be represented. John A. Stevens, a consulting engineer of extended power plant experience, who was appointed chairman, offered the advantages of his experiences in formulating the Massachusetts code, the first State boiler code that was put into effect in this country. R. C. Carpenter and E. F. Miller, professors of engineering, came as representatives of the steam boiler users; E. D. Meier and Richard Hammond brought in the fund of experience that only long experience in boiler manufacturing rendered possible; Charles L. Huston was particularly valuable to the Committee as a manufacturer of steel boiler plate and an investigator in the scientific manufacture of iron and steel plate, and William H. Boehm, an insurance engineer, brought to the Committee valuable suggestions as a representative of the field of boiler inspection and insurance.

Boiler Feed Connection

The scheme that looks most logical to me for feeding boilers is to feed through the blow-off pipe about as indicated in the sketch reproduced herewith.

Using this means only one opening—a large opening—that is easily stiffened. The feed pipe does not come into actual contact with the boiler shell, but is separated from



Feed Pipe Connection

it by a water jacket. The water in this jacket has a temperature intermediate between the feed water temperature and the temperature in the boiler, because the feed water will keep it down. This does away with the dangerous stresses caused in boiler shells by the cold feed coming in contact with the hot shell.

Besides, this method protects the blow-off against the high heat to which it is subjected and prevents burning.

There are some objections to this scheme in that it does not prevent *all* stresses, and that more scale is liable to be deposited near the blow-off than otherwise, but these are almost trivial compared with the objections where the feed pipe enters the boiler by other means. If there is a better scheme I would like to know about it. N. G. N.

Electric Welding

BY J. E. BULLARD*

All electric welding is based upon the principle that in the work of overcoming resistance electricity produces heat. This principle is made use of in incandescent lamps, arc lamps, heating utensils, etc. An electrode welding experiment which can be made with an ordinary tungsten lamp is as follows: When the filament in the lamp is broken place the lamp in a portable socket, turn on the current and shake the lamp in such a way as to cause the broken ends to come into contact. The moment they touch each other they fuse together and the lamp is given a new lease of life. This simple experiment, which is repeated hundreds of times every day, illustrates the simplicity, ease and rapidity of electric welding.

There are in commercial use two general forms of electric welding. These are called the arc process and the resistance or incandescent process. Both of these processes are, of course, based on the same principle. Their main difference lies in the degree of heat employed. In the resistance process only a sufficiently high temperature to form the weld is used. This temperature varies to a considerable extent with the metals being worked. The arc process, on the other hand, employs a heat of 7,232 degrees F. (4,000 degrees C.). This is the highest temperature yet produced by man.

The application of these two processes may in a general way be classified as follows: The resistance process is used in the factory for welding new work, and especially small parts turned out in large numbers and at high rates of output. As many as 1,000 welds have been made in wire hoops in an hour. The arc method, on the other hand, is applicable to repair work, such as repairing breaks in heavy castings, locomotive frames for instance, repairing boiler seams, building up worn parts, etc.

In the resistance process a comparatively low intensity of heat is applied over a large area. In the arc process a high-heat intensity is applied at a single point.

The resistance process is employed principally in the following classes of work:

Butt welding, end to end; whole abutting surfaces of nearly the same cross-section welded together.

Tee and angle welding, in the form of a letter T or L.

Cross welding, in the form of an X.

Lap welding, overlapping and squeezing or mashing together.

Seam welding, either by abutting or overlapping the edges of the metal.

Spot welding instead of riveting; practically one spot at a time.

Point welding, surfaces in contact only at raised point or multiplicity of points, at which the current is confined; welding only at these points. Usually in sheet metal.

Ridge welding; instead of a point, a ridge, across which a weld is made.

Upsetting, to form collars and the like.

Heating of blanks for forging, bending and working.

In all electric-heating processes the amount of heat is determined by the quantity of electricity, that is, the number of amperes of current flowing through a given resistance. The amperes of electricity are determined by the volts of pressure divided by the ohms of resistance. Since, in this process of welding the resistance is comparatively low, a disastrous amount of current would flow through the work if the ordinary commercial voltages of 110 volts or 220 volts were used. For this reason it is necessary

* Member of the Society for Electrical Development.

to reduce the voltage by means of specially constructed transformers to from 1 to 7 volts, at which potential from 2,000 to 50,000 amperes are used.

RESISTANCE ELECTRIC WELDING

For electric welding an ample supply of electricity is necessary. For the resistance process, alternating current is preferable. This is the form of electricity which is sold in almost every section of the country with the exception of the more densely populated sections of our large cities. Its main advantage for this work lies in the fact that its pressure or potential can be readily changed through the medium of a transformer consisting of coils of wire with an iron core and having no moving parts. Direct current can also be used, but requires more cumbersome apparatus, having moving parts, in order to reduce the voltage. Otherwise it is as satisfactory.

With alternating current the only equipment required is an electric transformer, a clamping device for attaching the current conductors to the pieces to be welded, and a pressure device for exerting pressure on the surfaces to be welded as soon as the temperature is raised to the correct point. All these are commonly assembled together on the machine. The pressure is applied by hand, spring or hydraulic power, depending on the degree of pressure required. The electrodes and clamps frequently have to be made in special forms so that this machine is more or less a special machine. No machine is suitable for a great variety of sizes or forms of work. Some machines are semi-automatic, as when the operator's duty is only putting in and taking out the pieces. Others are entirely automatic, clamping, exerting pressure for welding and controlling the current automatically.

Some advantages possessed by this process of electric welding are as follows: The heat is generated in the metal itself, uniformly over the section to be welded. Absolute control of the heat is obtained. The pieces are heated in full view of the operator, and, if for any such reason as collections of rust or scale the process is not going on as it should, the operator can remedy the trouble at once. Usually no flux is required. Practically all metals can be welded, also all sorts of steel and many alloys, as well as many combinations, such as carbon steel to mild steel, malleable iron to steel, nickel and brass to platinum, etc.

ARC WELDING

The arc process of welding differs from the resistance method, not only in the temperatures employed and in the class of work done, but also in the kind of current used. In this process alternating current is not as effective as direct current, that is, electricity flowing continuously in one direction. Instead of using such low pressures as from 1 to 7 volts, a pressure of from 10 to 60 volts, or potentials about ten times higher, is used, this higher potential being required to overcome the resistance in the arc. Direct current is used because of the fact that with it higher temperatures may be reached. In this process the two pieces of metal to be joined are actually melted together.

The current is usually supplied by a motor-generator set—an equipment consisting of an electric generator driven by a direct-connected motor, the whole being mounted on one base.

In this process of welding the positive terminal of the electric-welding circuit is connected to the work and the other to an electrode holder handled by the operator. The positive terminal is connected to the work for the reason that it is at this terminal the highest temperature is obtained. This means that the work to be welded is kept at a higher temperature than the electrode the operator handles. It also has the advantage that in building-up work the material from the operator's electrode is deposited on the work through the influence of the arc, and the operator can safely work on breaks which are above his head.

To produce the arc the operator brings his electrode in contact with the work in order to complete the circuit and immediately brings it a short distance away. He can then move the electrode over the work and the arc will follow. He is able to concentrate the heat at one spot or distribute it over a wide area.

There are two general classes of arc welding. These are the graphite electrode and the metallic electrode processes.

GRAPHITE ELECTRODE PROCESS

The graphite electrode customarily requires a potential of 50 to 60 volts and a current of 300 amperes or more. It can be used for all kinds of welding, filling in, building up, pre-heating, cutting, etc. When welding by this method the filling-in or welding metal is supplied from an outside source; that is, the operator has a rod of soft iron or steel or uses scrap metal, which the arc reduces to a state of fusion and forms into a homogeneous mass with the part being repaired.

When the metal electrode is used, the potential at the arc is usually lower, according to the nature of the work. In this process the metallic electrode is fused, particles of molten metal from the electrode being deposited on the work. An important use of the metallic electrode is the repairing of cracks in large work in locations hard to get at. For instance, a crack in the crown sheet of a boiler can be repaired from below. All the metal from the electrode is deposited on the work. There is no necessity of the operator stepping aside to dodge drops of molten metal.

CUTTING METAL BY ELECTRICITY

Another use to which the arc process may be put is the cutting of metal. In the electric arc the highest temperatures are obtained. This means that with a graphite electrode metal can be more rapidly and cheaply cut than by any other heat process of cutting.

In the arc process of electric welding, on account of the intensely high heats used and the blinding intensity of the arc, the operators should always be provided with face and hand shields.

These two processes of electric welding taken together thoroughly cover the welding field. In other words, all welding of whatsoever nature can be done satisfactorily, expeditiously and cheaply by means of electricity. Electric welding is now rapidly replacing rivets and other methods of joining metal in a number of industries.

The general adoption of electricity purchased from the electric central station for all shop purposes requiring light and power makes this process of welding superior to all other processes in the following respects: An unlimited supply of energy is always at hand. No gases have to be stored under high pressure in tanks. No gases have to be generated. There is no danger of explosion. Cimpressed air is not required.

BOILER EXPLOSION ON U. S. S. FULTON.—The *Fulton*, a submarine tender only recently placed in commission, had an explosion in the firebox of her boiler on the afternoon of January 20, 1915, which resulted in the death of one man and prevented her accompanying the fourth division of submarines to Pensacola for winter maneuvers. The casing of the boiler was badly damaged and the steam-line connections were broken.

"Safety First" in Boiler Shop Operation

Ninety Percent of the Accidents in a Boiler Shop are Due to Ignorance—Examples of the Right and Wrong Ways to Handle Work

BY C. E. LESTER

The operation of large boiler shops is fraught with more or less danger irrespective of the care used. The dangers, however, can be brought to a minimum by adopting standard methods and schooling men into thinking. Few men are criminally or purposely careless of their own or others' welfare. Most accidents come simply of careless thinking.

One of the foreman's principal duties should be to school the men of his department into careful and safe ways of thinking. Don't blame a man for what he does, for he does as he thinks, and any one is liable to think wrong. What is thought right to-day may be thought wrong to-morrow.

The first thought to be impressed on a new employee's mind is that safety is the first and prime consideration. The young apprentice should have "safety first" shot into him like bullets out of a machine gun.

"An ounce of prevention is worth a pound of cure."

As a general rule, workmen are promoted to foremen through what their superiors deem their mechanical skill and their ability to get the work out. Too often, however, are men promoted without due regard to their general fitness to look after the physical welfare of a body of men. The number of accidents in a department of a shop, in my opinion, bears a definite relationship to the ability of the foreman.

Too often does a foreman consider his work well done when he gets his work out in a given time at the allotted expense. Too often does a foreman see dangerous practices without stopping them and dangerous equipment without reporting it. The ability in a foreman to see all the necessary moves to successfully operate a department is quite essential from the viewpoint of output, but a really successful foreman is one that can get his work out at a minimum cost, keeping his men satisfied and protected from accidents.

The trouble mostly experienced is due, however, to lack of training on the part of the foremen. The thought of trying to conserve life and limb in a shop is comparatively a recent one and the foreman of the past could hardly be blamed for some things he was more or less ignorant of. However, in the past five years the safety movement has been agitated so much that any foreman of to-day who pleads ignorance of it should be demoted, for he doubtless is so ignorant that he would never learn anything of it.

The Foreman's Responsibility

The success of a movement to promote safety in a department, as stated before, is entirely up to the foreman. If the foreman is not in sympathy with progressive methods of safety or is careless of his men's welfare, so also will be the men. An honest effort on a foreman's part to enforce rules for safety usually will have the desired effect without discipline. It may, however, be necessary to dismiss some persistent offender. It will generally be found that the so-called difficulties of getting men to follow rules for safety lies chiefly in the foreman's mind and attitude. His actions should be a criterion for his men. A little diplomacy, a little tact, will usually get things cheerfully done that harsh and severe methods will force grudgingly and stubbornly. However, a successful foreman must teach his men. The methods used successfully on some men would be a rank failure with others. Figuratively, some require coaxing along, others pushed, some dragged, while some few require a club. We are all human, with the same hopes, desires and feelings; each has his good and bad qualities. In some the intelligence is quick, in others latent. Characteristics prominent in some are practically nil in others. The quick intelligence grasps an idea like a flash of light, to the slow dull brain a full exposition of what is desired may have to be made several times. It behooves the foreman to know his men—to learn their little peculiarities and profit by his knowledge.

Too often is the workman kept in ignorance of the plans of the management. The writer has found, in a number of years' experience in a supervisory capacity, that it often pays to confide, in a measure, with his subordinates. To trust most men is to make them trustworthy.

In the past (I fear not altogether in the past, though, as I believe it, somewhat in vogue to-day) it has been considered policy to conceal or minimize accidents. This policy is undoubtedly a bad one. Every accident should be given the greatest publicity, and by so doing its recurrence is considerably lessened.

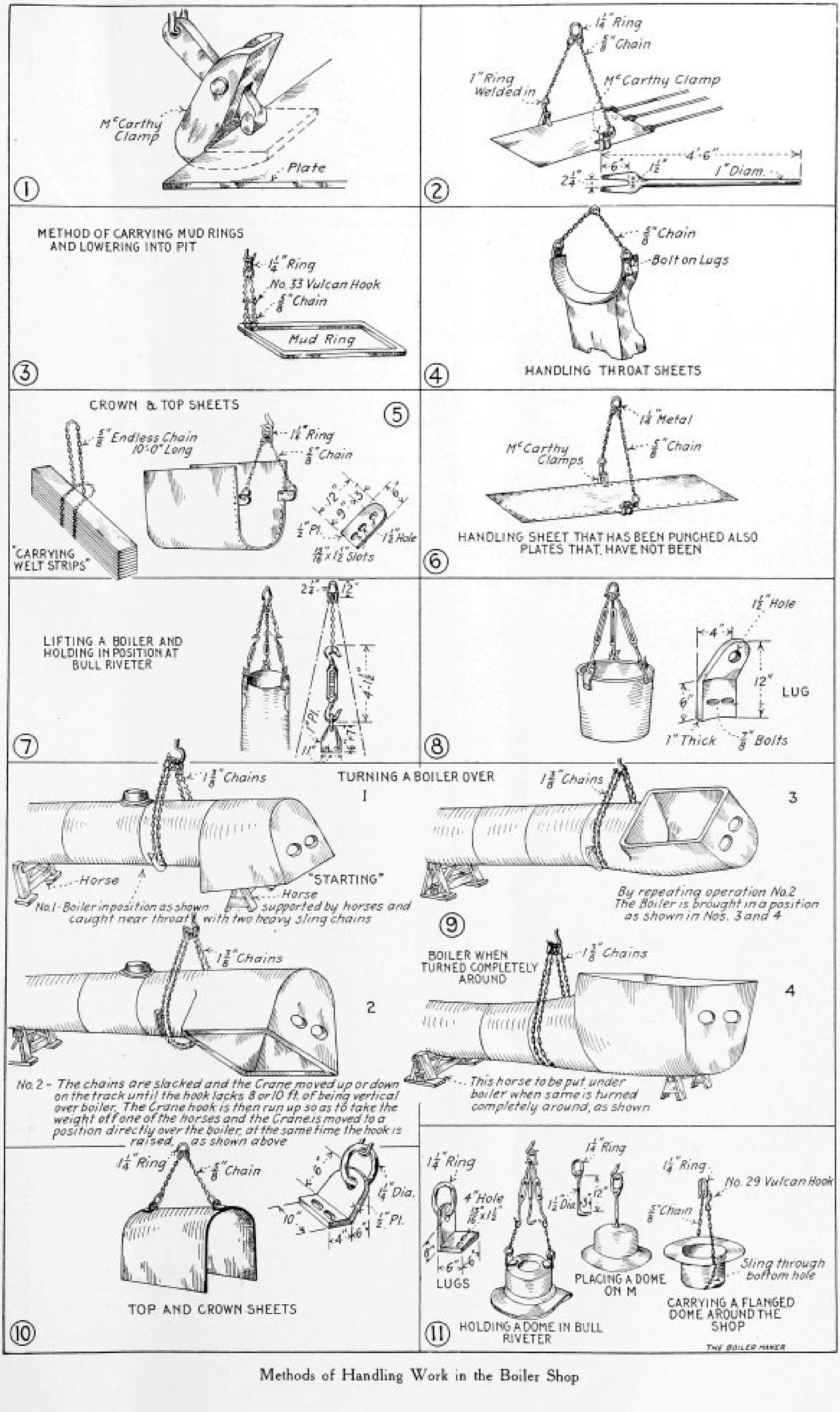
Accidents Due to Ignorance

The sum and substance, in a nutshell, of 90 percent of the accidents in the boiler shop and every other department, for that matter, is ignorance, or, if you please, lack of education. The tensile strength of materials is Greek to 75 percent of the men in every boiler shop—in not a few cases the foreman included. The faintest conception of such a thing probably would have prevented the following described accident:

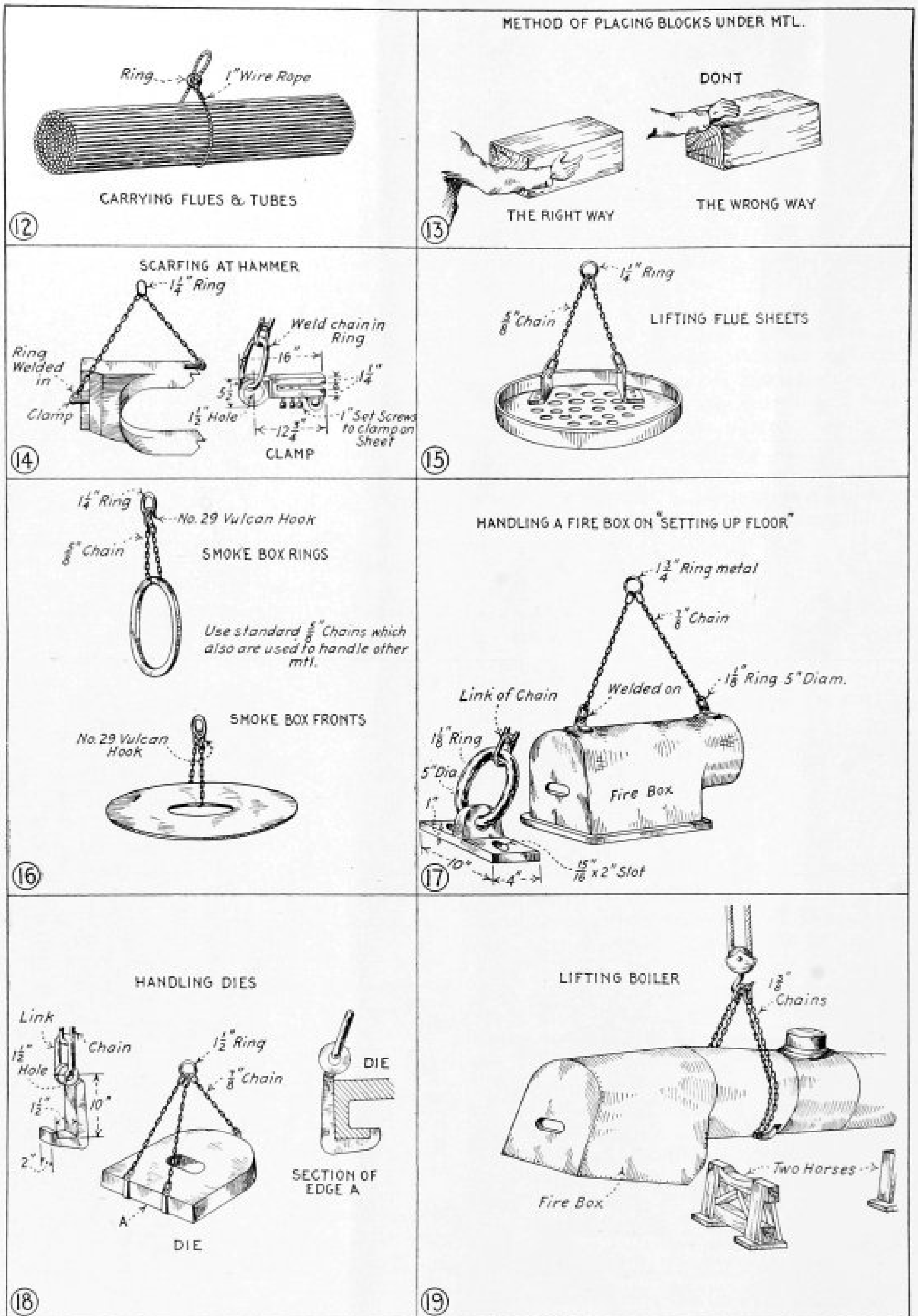
Recently, in a large boiler shop where locomotive boilers are constructed, a man was badly injured by a back-head falling on him. The head weighed approximately 1,500 pounds. The workmen were bolting it in the casing, getting it ready to be laid up. The head had been lifted into position by the electric crane and a 5/8-inch bolt had been put in the top center hole. These fitting up bolts are, as a rule, made from all sorts of scrap iron and have a tensile strength of not more than 45,000 pounds per square inch. Assuming the strength to be about that amount, there was a factor of safety of less than six before any strain was put on the bolt by tightening it up with the wrench. A 16-inch wrench in the hands of a husky helper pulled the bolt until it broke, the head fell, and nearly killed a man when it dropped on him.

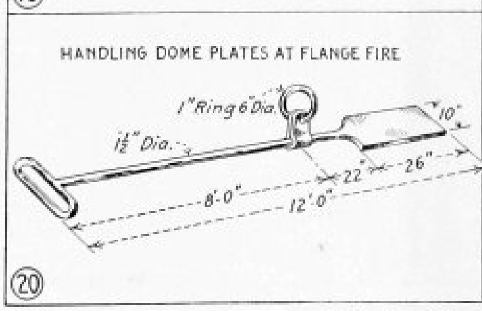
The man in charge of the job was not, in a measure, to blame for the accident. He had been on the same work for several months and had done the same thing many times without censure. The accident was undoubtedly the fault of the foreman for not insisting on the workmen applying at least three bolts before letting go of the crane.

There are many simple ways that men are injured and just as many simple ways of avoiding them. The sketches



Methods of Handling Work in the Boiler Shop





SIZE CHAIN	SAFE LOAD DOUBLE CHAIN	SIZE CHAIN	SAFE LOAD DOUBLE CHAIN
1/4"	1200 Pounds	1 1/8"	25,500 Pounds
3/8"	2800 "	1 1/4"	31,200 "
1/2"	4900 "	1 3/8"	36,100 "
9/16"	6300 "	1 1/2"	43,400 "
5/8"	8000 "	1 3/4"	60,000 "
3/4"	12,200 "	2"	78,600 "
7/8"	16,100 "	2 1/4"	100,000 "
1"	20,500 "		

21

THE BOILER MAKER

Methods of Handling Work in the Boiler Shop showing the right and wrong way of placing blocks under material is a fair example. There are some willful violations of rules laid down for safety that often result fatally. It is but a few months ago that a throat sheet was picked up by a traveling crane that had been improperly hooked on. The result was that the slings came loose and the sheet fell and killed a man.

Had the clamp shown in sketch No. 14 or the lug shown in No. 5 been used, the accident would not have happened. This was a case where standard methods and devices had been adopted for handling material. The employee was an old one and familiar with the instructions. He was in a hurry, took a chance, and lost a life. This was in a shop where "safety first" is deemed, by the management, to be the first consideration, and the subject had been threshed out with the men repeatedly.

The cranemen in the shop have positive instructions not to lift a load when they think there is the least doubt of it being safe. However, both the craneman and the floormen violated instructions with the fatal result shown. In adopting rules, devices, etc., for safety, the personal equation should always be taken into consideration. Wherever possible, "foolproof" devices should be provided.

Concealing Accidents a Mistaken Policy

It is a mistaken policy on the part of some concerns to conceal or minimize accidents. This is done in many cases to prevent damage suits. The thought occurs that if many employers who have many accidents in their plants would spend less money in trying to defend damage suits and increase their appropriation for education for employees and installation of safety appliances, they would profit in diverse ways—particularly in being able to practically dispense with a corps of high-salaried attorneys and court expenses.

It is a deplorable thing for a man, otherwise strong and healthy, to lose an arm or leg or an eye, or to have his body otherwise mutilated; but the hard, practical, hard way of looking at it is the lessening of his ability as a money-getter. Every wage earner has a monetary value based on his earning ability. He is worth that to himself and dependents and to his employer. When, by force of accident, he is mutilated or bereft of part of his anatomy, he at once becomes damaged goods and depreciated in value. As an asset to his dependents he is reduced anywhere from 20 to 100 percent, depending on the nature of the injury. To his employer he at once is transformed from an asset into a liability.

The writer is illustrating some few devices and methods for handling work in the shop. There may be other devices and methods easier and more rapid, and undoubtedly some of the methods could be improved, but they have been without exception tried and proved safe and practical.

Platform planks used for scaffolding are quite a costly item as they are generally used. They frequently split and break up, as a rule caused by rough handling. They are also a source of danger. By reinforcing them with bands of iron the life is increased enough to make it a paying proposition as well as increasing the strength. This is done by placing on each end and in the middle close fitting iron bands about 1/8 inch by 2 inches. The bands can be kept in position by drilling and countersinking and applying several screws.

The writer saw illustrated some time ago in The Boiler Maker a device to pass staybolt taps made out of a capped piece of pipe. It is thought that this device is more or less dangerous on account of the liability of the tap dropping out if the shank end is lowered below the reamer end. A piece of 3/4-inch hose 8 or 10 inches long is about the best thing obtainable for the work, and is absolutely safe, as the tap will turn in it and yet the hose grips hard enough to prevent it falling out when passing.

The careless handling of oil is a constant source of danger in divers ways. It is but a few weeks ago that the writer stepped on a sheet of tank steel laying on a slight inclination on the floor. Oil had been smeared over it and the result was that the writer had a very bad fall—fortunately without serious results other than a bad shakink up. Oil burners in the hands of a careless man are exceptionally dangerous.

A Safeguard for Traveling Cranes

The American Locomotive Company has the sheave casing and big hook at the floor end of the main and auxiliary hoists on all traveling cranes painted with white enamel paint, so that the cranemen can follow the route of the hook in a dark corner or along the floor when the lights are poor. This also helps the man on the floor to keep out of the way of the hook, which ordinarily might not be seen.

The practice of having the weights of the principal heavy articles handled posted in the cab of the crane is a good one which should be also extended to the floor. The maximum approximate weight of all heavy articles, as well as the capacity of the chains, should be posted on every bulletin board and in various conspicuous places in the shop.

The adoption of safety clamps along the lines of the one illustrated should be urged and put into use whenever possible.

Where gas flanging furnaces are used and the construction will permit, the doors should be kept open when not in use. If this is not practical, instructions should be posted and enforced that doors should be opened at least two minutes before any attempt is made to light it off.

There are innumerable ways in which the safety of workmen can be enhanced. The writer described some of these in an article on "Safety First in the Boiler Shop," in The Boiler Maker a few months ago. There have been many papers along the same line published frequently in various technical papers for several years past. The writer has been much benefited by them. It is a very good plan when reading a paper wherein some good practices are delineated or some good devices are illustrated, to make a note of them to be brought up with the management at an opportune time, or to be continually where your eyes will not allow you to forget them.

Riegel Design of Locomotive Firebox Adopted.—There has recently been placed in service on the Delaware, Lackawanna & Western Railroad a "Pacific" type of locomotive fitted with a special design of firebox construction of the type known as the "Riegel" firebox, a description of which was published on page 226 of the July, 1913, issue of The Boiler Maker. The purpose of this design is to enhance circulation about the firebox and thus afford a higher rate of evaporation. The manner in which this is accomplished consists in the installation of two nests of watertubes connecting the space in the lower leg on either side of the firebox with the space directly above the crown sheet. These tubes, which together afford 471 square feet of service, are exposed to the highest temperature obtainable in a locomotive firebox.

Strength of Flat Plates for Bins, Tanks, Coal Bunkers, Etc.

In the construction of rectangular tanks, bins, etc., comparatively thin plates are used which are supported by I-beams, channels and angles. The supporting members of the structure are placed sufficiently close to prevent undue stresses on the plates and to keep the deflection within proper limits. In work of the class under consideration, the plates are usually rectangular or square and are fastened to the supporting members by rivets or bolts around the four edges of the plate. Under these conditions the ability of a flat plate to carry a uniformly distributed load varies directly as the square of the thickness of the plate and inversely as the area supported. If the plate is not fastened at its edges, it will safely carry two-thirds the load per square foot that it would sustain if fastened.

The formula for the fibre stress produced in a flat plate supported and fastened at its edges under a uniformly distributed load may be written:

$$f = \frac{WA}{4t^2}. \qquad (1)$$

in which

f = fiber stress—pounds per square inch.
W = load per square foot.
A = area of plate between supports in square feet.
t = thickness of plate in inches.

The fibre stress f can be taken at 12,000 pounds per square inch, putting this value for f in equation (1) and solving for W, which is the safe load per square foot of plate, we have

$$W = 48{,}000 \frac{t^2}{A}. \qquad (2)$$

To illustrate the use of formula (2), assume that it is desired to find the safe load per square foot which can be supported on a rectangular plate ¼ inch thick, 4 feet long by 2 feet 3 inches wide (measured center to center of supports), using formula (2) and putting for t^2 its value, $\frac{1}{4} \times \frac{1}{4} = 1/16$, and for A, $4 \times 2.25 = 9$ square feet, we have

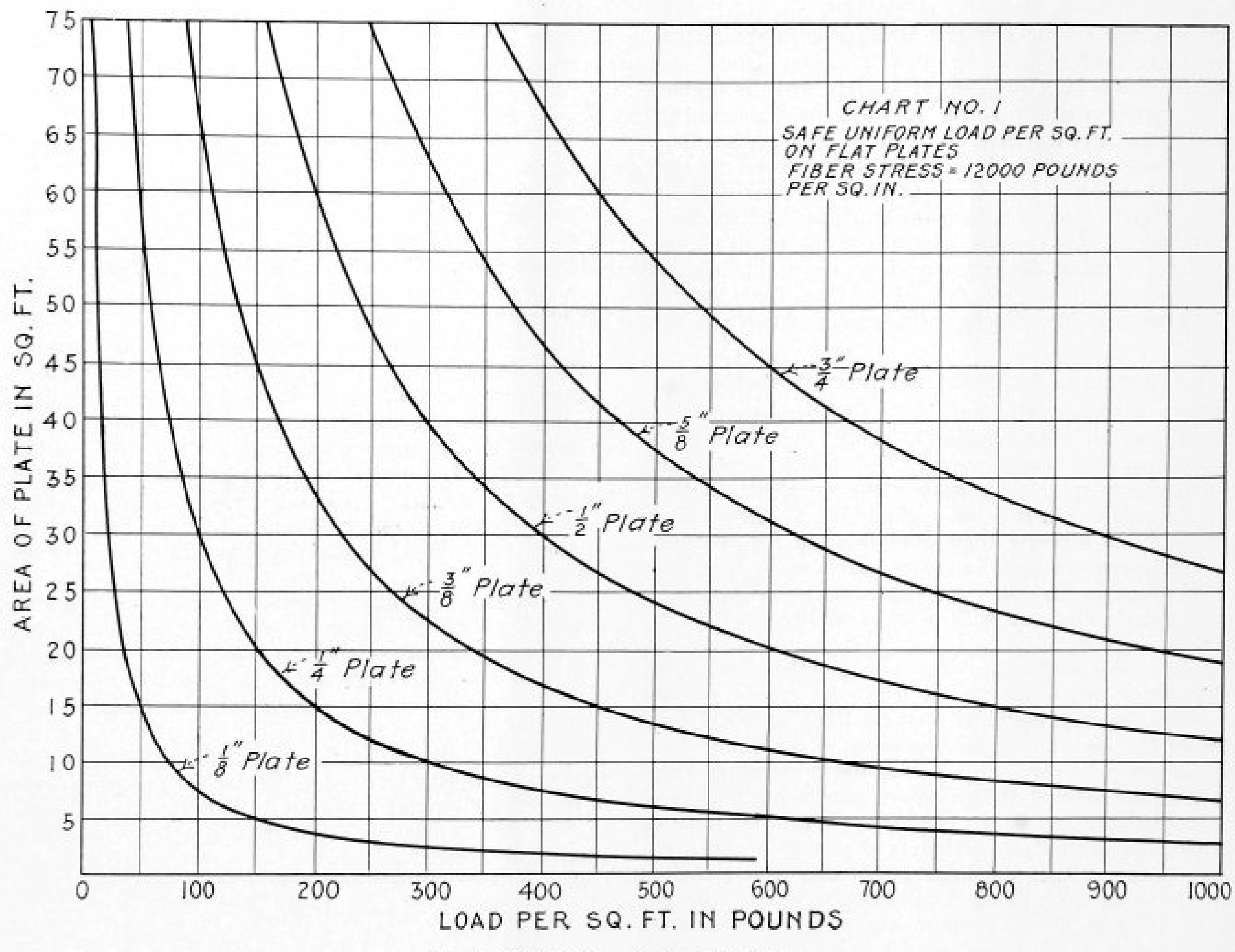


Fig. 1.—Safe Uniform Load on Flat Plates

$$W = 48{,}000 \times \frac{1/16}{9} = \frac{48{,}000}{16 \times 9} = 333 \text{ pounds.}$$

From which it is seen that a plate with the above dimensions is able to safely carry 333 pounds per square foot, or a total load of 333×9 = about 3,000 pounds, uniformly distributed over its entire surface.

To further illustrate the use of formula (2), let it be assumed that a rectangular water tank is to be designed, having a depth = 21 feet and the distance between the stiffening members on sides of tank near bottom is 4 feet $\times$ 3 feet 6 inches, what is the required thickness of plate to safely carry the load due to the pressure of water? The maximum head of water acting against the plate is 21 feet, and for calculations in tank work the maximum head is assumed to act over the entire surface of plate. A head of 21 feet is equal to

$21 \times 62.5 = 1312.5$ pounds per square foot $= W$.
Area of plate $= 4 \times 3.5 = 14$ square feet $= A$.

Putting these values of W and A in equation (2), and solving for t, we have

$$1312.5 = \frac{48,000\,t^2}{14}$$

$$t^2 = .3827.$$

Thickness of plate $t = .62$ or 5/8 inch.

The load on the horizontal plates on the bottom of a tank or bin is equal to the weight of the substances directly over the plate. Thus the load per square foot on the bottom of a tank containing water 30 feet deep is equal to 62.5 × 30 = 1,975.0 pounds per square foot. (Weight of water = about 62.5 pounds per cubic foot.)

If a bin holds sand 30 feet deep, the load per square foot on the bottom plates would be 30 × 90 = 2,700 pounds per square foot. (Sand weighs about 90 pounds per cubic foot.)

By aid of Chart 1, it is a very easy matter to find the required thickness of plate for uniformly distributed loads and area of plates, as noted thereon.

With the exception of that due to water, the load on the vertical side plates of a rectangular bin is not readily calculated, because the load depends upon the angle of repose of the material, and the solution of this problem requires the use of higher mathematics or graphics. By aid of Chart 2, the total load on the side plates of bins of various depths for each foot horizontal length of bin can be easily read off. Curves are given for bituminous coal, anthracite coal, ashes and sand. The calculations were made for total loads when bins are full without surcharge. The load for any unit of area is equal to the difference between the total load, including the unit area under consideration and the total load just above this area. Thus, suppose that a bin 20 feet deep is to be designed for bituminous coal and in order to calculate the thickness of plates it is necessary to find the load on the four feet of vertical plate nearest the bottom. From the chart the total pressure per square foot at 20 feet depth for bituminous coal = 2,700 pounds, and the total load at 16 feet depth = 1,728 pounds, then the pressure on the plate between the depth of 16 feet and 20 feet for each foot horizontally = 2,700 — 1,728 = 972 pounds, or a little less than an average of 250 pounds per square foot. If the plate is to be supported at 4-foot intervals by proper supporting members or stiffeners, under which condition the area of the plate being 16 square feet, the required thickness of the plate, as found from Chart 1, is about 5/16 inch.

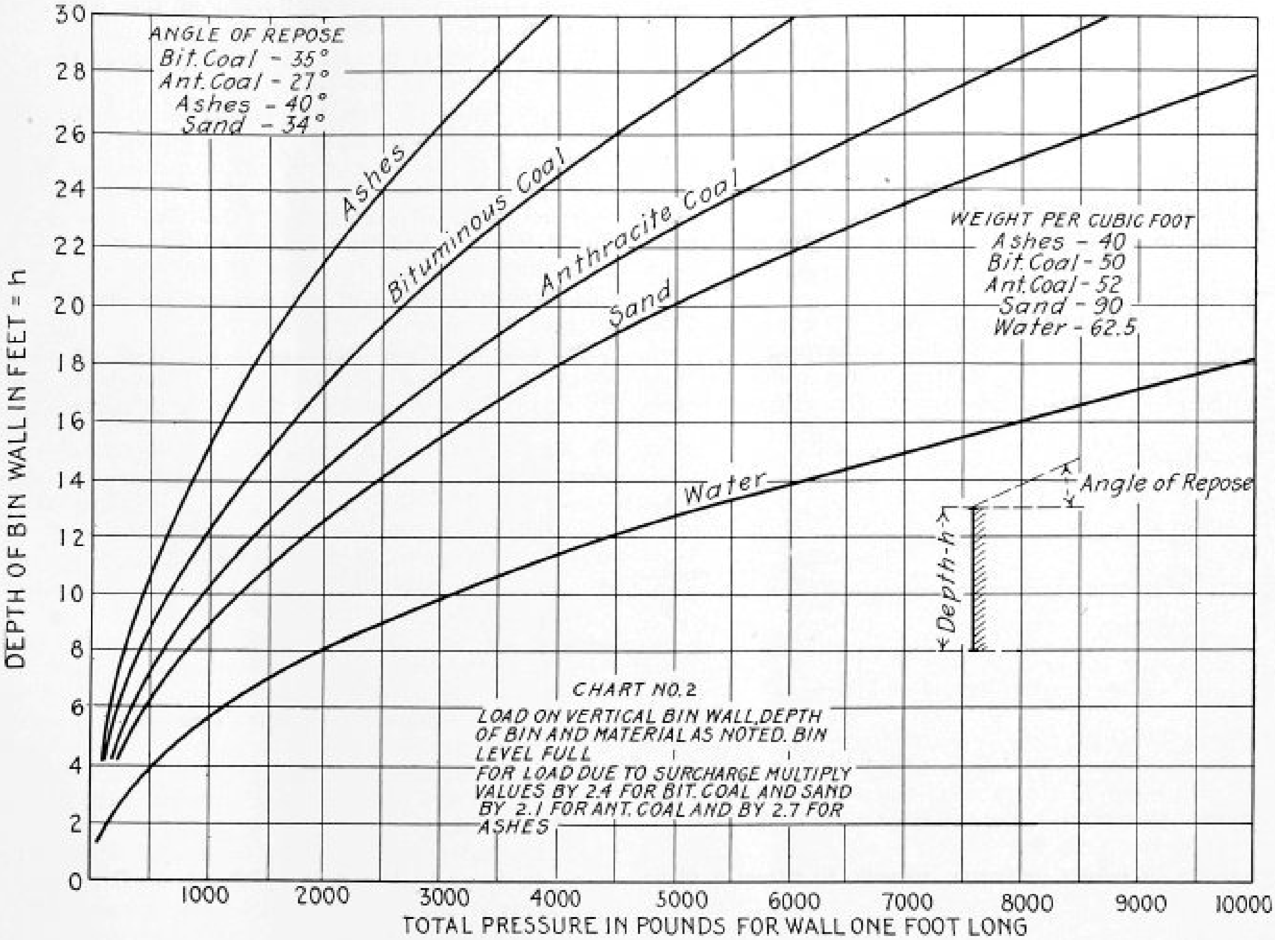


Fig. 2.—Load on Vertical Wall of Bin Containing Coal, Ashes, Sand or Water

If the bin is surcharged, that is, material piled above the sides of the bin to the maximum angle of repose, the total load perpendicular to the sides of the bin, as given by Chart 2, would be increased very nearly 2.4 times the values given for bituminous coal and sand, ashes 2.7 and anthracite coal 2.1 times the values given.

In the calculation of the strength of the vertical stiffeners on the sides of bins, the normal load due to pressure may be considered as acting at a point two-thirds the distance from top to bottom of tank. Thus, if a tank is 21 feet deep, the center total pressure acting on the sides could be considered as concentrated at a point 14 feet from top of bin.

Syracuse, N. Y. G. M. K.

John Trisects an Angle!

A Simple Problem in Geometry in Which Some Long Names Are Used

BY JAMES F. HOBART, M. E.

"Say, Mr. Hobart, I've 'got one on you' this time. You told me about something which could not be done, or you said it would not pay for doing, and here's a man who calls you and tells about a way of doing that very thing. How about this, is it 'on you,' or what's the matter?"

"What is it all about, John? I don't quite seem to understand what you're driving at."

"Why, it's about that angle trisection business—the dividing of an angle or of a line into three equal parts or portions without measuring or stepping it off with the dividers."

"Oh, that old problem, eh? Well, it's a good one, but what does your man have to offer concerning it?"

"Why, somebody has written to the editor of THE BOILER MAKER, saying: 'In one of Mr. Hobart's letters to "John," that appeared in THE BOILER MAKER some five or six months ago, I think he tells John that there is no way of trisecting an angle. On looking in Webster's Unabridged Dictionary I find the word 'Cissoid,' a curve invented by Diocles for the purpose of solving two celebrated problems of higher geometry, namely, to trisect a plane angle and to construct two geometric means between two straight lines. And would Mr. Hobart, or any of the "high brows," as he calls them, 'be so kind as to explain this curve in the columns of THE BOILER MAKER?' So you see by that letter, Mr. Hobart, that you are right up against it hard. You said it couldn't be done, and this gentleman says it can. How about it?"

"John, I haven't my copy of that issue of THE BOILER MAKER, for one of the boys pinched it before I had read half of it. Most of my papers go that way, too. But didn't I say something about the problem of trisecting an angle being one which could only be solved by higher mathematics, calculus and all that? And didn't I mention something about a man in California who would, upon the receipt of three dollars, send two methods of trisecting an angle, and then he winds up his advertisement by offering to pay $100 to any party proving that the methods in question are not correct. Didn't I mention these things? Seems to me I did. Wish I had a copy of that issue here and we would see just what I said."

"Never mind the paper, Mr. Hobart; just show me what he means. What is a 'cissoid,' anyway?"

"The 'cissoid of Diocles' is the name of a certain geometrical figure, and it is a sort of parabola. The ancient mathematician, Diocles, who worked out that figure, was trying to find some way of determining the side of a cube which would contain just twice or three times as much volume as another cube. They call this the 'duplication of the cube.' Another process, which I like better than the cissoid way, has been worked out by another old mathematical sharp. The method in question is known to mathematicians as the 'conchoid of Nichomedes,' and may be drawn in several ways. One way is to draw a line *A-B*, Fig. 1, and from any point outside that line, say at *C*, draw radial lines *D*, *E*, *F*, *G*, etc. On the vertical line through *C* draw *C D*, and measure the distance *I-D*, or take this distance on the dividers or on a piece of paper and lay it off, beginning at line *A-B*, on all the diagonals, *E-J*, *F-K*, *G-L*, *H-M*, etc. Through the points *D*, *E*, *F*, *G* and *H* sketch in the curve as shown. This

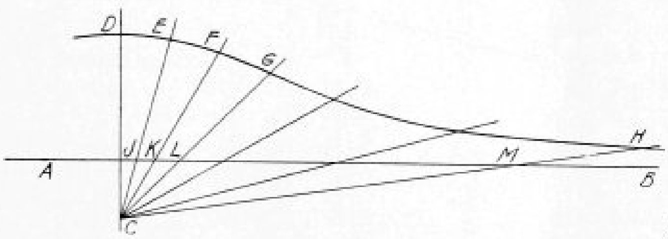


Fig. 1.—The Conchoid of Nichomedes

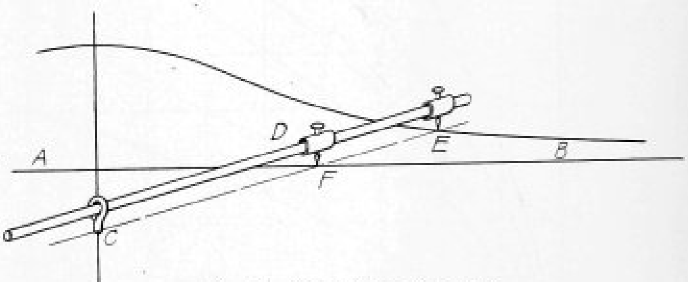


Fig. 2.—Tramming a Conchoid

will be the conchoid which we are after. A cissoid can be laid down in a somewhat similar manner, but the conchoid is the simpler for trisecting an angle.

"A fine but rough and ready method of drawing this curve is shown by Fig. 2, in which a tram *D* is set with the points *E* and *F* the required distance apart (corresponding with *I-D* in Fig. 1), than with one end of the tram sliding in the screw-eye at *C*, point *F* is made to move in the line *A-B*, and point *E* will trace the conchoid."

"But, Mr. Hobart, what is the curve good for, now that we have got it? I don't see any angle trisection in it. Where do we get off at?"

"Say, John, you will fly off the handle pretty regularly, won't you? Can't you wait until we get a layout, and then see for yourself?"

"Y-y-yes, I s'pose so; but you know I wanted to see that angle cut into three pieces like a minçe pie, and I don't see it yet and haven't even seen the angle."

"All right, John; you'll get to that presently. Don't you have to lay out a boiler sheet before you can punch the holes? Yes? Then what in creation are you bellyaching for about trisecting that angle before you even yet your tools on the job?"

"All right, Mr. Hobart; I'll be good if you will only show me how that angle is divided up."

"I'll not show you, John; you have just got to trisect that angle by yourself. I will tell you what to do on the first one, then you can do the work all by your lonesome."

"My goodness! I don't know how to do that sort of thing. I won't be in it on this work, Mr. Hobart. You do it first time, will you?"

"Not a bit of it, John. This is your funeral—or will be if you don't take the trick—so you just close your yawp-trap and get busy."

"Well, I'll try it. What shall I do first?"

"That's the talk, John. Just draw the angle you want trisected—no, it makes no difference what the angle is, but you had better take one between 20 and 70 degrees to begin on. There is more trouble with very oblique lines in very small, as well as in very large, angles; so take one for the first trial which doesn't go to either extreme. If the angle is greater than 90 degrees you may divide it into two smaller ones by a line in the middle—bisect it with the dividers—then trisect one side of the divided angle and swing the dividers over the other side of the division line with the third of smaller angle between them, and the part thus laid off on both sides of the division line will be the third required of the larger angle, and it will be laid off right in the middle of that angle, too, with the remaining thirds on either side."

"Say, how will sketch I, Fig. 3, do for an angle to work on? The angle is shown by the lines *E-C-D*."

"That will do first rate, John. Now draw a line *A-B*, square with line *C-D*—perpendicular to line *C-D*, the mathematicians say, while the boiler shop boys like to say 'square with.' Start the line at *A*, anywhere in line *C-D*, it makes no matter where, but to avoid too large a diagram it is well to start well down toward *C*, as shown at *A*, sketch II."

"Doesn't it make any difference where you begin with line *A-B*? I should think that the answer would be all wrong if point *A* were taken in the wrong place."

"No, John; it makes no difference where we start *A*. One place is just as good as another, and that is where the beauty of these geometrical stunts comes in. You don't have to be everlastingly making exact measurements to get results. You can start *A-B* anywhere, and as that line is longer or shorter, so are all the other lines, thus bringing the same answer, no matter where *A-B* was laid down. And now you have, in sketch II, Fig. 3, about the same layout that you made in Fig. 1, so just go to work and find the points in the conchoid, the same as you did in Fig. 1."

"Oh, I begin to see something now. You want the conchoid to work from in getting the angle divided up. Isn't that it? The end *E-D* of the angle is all open and there's nothing there to work against, so you draw the conchoid across that end and work from that. Isn't that the reason for using the conchoid?"

"You may call it that if you wish, John. Perhaps it is as good a reason as any. If I should tell you right here the scientific reasons for using the conchoid, you would have some columns of reading so mighty dry that the dictionary would seem a dime novel compared with the description, so I just won't, and will only say that they have proven beyond dispute that the conchoid, or the cissoid, is of just the right shape to form the working line in trisecting the angle. Why this is so, you must find out from geometry, and you will have to go higher than that branch of mathematics—yes, even into the calculus—to find the real proving reasons of 'wherefore the conchoid.'"

"Well, Mr. Hobart, I'm willing to take your word for it and leave the calculus proof go for a time—till I get tired and want a rest, anyway. Then I might try to dig out the scientific reasons for using the conchoid, but not to-day for little Johnny."

"Well, then, John, lay off the conchoid from *D*, as in sketch III, Fig. 3, and you can use the method shown by Fig. 1 or Fig. 2. Just make *B-D* = 2 *A-C*, then find diagonals 1-2, 3-4, 5-6, etc., lay off length *B-D* on each and sketch in the conchoid curve as already directed."

"Here it is, Mr. Hobart, and now what is it good for?"

"Keep your courage, John, you are almost finished now. Just start at point *A*, and draw a line parallel with *B-D* right to the conchoid. We will call this line *A-G*. Next, from the point *G* on the conchoid, draw another line right to point *C*, as shown by sketch IV, Fig. 3. Got that, John?"

"Yes, Mr. Hobart; here it is. Now what?"

"Nothing, John; you have the answer now, for that line *C-G*, sketch IV, splits angle *E-C-D* right into thirds—at least, it splits off one-third, and the angle *G-C-D* is just one-half of angle *G-C-E*."

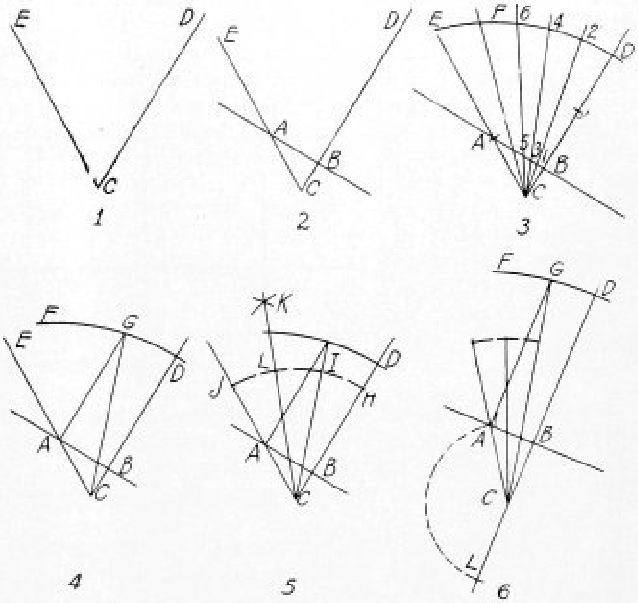


Fig. 3.—John Trisects an Angle

"Say, is that so? How can I prove it?"

"Well, as stated above, to prove it geometrically by demonstration would be more of a job than you would relish, and more than I would, either; but you can prove it graphically, as they say when they figure things by lines and diagrams. Sketch V shows how you can prove the work. Place one leg of the dividers at *C*, opening them any convenient distance, and draw the arc *H-I-J*. Now bisect the angle *I-C-J* by placing the divider leg in turn at *I* and at *J*, and describing short arcs cutting each other at *K*. Then draw the line *K-C*, and by testing with the dividers you will find that *H-I*, *L-I* and *L-J* are all equal to each other, therefore the line *C-G* cuts off one-third the angle *D-C-E*, and the line *L-C* cuts off another third, so we have actually trisected the angle at *C*, and that without making a single measurement."

"Well, that conchoid matter is certainly a beautiful piece of business, but isn't there a more simple way of getting the conchoid laid down without drawing and spacing off all those diagonals in sketch III, and then sketching in the conchoid?"

"Yes, John; I have just worked out an approximate method of doing the stunt. It will not be quite as accurate as the conchoid way, but it will approximate pretty closely the result obtained by the above method."

"How is that method worked, Mr. Hobart? Can I get next to it?"

"Yes, John. Fig. 3, sketch VI, shows the way it is done. Go ahead the same as in sketch II, and lay down line *A-B*; then, instead of developing the conchoid by either of the methods already shown, just take distance *A-C* on the dividers and when you lay it off from *B* toward *D*, sketch III, lay it off to *L*, in the opposite direction from *D*. Now, open the dividers to the distance *L-D* and draw the arc *D-G-F*, which will lie so very close to the direction of the conchoid that it is hard to tell which is which in the very short space occupied by the third of the angle we are trisecting—that is, from *D* to *F*, Fig. 1, the conchoid departs very slightly from the circle, whose center is at *L*, sketch VI, Fig. 3. But while the result obtained is quite close when point *G* lies close to line *C-D*, the answer will be far from accurate when the trisecting line moves over toward *H*, Fig. 1, for the conchoid has departed from even an approximation of a circle and the radius from *L* to *D*, sketch VI, will not give even approximate results. Therefore, do not try this radius method except for very small angles, say less than 15 degrees in the part of the angle as trisected. This means that for trisecting angles greater than 60 degrees it is not safe to use the approximate method, where much accuracy is required."

"Oh, Mr. Hobart, I'm just going to try both methods on all sorts of angles, from three or four degrees up to as large as I can do. I'll try each angle by both the regular and by the approximate methods, then I will know how large an angle the radius method is good for."

"That's a good plan, John. Go to it. But you will find, as stated at the beginning, that trisecting an angle between 80 and 90 degrees is not very satisfactory, and as also stated, you had better bisect the angle to be trisected, work on half of it, then double the angle found by swinging an equal angle over on the other side of the bisecting line with the dividers. But, John, in doing this stunt, be sure to take the bisecting line to work to—that is, make it into the line corresponding to *C-D*, which in that case will be in the middle of the angle instead of to one side."

"Mr. Hobart, where would line *G-H*, Fig. 1, get to if it were carried out far enough? It seems to be headed to reach line *A-B*. Would it get there if it were developed far enough?"

"Now you have raised a question which is hard to answer. The geometry people call it that the lines eventually meet, but only at infinity—that is, for any distance which can be measured or imagined the two lines will not touch each other. They are always approaching each other, but never quite get together. Finally they come so close, at a distance so far away, that neither can be measured or imagined."

"But how is that, Mr. Hobart? If two things are always approaching each other, they must reach each other sometimes, mustn't they?"

"No, John, not necessarily. If they approached always at the same rate, then they surely would get together some time, but they don't in this case. They approach less and less as they go farther along the line *A-B*, and this is what keeps them from ever reaching each other."

"I wish I could get that matter made a little plainer; it sure is hard to comprehend. Isn't there some plain way of showing it?"

"Yes, there is a way to do it, as there is a way to do everything—if we can only find that way."

"Crackee! Just show me that way, quick!"

"Fig. 4 does it, John. There you have a picture of 10 divided by 3. The correct dividend is 3⅓, but the first time you divide you get 3, do you not?"

"Yes, that's what, sure enough."

"Well, divide again, and you get 3.3, which is shown closer to the 3⅓ line."

"Oh, I see it now. You need not tell me any more. The line keeps rising as the dividend gets larger—3.33, 3.333, 3.3333, etc.—and keeps approaching 3⅓, more slowly each time you divide, and is always approaching but never gets to touch the 3⅓ line. Therefore, the more you divide, the closer you get to 3⅓, but you never quite get there. On the other hand, the geometry sharps say you *must* get there at infinity, and there you have it. Always approaching, never getting there, but you do get there in the forever.

"And, John, that's just the case with the conchoid *D-H*, in Fig. 3—always approaching line *A-B*, but never touching it until in the infinite distance we can't tell one line from the other, and therefore say they come together at infinity."

"Say, there's not a limit to this game, is there? Not even the sky?"

"No, John, there no limit to a man, either, only what he thinks is his limit, so go ahead. There's nothing to stop you if you will only think so."

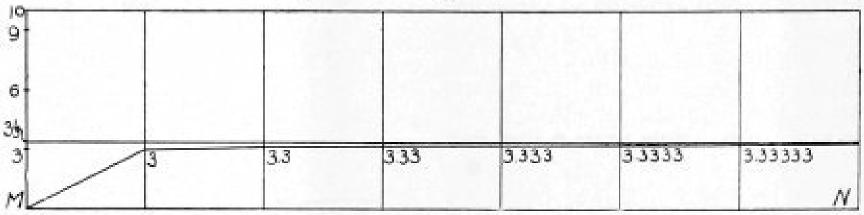


Fig. 4.—Lines Always Approaching But Never Touching

Two-Ten-Two Locomotives for the Chicago, Burlington & Quincy.—In the spring of 1912 the Baldwin Locomotive Works built five locomotives of the 2-10-2 type for the Chicago, Burlington & Quincy Railroad. These were at that time the largest non-articulated locomotives in service, and ten additional locomotives generally similar in design have recently been constructed for this road by the same builders. The rated tractive force for all these locomotives is 71,500 pounds, and with equal hauling capacities and a large number of interchangeable detail parts they constitute a notable group of unusually large units. In eight of the ten new locomotives, counterweights keyed to the main axle have been fitted in conjunction with the usual weights in the wheel centers, balancing a large proportion of the reciprocating and revolving parts to avoid destructive effects at the speeds at which these engines run. In the two remaining locomotives this important and difficult problem of design has been worked out so that, by using special steels to reduce the weights of reciprocating parts, the necessity of applying additional counterweights has been avoided. With 25 percent greater hauling capacity than a Mikado type locomotive carrying the same weight per pair of driving wheels, this type will, it is claimed, under favorable conditions effect a material reduction in the cost per ton mile of moving freight.

Some Principles of Boiler Design

BY GEORGE SHERWOOD HODGINS *

A locomotive boiler is necessarily a very small appliance for boiling the amount of water which it is called upon to handle. The object of the design is to provide a vessel which, with the water it carries, shall have the least possible weight necessary to do the work. Water must be turned to steam in large quantity and at a rapid rate, and the fuel carried is often burned on an area about the size of an ordinary dining-room table. The horsepower to be developed is such that the weight of fuel, water and boiler seems altogether inadequate, but yet we know that the thing is done, and done most satisfactorily.

When we determine the kind of fuel to be burned, i.e., anthracite or bituminous coal, we have practically fixed the type of boiler; for, roughly speaking, hard coal requires a larger grate area than soft coal does. Soft coal burns faster than hard coal, and a smaller grate area is permissible. Soft coal gives off a large quantity of hydrocarbon gas, by distillation, and it is therefore not only necessary to provide for a sufficient supply of air to effect the combustion of the coal, but also to afford adequate room for the proper mixing of air and hydrocarbon gas.

In burning the volatile constituent of coal, one of two gases may be formed, and these produce very different quantities of heat. Where the supply of air, and of course of oxygen, is sufficient, carbon dioxide or carbonic acid gas will be formed. This gas, in forming, gives off 14,500 heat units, but where carbon non-oxide, or carbonic oxide gas is formed, as it will be with insufficient supply of air (oxygen), then only 4,500 heat units will be given off. There is, therefore, a loss of about 10,000 heat units per pound of coal when the volatile hydrocarbon is imperfectly burnt. The fixed carbon in the coal burns more slowly and turns to ash.

It may here be remarked that a heat unit, or more correctly, a British thermal unit (written B. T. U.), is the quantity of heat required to raise one pound of pure distilled water at 39 degrees F. to 40 degrees F., or generally the amount necessary to raise a pound of pure water 1 degree Fahrenheit. The loss of 10,000 British thermal units, therefore, is equivalent to a loss of energy capable of raising 7,780,000 pounds one foot high, and this is equal to the raising of one ton (2,000 pounds) 3,890 feet.

To us the center of a circle is always the important point, and it may come as a surprise to some, to find that in dealing with a locomotive boiler the diameter is the more important factor. A circular boiler shell containing water and steam under pressure has to constantly resist a force tending to burst it. This force is measured in pounds per square inch. The pressure acts in all directions, but it is considered and measured as if it acted only upon the diameter of the boiler.

A boiler cut in two along its horizontal length presents the appearance of two arches, one right side up and the other inverted. One of these arches alone is considered, and this arch is, in the mind, reduced to a half hoop by thinking of it as just one inch wide. If the boiler is 50 inches in diameter, the portion considered is 50×1 inch in area, or 50 square inches. This area approximates to what the shadow of a half hoop would be on the floor, if set immediately below a powerful electric light. If the pressure carried was 200 pounds per square inch, it is evident that the total disruptive force would equal 50×200, or 10,000 pounds.

This pressure would be sustained by the two edges of the hoop. If the boiler plate was ½ inch thick, each edge would have a cross-sectional area of $1 \times \frac{1}{2}$, or ½ square inch. Together they would have an area equal to 1 square inch. If the breaking strain of boiler steel is taken at 60,000 pounds per square inch, we have a total of 10,000 pounds, tending to burst the boiler, and this is resisted by 1 square inch of steel, capable of sustaining something under 60,000 pounds. Allowing for contingencies, that is where the breaking strain may not be exactly as quoted in the tables, for authorities vary, taking the safe side and calling it 50,000 pounds, the steel is therefore five times stronger than the strain put upon it, and this is as it should be, giving a factor of safety of 5. The factor of safety is the number of times the plate, or seam or boiler is stronger than the pressure it is called on to bear. The smallest factor of safety which may be used is 4; but 5 is the factor which good practice calls for wherever it is in any way possible to use it in designing a boiler.

When it comes to joining the free ends of a rolled boiler plate, the strength of the joint has to be considered. The simplest form is the lap joint. This is where one plate overlaps the other, and the holes are punched out and the rivets driven through both. In order to find the percentage of strength of such a joint, an example will help. Consider the rivets to be spaced 2¼ inches, center to center, and the size of the holes ⅞ inch. This gives 1⅜ inches between the outer edges of the holes, and represents the amount of the plate not punched out.

A problem in simple proportion presents itself here. Let the strength of the original plate, not punched, be represented by 100, then this proportion holds: As 2¼ is to 1⅜, so is 100 to the answer. Stated mathematically, it becomes $2.25 : 1.375 :: 100 : X$. When this is worked out it appears that the punched plate is 61.1 percent as strong as the original plate. If the breaking strain of the steel is 60,000 pounds and this joint is 61.1 percent as strong, it is therefore able to stand 36,660 pounds to the square inch. If a factor of safety of 5 be used, it is manifest that this joint, as far as the plate is concerned, is too weak for safety, as it has only a factor of safety of 3.66.

When we come to consider the strength of the rivets, we may take the iron rivets in single shear, as able to stand 48,000 pounds. Each rivet carries the strain of only one side of a section of the boiler 2¼ inches wide. This stated in terms of mathematics comes out

$$\frac{200 \times 50 \times 2\frac{1}{4}}{2} = 11{,}250 \text{ pounds.}$$

The area of a ⅞-inch rivet is .6013 square inch. At 48,000 pounds pressure strain, each rivet carries 28,862 pounds, and this gives a factor of safety of 2.55 for the rivets, which is manifestly too small for safety. The example, while condemning the joint for punched plate and for rivets, nevertheless gives the method of working out similar examples.

Objections have been urged against the lap joint, so serious as to put it out of use for horizontal seams in modern boiler work. The principal objection is that the single-riveted lap joint is liable to readily corrode or "groove" on the upper inside edge of the plate. The rapid grooving of the plate along this line is due to the fact that the joint cannot lie in a true circle like the rest of the plate, and the internal pressure tends to pull it in such shape that the inside of the outer lap tries to get in line with the outside of the inner lap. When the pressure and heat are withdrawn, as when the boiler is cooled off, the joint assumes its original shape, and any scale or rust which formed on the upper inside edge

* Member of the American Society of Mechanical Engineers and formerly Consulting Mechanical Engineer of the National Transcontinental Railway.

of the lap is thereby broken off and a new, clean surface is exposed to hot water and steam, and the process is repeated until the plate gives way.

The lap joint which we have been considering was not strong enough as far as the plate and the rivets were concerned. If the joint was chain-riveted, that is, if it had two rows of parallel rivets placed one directly behind the other, the factor of safety would be 5.10 for the rivets, which would satisfy the condition imposed. It may be noticed that the factor of safety is double that found for the rivets in the first case, and this fact implies that the lap joint, when following the chain system with rivets and spacing, as previously supposed, is twice as strong as the single rivets in the first case.

Taking now the strength of the plate in the chain-riveted lap joint, we would have the proportion 2¾ : 1⅞ :: 100 : X, or 2.75 : 1.875 :: 100 : X, or 68.2. The chain-riveted lap joint with two rows is 68.2 percent as strong as the original plate before punching. With 60,000 pounds breaking strain, the plate, when punched, would stand 40,920 pounds per square inch, and this would give a factor of safety of 4.09. This is got by dividing 40,920 by 10,000 pounds, which is the total internal pressure acting to burst the boiler. This factor of safety is very close to the limit proposed, but the joint would be all the better if made stronger.

Another form of lap joint is where the rivets are zig-zag or staggered. When such a system is employed, good practice has established the custom of making the zig-zag pitch 6/10 of the straight pitch, to which is added 4/10 of the rivet diameter. In the example we are considering, if 2¾ inches is the straight pitch, we will get about 2 inches for the zig-zag pitch, and the rows of rivets will be 1½ inches apart. This makes the strength of the plate on the zig-zag pitch equal to the plate strength on the straight pitch.

The rivet strength will be determined, as in the other examples, and works out as follows:

$$\frac{50 \times 1\frac{3}{8} \times 200}{2} = 13{,}750 \text{ pounds per square inch.}$$

The area of a ⅞-inch rivet is .6013, and with 48,000 pounds per square inch shearing strain the rivet strength is, as in the former case, 28,862 pounds per square inch. The factor of safety, then, appears as

$$\frac{28{,}862}{13{,}750} = 2.091.$$

This is, of course, far too low a factor for safety, and the joint will have to be strengthened by an extra row of rivets, thus allowing for smaller individual rivets and wider spacing. The lap joint is at best a poor arrangement and has been superseded by the butt joint with welt. A consideration of the butt joint will follow later.

Ethics of the Boiler Shop

The Science of Moral Philosophy Applied to Every-Day Conditions in the Shop

BY JAMES FRANCIS

In the conduct of a boiler shop, as in any other business, there is a conflict of opinion, inclination and personality all along the line from the board of directors, general manager, superintendent, to straw boss, workman, and to the last cub apprentice and water boy. And it seems as though it were a case of "dog bite dog" from the top of the ladder to the bottom! Each official in turn receives "a wigging" from the one immediately his superior, and in order to get rid thereof, must necessarily pass it along to those of whom he is in immediate charge.

Some member of the board of directors, who already has more dollars than is good for him, gets an idea that the boiler shop tree only needs shaking to scatter down a big lot of dollars, and the official in question immediately begins to "shake" things for all they will stand—and sometimes more!

I do not know of anything which will demoralize a shop worse than one of these uncalled for "shake-downs" by the directors. Such things are usually ill-timed, to say the best, and like some of the strikes which have taken place, are brought into action when it would have been better to have waited for a more propitious opportunity.

The ethics of boiler making should prevent boards of directors from "throwing scare heads" into the shop. A lot better would it be to let all such things come down easy street than to tumble plump upon the shop from the precipice of Mount Arrogance! When "the board" has decided that certain things must be done to "shake down" the shop, then let them do it with kid gloves instead of with four-ounce gloves, and the business will be much better therefor.

Such "shake-ups and shake-downs" usually are done over the heads of general manager and superintendent, and done peremptorily at that. How much better for all concerned to let those officials work the changes gradually and in conformation with the policy upon which they are running the shop?

Although the manager and superintendent thus have a bad example set for them, it rests upon their actions whether or not the shop can carry the load. Let the officials named pass along the changes in the shape in which they received them from the board, and strife and dissension quickly claim that shop for its own and inharmony rules everything.

The wise manager and superintendent will sugar-coat such things as much as possible and let them dribble through the shop as gently as can be arranged. But, do all they can, there will be trouble if the spirit of forbearance is not carried out by everybody. The shop and gang foremen must receive and assimilate a whole lot before they pass the word along to the men. And the men themselves must "grin and bear it" as far as possible when word comes down the line that "the carpet is tore" and there is to be an upheaval in the shop. And next to the bad results of having such shake-ups at all, comes the ill effect of disturbing the ethical shop policy as above noted.

Let us all, whatever be our official station in the shop organization—let us be constantly on the line to make things as profitable and as pleasant as possible for shop and man. That is a slogan which it will pay us all to follow.

Shop ethics may be much better or much worse, according as we help to make them; therefore, let us, one and all, do a lot of thinking along this line. It will pay the owners and it will make things pleasanter for us all. Carrying the matter of shop ethics down the line, after it gets to the rank and file, does not mean that the mechanic should stand up for his fellow workman even to the extent of lying for him. Neither does it call for the passing of all mistakes and errors along to "Patsy Bolliver," but the observance of shop ethics does call for the helping of each and every one of our fellow workmen, and the officers of the company as well. It also calls for the use of tact and common sense in dealing with the thousand little annoying things which are constantly cropping up to hurt work or feelings in the shop or out of it.

The Ethical Standard

Shop ethics calls for a whole lot of brotherly "give and take," and the best shops are those in which the ethical standard is the soundest and best. "But what are 'ethics?'" asks somebody from the shop. "I never heard of any 'ethics' in any shop I ever worked in! What is it?"

And that's just the trouble in lots of shops. They are "short" on 'ethics'! "Ethics" is the science of moral philosophy. In plain English, it's the right and wrong of things. When you hear a man telling another not to let Tom be thought guilty of some poor work which he —Sam—had done, then that man is talking ethics, and is talking them from the right side, too!

The man whose ethics are sound will never say "Oh, shute! I didn't do that! Tom did it, or Bill or Sam! 'Taint my business to fix it. Let the chap eat the bread who buttered it!" This chap's ethics are all wrong and he won't ever get anywhere with that kind.

There used to be a man in our shop who was continually poking along in a quiet way—nothing ever disturbed him and you could never get the old fellow "riled"—but the things which that man did for everybody else in the shop were many and great! Did he find a badly finished rivet, he never said: "Let Bill fix it; he is the man who drove it." No, you never heard Old Henry say anything like that. Instead, the old man would take his hammer, get somebody to ride a dolly-bar, and finish that rivet the best he could, saying at the time: "Oh, well, boys, we may skip a bit ourselves sometime, and it's mighty fine to have somebody help you out on it!"

And the simple little things he did made things a whole lot easier in the shop. It may be thought that the men would leave things purposely, knowing that Old Henry would find and fix them before the bad work got out of the shop, but, to my surprise, it worked just the other way. I overheard a couple of men one day as they were quitting a finished job. One man said: "Hi, Bill, here's a job for Old Henry; somebody's left three rivets 'up' in this corner—lucky for us that we have Henry in the shop, isn't it?"

"Old Henry's" Method

"Yes, Sam,'" said the other man. "Old Henry's all right, but let's not leave those rivets for Henry. He never leaves such things for anybody else, and he will go out of his way and work overtime to help any of us out of trouble. Let's us do a little of the same!"

"All right, Bill! I'll go you. It's mighty decent of Old Henry all the time, and I'm glad to get back at the old man a little bit. He's all right, Henry is!"

The above shows the best variety of shop ethics—shows them in their most effective form for everyday use, and the shop which can boast of such ethics is one which it is good to work in or to hold stock in.

Right between foreman and men is the place where a whole lot of the right kind of shop ethics is needed. That is where the friction takes place, and it's where things are lubricated, too. Once the men find that the foreman is fair and "straight" and does the best he can in the interests of both men and shop, then there are no people on the earth who more quickly come across and meet the foreman's ethics half way than will the boiler makers in any shop, be it large or small, in East or in West.

How a Reputation Affects a Shop

The ethical reputation of such a shop and its foreman are not confined to its city or town, or to its State, either. Its reputation goes forth in every direction, and good men and good workmen are attracted to that shop and wish to stay with it. The boiler makers appreciate the ethics of the foreman, even though they don't perhaps recognize the condition by that name. To them, perhaps, it is merely a "good shop" with no look forward as to what makes it a good one to work in.

I recently asked a boiler maker why he liked so well to work in Blank's shop. He admitted that they didn't pay quite as high wages there as in some other shops, and the work was pretty hard, but he stated the real reason for his preference when he said: "Mr. Francis, I like that shop because it's so sort of neighborly!" The man didn't know what made it a good shop to work in, but he knew it was a good one, and that was all he knew or cared about it.

But, brother boiler makers, it is up to us, one and all, to know more about these things. About "shop ethics," and all that sort of thing, for we can add a good deal in that way toward making the shop "profitable and pleasant"; and let me tell you one thing more, brother boiler makers: if you want to make the shop pleasant, that's up to us, and our own business entirely, but if we don't make the shop profitable—well, it won't be long before there won't be any shop as far as we are concerned, for the shop simply won't have us. That's all and final!

Shop Ethics

A "profitable and pleasant shop" does not depend entirely upon ethics for its making or unmaking—not by a good deal—but it does depend a whole lot thereupon, and the shop with good ethical principles is *always* more pleasant and profitable than the one in which each and every man seeks only to "do others before they do him!" No, I don't blame you for not wanting to stay in a shop of that kind; therefore, just remember that the shop is just what the men make it, and the better *your* shop ethics, the better will be the shop—both as regards profit and pleasure.

Shop ethics strike in quite a number of directions which are not even noted in the above paragraphs. The timekeeper can do a whole lot in ethics to make things or to break them. His work and records are to be accurate and exact, of course, and no hour or minute is to be lost or added, but the manner in which the timekeeper does his daily work among the men has almost as much to do with the mental condition of things in the shop as has the influence and example of the foreman. Who ever saw an ethically comfortable shop—one which was "good to work in"—which carried a sour-faced, dyspeptic-looking timekeeper, one who wore an undertaker's face from Monday morning until Saturday night. Such a countenance in the shop, be it on timekeeper, foreman or waterboy, never helped the shop to be "profitable or pleasant." And if a man finds himself wearing such a face, for pity's sake, take some liver medicine quickly and get rid of that countenance. A man can't be ethical when he's bilious, but he won't be bilious if he's ethical, so there's a chance for us all!

There's just one other place regarding boiler shop ethics which I want to take a shot at, then I'm done and will shut up. And that place is the sales department. Now a man has no business in the sales department, any more than he has in the shop, if he isn't ethical, so all ye "ambassadors of commerce" get yourselves busy and absorb and assimilate shop ethics in liberal doses and you will sell a whole lot more boilers—and get better prices for 'em, too!

And, boys, there's another thing: don't try to sell boilers until you know boilers. A man who hasn't taken off his coat and wrestled with boiler shells, dolly bars and the rivet forge isn't fit to sell boilers. Before you try even to "locate a prospect," go into the shop and locate a boiler and see what it looks like, inside and out, in the stock pile and on the car.

Then, Mr. Salesman, you will know your stock and be able to talk all around all the other fellows. I don't care a rap whether you are able to drive a rivet or not, and as to whether you are able to calk a seam or expand a tube so it won't leak—well, that don't concern me in the least as long as you know how those things are done and what they stand for.

Ethics for the Salesman

But, above all other things, you must take a course in ethics. There is only one kind—the kind which is used in the shop is the same old kind which is used on the road or in the bank, so see to it that you lay in a mighty good stock of first-class ethics and you will sell boilers all around the other chaps. "What's the difference?" Well, just watch and listen to the salesmen as they come around and sing their little songs! Here is one now. *All* he knows or cares for is—himself. He is the *great* I. Nothing else matters. *He* is *"it,"* that's all there is to it. He comes in "knocking" everybody else's boilers. In fact, there is only *one* boiler in the world, and that's *his!*

He proceeds to knock everything and everybody outside of his company, and when he gets through we feel that the war in Europe has settled right here in our shop. His descriptions and remarks are punctuated with the mean things he can think of—or imagine—to say about his competitors, and he has never a good word for anything or anybody. When he goes, we feel a great relief, as though a great calamity had passed and just missed us all.

And then here comes the other fellow. He has a smile as big as a Dutch oven and a hand shake like a bear hug. Knock? Never heard a word from him. Why, he met the other fellow as he came in, and straightway began to talk about the man and to tell what a good boiler the fellow's company put up. This salesman understands shop ethics, all right, and gave the other salesman and his boiler a reputation that would almost pass them through the pearly gates, and then the salesman—and he is a salesman, too—begins to tell what better things his boiler has than are found even on the competitor's extra good boiler: paints the lily, this salesman does, whitewashes the glum salesman, too, and makes a better man of that fellow than he ever was or will be. And we think much better of the departed salesman after that spiel. We think better of everything, and we surely find ourself thinking best of all of the boiler which is being so heartily talked to us. We begin to feel that this boiler is the right one, and to want this boiler and no other. Why? Just because this salesman understands ethical and some other matters, and puts everything before us in such a bright, pleasant light that we *want* to do the things he so pleasantly holds up to us.

We feel that he is right, that his boiler is right, and that we will be doing right in purchasing his boiler and appliances. And that's what shop ethics are and are for —the right and being right. There's nothing more to it than that, but it is a mighty important thing and sure makes everything in the shop—and out of it—all to the good when we act as ethically as we can. And let's all learn all we can concerning boiler shop ethics, and then *do it!*

Finding Valley Angles Graphically

Boiler makers often have difficulty in determining valley angles for hoppers and boxes of the type shown in Figs. 1 and 2.

From a drawing similar to Fig. 1, one corner may be

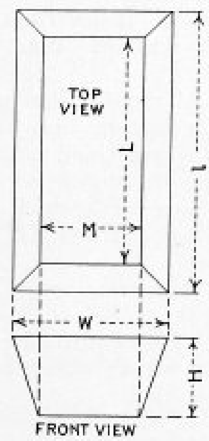


FIG. 1

FIG. 2

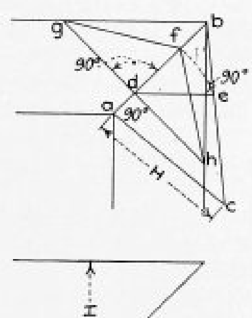


FIG. 3

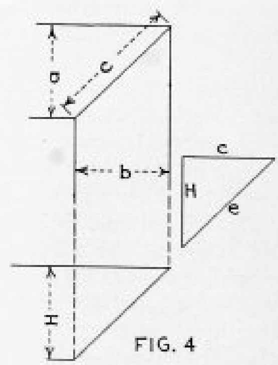


FIG. 4

laid out on paper, as in Fig. 3, and the valley angle obtained as follows:

(1) From point *a* draw line *a-c* perpendicular to diagonal *a-b* and equal in length to *H*, the depth of the hopper.

(2) Draw *b-c*.

(3) From any point on *a-b* as *d*, draw *d-e*, perpendicular to *b-c*.

(4) From *d* also draw line *g-h* perpendicular to *a-b*, intersecting the top edges of the hopper at *g* and *h*.

(5) Lay off *d-f* on *a-b* equal to *d-e*.

(6) Draw *g-f* and *h-f*.

(7) The angle between *g-f* and *h-f* is the required valley angle.

For those familiar with a table of tangents, the following formula will prove much quicker than the graphical method.

$$\text{Tan. Valley Angle} = \frac{H \times e}{a \times b}. \quad \text{(See Fig. 4.)}$$

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SERPENTINE CUT

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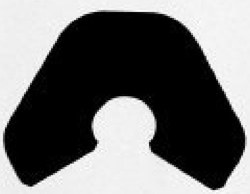
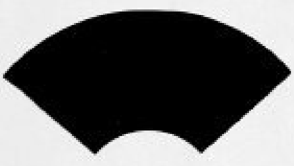


DEVELOPMENT OF SHEET FOR TAPERING BODY WITH OBLONG BOTTOM & ROUND TOP.



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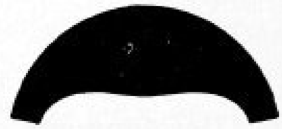
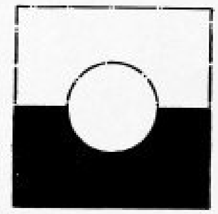
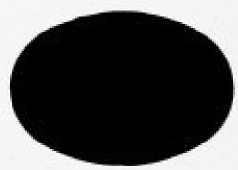


DEVELOPMENT OF CONE CUT ELIPTICALLY.

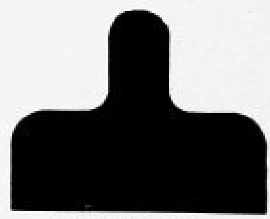


CULVERT SHIELD

SECTION OF HEMISPHERICAL TANK BOTTOM.

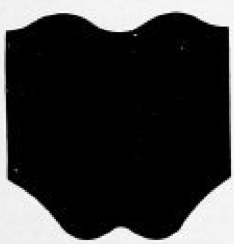


OVAL SHEET

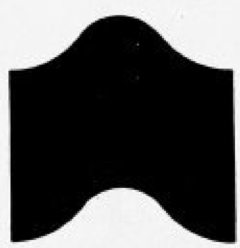


END OF CAR SEAT.

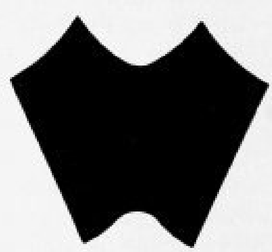
DEVELOPMENT OF OBLIQUE CONE SHEET



DEVELOPMENT OF SHEET FOR SLANTING TEE



DEVELOPMENT OF OBLIQUE CYLINDER SHEET



DEVELOPMENT OF TAPERING ARM OF Y-CONNECTION.

a, *b* and *H* are given dimensions of the drawing. *e* equals the square root of H^2 plus C^2 equals the square root of a^2 plus b^2 plus H^2.

As there is a minus sign before the value of the tangent, the angle found from the tables must be subtracted from 180 degrees to obtain the true valley angle.

WM. D. TAYLOR.

Elyria, Ohio.

Development of a Y Breeching

BY J. L. WILSON

The Y breeching shown in plan and elevation, Fig. 1, consists of a connection between a large cylindrical pipe with axis *D-d* and two smaller cylindrical pipes equally spaced from the axis of the larger one. In general the smaller pipes will have some definite cross section as an oval, circle or ellipse, etc., and the connecting piece between these and the larger pipe will not always be a true cylinder.

Dividing the Surface

The circle or profile of base *E* is divided into an equal number of parts by points 1, 2, 3, etc., and these are projected up into the elevation to corresponding points 1, 2, 3, etc. The same number of equal spaces are laid off on the semicircle at *D* and points *a*, *b*, *c*, etc., are projected down to give points *a*, *b*, *c*, etc., corresponding on the elevation. Lines 1-*a*, 2-*b*, 3-*c*, etc., are then constructed as shown in this case by dot and dash lines forming the elements of the surface.

Following the system of triangulation, lines 2-*a*, 3-*b*, 4-*c*, etc., are drawn as shown in this case as dashed lines to distinguish them from the elements throughout the problem.

These lines are all projected and drawn in the plan view, as shown with their corresponding letters and numbers.

Now the simplest method to follow is to develop the full section with *d*-4 as an axis and then cut off the part *d-C* where the other section of the breech joins it.

Horizontal dotted lines are then drawn from *a* to *O* and through points 1, 2, 3, etc., as shown to form the diagram of triangles. The vertical through *O* remains fixed, but the heights of the triangles vary according to the heights of points 1, 2, 3, etc., as projected from the elevation.

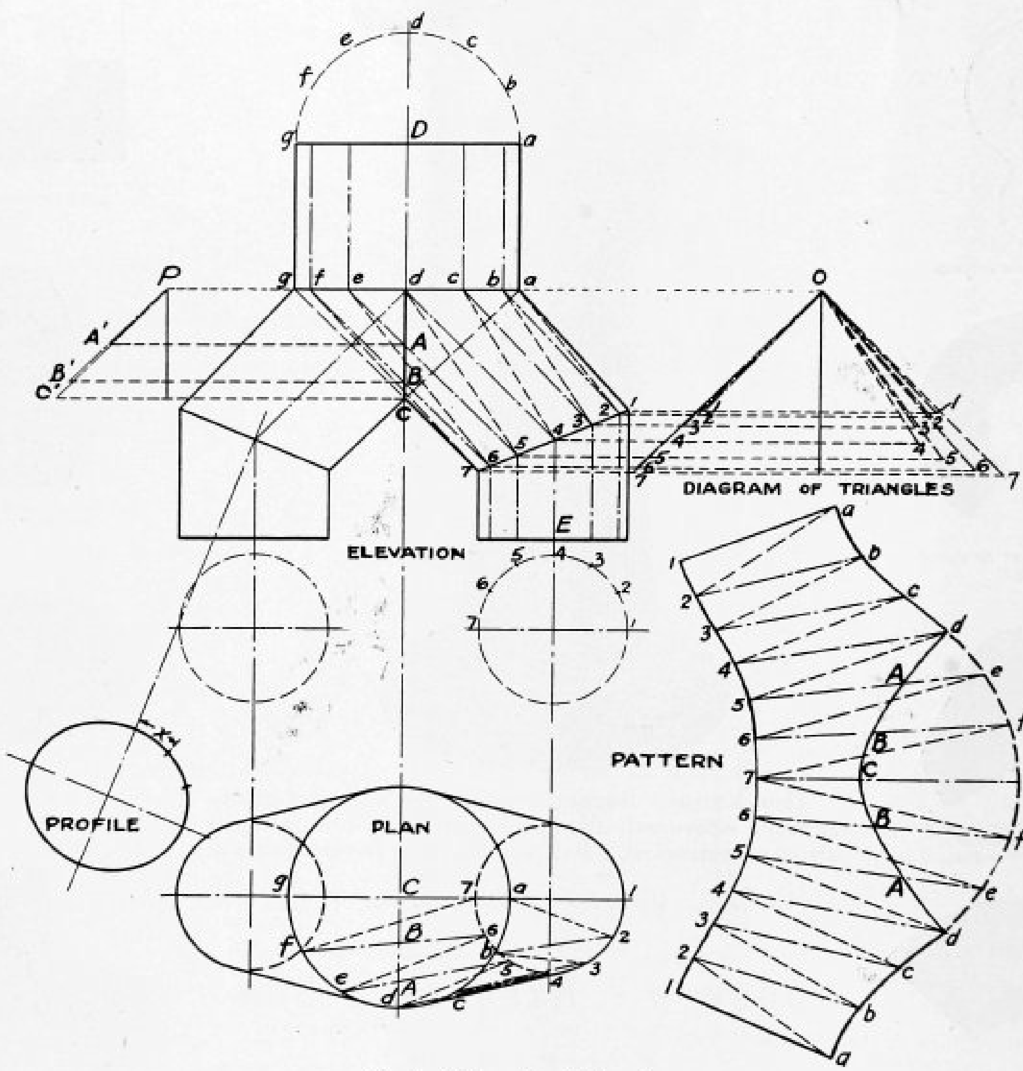


Fig. 1.—Patterns for Y Breeching

Development

First take the elements 1-*a*, 2-*b*, 3-*c*, etc., and transfer distance 1-*a* from the plan view to the diagram of triangles, laying it off as shown by point 1 to the left of the vertical line through point *O*. Then transfer 2-*b* from the plan view to the diagram of triangles, laying it off to the left of the vertical, as shown by point 2. Follow this method for all the elements to 7-*g*, since it is only necessary to actually develop one side of the figure as the other side is exactly the same only to the other hand.

Now connect points 1, 2, 3, etc., on the left of the vertical in the diagram of triangles to the point *O*, which gives *O*-1, *O*-2, *O*-3, etc., as the true lengths of the elements 1-*a*, 2-*b*, 3-*c*, etc. Following the same method for the diagonals, 2-*a*, 3-*b*, 4-*c*, etc., we transfer 2-*a* from the plan to the diagram of triangles, only laying it off to the right of the vertical as shown by point 2. Similarly lay off points 3, 4, 5, 6 as shown by transferring 3-*b*, 4-*c*, etc., from the plan view to the diagram of triangles.

Now connect these points 2, 3, 4, etc., to *O* in the diagram of triangles, giving lines *O*-2, *O*-3, *O*-4, etc., or the true lengths of the diagonals 2-*a*, 3-*b*, 4-*c*, etc.

Now by projecting the intersection of the breech and smaller pipe to the left we obtain a profile in the form of an ellipse. This profile is dividing into the same number of equal parts as the section at *E* in the elevation giving length *x* as the length of one of these divisions.

Laying Out the Pattern

Element 7-*O* is transferred from the diagram of triangles and laid off as 7-*g* in the pattern. This forms a center line and the pattern is laid off equally on both sides of it. Now with 7 as a center and 7-*f* as radius equal to 7-*O* on the right of the diagram of triangles draw an arc through *f* in the pattern. Then with *g*-*f* as radius and *g* as a center, draw an arc intersecting this arc at *f*. Radii *g*-*f*, *f*-*e*, *e*-*d*, etc., throughout the pattern are equal to each other and to the arcs *g*-*f*, *f*-*e*, *e*-*d*, etc., of the plan view.

Next with 7 as a center and with length *x* as a radius, transferred from the profile, strike an arc through point 6 in the pattern. Intersecting this arc at 6, draw another arc with *f* as a center and with a radius equal to 6-*O* on the left of the diagram of triangles. This will determine point 6 of the pattern. Continue this process on both sides of the pattern until the pattern is determined throughout by points 1, 2, 3, etc., and *a*, *b*, *c*, etc.

The distances 1-2, 2-3, 3-4, etc., of the pattern are equal to each other and equal to length *x* of the profile. It will also be easier to follow the layout if it is noted that the elements are dot and dash lines throughout and that the diagonals have been carried throughout as dashed lines.

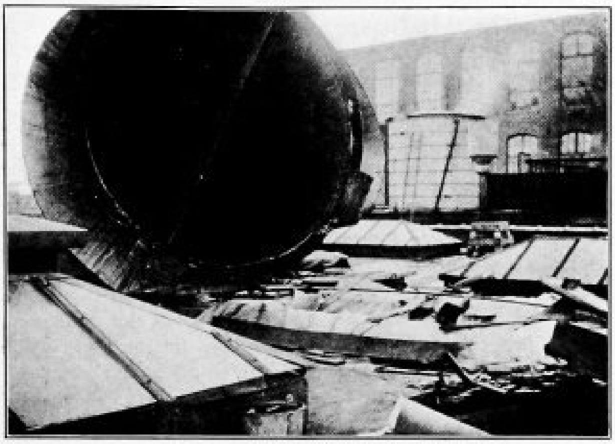


Fig. 1

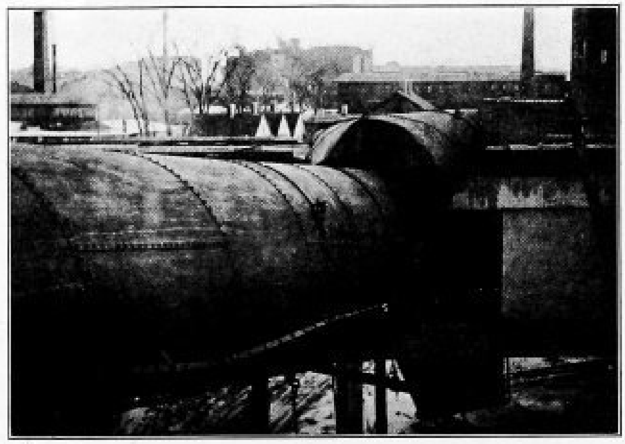


Fig. 3

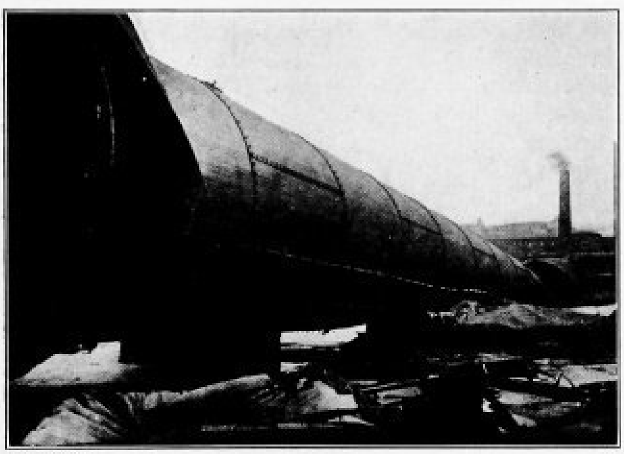


Fig. 2

The next step consists of laying off the part to be cut out for the intersection of the other side of the breech as shown by *d*-*A*-*B*-*C*-*d* in the elevation and pattern.

A new diagram of triangles is constructed to the left of the elevation by projecting dotted lines horizontally from *d*, *A*, *B* and *C* and drawing a vertical through point *P*. Transfer *e*-*A* from the plan view and lay it off from the vertical through *P*, giving point *A′*. Continue this with *f*-*B* and *g*-*C* of the plan view, giving points *B′* and *C′*. Connect these points with *P*, giving *P*-*A′*, *P*-*B′* and *P*-*C′* as the true lengths of that part of the elements, *e*-5, *f*-6 and *g*-7, to be cut out. Transfer these lengths to the pattern, laying them off from points *e*, *f*, *g*, respectively, and draw in curve *d*-*A*-*B*-*C*-*B*-*A*-*d*, which, together with the curve drawn through points previously obtained on the pattern, complete the outline as shown. The part of pattern to be left out is shown by a dash line and is only used for convenience in laying out.

Collapse of Steel Stack

BY FRANK T. SAXE

The accompanying illustrations show a 150-foot steel stack built last summer, which was blown over in a recent storm. The stack was 7 feet 6 inches diameter, made of 7/16-inch, ⅜-inch, 5/16-inch and ¼-inch stock, costing about $1,100 for erection.

Fig. 1 shows the base of the stack, and in the lower right-hand corner the dark space shows the hole in the roof where the stack formerly stood. It is clearly seen that the stack jumped about 6 feet from the spot where it was erected when it was blown over.

Fig. 2 gives an idea of the length of the stack, and also shows how it broke in two. A better view of the break is shown in Fig. 3, in which can also be seen a concrete bridge connecting one building to another which the stack struck when it fell and over which it bent at right angles. The way in which the stack collapsed is shown in Fig. 4, the material shown in this view being ¼-inch stock.

The apparent reason why this stack fell down was due to the fact that one end of a turnbuckle which was not

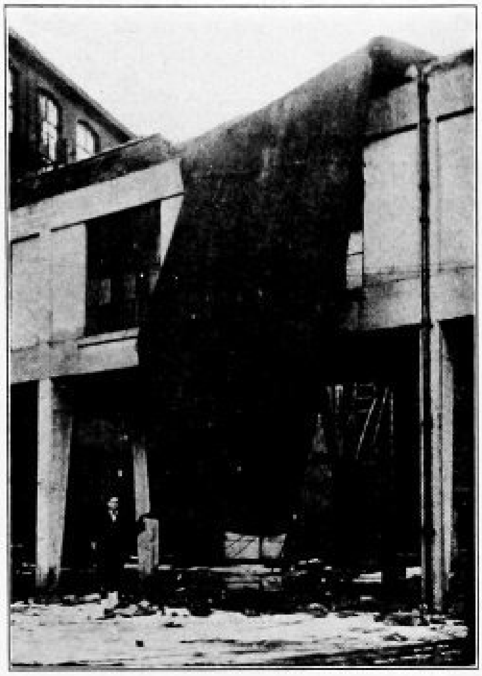


Fig. 4

welded opened out, so that when this gave away the others straightened out and the stack was no longer supported against the force of the storm.

Too much stress cannot be laid upon the importance of welding the eyes of turnbuckles when used in holding a large stack. In this case there were four sets of guys supporting the stack and the base rested on I-beams.

CAUSES OF HONEYCOMB ON FLUE SHEETS.—The formation of honeycomb on flue sheets is doubtless contributed to by the presence of excess ash material and sulphur in the fuel. In this connection it is interesting to note that the fine material produced in the ordinary process of mining has a higher percentage of both ash and pyrites (iron sulphide) than is present in lump coal taken from the same mine. In a series of tests conducted by Prof. S. W. Parr, of the University of Illinois, on samples of coal from seventy-five mines in that State, each mine being represented by one sample of screened lump coal and one of screenings, the results showed an almost uniform ash percentage in the screenings, at least double that of the ash in the lump coal. In run-of-mine coal the product is somewhat deceiving, having the appearance in the mass of being very largely lump material. Of course, it is possible for occasional car loads of run-of-mine coal to be fully equal to the best screened lump from the same mine, but the fine material must sooner or later come along somewhere in the output. After the blast and the breaking down of the coal at the working face the miners enter and clean up the rooms by sending out first the coarse or lump material. At the clean-up, which is made before the new drill holes are started, that part of the underlying floor which has been more or less pulverized and loosened in the various processes is shoveled up and sent out along with the coal. In this way it is evident that the fine material will be much higher in ash and will, moreover, contain mineral constituents which usually are in themselves higher in sulphur. Therefore, in run-of-mine material there will often occur exactly those physical conditions of fineness of division and high content of iron pyrites which are productive of pasty articles that can be made to grow by small accretions, finally forming a honeycomb structure on the flue sheets.—*Electrical World*.

Double Oblique Pipe Connection

BY GEORGE A. JONES

To develop patterns for an oblique pipe connection, as shown in the general plans, proceed as follows:

First draw the plan and elevation of the center lines. The vertical pipe in the plan is set to one side of the horizontal pipe, a distance equal to B-B_1. The elbow is above the horizontal pipe a distance equal to B-A_1 in the elevation.

First find the true angle of the elbow, as shown in Fig. 1. Lay off the distance D-C equal to B-C in the plan. At right angles to D-C, Fig. 1, draw the vertical line D-A and make the distance D-B, Fig. 1, equal to B-A_1 in the elevation, and also B-A equal to B-A in the elevation. Draw the diagonal B-C, which is the true length. The angle A-B-C is the true angle.

The outline and profile can be drawn in in the usual way. Next, it will be necessary to get the true angle of the branch, as shown in Fig. 2. On the horizontal line, Fig. 2, set off the distance B_1-X equal to B_1-C of the plan. At right angles to B_1-X draw B_1-B equal to B-C of the elevation. Then draw the diagonal B-X, which gives the true angle of the branch.

TRUE LENGTH OF THE BRANCH

Now check Figs. 1 and 2 and see if BC, Fig, 1, equals B-X, Fig. 2. These are both the true lengths of this piece of pipe, and, if the layouts are found to be correct thus far, proceed to outline the pipes in the branch connection in the usual way, and letter these lines A, B, C, D, E, F, G.

Before we can combine in one piece the pattern for this section, we must draw another view in order to find how much the developing lines for the branch are offset from those for the elbow. Below Fig. 2 and parallel with the line B_1-X draw the line R-R_1. Upon this line lay out plan No. 2, which is exactly like the first plan. R-B equals B_1-B and B-C equals B-C. To the left of plan No. 2 draw elevation No. 2, which is like the first elevation. R_1-C equals A-A_1 and R_1-A equals A_1-C.

HORIZONTAL PIPE

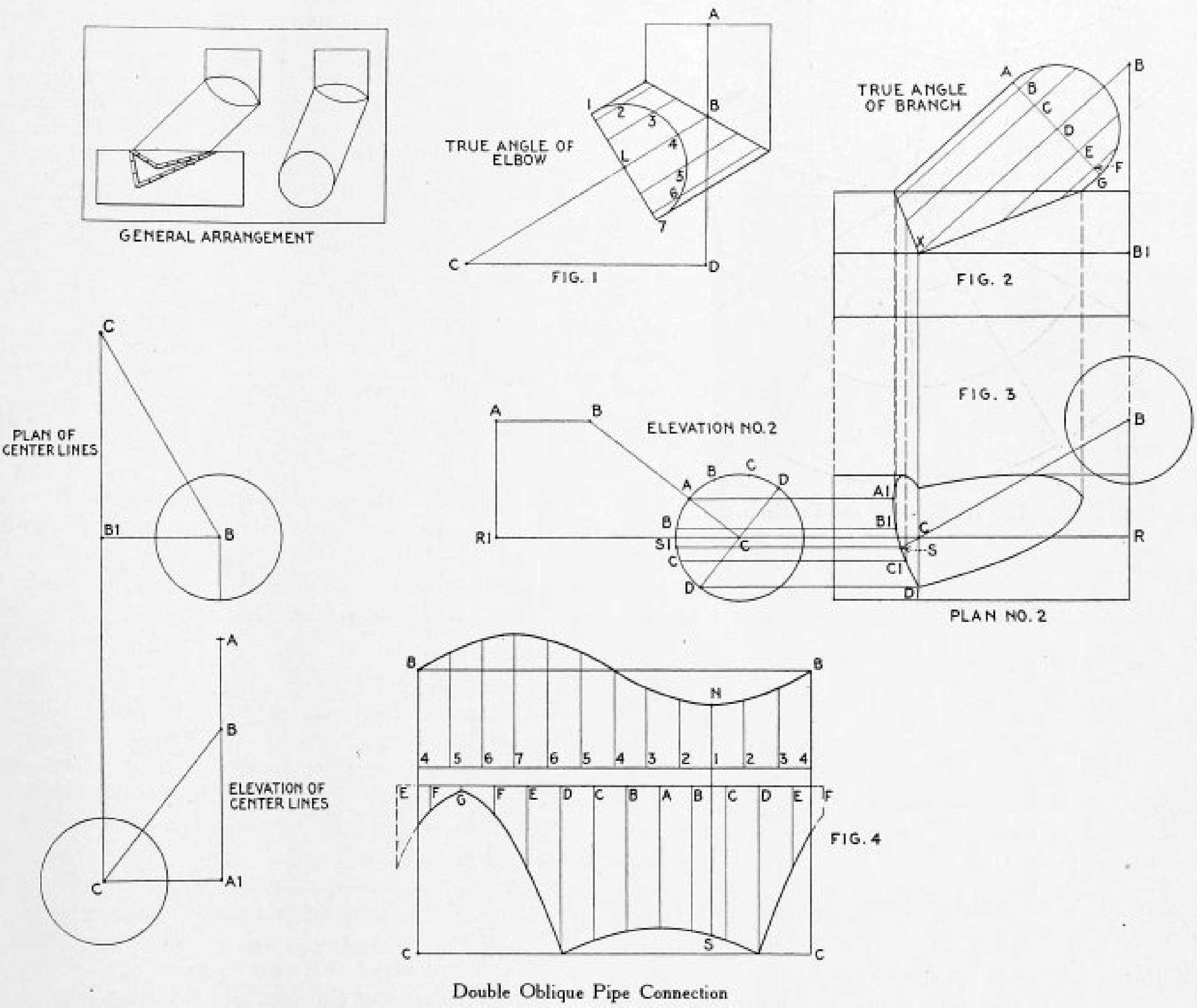
Now we will draw the hole in the horizontal pipe, plan No. 2, as it will appear when in its proper position, or in the position shown in the elevation. Draw D-D at right angles to B-C and space the half circle into six spaces the same as in the branch, and letter the division points A, B, C, D. Draw lines through these points to the right and parallel to R-R_1. Drop lines from similar letters in Fig. 2 and locate points A', B', C', D', in plan No. 2. A smooth curve drawn through these points represents one-quarter of the hole. The remainder is found in the same way, although only one-quarter is all that is needed for the layout.

In plan No. 2 the line B-C represents the axis of this pipe, and it also represents the throat or highest position of the elbow marked *N* in Fig. 1. Therefore, if this line *B-C* is extended to the curved portion of the hole, and point *S* is located, then a line drawn parallel to $R\text{-}R_1$ will locate S_1 in the circle. This point determines the relation between the developing lines for the elbow and the developing lines for the branch. With this much known, we can now proceed to lay out this section of pipe.

In Fig. 4 draw the line *B-B*, the length of which is equal to the circumference. Square up the plate and mark the length *B-C* equal to the length *B-C*, Fig. 1, or *B-X*, Fig. 2; both are the same and true lengths. Now take the distance *B-L*, Fig. 1, and place it on the line *B-C*, as shown in Fig. 4, and mark *B*-4. On the line 4-4 step off twelve equal spaces, and through these points draw lines parallel to *B-C* extending up above the line *B-B*. As it is customary to lap elbow work on the side instead of a few holes at the throat, we will lap this elbow on the side, as this makes the neatest looking job. Take the lengths of lines 1 to 7 in Fig. 1 and lay them off on corresponding lines in Fig. 4. A smooth curve drawn through these points will finish the elbow layout.

BRANCH PIPE

Turning now to the branch pipe, in order not to confuse the lines we will draw another line parallel to 4-4 an inch or so from it, as shown by line *E-F*. Now, as shown in elevation No. 2, the point S_1 falls between the points *B* and *C*, and, as S_1 in elevation No. 2 represents the throat or the line *N*-1 in the pattern, Fig. 4, it also must fall between the points *B* and *C*. Now with the dividers take the length S_1 to *B* in elevation No. 2 and place it to the left of the line *N*-1 in Fig. 4 and locate point *B*. Lay off one-half of the circumference to the left of *B* and locate point *F*, dividing the length into six spaces. Continue these spaces to the left of *F* and to the right of *B*, running one space over the sides of the pattern, as shown by the dotted section. Number these spaces, as shown, in proper order, and through these points draw lines parallel with the line *B-C*. Next take the lengths of the lines *A, B, C, D, E, F, G* in Fig. 2 and lay them on similarly lettered lines in the pattern. The dotted pattern is used only to finish drawing the curve and is not left on the pattern. Allow for laps and flanging and this completes the pattern.



Double Oblique Pipe Connection

The hole in the pipe is obtained in the regular way, as is also the top section of the elbow. Before allowing the pattern to leave his hands, the layer out should check the overall length *B* to *C* and also the twist S_1 to *B*. The layer out should also be sure that the elbow of the branch was started on the right lines.

In the layout given no allowance has been made for the thickness of material, so in taking the length S_1 to *B* it should be taken on the centerline of the iron.

Layout of a Spiral Pipe

The profile and elevation of a spiral pipe are shown in Fig. 1. The pipe is shown as if wound spirally around a cylindrical column equal in diameter to the diameter of the pipe, so that as the pipe makes one round of the column it rises through a distance equal to one and one-quarter times the diameter of the pipe, as shown in Fig. 1 by *A-E*.

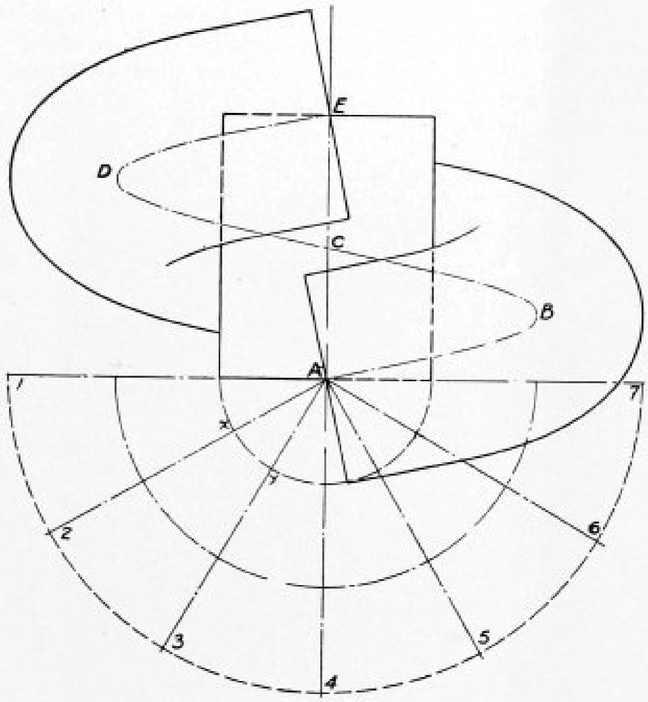


Fig. 1.—Elevation and Profile

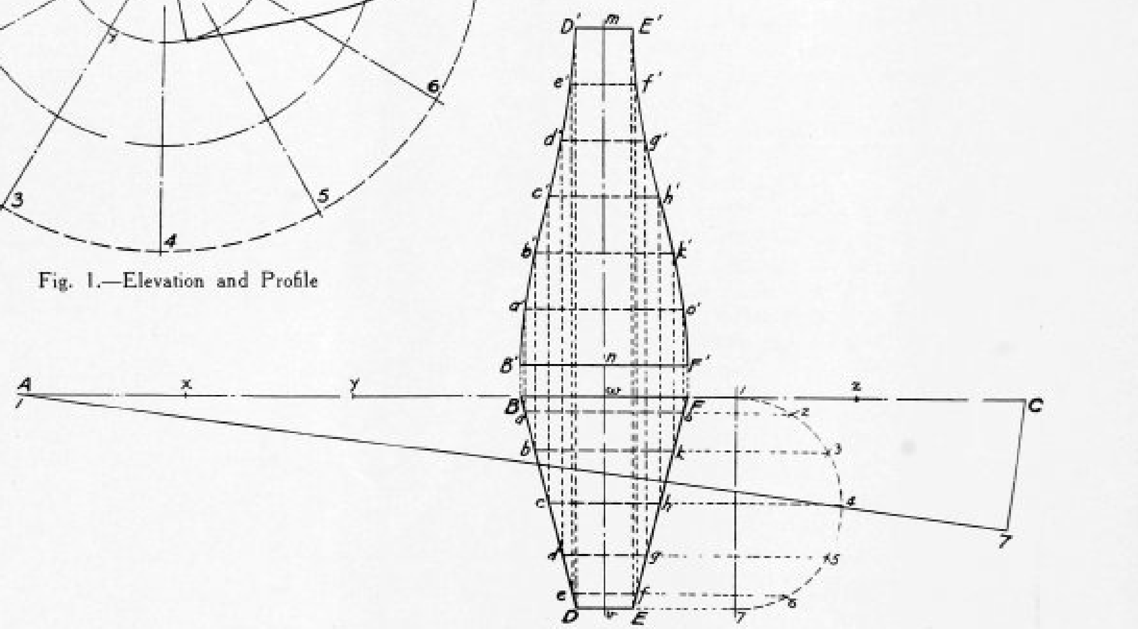


Fig. 2.—Diagram and Pattern

Division of Pipe into Elbows

In order to lay out such a pipe in a simple manner it is necessary to divide it into elbows, so that one pattern will apply to all elbows or sections. The elevation, Fig. 1, shows the pipe as though it were continuous and without elbows, but is used only to assist in laying out the pattern and does not represent the finished pipe. In this case twelve sections are used for one complete round of the pipe, and as shown in the profile the semicircles about *A* as a center are divided into six equal parts by points 1, 2, 3, etc. The axis of the pipe is shown by dot and dashed lines, while the outline is shown by the dashed line semicircles.

If the pipe were unwound so that its axis formed a straight line we could represent it by a straight cylinder equal in length to a line drawn completely around the outside of pipe from *A* to *E*, Fig. 1. This line in profile would be just as long as the full circumference of the outer circle 1-7 in the profile. But it is not shown in its true length, as it should be for development.

To make the diagram smaller let us take one-half the length of one round of the pipe and, as shown in Fig. 2, lay off 1-7 equal to the semi-circumference 1-7, Fig. 1. From 7, Fig. 2, lay off 7-*C* equal to *A-C*, Fig. 1, and draw the diagonal 1-*C* represented by *A-C*, Fig. 2. This will be the true length of the longest side of the pipe for one-half of a revolution around the column. Divide this line *A-C*, Fig. 2, into six equal parts by points *X*, *Y*, *B*, *F* and *Z*. Then take any section, such as *B-F*, and construct an outline of the elbow as follows:

Construction of Elbows

With *w* as the center of *B-F*, Fig. 2, lay off *w-v*, equal to the diameter of the pipe. Through *v* line *D-E* is drawn equal to arc *x-y*, Fig. 1, and points *B-D-E-F* connected to form the outline of the elbow as shown. This is a section of a cylinder and is subdivided in the usual manner to be rolled out in pattern.

The section *B-D-E-F*, Fig. 2, is subdivided into six equal parts by lines *a-o*, *b-k*, *c-h*, etc., projected over from points 1, 2, 3, 4, etc., of the half profile shown by dashed lines.

Laying Out the Pattern

On a continuation of *w-v* then lay off *m-n* equal to one-half the circumference of the pipe and on it lay off perpendiculars which will divide it into six equal parts. Project points *a*, *b*, *c*, — *o*, *k*, *h*, etc., to their respective perpendiculars, giving points *a'*, *b'*, *c'*, etc., and *o'*, *k'*, *h'*, etc. Now draw *B'-F'* and *D'-E'* the extremities of the half pattern and connect points *a'*, *b'*, *c'*, etc., and *o'*, *k'*, *h'*, etc., by curved lines *D'-B'* and *E'-F'* to form the outline of the half pattern of the elbow. The other half pattern will be exactly the same, only reversed in direction, and the full pattern will apply to all sections of the pipe.

This forms a simple method of developing a difficult problem without making complicated projections on the original plan and elevation, and depends on the same principles as the development of a screw thread.

J. L. Wilson.

The Boiler Maker

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NOTICE TO ADVERTISERS.

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

In the excellent article on electric arc welding in boiler shops, contributed by Mr. George W. Cravens, of the C & C Electric & Manufacturing Company, to our February issue, an unfortunate error was made in printing one of the statements made by the author regarding the benefits to be gained through the use of arc welding. On page 33 of that issue the following statement appears: "Aside from the inconvenience of the process, it is a better, quicker and cheaper one than any other method of making permanent joints of great strength." This sentence should read: "Aside from the *convenience* of the process, etc." To anyone who is familiar with the process of electric arc welding as applied to boiler work, the incongruity of the statement as printed in the February issue is obvious, for one of the principal advantages of electric arc welding is its convenience.

The completion of the boiler code, formulated by the American Society of Mechanical Engineers, marks a turning point in the history of steam boiler construction in the United States. Out of the chaotic conditions caused by the existence of various conflicting boiler codes, there is now available a standard which should tend to bring about uniformity and greater safety in boiler practice. The amount of work involved in formulating this code, and the amount of time gratuitously given to the work by the experts who composed the committee, can be realized only by those who were constantly in touch with the activities of the committee. It is sufficient to say that of the thousands of men directly or indirectly interested in the construction and use of steam boilers, a great many took advantage of the opportunity to place at the disposal of the committee their ideas and the results of their experience, so that the code as finally adopted and approved by the Council of the Society, represents not only the expert knowledge of the members of the committee, but also the knowledge and experience of hundreds of others interested in one way or another with the construction and use of steam boilers. It is encouraging to note that even before the A. S. M. E. Code was completed, at least one State had taken action providing for the adoption of this code. This was the State of Wisconsin. Indiana has for some time withheld action towards revising its boiler code, awaiting the completion of the A. S. M. E. Code, and it is quite probable that Ohio will also adopt the new code. At least four other States—Florida, New Jersey, Tennessee and Pennsylvania—are considering the adoption of the code, and it is to be hoped that others will speedily follow.

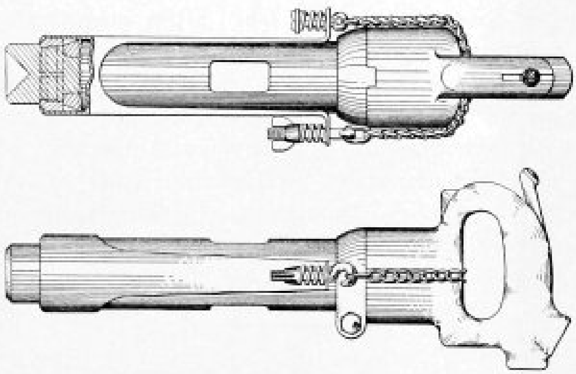
In discussing the report of the sub-committee on railroads, presented at the annual meeting of the American Society of Mechanical Engineers, F. J. Cole, consulting engineer of the American Locomotive Company, described a method which he has recently developed for adapting cylinder horsepower requirements to proportioning locomotive boilers. With this method, suitable values are assigned to grate surface, tube heating surface, etc., with corresponding evaporative values, so that the balance between the amount of steam required by the cylinders and the amount of steam which the boiler is capable of generating can be expressed in percentage of cylinder horsepower. As a result of careful investigation, data were obtained on which to base the evaporative values of different parts of the boiler. For firebox heating surface, combustion chamber and arch tubes, an evaporation of 55 pounds per square foot was adopted. For tubes and flues from 10 to 24 feet long, of 2 inches, 2¼ inches and 5½ inches outside diameter, spaced 9/16 inch to 1 inch, the evaporation adopted was from 7.50 to 14 pounds per square foot per hour. The grate area required for bituminous coal was based on the assumption that 120 pounds of coal per square foot of grate per hour is a maximum figure for economical evaporation. For hard coal the grates should be proportioned for a range of from 55 to 70 pounds of coal per square foot per hour, according to the grade of the fuel. Complete tables of horsepower for saturated and superheated steam, evaporation of tubes and flues of various lengths, diameters and spacing, and diagrams of temperature of flue lengths have all been prepared to facilitate the calculations in determining the proportion of grate surface, firebox, tube and flue heating surface. This information will be found of much value to locomotive boiler designers and should result in boilers better proportioned for the work for which they are designed.

Engineering Specialties for Boiler Making

New Tools for the Boiler Shop and New Fittings for Boilers—Safety Appliances for Practical Use

Safety Rivet Set Retainer

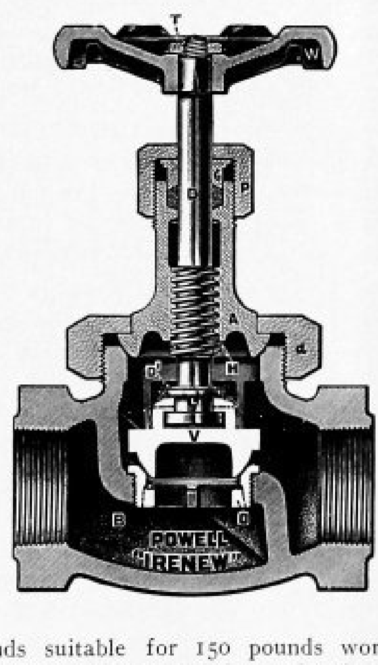
The George Oldham & Son Company of Frankford, Philadelphia, Pa., manufacturers of pneumatic tools and appliances, have recently placed on the market a safety rivet set retainer which is a decided step in advance in



the "Safety First" movement. The details of the device are clearly shown in the illustration. One of the chief advantages claimed for it is its flexibility, as it can be used on a pneumatic hammer of any make. The retainer weighs 2 pounds.

New Powell "Irenew" Valve

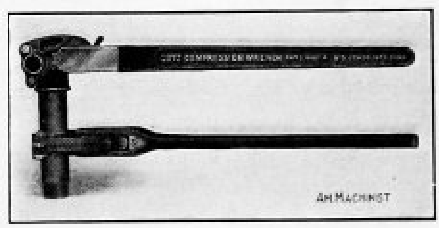
The William Powell Company, Cincinnati, Ohio, has placed on the market a new iron body bronze-mounted valve made in sizes of ¼ to 2 inches, inclusive, with



screwed ends suitable for 150 pounds working steam pressure. The body is of cast iron with four guide ribs cast in the neck extending down close to the seat for a true axial guide to the disk while opening or closing the valve. The valve seat ring is cast of white "Powellium" bronze, a non-corrosive metal applicable to most tempertaures of superheated steam, or cyanide solutions. Whenever a renewal is necessary, it is simply necessary to unscrew the seat ring by means of a flat tool of any kind engaging the lugs projecting from the inner circle. The valve disk is of the renewable horseshoe type arranged to slide over the head of the stem into a socket, permitting it to swivel freely. It is cast of white "Powellium" bronze, making it practically indestructible. For regrinding, it is simply necessary to release the bonnet by unscrewing the hexagonal end, withdraw the valve trimming and insert a pin or nail of suitable size through a drill hole to lock the disk. Fine sand or brick dust, ground glass and soap water is then applied to the disk, and it is rotated back and forth on the seat ring until a good bearing is obtained. The valves are made in globe, angle, cross and check valve patterns with screwed ends.

Lutz Compression Wrench

The Lutz compression wrench, manufactured by the Lutz-Webster Engineering Company, Inc., Philadelphia, Pa., is a universal tool which, it is claimed, can be applied to almost any job which confronts the machinist, boiler maker, steam fitter, engineer or manufacturer. Its construction and operation are clearly shown in the illustra-

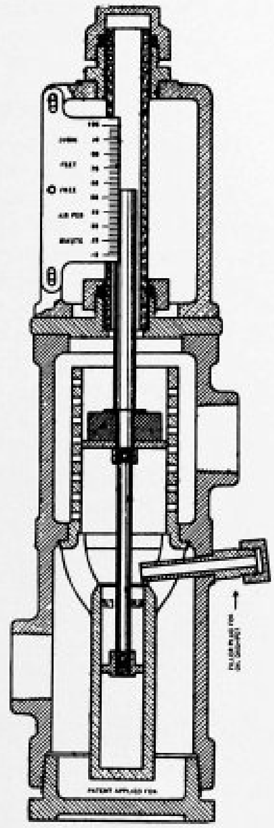


tion. It is evident that it will be especially useful for driving studs, taps, reamers, drills, etc., and for the adjustment or installation of pump and valve rods, pins, shafts, bolts, pipe fittings and the like.

The Tool-Om-Eter

The Tool-Om-Eter, which has just been placed on the market by the New Jersey Meter Company, Plainfield, N. J., is an instrument for the measurement of air used by pneumatic tools. The meter is so constructed that it shows direct on a scale in cubic feet of free air per minute the flow of air in a pipe or hose. Reference to the sectional drawing will show that there is only one moving element consisting of a weighted piston in the upper or metering cylinder, a small piston in the oil dashpot cylinder and a rod joining the two pistons and extending upward, where it moves freely without contact inside the sight glass at the top of the meter. This moving element floats on air and is, consequently, frictionless and non-wearing. The rod rises and falls with the pistons, so that its height in the sight class corresponds exactly to the position of the piston in the metering cylinder. The scale plate mounted against the outside of the sight glass permits reading the exact height of the top end of the rod.

The meter operates in accordance with the well-known law that the volume of a definite compressed fluid, or gas, flowing under small constant head through multiple orifices of the same shape and size is directly proportional to the number of orifices exposed to the flow. It can be seen from the sectional drawing that the air enters at the lower left-hand opening into the chamber surrounding the dash-pot cylinder and passes through ported openings into the interior of the meter cylinder, the wall of which is drilled with a large number of small, accurately reamed holes uniformly spaced. To pass to the



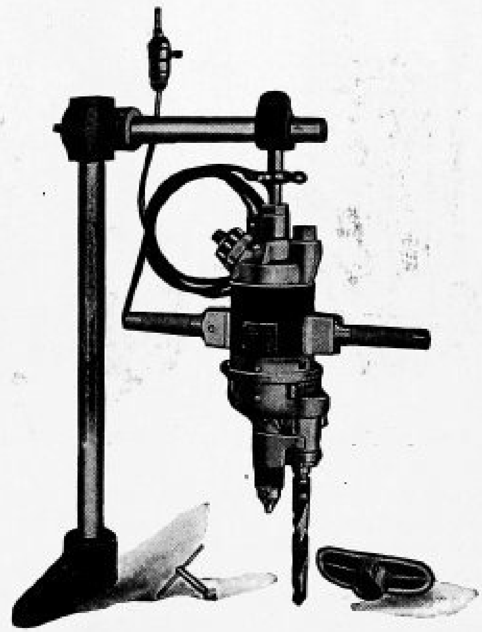
outlet chamber the air lifts the piston and exposes some of these holes to the flow. A small head, or difference of pressure, is established between the interior of the cylinder and the outlet chamber, the pressure difference amounting to only a few ounces per square inch, being fixed by the exact weight of the moving elements and the area of the piston on which the difference of pressure acts. The moving element rises until the weight is exactly supported by the difference in pressure. The pistons and rod are then floating in static balance in a position corresponding exactly to the volume of air flowing, the number of holes exposed and the height of the top of the rod in the sight glass.

An accurate and easily handled instrument of this sort is especially useful for comparing the economy of different makes of compressed air tools and for maintaining efficiency at a maximum by knowing how much air such tools take when new and after use, and before and after repairing, adjusting or putting in new parts. While practical men can judge the work performed by pneumatic tools, they are unable to judge when the air consumption of individual tools is excessive. A tool may work fairly well, even though the rated air consumption may be exceeded 100 percent or more. The Tool-Om-Eter, it is claimed, will detect and measure any leakage in air lines, valves, hose, cocks, etc., and determine the net volume of actual air produced by compressors for comparison with a nominal rating or displacement, and, therefore, show whether the machines are operating efficiently or not.

These meters are manufactured in two sizes, one known as the Tool-Om-Eter, of 10 to 100 feet capacity with 1-inch openings, which is recommended for most small tools, such as chipping and riveting hammers and drills, rated by manufacturers at not over 60 feet per minute when new, and another size styled the "Drill-Om-Eter," of from 50 to 300 feet capacity with 2-inch openings for large drilling machines, motors, air lifts, compressors, etc.

Stow Two-Spindle Drill

The Stow Manufacturing Company, Binghamton, N. Y., has placed on the market a two-spindle drill particularly adapted to heavy work such as would be required in machine shops, railroad shops, shipyards and large industrial plants. One spindle is fitted with a Jacobs chuck taking



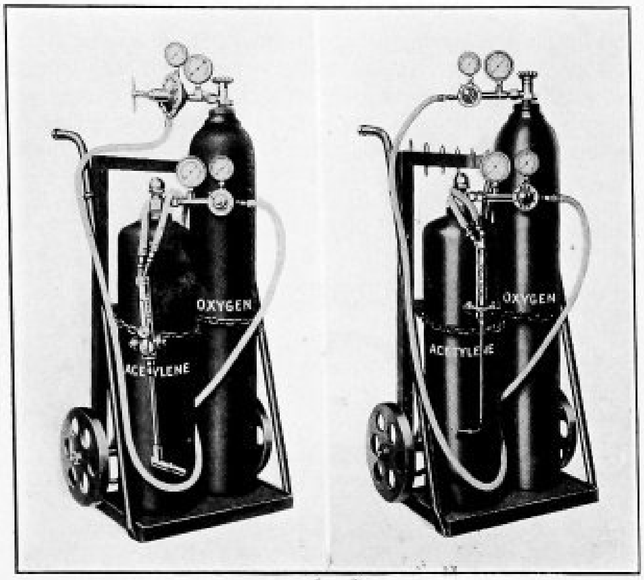
S. S. drills up to ½ inch running at a speed of 450 revolutions per minute. The second spindle takes M. T. drills up to ¾ inch, operating at a speed of 225 revolutions per minute. The drill is furnished complete with a breast plate and screw feed and will drill holes up to a 1-inch diameter in cast iron.

This tool is claimed to be the only two-speed, two-spindle drill on the market, and among the special advantages claimed for it are greater power for heavy drilling from the large spindle and the ease with which either spindle can be reversed, which will be found a great advantage in light tapping, etc. The tool is operated by electricity and, as shown by the illustration, can be readily attached to an ordinary socket.

Imperial Oxy-Acetylene Equipment

Oxy-acetylene welding and cutting equipment, possessing some new exclusive features, has recently been placed on the market by the Imperial Brass Manufacturing Company, 1204 West Harrison street, Chicago, Ill. For the safe, efficient, economical and continuous operation of oxy-acetylene equipment two vital points are necessary, namely: (1) Thorough and uniform mixing of the two gases employed, and (2) close and accurate regulation of both volume and velocity of the gases delivered to the mixing chamber of the torch, and ability to maintain a sudden fixed pressure under continuous operating conditions, as well as to control a wide range of pressures called for by the various requirements of service. These features, it is claimed, have been attained in "Imperial" welding and cutting equipment.

A new principle is used for mixing the oxygen with the acetylene. Before entering the mixing chamber of the torch the oxygen under high velocity passes through a spiral groove which imparts to it a whirling motion. The whirling motion of the oxygen, it is claimed, causes it to mix thoroughly with the acetylene, with the result that a uniform mixture is obtained before the gases reach the combustion point. In this way a saving of oxygen is obtained, together with an increased intensity of the welding flame and greater efficiency in cutting.



Cutting Equipment Welding Equipment

"Imperial" welding and cutting torches are fitted with interchangeable tips to cover all ranges of work within the limits of the process. The needle valves permit a fine adjustment and are located so that the operator can make any desired adjustment of the flame with the hand that holds the torch, making it unnecessary to lay aside the welding stick. Due to the thorough mixing and accurate regulation of the gases, the welding flame generated is a long, white, incandescent jet free from carbons and oxides. The cutting flame is a very closely confined and accurately proportioned jet designed to make a clean, quick, narrow cut with a minimum consumption of gas.

"Imperial" regulators, it is claimed, deliver an absolutely constant pre-determined volume and velocity of gas to the torch and the movement of the valve with relation to the valve seat is limited in such a way as to prevent cutting of the seat, thus insuring long life. In cutting operations under high-pressure "Imperial" regulators will automatically shut off in an emergency.

A Correction

We are informed by the National Tube Company, Pittsburg, Pa., that the statement published on page 66 of our February issue, which reads in part as follows, "The Worth Brothers-Coatesville Rolling Mill Company, Coatesville, Pa., which holds the unique position of being the only tube manufacturer that can supply itself with basic open-hearth steel skelp for tube manufacture . . . ," is incorrect for the reason that the National Tube Company has for a number of years used basic open-hearth steel in the manufacture of boiler tubes, and this material is still used by them for this purpose. They have also used this material for a number of years in the manufacture of both lap-welded boiler tubes and pipe, and also in the manufacture of seamless tubes from ore to the finished product. It should be understood, therefore, that the National Tube Company was the first tube manufacturer to use basic open-hearth steel in the manufacture of boiler tubes, and has continuously used this material up to the present time.

Boiler Inspectors' Annual Dinner

The fifth annual dinner of the New York section of the American Institute of Steam Boiler Inspectors was held at Rector's in New York City on February 20. Over one hundred attended the banquet and the evening was one of the most entertaining and enjoyable the boiler inspectors in New York ever held. Among the speakers were Dr. J. S. Jacobus, consulting engineer of the Babcock & Wilcox Company; Fred R. Low, editor of *Power*; Herman van Ormer and John H. Gleason, of the Hartford Steam Boiler Inspection and Insurance Company, and others, including the newly elected and retiring officers. Michael Fogarty, one of the best known boiler manufacturers in New York, acted as toastmaster.

Personal

Harry J. Ernst, formerly advertising manager of the D. T. Williams Valve Company, Cincinnati, Ohio, has been elected treasurer of the company, succeeding Mr. R. E. Mullane, recently elected president.

H. A. Lacerda was appointed gang foreman in charge of the boiler department work in the tank department of the West Albany shops of the New York Central Railroad on February 1, vice O. Shellenberger deceased.

C. E. Lester, formerly with the American Locomotive Company at Dunkirk, N. Y., and well known as a valued contributor to this journal, has been appointed foreman boiler maker of the west bay of the Sayre shops of the Lehigh Valley Railroad, succeeding Mahlon Stark, who has been appointed boiler inspector.

M. E. Sherland, general foreman boiler maker of the Missouri-Pacific Iron Mountain Railroad shop at McGehee, Ark., for the past five years, received the appointment of postmaster at McGehee on February 4, to become effective March 2.

Thomas F. Nurten, formerly boiler inspector with the Missouri-Pacific Iron Mountain Railroad, become Mr. Sherland's successor as foreman boiler maker.

Wallace W. Manning, chief inspector for the New York branch of the Hartford Steam Boiler Inspection and Insurance Company, died of pneumonia December 27, 1914, at his home in Brooklyn, N. Y., aged thirty-four. Mr. Manning was with the Hartford Company for sixteen years and for the last six years was chief inspector.

John W. Exler has been elected president of the James Lappan Manufacturing Company, of Pittsburg, Pa. For over forty years Mr. Exler has been actively engaged as a boiler maker and iron worker, holding important positions with various large concerns in Pittsburg and other places.

Letters from Practical Boiler Makers

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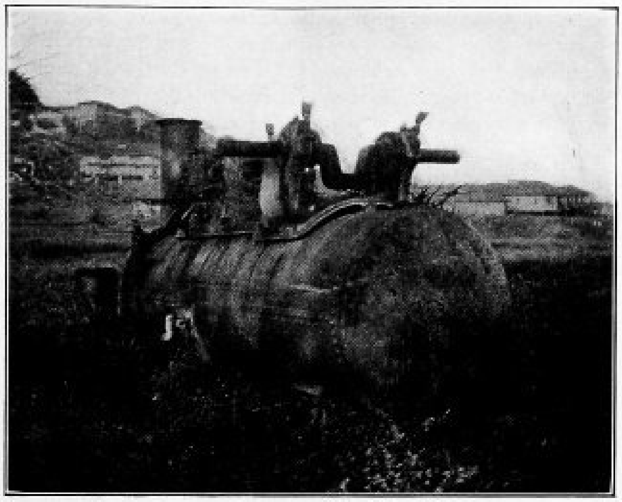
Old Boilers in the Wilds of Panama

Waste? There probably has never been such a splendid aggregation of waste in the history of the Western Hemisphere, if not of the world! Locomotives, dredges, steam-shovels, steam-scrapers—pulleys and wheels and boilers—the last-named in particular, and by the countless hundreds!

Jack Roosa, who has an eye to figures, counted—well, no matter how many, just rusting away amid the rushes and the reeds and beneath the palms of the jungle—simply rotting—it's more that than rusting—within plain view of the Panama Railway; and all over the line of the



Discarded French Boiler at Panama

French course of operations on the Isthmus of Panama there are more and still more such!

These old boilers, often overgrown with ivy and seemingly buried, in part, by tropic vegetation, are souvenirs of the French attempt to build a Trans-Isthmian canal and of the work of De Lesseps, which ended in such glorious failure. Somehow or other they seem just the proper foil against the magnificent work of the American engineers here—to show the latter in its proper light. They represent the days of graft and inexperience and of make-for-yourself-what-you-can-out-of-it—in sharp contrast to which the finished canal awaits such fleets as may care to pass through.

The old boiler in the picture is resting on a slope near Corozal.

Cincinnati, O. FELIX J. KOCH.

The Boiler Maker Apprentice

I have read various articles on training and educating apprentices and I have heard a lot about what the different railroad companies are doing toward making first-class mechanics out of the apprentices. In an article on the apprentice question published in the November, 1914, issue of THE BOILER MAKER, the author of the article refers to the old-time boiler maker. I would like to say that my views of the question are that the old-time boiler maker's day is a thing of the past, for the simple reason that railroad officials do not take proper interest in the boiler maker apprentice or in the boiler maker in order to develop the men into the kind of mechanics that boiler makers were in the olden days.

Less encouragement is offered for young men in the boiler maker's trade than in the machinist's trade. What I mean by that it that when a young man seeks apprenticeship in the railroad shop, more than likely he will select the machinist's trade in preference to the boiler maker's trade, because he knows that the boiler maker never gets an opportunity to hold a position higher than foreman of the boiler shop, although, occasionally, on some of the roads, a boiler maker is promoted to the position of general master boiler maker.

I must admit that a large percentage of the men who are following the boiler maker's trade, and call themselves boiler makers, are men of a very rough character. The height of their ambition seems to be to beat their brains out against flues and staybolts month in and month out. When pay day comes around they will draw their pay checks and probably keep out enough to pay their board, while the balance will go into the hands of some saloon-keeper, or into some poker joint or other disreputable place.

On the other hand, there cannot be found anywhere better men, either morally or mentally, than some of the men who are following the boiler maker's trade, who are working for the betterment of themselves and of the company by whom they are employed. I am sure that if these men, who are showing the proper spirit, should be taken hold of by some good capable officer of the company, and be given the proper encouragement, they would in return be of greater benefit to the company. Moreover, they would show the other class of men referred to above what they are doing for themselves, and this would naturally have a tendency to make the other men "sit up and take notice," so that eventually they would begin to realize that they would never accomplish anything by the way they were conducting themselves, and would soon get busy and try to make something better of themselves.

If this were done, what would be the consequence? Instead of on every pay day having half of the boiler shop force out on their monthly jag, we would have our full shop force all the month 'round and everyone would be working to better his own condition, and, consequently, the railroad companies would be getting better results from a better class of men, and the foreman also would have an easier time, for he could place his men on jobs without worrying about whether he was going to get a good job done or not.

In my shop, at one time, there was an opening for a boiler maker apprentice. It was impossible for several months, however, for me to get a boy who would accept the job. I went to several young men who were working around in different departments, waiting for their turn to go in as machinists' apprentices. I tried very hard to get one among them, but one of them told me he would prefer to wait a year longer and get in as a machinist's apprentice and take the chance of some day being a general foreman or master mechanic, than he would to take up the boiler maker's trade, and spend the balance of his days driving staybolts and rivets.

There is no doubt in my mind that if the boiler makers were given as much encouragement as the machinists, when it became necessary to appoint a man as a roundhouse foreman or general foreman, the boiler maker would make just as good a man for the position as the machinist and, in some cases, better than some of the machinists that I know of who are now filling such positions.

Take, for instance, the apprentice instructor. The writer served his apprenticeship in a shop where there was an apprentice instructor, who was by trade a machinist. In the mornings he would hold his classes with the boiler maker apprentices, and in the afternoon he would spend his idle moments in the machine shop with the machinists' apprentices, and he very seldom came over to the boiler shop to see how the apprentices in that department were getting along. If a drawing or sketch of some part of a locomotive or some tool was to be made, the machinist's apprentice was always selected to make the drawing.

The reader, I think, will readily agree with me that the railroad companies cannot expect to make any better boiler makers out of their boiler maker apprentices as long as they are not given any more encouragement along mechanical lines and also as long as their ambitions for promotion are not gratified when they have proved themselves capable. After a close analysis of this subject I do not see any reason why the boiler maker, trained as we have suggested, would not be capable, in preference to all others, to fill such positions as general foreman or master mechanic.

It is a fact, however, that very little thought is given to the study of what the modern locomotive boiler represents in original cost, in the theory of its construction, and in its maintenance, which are the most important features of a locomotive. Compare, for instance, the locomotive boiler of twenty years ago, or even ten years back, with its 150 pounds pressure, its small heating surface and insignificant requirements, with the superheater Mikados which, with a full tonnage, ignore grades and almost every other obstacle, except orders, jumping this hill, pounding down a grade, driven as though by a madman, with every pop valve up, and a smiling fireman, and best of all, an unhindered trip. This is the kind of service railroad companies want, and it is what they get, but still how little encouragement they give to the men who know how to give this service and how to maintain it!

Another thing that is very important and must not be neglected by anyone, is the Federal Locomotive Boiler Inspection Service, which is part of the work of the Interstate Commerce Commission. This is no little thing to consider, as everyone knows what it means to overlook the rules prescribed by this service. It not only means trouble for the railroad company, but it means trouble for the officer in charge, who is held responsible for the inspection, test and repairing of locomotive boilers.

Referring again to the apprentice question, here is where the apprentice needs a jacking up; all of them, excepting none. If they do not develop along the above lines, they should be thrown out bodily. They should know first something about laying out and the chemical analysis of boiler plate, rivets and staybolts. What I mean by this is that they should simply memorize these formulas and familiarize themselves with the most important properties in the manufacture of different grades of material, so that in time they will appreciate the knowledge, however little they may be fitted for scientific observation. They should study how iron is tested for its value in resisting stresses. I do not mean the deeper problems in mathematics (that should not be expected of an apprentice), but they should know every possible detail of the scientific side, as by studying this their curiosity and interest will be aroused, and if they show the proper spirit they will be able to go into the subject more fully.

The apprentice should also have some idea about the heat units in coal, what they are there for, how many a properly designed boiler catches, how many it lets go by, and what the boiler does with them after they are caught. By teaching the boiler maker apprentice these things you will prepare him just as well as you could equip any apprentice in the machine shop for a position of trust and responsibility. It is not so much a matter of the actual trade that the young man has been developed in, in the present railroad shop, but it is more a matter of what attention and what demands are made on these young men. Proper attention is not only for their own benefit, for with consistent encouragement these men can give a great deal more in return than they have ever received.

The reasons why I base this letter so strongly on the question of the boiler maker being made a general foreman, is that I do not think it altogether requires so much mechanical ability for a man to hold such a position, but it requires a man with some technical knowledge and a fair education, and a man who knows how to handle men, to obtain the best results. I am sure that such men can be selected from the boiler shop as well as from the machine shop. When you have found a man of this kind you will be able to obtain as good results, if not better, towards increasing the monthly output of the shop. As a matter of fact, the boiler maker has been held back and not even considered, not because he was lacking in ambition, but because he has not been given an opportunity to show what he could do in a position of this kind.

After these long years of being mastered by a machinist, and having them think that they are the only ones that have any brains, the boiler maker will be as proud of one of these appointments as some men would be if elected President of the United States. This would be true, not because he had been honored so much, but because he would have an opportunity to show the mechanical trades that a boiler maker had strived hard to obtain a goal honored among tradesmen, and had finally won.

I hope that every reader of THE BOILER MAKER will give this subject due consideration, and I would also like to hear from others on this same subject.

H. C. AARON,
Foreman Boiler Maker, Southern Railway Co.
Alexandria, Va.

Talks to Young Boiler Makers

Laying out is one of the most interesting parts of boiler making. I venture to say that the greater percentage of men who are perfectly capable of designing a boiler could not lay out the work required to produce it. I have been somewhat surprised to find so many apprentices and young boiler makers who seem unable to grasp the fundamental ideas of the beautiful work of laying out, and I am not going to show readers of THE BOILER MAKER how to lay out a boiler "while you wait," but I do want to present some ideas on the subject.

Let us assume for a moment that we are going to make a square chimney or smokestack out of plates and angles, and it is to be four feet square and any length. The boss comes along and says, "Ten feet from the bottom of the stack I want to have an outlet two feet square, running off at right angles." Now this is a pretty easy job to lay out. It is supposed that the outlet is to be in the middle of the stack. The boiler maker will measure off ten feet from the bottom and make a chalk line, then he will take a square and square across the stack. Then he will measure two feet up from this line and square again. Then he will measure one foot each side of the center line and the laying out will be done.

Of course in actual practice this outlet would have been punched out before the stack was put together or erected. The boys on the job would then make a two-foot square outlet as long as necessary out of plates and angles, and drill and rivet the outlet to the stack. If now, instead of having smoke go up the chimney, we hoisted up a box just two feet square or a little less we could shove it into this outlet and push it on to the end.

Now if ten feet above this first hole the boss wants another outlet, just the same size as the first one, but instead of going out at right angles, it is to lead out at forty-five degrees, how about the hole then that you will have to cut?

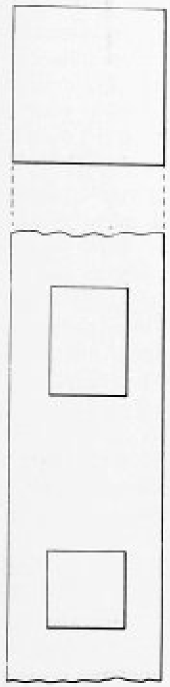


Fig. 1

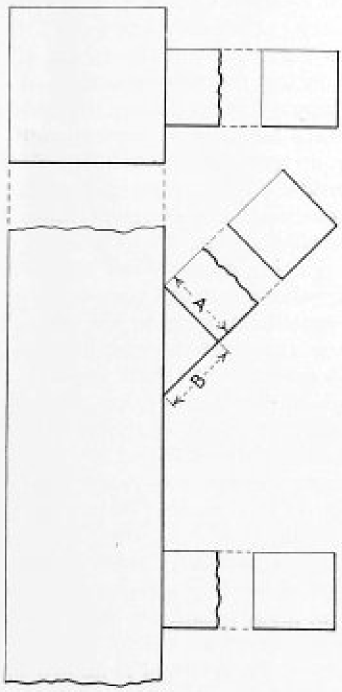


Fig. 2.

At first sight a young fellow might say it would be the same two-foot square hole; if you could get a two-foot square box through the first hole cut you could certainly get it through the second one if cut the same size. But this will not be the case. Fig. 2 shows this box stack and the right angle outlet. If now this outlet had no sides to it and the top and bottom were hinged to the stack, and these two sheets were swung on their hinges upwards, the top one would finally come against the stack and the bottom one up against it, which would practically close the two-foot outlet entirely.

Looking at the 45-degree angle opening, it will be at once seen that it is considerably longer than two feet, and the reason is obvious, which is, that a two-foot outlet pipe lying at an angle must be cut on a bevel, and this bevel will, of course, give a longer line. This the boys will understand if they remember how they cut a sausage in a delicatessen shop, as this makes the slice from a round sausage oval instead of round.

If, now, our square 2-foot outlet pipe is put up at right angles to the stack, but is hinged at the top to the stack, it will be easy to see that if this pipe is swung on the hinge as the pipe is pushed up an opening will be made between the lower end of the pipe and the stack. This opening will be triangular in cross section—that is, looking from the side of the 2-foot outlet pipe.

When the pipe has been raised, or swung on the hinge, to a 45-degree angle with the vertical stack, the triangular opening will be 2 feet on the side *A* (Fig. 2), which is, of course, the diameter of the pipe, and the distance *B*—that is, from the edge of the pipe to the vertical stack will be the same. Here is the point to be remembered in laying out: you must always continue your surfaces in straight lines. In his case the bottom of the 2-foot pipe must be continued until it strikes the vertical smokestack. By geometry we know that in a right angle triangle the length of the long diagonal side can be found by adding

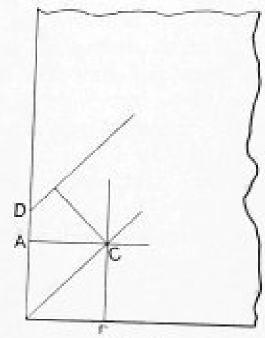


Fig. 3

together the squares of the other two sides and extracting the square root of the sum, which will be the length of the hypothenuse.

In this case we would have the length of the side *A* (2 feet) multiplied by 2 feet equals 4 feet, plus the side *B* (2 feet) multiplied by 2 feet equals 4 feet, or 8 feet. The square root of 8 feet equals 2⅞ feet. Therefore the length of the hole which would have to be cut in the vertical pipe can be found by this mathematical calculation. To extract the square root of a number is quite a little job, and tables which give the square root of all numbers within reason are to be found in all text-books, so I will not explain the operation.

To lay out this opening graphically, as it is called, a boiler maker would take any good-sized plate and start from, say, the lower left-hand corner (Fig. 3) and chalk a line from it at an angle of 45 degrees, making this line, say, 6 feet long, or any convenient length. He could lay this line off with a protractor, or if the sheet is sheared square he could divide the right angle equally.

One way to do this would be to take a 2-foot square, mark off 2 feet each way from the corner, and square across from these two points *A* and *B*, Fig. 3; where the lines cross would be a point *C*, and laying the straight edge so that it will touch the corner and this point of intersection you have a 45-degree line. Measuring from this line at right angles to it a distance of 2 feet, and then running through this point a line parallel to the first, the left-hand edge of the plate will be cut by it at *D*, and the distance from the lower left-hand corner to this point *D* of intersection will be found to equal 2⅞ feet.

The intersection of our 2-foot pipe with our vertical stack is what the highbrows call the intersection of single planes—that is, the surfaces that meet are both flat. To lay out work in a single plane is not difficult, but when it comes to laying out surfaces which are not flat, but curved, the problem becomes very difficult, but the whole idea of continuing all lines until they intersect is the point to be borne in mind.

As an example, let us suppose our 2-foot square pipe to be changed to a round one 2 feet in diameter. If it leaves the vertical square stack at right angles a perfectly round hole 2 feet in diameter would have to be cut in the stack to receive it, but if the round outlet be tipped up to 45 degrees, the hole which would then have to be cut would be an oval, longer than it is wide. And if our square vertical stack was turned into a round one the hole would have to be oval still, but when laid out flat, or developed, as it is called, it would be found to be very much larger in all directions than our 2-foot pipe. In other words, if the round pipe enters the square smokestack at an angle of 45 degrees, the horizontal measurement of the opening to receive it would be 2 feet, but the vertical measurement would be considerably more, as in the case of the square pipe; if, however, the smokestack too was round, then the horizontal measurement of the developed hole would be greater than the diameter of the outlet pipe and the vertical measurement would be the same as in the previous case. The vertical measurement, when the outlet leaves the stack at 45 degrees, would be the same whether the pipes were both square, both round, or one square and one round. This is not easy for the young or untrained mind to grasp, and I strongly advise the young boiler maker to get some paper tubes of various sizes and experiment by fitting them to each other at various angles.

While the word trigonometry is quite likely to scare a young boiler maker, it is really nothing more or less than the study of angles, only it goes a little further and takes in the study of curved surfaces as well as of planes. For instance, if a circular tank of a given diameter is made and a line is stretched across it anywhere, and the length of this line, which is called the chord, is measured the length of the arc between the ends of the line can be calculated by geometry.

It will be a pretty good thing for all young boiler makers to start in at once to study plane geometry and trigonometry, and I hope that I have pointed out enough of these beautiful studies to interest my readers to go into them, which will be much to their advantage.

W. D. Forbes.

New London, Conn.

Expense of Caring for Locomotives on Railroads

Many of the readers of The Boiler Maker, no doubt, will be very much interested to know what the common expenses are which are required to keep a locomotive in operation annually. The amount seems greatly in excess of what it should be, and it is claimed by engineering experts that it can be considerably reduced so as to save millions annually for the respective roads.

Willard A. Smith, of the *Railway Review*, speaking before the Western Railway Club, says: "Fuel saving is extremely important. I would not depreciate it in the least, but its relative importance has changed very much within a few years. We find that during the past year the maintenance cost of American railroads took between 31 and 32 percent of their entire gross revenues, while the transportation which involved the entire operation of the road, and included fuel as well as other supplies of that kind, only took an average of about 35 percent. Maintenance costs have increased right along and are increasing right along, in spite of everything that can be done. Apparently there has not been much accomplished in attempting to reduce the proportion of gross revenue they consume, therefore it is up to the railroads to increase the efficiency of operation to get more out of their plants. You will recall that a year or two ago one of our large western railroads had an investigation made regarding locomotives as to the time in which they were doing work. The average locomotive on that road—and it is not different from any other large systems—was actually doing work, earning money by hauling traffic four and one-half hours out of the twenty-four hours. It spent something like six hours in the round house, which would give ample time for overhauling the stokers and other appliances out of the twenty-four, and it spent seven and one-half hours undergoing heavy repairs. That is the way the average locomotive on the road spends each twenty-four hours.

"Now if conditions are such that you can only get actual work out of a locomotive for four and one-half hours out of the twenty-four, is it not of the utmost importance that you should get all the work possible out of it during those four and one-half hours? Of course, it is important to change the conditions and keep your machines working a greater length of time, if it is possible to do so, but there are railroad companies that have worked on that for years without making appreciable improvement, therefore anything that will greatly add to the efficiency of the locomotive during the short time that it is doing actual work will add enormously to the revenue of the railroad company. It seems to me that that is a consideration to which the mechanical men should give their very best thought, and that they should not hesitate to recommend to their superior officers when anything of this kind comes up, that they should spend money to save money; because if there is any principle that has been thoroughly established in America's railway management during the past few years, it is that economy and efficiency can only be secured by spending money liberally to bring it about."

These remarks, coming from Mr. Willard A. Smith, are undoubtedly taken from records, and it is well to have them made public, for it shows undoubtedly that the range of engineering skill with the railroads is not sufficient to bar outside skill that is known to have developed improvements that are not allowed to come into use to reduce the expenditures that Mr. Smith speaks of as continually increasing all the time, which is surely a serious proposition for the presidents of all railroads, and especially where the president does not use his prerogative with the heads of the different departments. So long as a president allows the discretion to rest entirely with these heads, such things that are developed by railroad men will have to be used and the outside engineering skill, no matter how it may be endorsed by hundreds of the best engineers, boiler makers and laymen, cannot be used.

Below is a list taken from the last reports of various railroads, giving the expenses required to keep a locomotive in repair annually, which includes repairs, depreciation and renewals in most cases:

Pennsylvania Railroad	$4,258.39
New York Central & Hudson River Railroad	4,975.57
Philadelphia & Reading Railroad	3,189.77
Baltimore & Ohio Railroad	3,156.62
Atchison, Topeka & Santa Fe Railroad	4,176.90
Lehigh Valley Railroad Company	2,871.16
Chicago, Burlington & Quincy Railroad	2,679.41
Chicago & North Western Railroad	2,616.50
Chicago & Great Western Railroad	2,937.41
Southern Railroad	3,001.68
Central Railroad of New Jersey	3,010.24
Atlantic Coast Line	2,528.56
New York, Ontario & Western Railroad	2,788.95
Union Pacific Railroad	3,500.11

William H. Wood,
Mechanical and Constructing Engineer.

Media, Pa.

Selected Boiler Patents

Compiled by

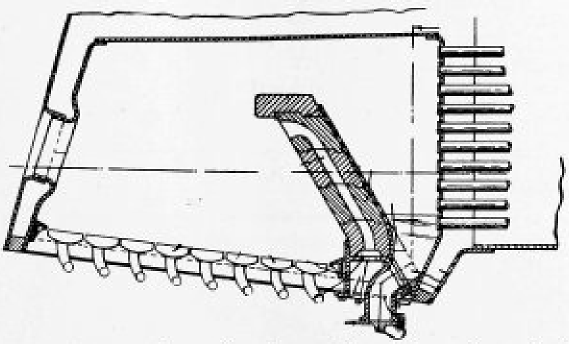
DELBERT H. DECKER, ESQ., Patent Attorney,

Millerton, N. Y.

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

1,115,802. LOCOMOTIVE FIREBOX. FREDERICK F. GAINES, OF SAVANNAH, GA., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 1.—In a locomotive-boiler firebox a rearwardly inclined bridge wall arranged at the forward end thereof, a channeled wall supporting members arranged at the forward end of the grate space and spaced slightly to the rear and above the lower edge of the flue sheet, an inclined buck stay arranged at the forward side of the bridge wall adapted



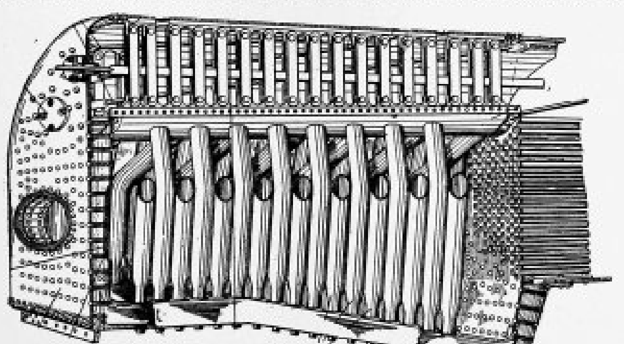
to support same and extending downwardly and forwardly to the lower edge of the flue sheet, a cinder outlet entering the space between the bridge wall and the flue sheet through the lower end of the inclined buck stay and a cinder outlet passage extending beneath the bridge wall

1,111,766. CIRCULATING SYSTEM FOR BOILERS. JAMES BLAKE SCOTT, OF CLEARFIELD, PA.

Claim 1.—In a boiler, the combination with a casing having a firebox therein, a water leg surrounding said firebox, and fire tubes extending from said firebox to the forward end of said casing; of a ring disposed in said water leg, said ring being provided with ports communicating with the water leg, and means to conduct water from the forward end of said boiler to said ring. Six claims.

1,117,145. FIRE-BOX FOR BOILERS. WILLIAM J. LEIGHTY, OF SPRINGFIELD, MO.

Claim 1.—A fire-box provided with a front and a back fluid-containing head, a crown-sheet composed of a series of longitudinally disposed channeled sections, a sectional mud-ring provided with longitudinally disposed fluid-containing headers, and means disposed longitudinally of the



fire-box, at the sides and longitudinal center thereof, whereby communication between the longitudinally disposed headers of the mud-ring and the water space above the crown-sheet may be had. Twenty-one claims.

1,116,366. BOILER-FLUE CLEANER. RICHARD H. BATE, JR., OF CONSHOHOCKEN, PA.

Claim 1.—In a boiler flue cleaner a discharge pipe or header connected with a boiler, a number of valves situated in said discharge pipe, a distributing pipe leading from each of said valves, branch pipes leading from the distributing pipes and nozzles carried by the distributing pipes and branch pipes and located at points opposite the ends of the flues to be cleaned. Three claims.

1,105,213. DIVISION-WALL FOR WATER-TUBE BOILERS. WILLIAM F. SELLERS AND HENRY B. BRADFORD, OF EDGEMOOR, DELAWARE, ASSIGNORS TO EDGEMOOR IRON COMPANY, OF EDGEMOOR, DELAWARE, A CORPORATION, OF DELAWARE.

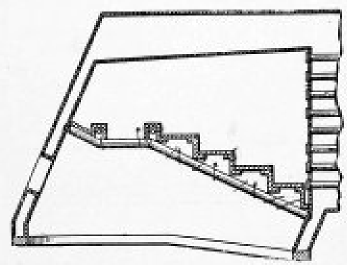
Claim 1.—In a water-tube boiler the combination with a bank of water tubes, of a transverse division wall which divides the intertube space into separate passes for the hot gases, and comprising a skeleton framework formed of metallic bars passing through the spaces between the tubes transversely to the latter, some of said bars extending transversely to others, and a body portion of refractory material plastered on said bars and supported by and securing together said bars and said tubes. Four claims.

1,111,916. CIRCULATING MEANS FOR LOCOMOTIVE-BOILERS. JOHN P. NEFF, OF EAST ORANGE, N. J.

Claim 1.—A water circulating system for locomotive boilers including in combination with the boiler and fire tubes, a separating diaphragm arranged below the fire tubes and extending across the boiler forming a mixing compartment open at one end and closed at the other, means for establishing communication between said compartment and the top of the boiler, and operative means for forcing the water through the latter. Three claims.

1,118,567. LOCOMOTIVE-BOILER FURNACE. CHARLES BREARLEY MOORE, OF EVANSTON, ILL., ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

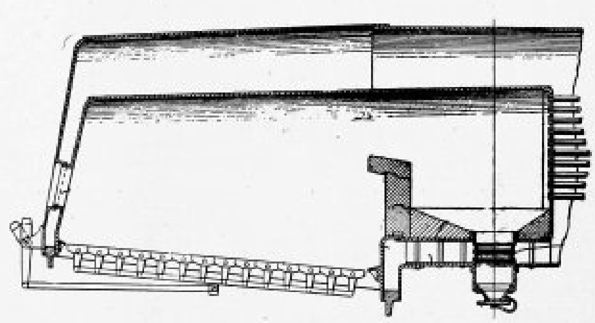
Claim.—A locomotive fire-box having a flue sheet at its front end, in combination with a plurality of refractory members spaced in ascending step-like form in the fire-box from the lower portion of the flue sheet,



said refractory members being substantially vertical and having substantially horizontal extending portions, the said refractory members being adapted to deflect, baffle and thoroughly admix the gases rising from the fuel bed before they pass into the flues. One claim.

1,118,615. LOCOMOTIVE-BOILER FIRE-BOX. JAMES T. ANTHONY, OF EAST ORANGE, N. J., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

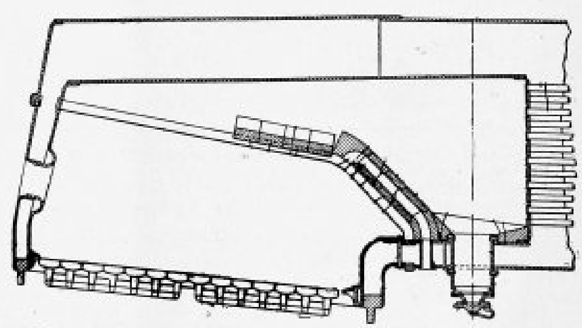
Claim 1.—In a locomotive boiler of the extension fire-box type having a water space beneath the extension defined by the floor of the extension and the outer shell of the boiler, a tube extending through the water



space rigidly connected at its ends to the opposed boiler sheets, said tube being corrugated between its ends and one of the ends being larger in diameter than the largest diameter of the corrugations. Two claims.

1,118,646. LOCOMOTIVE-BOILER FIRE-BOX. FREDERICK F. GAINES, OF SAVANNAH, GA., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 1.—A locomotive boiler fire-box having a barrel-like extension at its forward end beyond the forward end of the grate, which extension is closed at its forward end by the flue sheet, water circulating tubes rising from the rear part of said extension and extending upwardly and



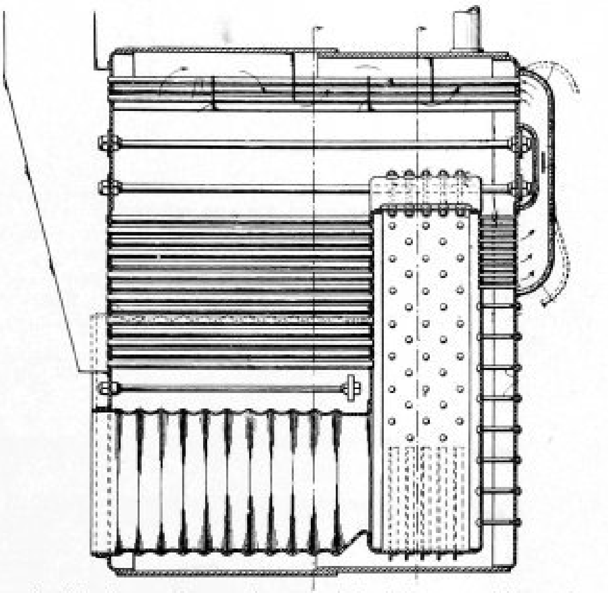
rearwardly through the fire-box, a refractory wall arranged in contact with said tubes and supported in inclined position thereby, air passages rising through said wall from the lower end thereof and adapted to admit air to the fire-box above the fuel bed, air inlet thimbles arranged in the lower part of the boiler beneath said wall adapted to admit air to said passages and a cinder opening or outlet also arranged in the lower part of the boiler and between the wall and the flue sheet adapted to permit the easy removal of cinders from this space and a removable cover normally closing the lower end of the outlet. Two claims.

1,113,731. LOCOMOTIVE SUPERHEATER. ANDREW W. ANDERSON, OF CHICAGO, ILL.

Claim 1.—In a superheater for locomotives, the combination with a casting comprising therein a wet steam chamber connected to the steam supply and headers depending from and communicating with said chamber, of a second casting comprising therein a superheater steam chamber connected to the cylinder steam chests and headers depending therefrom in alternate relation to the headers depending from the wet steam chamber, means for yieldingly connecting said castings, and superheating coils located in the boiler flues, each coil being connected at one end to a header depending from the wet steam chamber and at its other end to an adjacent header depending from the superheated steam chamber. Six claims.

1,119,025. LUTHER D. LOVEKIN, OF PHILADELPHIA, PENNSYLVANIA. BOILER.

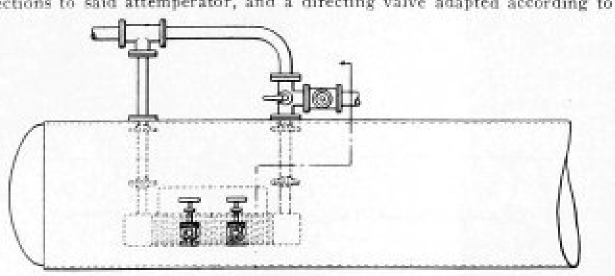
Claim 5.—The combination in a horizontal cylindrical boiler comprising an external boiler shell, an internal combustion chamber located at a distance from one end wall of the boiler, and the usual submerged flues leading from said combustion chamber to the other end wall of the boiler, and having a steam outlet adjacent said other end wall, tubes located within said boiler shell above the water level in the boiler and extending between said end walls, means for causing hot gases discharged by said flues at one end of the boiler to be conveyed



through said tubes to the opposite end of the boiler comprising a chambered casing external to the boiler shell, means for regulating the flow of hot gases through said casing, and a baffle arranged within the boiler shell above the water level and below said tubes and steam outlet to provide a steam space above the baffle freely communicating with the steam generating space beneath the baffle only at the end of the boiler remote from said steam outlet. Seven claims.

1,119,318. JAMES HERMANN ROSENTHAL, OF CHISELHURST, ENGLAND, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY. SUPERHEAT-REGULATOR FOR STEAM-GENERATORS.

Claim 3.—The combination with a steam boiler drum of a superheated steam attemperator located therein, steam inlet and outlet connections to said attemperator, and a directing valve adapted according to



its position to cause the superheated steam to flow through said connection or partly or wholly to by-pass said connection, partitions forming a compartment in which said attemperator is positioned and cut off from the main body of feed water, and a feed water inlet to said compartment. Three claims.

1,109,526. WATER TUBULAR BOILER FOR LOCOMOTIVES. PATRICK J. HEALY, OF SEATTLE, WASH., ASSIGNOR OF ONE-THIRD TO WILLIAM R. HOUGHTLING, OF SEATTLE, WASH.

Claim 4.—A locomotive boiler, the shell of which is formed of water tubes, the rear end of said boiler being substantially closed, the water tubes at the rear end being deeper than the remaining tubes to provide a fire-box, a draft regulator pivotally connected to the bottom of the boiler adjacent the forward end of the deeper water tubes and adapted to close the air connection between the fire-box and the rest of the locomotive, means for inter-connecting the tubes, and a common steam reservoir in connection with said tubes. Sixteen claims.

1,109,882. WATER CIRCULATOR FOR STEAM BOILERS. JOHN EDWIN TULL, OF BROOKLYN, N. Y.

Claim 1.—The combination with a steam boiler, of a turbine operated by the feed-water supply, and means operated by the turbine for drawing the dead water from the bottom of the boiler and discharging it at the top thereof. Six claims.

1,109,627. WATER-TUBE BOILER. ROBERT DELAUNAY-BELLEVILLE, OF ST. DENIS, FRANCE, ASSIGNOR TO SOCIÉTÉ ANONYME DES ESTABLISSEMENTS DELAUNAY-BELLEVILLE, OF ST. DENIS, FRANCE, A CORPORATION OF FRANCE.

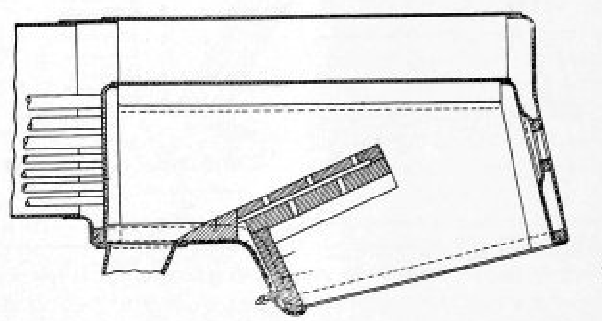
Claim.—A boiler element of the Belleville type, composed of a spiral coil having clockwise convolutions and a spiral coil having anti-clockwise convolutions, the front boxes on the one hand and the rear boxes on the other hand being superposed but disposed in staggered relation, the left-hand half of the boxes of the second spiral coil resting upon the right-hand half of the boxes of the first spiral coil and vice versa, all the tubes rising from front to rear on the one hand and all the tubes rising from the rear to front on the other hand being parallel and equally spaced. One claim.

1,116,428. STEAM GENERATOR. JAMES HOWDEN, OF GLASGOW, SCOTLAND.

Claim 1.—In a water-tube steam generator, in combination a top and a bottom drum, each drum being of semi-cylindrical formation and having its ends integral with the body, the edges of the body and of the ends being inturned and of thicker section than the rest of the drum, said edges forming the boundaries of an aperture, and a flat tube plate fitted to said inturned edges and closing said aperture, and water tubes connecting the tube plates of the top and bottom drums. Two claims.

1,119,490. JAMES BLACK AND JAMES FRAME, OF GLASGOW, SCOTLAND. LOCOMOTIVE FIREBOX.

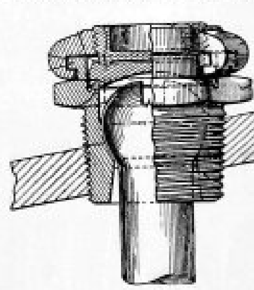
Claim 1.—In a locomotive firebox having two chambers, a firing chamber and a combustion chamber, a foundation ring for both chambers and which from the level of the bottom of the front wall of the



firing chamber is stepped vertically or substantially vertically upward to the level of the floor of the combustion chamber. Seventeen claims.

1,119,652. BENJAMIN E. D. STAFFORD, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURG, PENNSYLVANIA. FLEXIBLE STAY-BOLT.

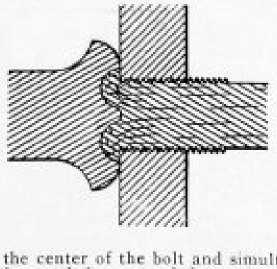
Claim 1.—In flexible stay bolt construction, the combination of a sleeve adapted for attachment to a boiler sheet and having a seat for

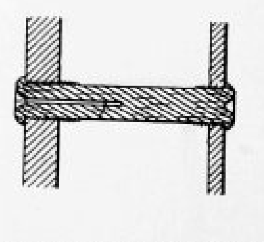


the stay bolt head, a cap for closing the outer end of the sleeve, a member detachably secured to the outer end of the sleeve, and adjustable means carried by said member and adapted to engage the cap for holding the latter on its seat. Six claims.

1,119,735. CHARLES P. VAUCLAIN, OF ROSEMONT, AND JOHN M. BURNS, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNORS TO THE BALDWIN LOCOMOTIVE WORKS, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA. PROCESS OF HEADING STAYBOLTS.

Claim 1.—The process herein described of heading staybolts, said process consisting in first screwing said staybolt into the plate to which it is to be secured so that its end projects beyond the plate, then indent-





ing the center of the bolt and simultaneously forcing the projecting metal of the staybolt outward from the central depression without materially displacing the metal within the opening of the plate while the periphery of the bolt is confined, thus making a steam-tight joint between the bolt and the outer edge of the plate, then, as the displacement of the metal is continued, turning it down onto the outer surface of the plate so as to make a completed circular head having a central depression and making a steam-tight joint between the outer end of the bolt and the outer portion of the plate.

THE BOILER MAKER

APRIL, 1915

Bending Foundation Lugs

A Simple and Inexpensive Method of Bending Small Pieces of Heavy Plate

BY JAMES FRANCIS

"Here's a sketch of that Chimney Foundation Lug, Mr. Foreman. Wish you would get out sixteen of them as soon as you can. Here's the sketch, Fig. 1."

"Oh, I say, Mr. Francis, the shop isn't very well fitted to make lugs like those. Hadn't we better send them down to Smart's? They have got all kinds of benders and bull-dozers down there. If we make a form to bend those lugs over, it will cost more to get ready than the whole bill would amount to at Smart's."

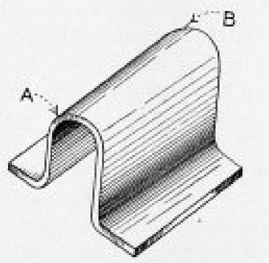


Fig. 1.—Chimney Foundation Lug

"Send nothing out, Mr. Foreman. You just bend them in this shop, and there is no need of spending one cent for forms. A dollar will pay for all the time used in rigging up, and you can bend up these lugs right here on your forge floor plate, and all the stuff you need is right here in the shop!"

"Guess you had better 'show me' a bit, Mr. Francis, for I don't exactly catch it yet."

"All right, Mr. Foreman. Just lug in a section of steam pipe which will fit the curve of the lug—about 5-inch pipe, I should say, and block and clamp that pipe upon the floor plate as shown by Fig. 2. A couple of short blocks will answer under the high end of the pipe, while the low end can lay on the plate, rest against a pin, and be held by a goose-neck clamp as shown. The high end of the pipe may be held by two goose-neck clamps, placed so the blocking may bear against them, and also so they act opposite to each other to keep the pipe from sliding in either direction. Fig. 2 shows the matter plainly, and neither pipe nor blocking can 'fetch away' when clamped, as shown by the engraving."

"But how are we going to heat these sheets? The floor plate is too far from the large fire—the flanging furnace—and we can't heat all the lug-plates at one time in the forge fire."

"You don't have to heat all the plate at the same time. Fig. 3 shows the plate (sketch I) as laid out and sheared to size. The dotted lines across either end indicate where the foot bends are to be made. Just heat one end of each piece, catch it in the brake-clamp and welt down the foot flange with a sledge—why, you can do it in less time than it takes to tell how it is done. Now take a heat in the middle of each lug-plate and flop it across the pipe on the floor plate, a good hearty throw of the plate across the pipe will start the bend, but it takes a little care to hit the pipe with just the right part of the plate, so the bend

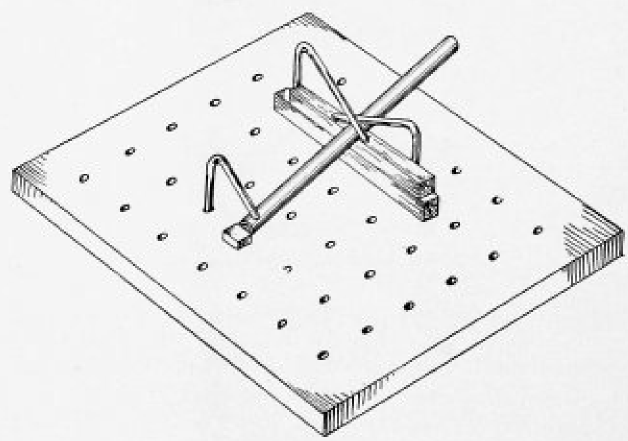


Fig. 2.—Floor Plate, Rigged for Bending Lugs

will start even and square. Perhaps it may be better to just lay the hot plate over the pipe and bend it down by means of a couple of wrench-clamps, as shown at *A*, Fig. 4. This is a subsequent operation, but the first bend may be made in much the same manner, except that two wrench-clamps are used—one at either end of the plate, instead of a goose-neck clamp, as shown by Fig. 4.

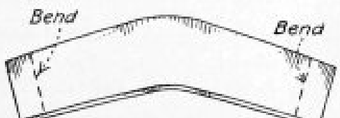
"Sketch II, Fig. 3, shows the plate with the foot lugs bent up, ready to be heated in the middle and bent across the pipe form, and sketch III shows the lug-plate after the second bend has been made. And, Foreman, be very sure that you start this bend fair and square in the middle of the sheet, with the middle of the bend running in the right direction. If you start the bend ever so little on a different angle, then there will be big trouble in getting the bend right, and the feet will stand 'cock-billed' on the plate, striking on the heel of one and the toe of the other. But start the middle bend exactly square, and there will be no trouble in getting both feet square upon the floor plate."

"Won't the feet ruffle up and double out of shape when we pull on them with the wrench-clamps or pound on a foot with the sledge?"

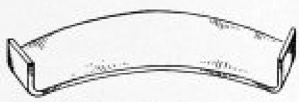
"Not so you would notice it, if you put the heat in the middle of the plate where it is to bend and keep the flanges cold. They are bent up out of the way of most of the heat, and if you do the heating with the toes of the feet upward, as shown in the sketches, then the heat can be kept away from the feet and they will stand the strain of the wrench-clamp and sledge without getting out of shape much. And if they do, a few blows of the sledge will flatten the feet right out again."

"How are you going to bend the sides of the lug down square. They stand out at a considerable angle in sketch III, Fig. 3, and the lug is a bad thing to hold or to hit in its form as shown there."

"Fig. 4 shows how the third bending operation is managed. Just throw the lug over the pipe, bringing one



I THE PLATE



II THE FIRST BEND

III SECOND BEND

Fig. 3.—Some Bending Operations

foot down square upon the floor plate, then slip a goose-neck clamp upon that foot as shown by Fig. 4, and you can bend down the other side with wrench-clamp and sledge, and do a good job easily and quickly, too."

"How about keeping the bend in the middle of the lug? I should think that this way of doing it would result in one leg being bent down longer or shorter than the other leg."

"That matter is entirely under the control of the smith, Mr. Foreman. All he needs to do is to watch the work and see that both legs come down of the same length. When he sees that one leg of the lug is coming longer than the other leg, the goose-neck clamp is at once shifted to the longer leg and placed upon the foot thereof; then the bending is continued in the other or shorter leg, which is gradually brought down to the same length as the clamped leg. Sometimes it may be necessary to change the goose-neck from one side to the other several times, but if the smith keeps his eye on the job, only one or two changes will be necessary, and the lug comes down into shape as though it were made of paper instead of 17/32-inch steel plate."

"But, Mr. Francis, you can't bend the second leg clear down with a wrench-clamp at *A*, Fig. 4. As soon as the clamp strikes the floor plate you are done as far as bending is concerned."

"Sure! You can't go ahead after you get to the end of your journey. Just take off the clamps, grasp the lug with the tongs, hold it up on one foot as shown by Fig. 5, and your helper can welt down the flaring leg in short order. Turn the lug upon one foot or the other, as needed, in order to bring it down with both feet square and both legs of the same length. A final flatting of the feet, upon the floor plate will finish the job, and the lug will be made in about the length of time it has taken to tell about it."

"What is the best way of finishing the round portion of the lug—that part which shows so nice and round at *A* and *B*, Fig. 1? If I hammer this part I'm afraid marks will be left, making the whole thing look like a ragged forging."

"There is no need of hammering the lug at *A* and *B*. On the other hand, the lug should be bent without striking a single blow of the sledge, save upon the feet, upon the flats of the feet to square them up, and upon the edges of the feet when bending the legs down squarely, and of even length. Even after operations have been finished upon the pipe, as shown by Fig. 5, if care be taken to heat the lug evenly when bending it, the round top will form over very evenly and smoothly, and there will be no need of placing it back upon the pipe again. If, however, you should let the top go bad, and be forced to round the lug again upon the pipe, then do not hit it with the sledge, but use the wooden maul to shape the round part with. Wood will not stretch or draw as a steel hammer will, and you can hammer a sheet as much as you want to with a wooden maul without danger of getting a dent or a buckle into it!"

"Say, that's some scheme for bending those lugs, Mr. Francis, and I reckon we can make them up all right now without building any forms to bend them over!"

"That's the talk, Mr. Foreman. I like to hear that, and when a man talks in that way I know he intends to do the best he can, and to 'get there' in some way with whatever the shop affords—and that's a good deal, if only a man will look at it the right way. You see, Mr. Foreman, that while a shop would like to be fitted with every fancy jig and fixture which we see in every other shop, we can't afford to do so, however much we would like it; but whenever it will pay us to put in jigs or fixtures, you may be very sure that we are going to do it—right off, quick!"

"But how is it that the other shops have these things, and we don't?"

"Why, at some time or other the other shops have had big orders to get out, and were obliged to buy or make the jigs and tools in order to fill those orders profitably. And now they have the fixtures on hand, all ready to be used on other jobs for which the tools and fixtures are fitted. It is in this way that other shops have things we can't afford. And, Mr. Foreman, if you will look around a bit closely, you will find that the shop which has a fine set of jigs is awfully short in the way of some equipment which our shop has—just because we have at some time handled a job which warranted the tools in question. For instance, there's our hydrostatic press and forms for making 'bumped-up' heads at a single operation. That outfit is the envy of every shop within two hundred miles, but if we never had done that big order for sulphite digester shells, than we would never have had that press and forms. To be sure we use them on lots of jobs, but it wouldn't have paid us to put them in except for doing that big digester order. But even now it will not pay us to put in forms for bending these foundation lugs. To be sure, we could use the tools for some future operations of a similar nature, same as we still make use of the digester tools. But—let us get an order for enough of these lugs to pay for making a set of press forms, and we will do so P. D. Q., and make the forms to fit right into the hydrostatic press, too!"

"Say, Mr. Francis, why do you say 'hydrostatic' press? Don't they call it the 'hydraulic' press?"

"Yes, Mr. Foreman, they call it so, but the name is not a correct one for the machine. Just take the name to pieces and see what it means. 'Hydro' means water—just plain, everyday water—and 'static' means still, at a state of rest, with things just balancing each other, and that's just what happens in the hydrostatic press. A pressure, say, of 100 pounds per square inch is pumped up by the little pump piston with only an area of half an inch or so; therefore, neglecting friction, it will take about 50 pounds to move the piston, which works up a pressure of 100 pounds per inch in a large cylinder, the piston of which has an area, say, of 100 square inches."

"Isn't there 10,000 pounds pressure on the big piston and only 50 pounds on the little one? And if that's so, how do you get a balance between the two pistons?"

"That's just what you do get, Mr. Foreman, 50 pounds on the half-inch area of the pump plunger exactly balances 50 pounds on each half-inch area of the big plunger, and there you have a balance—static pressure, hence the name—and the water in the pump is balanced against the water in the cylinder by a pressure of 100 pounds per square inch at each, hence the name—hydrostatic, or water-balance, press."

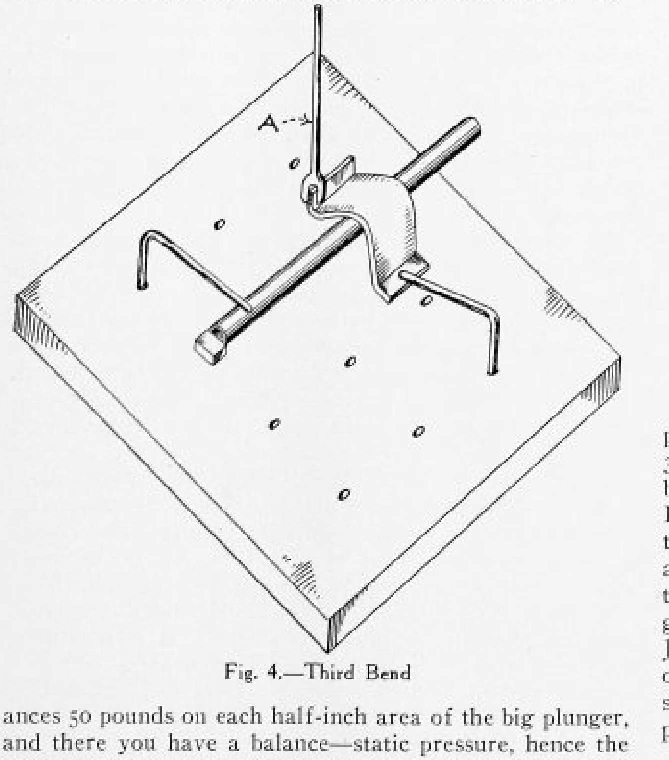


Fig. 4.—Third Bend

"Well, what about the 'hydraulic' press? Why do they call it by that name, and what does hydraulic mean?"

"Hydro means the same in this word as in the other—water—and the 'o' has been cut off for sake of the man who had to do the spelling."

"But where do they get the rest of the word, and what does it mean, anyway?"

"Oh, they get that from the Greek language. In fact, both parts of the word come from the Greek, 'hydro' meaning water and 'aulos' meaning pipe. They patched the two words together and riveted them into the single word 'hydraulic,' which means water in pipes, or water in motion. It's just the opposite of hydrostatic, which means water at rest, or water under pressure."

"But why can't they call it a 'hydraulic' press, for the water flows in the pipe during the pump-stroke?"

"To be strictly accurate, Mr. Foreman, you might call it a 'hydraulic' press while the pump is actually in operation, but when the pump comes to the end of its stroke then we have an 'hydrostatic' press, and you can't get away from the fact. And as it would be rather inconvenient to change the name of the tool twice during each and every stroke of the pump, we had better be accurate and speak of the 'beast' as the 'hydrostatic' press once and all the time."

"All right, Mr. Francis, we'll do it, but I reckon the press will work just as well by one name as by the other, eh? But, Mr. Francis, how is it that the pipes which connect the pump and the cylinder are able to stand such a great pressure as is in the cylinder? That is made of steel, about 5 inches thick all around, and the pipe seems just ordinary steam pipe, barely 1/8 inch thick in its wall, against 5 inches thickness of press cylinder. How does the pipe stand it?"

"Oh, pshaw, Mr. Foreman! Have you fallen down on that simple question? How does the little steam gage pipe stand boiler pressure? The wall of the pipe is barely 3/32 inch thick, yet it withstands the pressure inside a boiler with a shell 9/16 inch thick! Don't you see, Mr. Foreman, that it is the diameter of the pipe which causes the necessary variation in shell thickness? The boiler and the press cylinder have many times the diameter of the pipe, hence their walls must be of correspondingly greater thickness to withstand the pressure—that's all. Just the old matter of multiplying the gage pressure by one-half the shell diameter and dividing by safe working stress of the metal wall, to determine what pressure the pipe, boiler or cylinder will safely carry. See?"

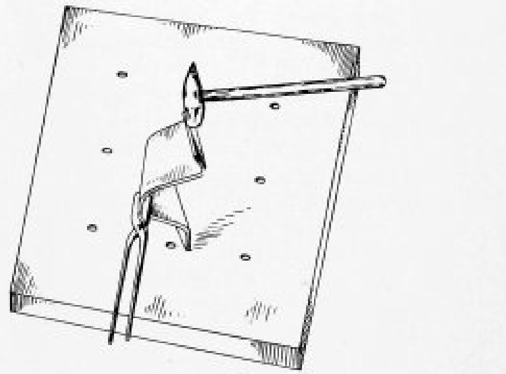


Fig. 5.—Last Bend

"Oh, thunder, yes! And I ought to be kicked for asking such a fool question, but it did look queer at first. I see it now though—about like the mill-dam question, isn't it? The dam is under the same pressure whether the pond above it is 20 feet or 20 miles long! Oh, pshaw! kick me once, will you?"

A DISTINGUISHED RIVETING GANG.—When the keel of the U. S. submarine L-8 was laid at the navy yard, Portsmouth, N. H., on February 24, the first rivet was driven by the following riveting gang: Riveters, Captain Thomas Snowden, U. S. N., commandant of the yard, and Naval Constructor L. S. Adams, U. S. N., industrial manager of the yard; holder-on, Paymaster Charles Conard, U. S. N., general storekeeper of the yard; rivet heater, Naval Constructor E. C. Hammer, U. S. N., shop superintendent; and rivet passer, Surgeon B. L. Wright, U. S. N., medical officer of the yard.

MASTER BOILER MAKERS' CONVENTION.—The annual convention of the Master Boiler Makers' Association for 1915 will be held at the Hotel Sherman, Chicago, Ill., May 25 to 28.

Behavior of Riveted Joints Under Stresses*

Elasticity of the Joints and Factors Affecting Their Actual Strength—The Spacing of the Rivets—Repeating Stresses

BY JAMES E. HOWARD

The efficiencies of riveted joints under rupturing tensile stresses constitute the values on which working loads are commonly based. Alleged factors of safety are employed, fortunately not less than five on important work. One of the reasons why it is fortunate that a large factor of safety is used in found in the fact that a fairly good distribution of the loads is not always characteristic of riveted construction. Furthermore, the unit values on which computations of the strength of riveted joints are based, in some respects, are not fixed values, as they are generally taken to be.

The most important feature of the case, however, resides in the elastic behavior of the joints, one which appears to be ignored, in consequence of which local strains are introduced entirely at variance with those which purport to be present in well-designed engineering structures. Nominally, the elastic limit of the material represents a limit which should be approached with temerity. As a matter of fact, few, if any, riveted structures are erected which are free locally from strains which do not exceed the elastic limit of the material. The structures are not necessarily endangered by the presence of such overstrains. It will depend upon the character of the work which they have to perform, however, whether or not ultimate failure will result and the place of rupture be located by an overstrained zone.

It may be remarked, with assurance, that a limited number of repetitions of stresses, twofold or three fold, the working loads are adequate to effect rupture, for working loads which are based upon the usual so-called factor of safety of five. The behavior of riveted joints under stresses leads to this inference. Multiple riveted, double butt-strap joints may have a degree of rigidity equal to or even in excess of the solid plate for comparatively low tensile or compressive stresses, but loads ranging from, say, 15,000 to 25,000 pounds per square inch commonly show a material divergence in the behavior of a joint over that of the solid plate.

When frictional resistance contributes toward the initial rigidity of the joint, as it commonly does, it is uncertain whether the favorable showing of the joint in the laboratory test is realized and maintained under service conditions. Vibratory effects and changes in temperature seem likely to cause a creeping of the plates and disturb the initial state of the different ply, when taken in conjunction with a constant load, or more marked it may be in the case of alternate stresses. In riveted joints, as in many other engineering examples, a careful analysis of the case is not reassuring that permanency is being fully provided for. Not that iron and steel are not enduring, but safety lies in the adoption of what appears to be low-working unit stresses, in order to avoid excessive local strains not contemplated in the design of the structure.

Referring specifically to the strength of those parts on which reliance is placed in the design of a riveted joint, first comes the tensile strength of the plate, taken as a whole. Next to this the strength of the steel between rivet holes, that is, on the net section. On the latter section the strength per unit of area is not the same with different pitches. It may be greater or less than that accredited to the gross section, per square inch. It is also modified according to whether the holes are drilled or punched, and may be greater in one case or the other, according to the pitch of the rivets or, rather, the distance from rivet holes to rivet holes. It is not likely that the strength with punched holes will be greater than with drilled holes in practice, since very close-pitched work is required to bring about such a result, much closer than other considerations in a good joint render permissible. The reason, however, that a punched plate may display greater strength than a drilled one is found in the hardening of the steel by the punch and die at the sides of the holes.

The tensile strength on the net section of the plate is usually greater than on a strip of uniform width several inches in length. The increased area of metal on each side of the center line passing through the rivet holes has a reinforcing effect on the net section of the plate. This gain in strength is a substantial one in single-riveted work, and in multiple riveting when the same pitch is maintained in the different rows.

Reinforcement of Net Section of Plate

The reinforcement, as natural to suppose, is greater in close-pitched than in wide-pitched riveting. The reinforcement is at the sides of the holes, but if they are very far apart there results a loss instead of a gain. The reinforcement is therefore not a fixed amount, but depends upon the proportions of the joint. It follows that the strength of a single-riveted joint, whether butt or lap, will not, with changes of pitch, remain proportional to the ratio of net to gross section of plate. As the net section increases relative to the gross section there is a loss in the reinforcement in strength per inch of area on the net section. Instances have been met in which one of these features practically compensated for the other and resulted in furnishing joints of several pitches, each of substantially the same efficiency in terms of the tensile strength of the solid plate.

When the pitch of the riveting has been considerably increased, as witnessed in butt joints with double covers, in which one strap is considerably wider than the other, joints which fail by the rupture of the plate not infrequently show a diminution in strength on the net section. The plate tears apart at the outside row of rivet holes, in detail. The presence of a few rivets, wide spaced, in the outside row promotes tearing of the plate, the line of rupture starting at a rivet hole and reaching an advanced stage before the plate at the middle of the pitch is separated.

It will be understood from this that tables of proportions of riveted joints based upon fixed values for the strength of the net section of plate are not in harmony with the results of tests on which the preceding remarks are based. Furthermore, it seems probable that modifi-

*A paper read before the Society of Naval Architects and Marine Engineers, New York, December, 1914.

cations in strength would be peculiar to each grade of steel, and mild steel plates which display a considerable portion of their ductility just before reaching their tensile strength would show a difference in behavior over those of less ultimate ductility or plates of quite different stress-strain diagrams. The strength of riveted joints hardly admits of being reached by computation in which only a balancing of areas is taken into consideration, assuming fixed values for the component parts.

Other details might be referred to, such as the compression on the bearing surface of the rivets, as modified by diameter of rivet or change in pitch, also by the relief afforded the outside row of rivets in multiple riveting. Still further the relative advantages of chain and staggered riveting could be taken up, also the question of distance between the different rows of rivets and the number of rows which are desirable to use. The thickness of the cover plates in single and double butt-strap joints should be considered, and in splice plates whether it is desirable or not to vary the distances between rows of rivets. This enumeration of details necessary to consider in a comprehensive review of the subject might be extended to very great length.

Tests on staggered riveting have led to the observation that it frequently happens that the tendency of the plate to draw down along shearing planes, oblique to the direction of pull, encounters in its course a rivet in the adjacent row. That is, the design of the joint was such that rivets in adjacent rows occupied critical positions with reference to each other, and while the zigzag path from one row to the other was longer than from rivet to rivet of the same row, nevertheless the plate showed a preference to fracture along this greater length, and the interposition of rivets in the second row in critical places was a probable source of weakness.

Chain-riveted work creates a favorable impression when observing and comparing the behavior of different types of joints under test. The distance between rows in chain riveting admits of being very much reduced over current practice without impairing the ultimate strength of the joint.

Effect of High Temperatures

It will be of interest to refer to the strength of riveted joints at higher temperatures. Under exceptional circumstances the joints of steam boilers might be exposed to temperatures considerably above that due to the steam pressure. Joints have been tested up to a temperature of 700 degrees F. The strength of the joints followed the law which governs the strength of plain bars of steel at different temperatures. There was a drop in strength at 200 degrees, followed by an increase, which reached a maximum at about 500 degrees, after which the strength fell off. Among the several joints tested at 500 degrees the maximum gain over the cold joints was 27.6 percent. The tensile strength on the net section reached 81,050 pounds per square inch, against a strength of 58,000 pounds per square inch, on the cold tensile test strip, an increase of nearly 40 percent. The shearing strength of the rivets showed an increase at the higher temperatures of these tests. Furthermore, it was found that joints which were overstrained at these higher temperatures, even beyond the limits of duplicate cold tests, when subsequently tested to destruction at atmospheric temperatures, retained substantially the strength which they had when hot. There was some loss in the ductility of the steel, but without approaching a state of brittleness.

So much for the ultimate strength of riveted joints. Under some circumstances it is probable that the riveted joints in an engineering structure might for a time resist loads approximating those which were required to effect rupture in the testing machine. More commonly they probably would not, nor would they be expected to display the ductility witnessed in the laboratory behavior of the joints. Stated in other words, structures designed to have a factor of safety of five based on the ultimate strength of these joints would not, as a matter of fact, in service possess such a margin in strength and safety. Attention must be given the behavior of the joints under stress, and whether the working loads are constant or variable, direct or reversed stresses; and, in the case of repeated stresses, how many repetitions there will be and the maximum stresses involved.

Extension of Joints

The examination of some stress-strain curves prepared from earlier tests show that the joints in general take a very wide departure from the curve representing the solid plate, this being noticeable at 15,000 pounds per square inch, and in some joints as early as 10,000 pounds. This was true with joints having efficiencies of 70 to 80 percent of the solid plate. Among the joints thus compared were double- and triple-riveted butt joints, and quintuple joints in which the inner butt strap was wider than the outer one.

Under 15,000 pounds per square inch, the joints, in general, among the strong ones, displayed an extension one and one-half times to over twice the extension of the solid plate. These joints were of the type which are used in steam-boiler construction. Observations on the behavior of double-riveted lap joints on some steam boilers which had been in service showed greater extension across the longitudinal seams at the middle of the width of the sheets than in the vicinity of the girth seams. Referring in the tests just mentioned to the effect of hydrostatic pressures applied just above the pressures at which the boilers had been worked.

It is a feature of interest whether riveted seams retain their primitive state under prolonged service stresses, or whether they do not slip and eventually display increased extensions under lower loads than suggested by the laboratory tests.

Cover plates and splice plates in bridge work do not immediately take up the full stresses which are acquired along the length of the plates after several rows of rivets have been passed. The loads are progressively taken up by these splicing members.

From the limited number of observations which have been made it cannot be said that the rigidity of joints on actual structures is greater than would be expected, judging from the laboratory tests. If there is a difference, they are probably less rigid in actual structures.

The frictional resistance due to the shrinkage of the rivets is apparently a factor in the early behavior of a joint. The shrinkage force which is available is, or should be, represented by the elastic limit of the rivet metal. Whether this force drawing the plates together is acting to its full extent will depend upon the manner in which the riveting is done. A limited range in temperature in cooling is sufficient to apply a contractile force equal to the elastic limit of the rivet metal. But since the hot rivet metal has a very low elastic limit it is necessary to hold the plates together firmly until the rivet has cooled to nearly its final temperature. This requirement is an obstacle to rapid driving, as will be readily seen, but full efficiency in frictional resistance between the plates requires its observance.

To attain a high degree of efficiency a state of rigidity in the joint, comparable to that of the plate is essential.

If not attained, the distribution of the stresses will not be as they are expected and computed. The few examples in which the strains in structures have been measured do not furnish ground for the belief that very good distribution is attained in current practice in all classes of structures. The conditions attending marine work would seem to make greater demands on the riveting than in most engineering structures.

Finding the Corner Angle in a Hopper

BY C. L. C. MAGEE

To the layerout in the shops and the draftsman in the office, one of the most difficult problems in tank work is to determine the corner angle between two converging sides of a hopper or a tank bottom. The method which the writer will develop in the following description is one which determines this angle with accuracy not obtainable in average shop practice and which may be used with safety even in those bottoms made of very heavy plate, and where watertightness and thorough shop inspection are part of the specification.

The basis of the method depends upon but one geometrical axiom, namely, that the intersection line of any

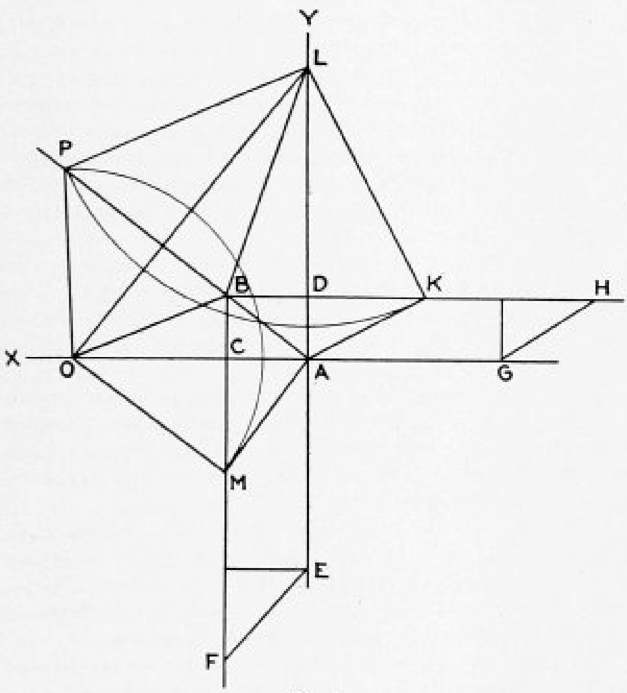


Fig. 1

two planes that are perpendicular to a third plane is perpendicular to all lines in the third plane, passing through its foot. We will accept this as a fact, as the reasoning for the above statement may be obtained in any text-book on plane geometry.

The method of measuring the angle between two intersecting plants is to measure the angle between two lines, each one of the lines laying in one of the planes and being perpendicular to the intersecting line, and meeting each other in a common point in the intersection line. These lines, in other words, are the intersection lines in the two converging planes, with a third plane erected perpendicular to the intersection line of the two converging planes that represent the two sides of the hopper bottom whose intersection angle we wish to determine. The method, described briefly, is then to develop the third plane above mentioned to its true dimension in the horizontal plane, and then by measuring the two we have solved our problem.

The writer is illustrating by sketch the method of procedure as detailed in the following, and the user of this method will note that it is equally accurate for all those

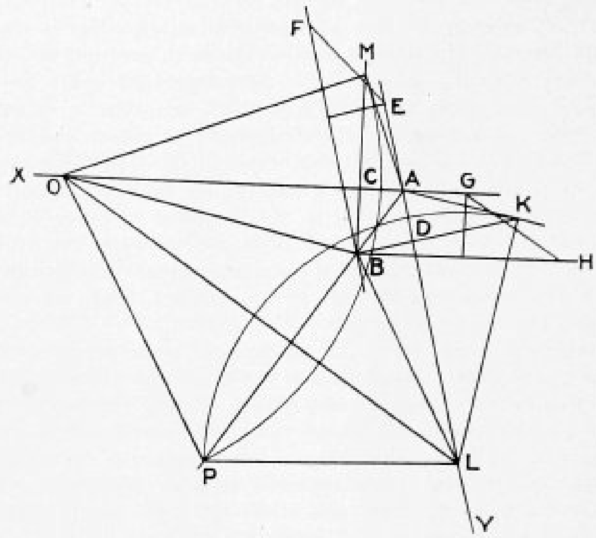


Fig. 2

hoppers whose vertical sides are not parallel, as nowhere in any of the assumptions do we depend upon the projected angle of the sides on the horizontal plane being a right angle.

To illustrate this clearly I will detail the method for a hopper with rectangular sides and give extra graphs of one with sides not parallel. We will assume a typical problem such as a hopper rectangular in shape 8 feet by 10 feet, the bottom sides converging to an opening 1 foot 6 inches square, the respective axes of the opening

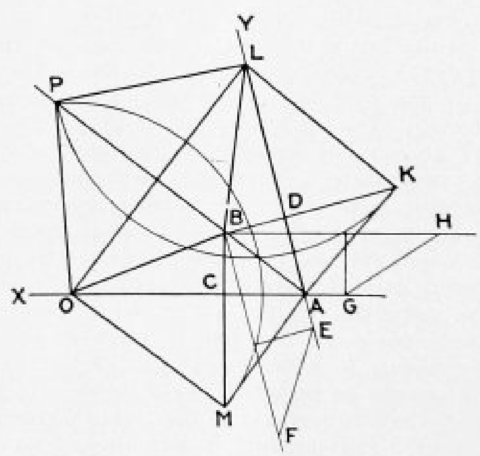
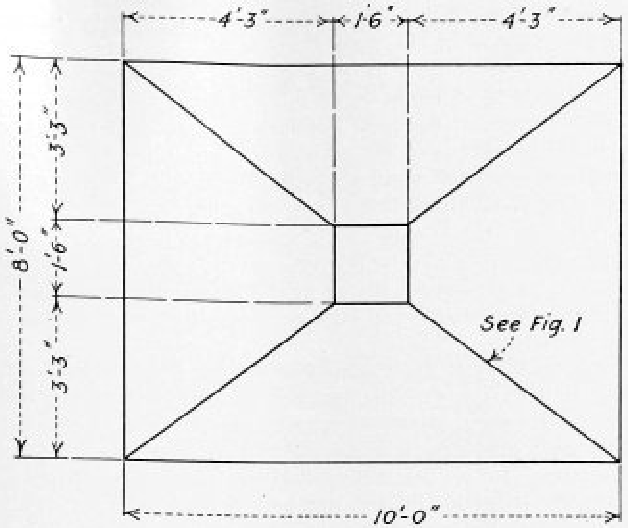


Fig. 3

corresponding with the axes of the hopper. In this case all four corner angles are identical and a layout of one corner gives us the angle.

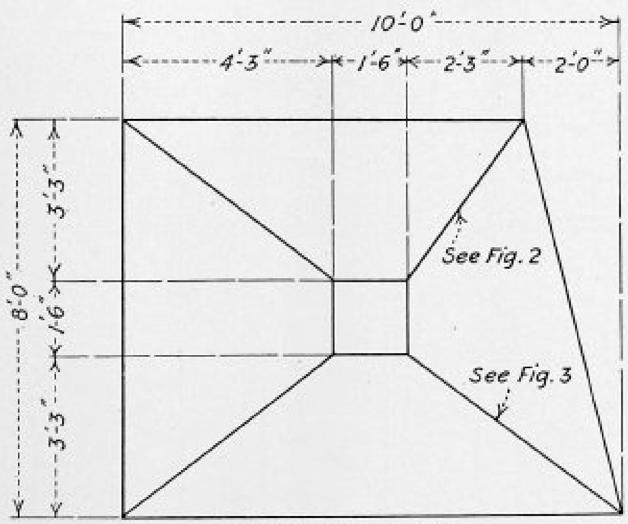
Assume a scale of ¾ inch = 1 foot, and lay out the horizontal projection of the sides and the intersection line. The depth of the converging bottom we will assume at 5 feet between working lines. Let *AB* be the hori-



RECTANGULAR HOPPER

Fig. 4

zontal projection of the intersection line. Extending lines from *B* and *A* perpendicular to the two sides of the hopper *AX* and *AY*, we lay out *GH* and *EF*, using the given depth. *GH* is the true length of *BC* and *EF* is the true length of *BD*. We then lay out from *D* on *BD* extended the distance *EF* to a point *K*. Connect *A* and *K*, and at point *K* erect a line perpendicular to *AK*, cutting *AD* extended at point *L*. From point *C* we lay off on *BC*, extended its true length *GH* to point *M*. Erect a line at *M* perpendicular to *AM*, cutting *AC* extended at *O*. Connect points *L* and *O* and from point *L* strike a circle of radius *LK*. From point *O* strike a radius *OM*, cutting the circle just laid out with radius *LK* at point *P*. The



IRREGULAR HOPPER

Fig. 5

angle between lines *PL* and *PO* is the angle we are after, as triangle *PLO* is the true development of triangle *LBO*.

This layout is automatically checked by simply extending *AB*. If point *P* lies in *AB* extended the diagram is correct. In this problem the angle between the sides of the hopper *AY* and *AX* is 90 degrees. This value is not necessary to the solution, as in sketch No. 2 I show a layout where this angle is greater than 90 degrees and in sketch No. 3 where it is less than 90 degrees.

Some Principles of Boiler Design—II

BY GEORGE SHERWOOD HODGINS *

When we come to consider the butt joint in boiler work, we see at once that the design is what might be called rational. It allows the boiler plates to remain in a true circle, whether cold or hot. There is no internal strain put upon the material by reason of its method of construction, and there is no tendency to cause minute pieces of scale and rust to chip off, as is the case with the objectionable lap joint. This is why the joint appears to be a rational design—that is, it is agreeable to reason, as the word rational means.

The lap joint, on the other hand, by the alteration of its shape when hot and cold, has a tendency to break off the thin film of protective scale, and carry with it a slight portion of the outer surface of the plate. In this way a clean, new surface is exposed at each alternate cooling and heating of the sheets, and this new surface is at once affected by the rust-producing action of the water.

It may at first sight appear strange to speak of the protective function of a film of scale on the interior of a boiler; but sometimes water has been used which was so pure that no scale formed, and the plates rapidly rusted in consequence. It is the excess of scale that is objectionable, because, among other things, scale is a very effective heat-resisting material, and if allowed to accumulate in considerable quantity, it prevents a great deal of heat from reaching the water. Scale is also difficult to remove when it is present in quantity and gives trouble to the boiler washer, while it reduces the efficiency of the boiler. A slight or very thin coating of scale is actually beneficial by its protective action.

The butt joint, as we have said, is a rational design. One of the most common forms consists in bringing the sheets together along their edges, and covering the seam with two plates or welts, over and under the joint. The top or outer welt is usually narrower than the inner and under welt, so that while plates and both welts take two rows of rivets, the under welt is made wider, and not only takes the central two rows, carried by the sheets and top welt, but in addition takes two outer rows of rivets, which pass through the sheets and the inner welt. This form of butt joint, when viewed from above, shows in each half two closely spaced rivet rows near the center line and one row of rivets outside that, with welt hidden below this row, on the inside of the boiler.

In dealing with a specific example, suppose the plate to be half an inch thick. The spacing of the close rivets is 2¾ inches and the outer row of rivets is spaced 5½ inches apart, center to center. The tensile strength of the sheet is 60,000 pounds per square inch, and the rivets are all 1 inch in diameter. The shearing strength of the rivets is taken at 45,000 pounds, which is three-quarters of their tensile strength. The crushing resistance of plates and rivets is here taken at 95,000 pounds.

A joint such as we have described when properly designed and carefully made is satisfactory, but if defective it will give out in any of five distinct ways. In the first place, it may shear the two rivets near the center line and the one outer rivet; that is, taking a section of boiler 5½ inches wide. The two rivets near the center line pass through the plate and each of the welts, and these rivets will therefore be in double shear. The one outer rivet in this given width of 5½ inches will be in single shear, and all the rivets when thus strained are practically

* Member of the American Society of Mechanical Engineers, and formerly Consulting Mechanical Engineer of the National Transcontinental Railway.

equivalent to five rivets in single shear. This strain is opposed by the shearing strength of the rivets, and when set down as an equation it appears as

$$5\,A \times S = R,$$

where A is the area of the rivet,
S is the shearing strength of rivet.
R is the resistance.

In figures the equation becomes

$$5 \times .7854 \times 45{,}000 = 176{,}715 \text{ pounds.}$$

The joint may fail by the tearing of the plate at the outer row of rivets; that is, the row which passes through the lower welt and the plate. When stated as an equation it appears:

$$(P - D) \times T \times E = R,$$

where P is the pitch, viz.: 5½ inches,
D is the diameter of the rivet.
T is the thickness of the plate.
E is the tensile strength of the plate.

In figures the equation turns into

$$(5\tfrac{1}{2} - 1) \times \tfrac{1}{2} \times 60{,}000, \text{ or } (5.5 - 1) \times .5 \times 60{,}000 = 135{,}000 \text{ pounds.}$$

Another way the joint may fail is by the crushing of the plate in front of the two rivets near the center and the outside row of rivets. In other words, while the rivets may all hold, the plate in front of all of them may give way by crushing. The opposing force R, developed here, as shown in an equation is

$$3\,D \times T \times C = R,$$

where D is the diameter of the rivets,
T is the thickness of the plate.
C is the resistance to crushing of the plate.

In figures the result is as follows:

$$3 \times 1 \times .5 \times 95{,}000 = 142{,}500 \text{ pounds.}$$

The joint may also fail by the plate tearing along the inner row of rivets and by shearing the rivets of the outer row. In this form of failure we have a tearing and a shearing strain which, if inadequately opposed produces, like the other forms of failure, a serious rupture of the boiler. This double failure is represented by the equation

$$(P' - 2\,D) \times T \times E + A \times S = R,$$

where P' is the pitch of the close row of rivets, viz.: 2¾ inches,
D is the diameter of the rivets.
T is the thickness of the plate.
E is the tensile strength of the plate.
A is the area of a rivet.
S is the rivet shearing strength.

In figures this equation is

$$(5.5 - 2) \times .5 \times 60{,}000 + .7854 \times 45{,}000 = 140{,}343 \text{ pounds.}$$

The fifth or last form of failure may take place by the plate crushing in front of the two closely spaced rows of rivets and at the same time shearing the outer row of rivets. The resistance to this form of disruption is apparent in the equation

$$2\,D \times T \times C + A \times S = R.$$

In figures it may be stated,

$$2 \times .5 \times 95{,}000 + .7854 \times 45{,}000 = 130{,}343 \text{ pounds.}$$

We have here presented five different cases, in any one of which this butt joint might fail, and it is now in order to examine the joints so as to ascertain how much weaker this joint is than the full, unbroken plate. If we begin with what appears to be the weakest case, we will take the failure just given. It is the one in which the outer row of rivets sheared and the plate crushed in front of the closely spaced row. This is the fifth form of failure. In order to determine the percentage of strength of this joint in its least resisting condition, where R has its lowest value, we proceed to reason as follows:

The strength of the solid strip of plate 5½ inches wide, before drilling or punching for the rivets, may be stated as an equation of the form:

$$P \times T \times E = R.$$

$$5\tfrac{1}{2} \times \tfrac{1}{2} \times 60{,}000, \text{ or } 5.5 \times .5 \times 60{,}000 = 165{,}000.$$

The efficiency of the joint becomes apparent when its percentage is taken, and the reasoning is as follows: If 165,000 represents full plate strength or 100, will 130,343 give more or less? Manifestly less, therefore as

$$130{,}343 : 100 :: 165{,}00 : x.$$

when this is worked out it gives as result 78.9, or, say, the joint is 79 percent as strong as the plain, clear new plate. All the other cases given here develop a higher percentage of strength.

We have here dealt with one of the simplest kind of butt joints. The formulas worked out are intended to give the reader some information as to the "method of attack" for such problems. The butt joint proves itself to be "rational," for as the study progresses it will be apparent that the alteration in the number of rows of rivets and the size of the welts may be arranged so as to give a much larger percentage of strength. A form of lap joint with triangular welt was adopted for heavy plates some years ago by the Baldwin Locomotive Works which showed a calculated efficiency of 98 percent.

(To be continued.)

Layout of Y Breeching

BY J. L. WILSON

The problem of laying out the breeching as shown in the shop drawing, Fig. 1, is little different from the general problem of that type except that it is a little complicated because of the different diameters of the double openings. This, however, only makes it necessary to develop both sides of the breech instead of one and to take particular care of the joint between the two sides of the breech and the single lead.

As shown in the elevation, Fig. 2, the top of section A is cut on two slopes forming equal angles with the center line or axis, as in the usual layout. In profile this will

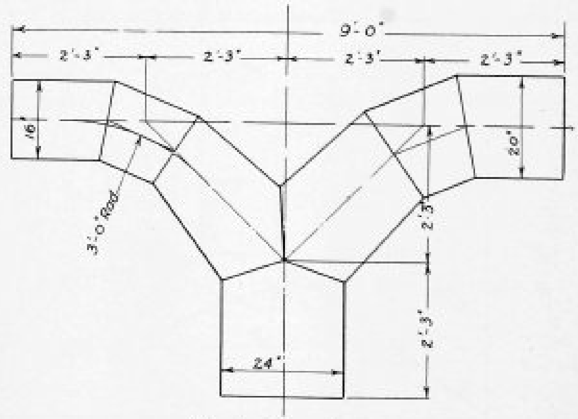


Fig. 1.—Shop Drawing

give two equal ellipses, one of which is shown as profile A forming the bases for sections B and C. This done, it is a simple matter to draw in the outline of the elbows, etc., completing sections D, F, E and G.

Subdivision of Surfaces

Lay out the profile or end views of sections F and G, dividing them into a number of equal parts, twelve in this case. In Fig. 2 this is shown by the semi-circles at the sides of the sections, which are divided into six equal parts. The points of division are them projected over to the sections and lines drawn to represent elements on the surfaces of the cylindrical sections, the elements drawn being parallel to the axis of each respective section. At the end of section *D* the ends of these lines are represented by points 1, 2, 3, etc.

Now we divide profile *A* into the same number of equal parts and in the same order, beginning at a corresponding point as shown. These points are projected up to the top of section *A*, as shown, giving points 1, 2, 3, etc., which are connected by full lines to the corresponding points 1, 2, 3, etc., at the other end of section *B*. These are also elements, but since section *B* is not truly cylindrical and must be developed, therefore, by some method such as triangulation, we draw the diagonals, shown dashed, as 1-2, 2-3, 3-4, etc.

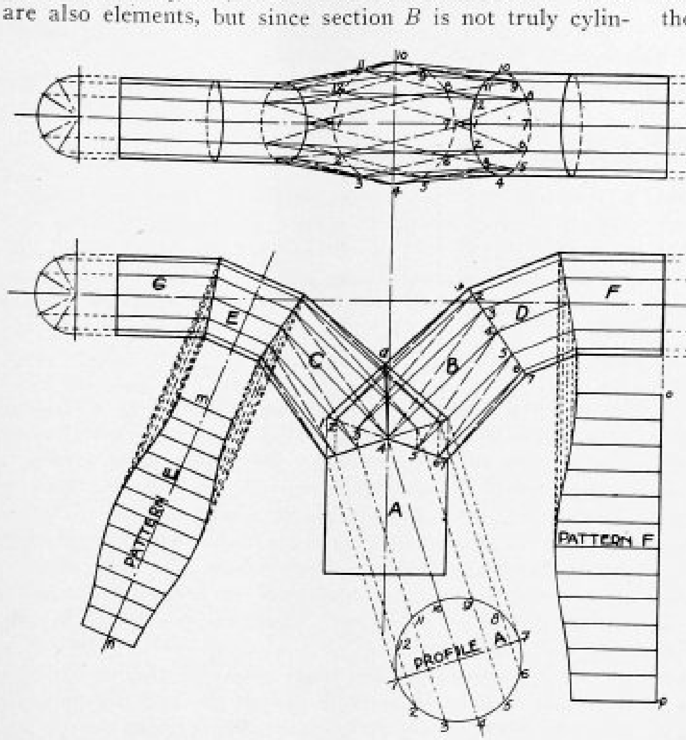


Fig. 2.—Plan and Elevation with Developed Elbows

The same divisions and lines are made for section *C*, and where the corresponding elements, etc., intersect as in line *a*-4, we can represent the intersection of sections *B* and *C*.

Development of Elbows

The elbows are developed in the usual manner of laying out a cylindrical surface. The end of section *F* is prolonged vertically downwards in Fig. 2 and on it *o-p* is taken equal to the circumference of the section *F* in end view. This line *o-p*, forming the base of pattern *F*, is divided into twelve equal parts as the end view was, and right lines or perpendiculars drawn to *o-p* at these points of division. These right lines represent the elements as they would appear as "rolled out," and it is only necessary to project their various lengths down from section *F* as shown.

The same is done for section *E*, in which a dot and dash center line is drawn and on it *m-n* is laid off equal to the circumference of the circular cross section of *E*. The length *m-n* is divided into twelve equal parts and right lines drawn to it at the points thus found. The lengths of the various elements are then projected to the corresponding right lines which represent them "rolled out."

Continuing this process for sections *D* and *G*, which have not been developed in the drawing, we obtain the layout of the elbows.

Development of Breech

In order to show clearly the layout of section *B*, it has been separately drawn in Fig. 3 with its diagram of triangles. The elements and diagonals have been drawn exactly as described for *B* in Fig. 2.

On the vertical line *O-P*, Fig. 3, the various points 1, 2, 3, etc., are projected for the upper base and horizontal *dotted* lines drawn through the points 1, 2, 3, etc., for the lower base. Then the lengths of the elements 1-1, 2-2,

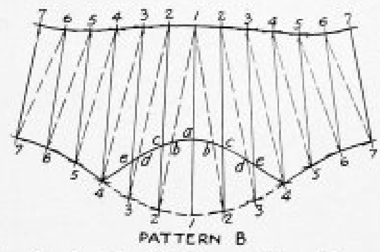


Fig. 4.—Developed Pattern of Breeching

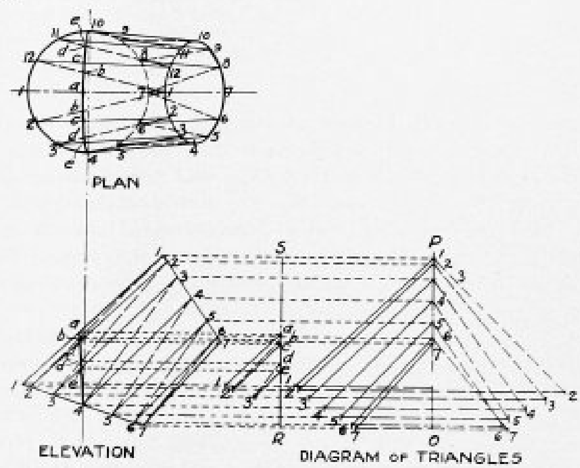


Fig. 3.—Diagram of Triangles for Breeching

3-3, etc., are transferred from the plan view, Fig. 3, and laid off on these horizontal lines to the left of the vertical *O-P*. This gives points 1, 2, 3, etc., on the horizontal dotted lines to the left of *O-P*, which are connected by full lines to corresponding points on the vertical line *O-P*. These lines represent the true lengths of the elements.

The same is done for the diagonals, as shown, only that point 1 on the vertical is joined with point 2 on the horizontal, and so on, representing the true lengths of the diagonals shown by dashed lines.

Now in Fig. 4, starting with 1-1 from the diagram of triangles, we proceed as in triangulation, laying out the pattern on both sides of 1-1, as both sides are the same, only oppositely directed. On the upper line of pattern *B*, Fig. 4, which represents its upper base the equal radius 1-2, 2-3, etc., is laid off equal to one-twelfth the circumference of an ellipse found from the intersection between *B* and *D*, Fig 2. On the lower base the equal radius 1-2, 2-3, etc., is equal to one-twelfth of the circumference as shown by profile *A*, Fig. 2. The elements and diagonals are respectively equal to those shown in the diagram of triangles.

As shown in Fig. 3, the part 1-*a*-4 is cut out of the pattern where section *C* intersects it. Points *a*, *b*, *c*, *d* and *e* are projected over to vertical *R-S*, Fig. 3, in the diagram of triangles. From the plan view the corresponding elements and diagonals are laid off from the left of *R-S* to points 1, 2 and 3, which are joined to *a*, *b*, *c*, *d* and *e*, as shown, giving the true lengths of the elements and diagonal parts to be cut out. These are laid out on the pattern *B*, Fig. 4, on their corresponding lines, and the outline is completed as shown by the full lines.

Layout of Section A

Section *A* is readily laid out, as shown in Fig. 5, by rolling it out in the usual manner for a cylindrical surface. The end view is divided into twelve equal parts, forming elements on the elevation. Line *r-s* is laid out equal to the circumference of the circular cross section

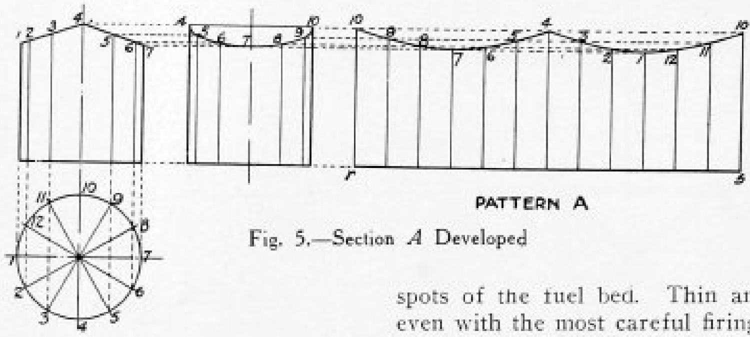


Fig. 5.—Section *A* Developed

of *A*, and divided into twelve equal parts as before. Verticals are erected to represent the various elements and their lengths are projected from the elevation, as shown, giving the curve to complete the outline for pattern *A*.

Section *C*, Fig. 2, will also have to be laid out in this problem, as it differs from *B*, but as the system for so doing is exactly the same as that used in developing *B*, it is not necessary to outline it further.

Seams and laps have been disregarded entirely, but will present no difficulty to the layer out, who is better prepared to handle such things under varying conditions.

Instructions for Firing Boilers with Soft Coal by Hand

"Hand Firing Soft Coal Under Power-Plant Boilers," is the title of Technical Paper 80, just issued by the United States Bureau of Mines, as an aid to the firemen employed in manufacturing establishments throughout the United States.

The paper, which contains descriptions of methods of firing soft coal under power-plant boilers and of methods of handling the fire so as to have the least smoke and to get the most heat from the fuel, seeks to meet the needs of the men, many without a technical education, who are employed in small plants of 1,000 to 2,000 horsepower capacity. For this reason the language used is plain and simple, and technical terms have been avoided as far as possible.

The publication under "General Directions on Firing Soft Coal," makes the following statements:

"When burning bituminous coal under power-plant boilers the best results are obtained if the fires are kept level and rather thin. The best thickness of the fires is 4 to 10 inches, depending on the character of the coal and the strength of draft. The coal should be fired in small quantities and at short intervals. The fuel bed should be kept level and in good condition by spreading the fresh coal only over the thin places where the coal tends to burn away and leave the grate bare.

"Leveling or disturbing the fuel bed in any way should be avoided as much as possible; it means more work for the fireman and is apt to cause the formation of troublesome clinker. Furthermore, while the fireman is leveling the fires a large excess of air enters the furnace, and this excess of air impairs good efficiency.

"The ash-pit door should be kept open. A large accumulation of refuse in the ash pit should be avoided, as it may cause an uneven distribution of air under the grate. Whenever a coal shows a tendency to clinker, water should be kept in the ash pit. All regulation of draft should be done with the damper and not with the ash-pit doors.

"In firing, the fireman should place the coal on the thin spots of the fuel bed. Thin and thick spots will occur even with the most careful firing, because the coal never burns at a uniform rate over the entire grate area. In places where the air flows freely through the fuel bed the coal burns faster than in places where the flow of air is less. The cause of this variation in the flow of air through the different parts of the fuel bed may be differences in the size of the coal, accumulations of clinker, or the fusing of the coal to a hard crust. Where the coal burns rapidly, the thin places form.

"Before throwing the fresh coal into the furnace the fireman should take a quick look at the fuel bed and note the thin spots. In a well-kept fire these spots can be usually recognized by the bright, hot flame. The thick places have either a sluggish, smoky flame, or none at all. In order to place the coal over the thin places the fireman should take a rather small quantity of coal on his scoop, for it is much easier to place the coal where it is needed with small shovelfuls than with large ones.

"The coal should be placed on the thin places in rather thin layers. If the fireman attempts to fill up the deep hollows in the fuel bed at one firing, the freshly fired coal may fuse into a hard crust, thus choking the flow of air, causing the fuel to burn slowly and starting new high places. If the high places in the fuel bed are missed on one or two firings, the hard crust at the surface will gradually burn through or crack, thus allowing more air to flow through, and the place will get back to its normal condition. Of course, if the high place in the fuel bed is caused by clinker the flow of air will not be free until the clinker is removed with the fire tool. Whatever may be the cause of the high places in the fuel bed, the fireman should remember that they are places where the coal does not burn. There is no use in placing coal on such a place.

"If the firings are too far apart, the coal in the thin spots may burn out entirely, allowing a large excess of air to enter the furnace in streams. If those streams of air are not properly mixed with the gases from the coal, only a small percentage of the air is used for combustion, and most of it passes out of the furnace, depriving the boiler of considerable heat. If, for instance, air enters the furnace at atmospheric temperature, say 75 degrees F., and leaves the boiler at about 575 degrees F., it carries away the heat that was absorbed in raising its temperature 500 degrees F. This heat is lost to the boiler. Another loss of heat occurs when holes form in the fuel bed, because pieces of unburned coal fall through the grate when the fireman attempts to cover the holes with fresh coal. Therefore, in order to avoid the formation of holes, firings should be made at short intervals, particularly if, for any reason, the fuel bed must be kept thin."

Copies of Technical Paper 80 may be obtained by addressing the Director of the Bureau of Mines, Washington, D. C.

Proportions of Locomotive Boilers*

Method for Adapting Cylinder Horsepower Requirements to Proportioning the Heating Surface and Grate Area

BY F. J. COLE

In recent years locomotives have increased so much in power that methods formerly employed are no longer adequate in proportioning the grate, heating surface, length and diameter of tubes, etc., when the class, tractive power and limitations of weight are known.

The size of cylinders is usually fixed by the permissible axle load allowed upon the track or bridges, in connection with the type, driving wheel diameter, boiler pressure and factor of adhesion. After these fundamental features are decided upon the boiler proportions must be outlined to see whether the required amount of heating surface can be obtained without exceeding the limits of weight.

There are two general questions involved in the consideration of this subject, namely, how many pounds of steam per hour are required to supply the cylinders in order to develop the maximum horsepower; and what proportion of grate, firebox and tube heating surface will best produce this amount of steam.

The locomotive, unlike most steam plants, varies in the speed and power developed. It must be able to run at any intermediate speed between starting and its full velocity and at the same time develop all degrees of tractive power within its capacity. At slow speeds the maximum pull must be exerted in order to start the trains easily, and for this reason the live steam is admitted to the cylinder during 80 to 87 percent of the stroke. As the speed increases it is necessary to reduce the admission period, thereby increasing the expansion of the steam. Therefore for any speed there is some point for the valves to cut off the live steam, at which the engine will develop its maximum power. There is also some minimum velocity at which the full horsepower of the locomotive is attained; after this velocity is reached the horsepower remains constant or slowly decreases. This critical point may be taken at 700 to 1000 feet per minute piston speed.

It has been customary to use certain ratios, based on cylinder volume, for locomotive proportions. These ratios left to individual preference such matters as rate of combustion per square foot of grate, length of flues, evaporative value of firebox heating surface or value of tube or flue heating surface in relation to the length, making it desirable to proportion boilers upon more uniform methods in which these variable factors are given due consideration.

The writer collected a considerable amount of data on this subject and drew up a report with the object of reducing this matter to a more uniform basis, substituting for the ratios hitherto employed, cylinder horsepower requirements. Suitable values were assigned to grate surface, tube heating surface, etc., with corresponding evaporative values, so that the balance between the amount of steam required by the cylinders and the amount of steam which the boiler was capable of generating could be expressed in percentage of cylinder horsepower. The tests made on sectional boilers on the Northern Railway and the Paris, Lyons & Mediterranean Railway of France, those of Dr. Goss on a Jacobs-Shupert boiler, and tests by the Pennsylvania Railroad on the Altoona testing plant were examined in order to obtain data on which to base the evaporative values of different points of the boiler. It is obvious that the evaporative value of a boiler tube of given diameter varies greatly with its length. The temperature of the firebox is fairly constant under similar conditions of draft and rate of combustion, therefore the temperature of the smokebox will be reduced with an increase in the tube length. While some additional draft will be required to draw the gases through the tube, yet the net result is a greater temperature absorption between the firebox and smokebox. The thermal efficiency of the engine is increased within certain limitations by the use of long flues. The economical length of tube is determined mostly by the number and arrangement of wheels of the engine required and only partly by thermal conditions.

About 1899 the wide firebox Atlantic (4-4-2) type was introduced. Because the firebox was placed behind the driving wheels, the grate surface could be made to suit the power of the locomotive. It was, therefore, no longer necessary to force the rate of combustion as heretofore, to 180 and 200 pounds per square foot per hour. Very uneconomical results had been obtained when high rates of combustion were necessary, as much unburned coal was drawn through the tubes into the smokebox and thrown out through the stack by the violent draft. With the Atlantic, tubes of 15 and 16 feet, and sometimes longer, were necessary. While at first some apprehension from leakage was felt with tubes of this length, it was soon found that there was no more difficulty in maintaining long tubes in good condition than short tubes. With the introduction of the Pacific (4-6-2) type, the Mikado (2-8-2) type and other locomotives having trailing trucks, still longer tubes were required. Tests made on long-tube boilers, compared with older locomotives having shorter tubes, showed a noticeable reduction in smokebox temperatures.

Instead of the old arbitrary and unsatisfactory method of designing heating surface by cylinder ratios, the idea of using the cylinder horsepower suggested itself as forming a very desirable basis. Curves were prepared from the most recent available data showing speed factors or drop in mean effective pressure in relation to velocity.

* Extract from discussion of paper on "Steam Locomotives of To-day," presented at the last annual meeting of the American Society of Mechanical Engineers.

With saturated steam the average maximum horsepower is reached at about 700 feet piston speed per minute, speed factor 0.412; constant horsepower is obtained at 700 to 1,000 feet piston speed, and then slightly decreasing at higher velocities for average conditions when engines are especially constructed for the highest speeds. For superheated steam the average maximum horsepower is reached at 1,000 feet piston speed, speed factor 0.445 and constant horsepower at higher speeds. Because the horsepower is based on piston speed, the stroke and diameter of wheels are omitted in the following figures, the calculation for saturated steam becoming by cancellation:

$$\frac{0.85\,P \times 0.412 \times 1{,}000 \times 2A}{33{,}000} = 0.0212 \times P \times A,$$

in which

A = area of one cylinder in square inches,
P = boiler pressure,
0.412 = speed factor.

In a similar manner the horsepower calculation for superheated steam becomes

$$\text{horsepower} = 0.0229 \times P \times A,$$

using 0.445 as the speed factor.

The maximum horsepower can sometimes be increased when the locomotive is operated under the most favorable conditions. It is considered safer to take figures which represent average conditions rather than the unusual figures obtained when all conditions are most favorable.

The horsepower basis affords many additional advantages in designing locomotives. For instance, in determining the maximum amount of water and coal required per hour, the size of the grate is found to be proportional to the amount of coal that can be burned to the best advantage, to be varied according to the quality. Knowing the amount of coal required per hour directs attention to the question of hand firing or the use of a mechanical stoker. Knowing the amount of water evaporated per hour determines the location of water stations, size of tender and tank, and also forms the basis for other features of the boiler, such as stack, size of injectors, safety valve capacity, and the size of steam pipes.

From the reports of Pennsylvania Railroad testing plant at St. Louis and Altoona, and from road tests, the conclusion is reached that a horsepower can be obtained from 25 to 29 pounds of saturated steam in simple cylinders with piston speeds of 700 to 1,000 feet per minute. A fair average value has been taken as 27 pounds, and in a corresponding way 23½ pounds for compound engines, 20.8 pounds for steam superheated 200 degrees and over, and 19.7 pounds for superheated steam used in compound cylinders. These figures provide steam for auxiliaries. While careful tests show that the evaporation can be increased under the most advantageous conditions, it is considered better practice to take the lower figure in order to provide a margin for average conditions.

Pyrometer tests recently made by the Pennsylvania Railroad at Altoona with various locomotives on the testing plant showed the temperature curves of tubes of various lengths and diameter. From these curves the increase or decrease of tube evaporation may be calculated. Short tubes have much greater evaporative value per square foot of heating surface than long tubes, but they discharge the gases into the smokebox at much higher temperatures. Therefore, while the heat absorbed per foot of length is much greater for short than long tubes, it is not so economical, and the short tube boiler, other things being equal, requires more coal for a given evaporation. Where tube lengths of 12 or 14 feet were common fourteen or fifteen years ago, lengths of 20, 22 and even 24 feet are used in the modern locomotive. The result is that the smokebox temperatures have decreased from 750 to 800 degrees to 550 to 600 degrees, the only increase of energy required being the slightly greater draft in the smokebox to pull the gases through the long tubes. This is not intended as a defense of the long tubes in modern engines, especially of the 4-6-2, 4-8-2, Mallet and other types, because in most cases their construction requires long boilers. Nevertheless tests show that economy results from the better utilization of heat in the modern engine than in older types because the range of temperature between the furnace and the stack is greater with the long tube locomotive.

As a result of these investigations conclusions have been arrived at as follows:

Firebox Evaporation

An evaporation of 55 pounds per square foot of firebox heating surface, combustion chamber and arch tubes has been adopted. The greater absorption of heat by the firebox than by the rear portion of tubes per unit of area is largely due to radiant heat. This varies as the square of the distance from the surface of the fire to the sheets separating the gases from the water. Again, it is probable that within certain limitations the amount of heat absorbed is independent of the heating surface and is a function of the grate area or the area of the bed of live coals. Assuming that there is sufficient heating surface to absorb the radiant heat, it is probable that very little additional heat will be absorbed by increasing the firebox heating surface. It therefore follows that the relatively greater area of the fire in proportion to the absorbing surface in wide firebox locomotives is more efficient than in the old narrow firebox.

Diameter, Length and Spacing of Tubes and Flues

The evaporative value in pounds of water per square foot of outside heating surface has been approximately calculated for 2-inch and 2¼-inch tubes, and for superheater flues of 5⅜ inches and 5½ inches. The range of length is 10 to 25 feet, and the spacing 9/16 inch to 1 inch. The best available data show that the evaporative value of a tube or flue varies considerably with differences in length, diameter and spacing. Curves of temperature compared with length have been used as a basis for determining the evaporation for different lengths of tubes and flues. The rate of evaporation on this basis will vary directly as the difference of temperature of the tube or flue gases and that of the steam contained in the boiler.

Tubes and flues from 10 to 24 feet long, spaced 9/16 inch to 1 inch, outside diameter 2 inches, 2¼ inches and 5½ inches, will evaporate from 7.50 to 14 pounds per square foot per hour.

Grate Area

Grate area required for bituminous coal is based on the assumption that 120 pounds of coal per square foot of grate per hour is a maximum figure for economical evaporation. While 200 and 225 pounds have at times been burnt in small, deep fireboxes and the engines made to produce sufficient steam, it is wasteful of fuel and it has been found, after numerous and careful tests, that the evaporation per pound of coal under these conditions is very low. If the rate of combustion is too slow, economical results will not be produced owing to the fact that at least 20 percent of the coal burned produces no useful work in hauling trains, but is consumed in firing up, waiting at roundhouses or terminals, on side tracks, or to the fact that the greater portion of the time locomotives are used at considerably less than their maximum power.

For hard coal the grates should be proportioned for a range of from 55 to 70 pounds of coal per square foot per hour, according to the grade of the fuel.

Complete tables of horsepower for saturated and superheated steam, evaporation of tubes and flues of various length, diameters and spacing, and diagrams of temperature of flue lengths have all been prepared to facilitate the calculations in determining the proportions of grate, firebox, tube and flue heating surface.

It must be remembered, however, that the boiler capacity for a locomotive, when other things are in proportion, cannot usually be made too large within the permissible limits of weight, and it can be shown by numerous tests that such increase in boiler capacity makes for considerable economy in the use of fuel and steam. For passenger service the boilers may often be made with advantage over 100 percent.

In a general way, a boiler will have ample steam-making capacity if proportioned by this method for 100 percent, provided the grate is sufficiently large and deep, so that the rate of combustion at maximum horsepower does not exceed 120 pounds per square foot of grate per hour for bituminous coal of average quality. For gas coal a smaller grate may be used, but it is better practice to use the larger grate and brick off a portion at the front end in order to obtain sufficient volume of firebox for proper combustion, because nearly all large modern engines are deficient in firebox volume.

Grate Area, Volume, Firing Clearance and Air Supply of Fireboxes*

From a furnace point of view, the principal points to be considered are grate area, flameway or volume, firing clearance and air supply. From the boiler point of view we must consider the extent and location of the heating surface.

In order to secure high efficiency the grate area should be sufficient to keep the maximum rate of combustion below 100 pounds per square foot per hour at full boiler capacity, as the losses due to imperfect combustion, cinder discharge, front-end gases, radiation and unaccounted-for losses increase rapidly above this rate, with a corresponding decrease in boiler efficiency.

The high efficiency at lower rates of combustion is due not only to a reduction in the heat losses enumerated above, but also to the relatively large proportion of the total evaporation that takes place around the firebox. Most of the heat received by the firebox heating surface is radiated directly from the fuel bed and luminous flames, only a small amount being due to convection or direct contact. The amount of heat received by radiation depends on the area of the radiating surface and the difference in temperature between the radiating and cooling surfaces.

Flues receive their heat by convection, and the amount of heat so received, other things being equal, depends on the weight of the gases going through them. This varies with the rate of combustion, and as this rate increases the flue evaporation increases. Under the same conditions the firebox evaporation increases somewhat, due to the slightly higher temperature and increase in mass of flames, but not nearly as fast as the flue evaporation.

High firebox evaporation means high boiler efficiency, for the high heat absorption by the firebox reduces the temperature of the gases entering the flues; and for any one boiler, the temperatures of the gases entering and leaving the flues are directly proportional when reckoned above steam temperature. Hence a lower temperature of entering gases means lower front end temperatures and an increase in efficiency.

A large percentage of the bituminous coal burns above the grate as gas. The rapidity and completeness of the combustion of these gases depend on the amount of oxygen present and the thoroughness of the mixing. In a firebox with 60 square feet of grate, with a rate of combustion of 60 pounds of coal per square foot of grate per hour, an air supply of 20 pounds per pound of coal and an average firebox temperature of 2,000 degrees, the volume of the gases evolved is about 1,200 cubic feet per second. A firebox of this size would have a cubic capacity of about 200 feet, and would have to discharge and be refilled with gases about six times per second. The average time available for combustion of each particle of gas would be insufficient for complete and proper mixing by diffusion. With the short time allowed, it is necessary to mix the gases by mechanical means, and this is generally accomplished by an arch or baffle which forces the gases through a restricted area, this area being not less than the net flue area.

Mere firebox volume is not sufficient of itself. It is necessary to have a flameway of such cross-section and length as to mix the gases intimately and provide sufficient space for burning before gases reach flues. In an ordinary firebox, without baffle or combustion chamber, the average length of flameway is only 5 or 6 feet. By the introduction of baffles and combustion chambers this length can be increased from 10 to 15 feet, which results in not only more complete combustion but also increased radiating surface, with a corresponding increase in firebox evaporation and a lowering in temperature of the escaping gases.

High efficiency is obtained at low rates of combustion in spite of the large air excess. The firebox absorbs a larger percentage of the heat evolved, and the amount so received depends primarily on the temperature of the fuel bed. It is possible that this temperature is higher with large air excess.

Firebox evaporation depends primarily upon the extent and temperature of the radiating surfaces and not on the extent of the heating surface. Increasing the firebox heating surface without increasing the grate area or flameway will result in very little increase in evaporation. An evaporation of 60 pounds of water per square foot of firebox heating surface requires a difference of less than 100 degrees between the water and the fire side of the sheet. If sufficiently high firebox temperatures or radiating surfaces could be obtained it would be possible to increase this high rate of evaporation without forcing the heating surface to its capacity.

In the Coatesville tests the two fireboxes gave an evaporation as high as 58 pounds of water per square foot of heating surface. There was practically no difference in the total evaporation by each of the fireboxes when working at the same rate of combustion and with the same grate area. One of the fireboxes had 12 percent more heating surface than the other.

Unless the fuel is materially changed, we are not likely in the near future to see any radical departures from the present type of firebox. Any improvement in the firebox efficiency will be obtained by paying particular attention to and making ample provision for grate area, firing clearance, gas mixing, flameway or combustion chamber space, and air supply.

* Extract from discussion by J .T. Anthony of paper on "Steam Locomotives of To-day," presented at the last annual meeting of the American Society of Mechanical Engineers.

A Complex Pipe Layout

Development of Patterns for Elbows Intersecting Main Pipe at an Angle

BY J. L. WILSON

A drawing similar to Fig. 1 is usually made from which the layer out must develop a pattern for each of the various sections of the pipe to be developed. In Fig. 1 the pipe is drawn as though it were a continuous surface, in other words, the parts are made to fit end to end and no allowance has been made for laps or seams throughout the problem.

Even with sufficient information, it is frequently a difficult problem for the draftsman to lay out the various views of the pipe with a true outline of the intersections of various parts on the shop drawing. It is therefore usually left to the layer out to do this, and the draftsman simply approximates to the outlines (ellipses) of the various intersections. The pipe as shown consists of a main lead having two elbows leading to openings offset 18 inches from the axis of the pipe, the elbows to lead 30 degrees from the vertical through the axis of the pipe, and finally turn into a horizontal opening. The flanges, etc., have been left off the shop drawing, Fig. 1, in order that the drawing may be more clearly referred to.

Let us first develop the elbow opening at *C*, Fig. 1. This requires a pattern for sections marked *F*, *G*, *H* and *M*, and also the profile of the end of the pipe, as at *B*, Fig. 1.

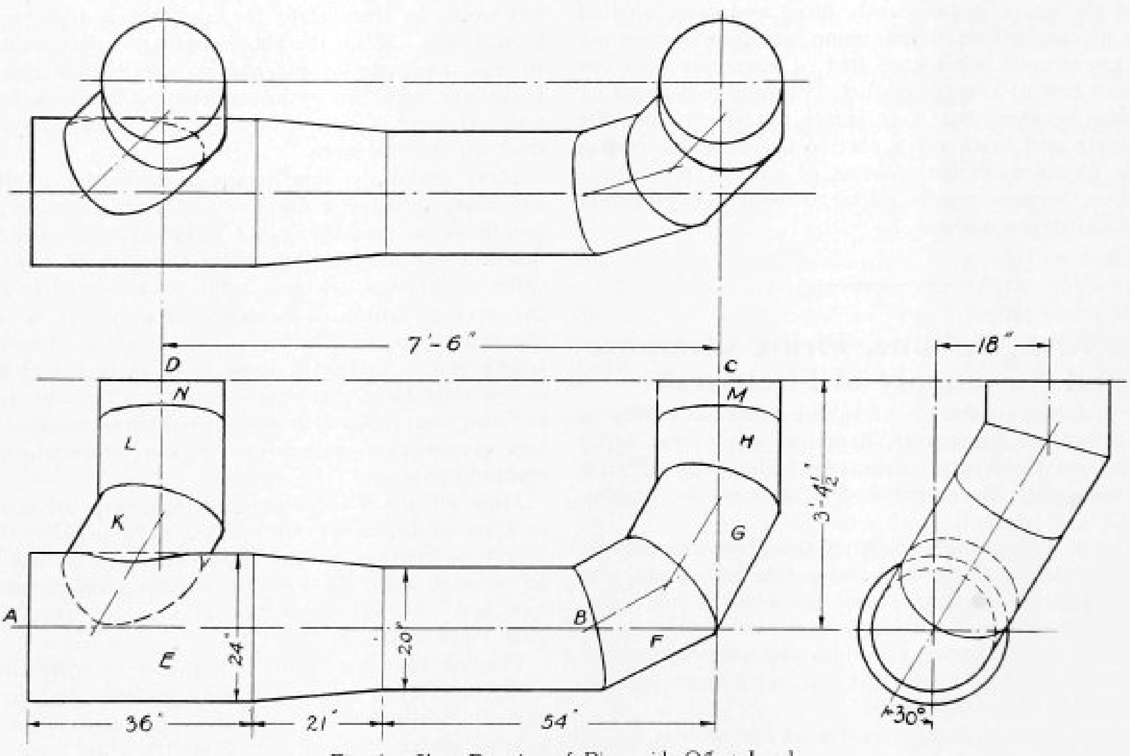


Fig. 1.—Shop Drawing of Pipe with Offset Leads

Laying Out Surface and Subdividing

Referring to Fig. 3, the end view is redrawn by first drawing a circle about *S* 20 inches in diameter and at 30 degrees to the vertical, drawing two lines tangent to this circle as the outline of the elbow, end view. The upper part of this must connect with the horizontal plane, however, with *T* as a center, *T* being 18 inches out from the vertical. This is easily done by laying off 10 inches on both sides of *T* and drawing the two short vertical lines to finish the outline of the end view.

Now in order to see the sections of the elbow in their true size and position relative to each other, we must look at it in a direction at right angles to its axis, as shown in the end view. This view is represented to the left of the end view in Fig. 3 and is drawn by projecting an axis through *S* at 30 degrees to the horizontal and assuming some axis at right angles to it through some point as *O*. Point *O* is taken on this latter axis at a distance of 2 feet 6 inches from the one through *S*. This is done because the elbow is required in this particular problem to have a turn with radius equal to 2 feet 6 inches.

Then with *O* as a center and radius equal to 2 feet 6 inches, draw an arc from *V* to *W*. Tangents are drawn to this arc at points *W*, *G*, *F* and *V*, as shown, forming the respective axes of each section of the elbow. By projecting the outlines of the cylindrical elbows, as shown, this view is easily completed.

Now to subdivide the surface in each view we divide the lateral surface by lines called elements—that is, the sides of the cylinders are divided by lines drawn parallel to their axes and dividing the surface into a number of equal parts, twelve in this case.

To do this we draw a half end view and divide it into six equal parts, as in the semi-circles above *T*, for each view. These are numbered for convenience in locating corresponding elements in each view. By projecting these points of division down to their respective views, as shown, we can draw the elements on the various sections parallel to their axes, and thus obtain the necessary subdivision of their surfaces for laying out the developed pattern. The extremity of the pipe or its opening at *T* is easily

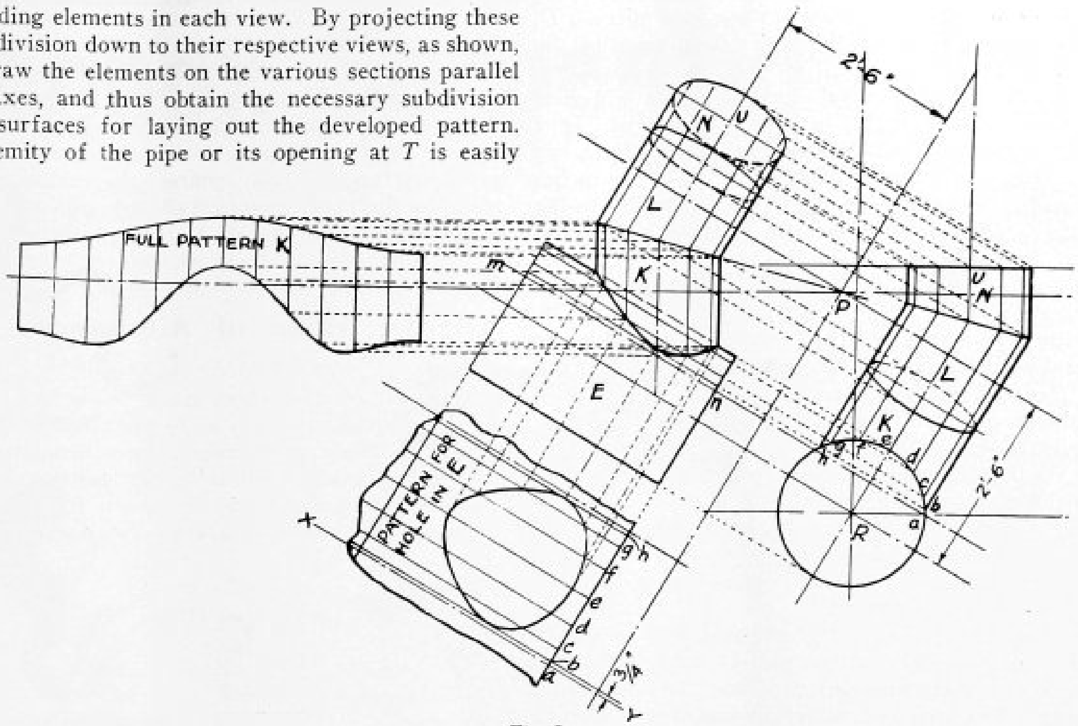


Fig. 2

drawn in the view at the left by projecting the various points over from the corresponding elements in the end view. This will give us an ellipse and the same can be done for the intersection at *S*, being careful to use only corresponding elements in projecting the various points. The intersections between *W*, *G* and *F* can also be brought over into the end view by following the same process.

The half-pattern for section *M* is easily obtained by laying off half the circumference of the section on a horizontal line, as through *T* in the end view, and dividing it into six equal parts by seven lines at right angles to it and representing elements. The lengths of the corresponding elements are then projected over and a curve drawn through their extremities, giving the outline of the half pattern.

Following the same process we can develop or roll out the full pattern or half pattern, as the case may be, of all of the various sections of the elbow. A full pattern

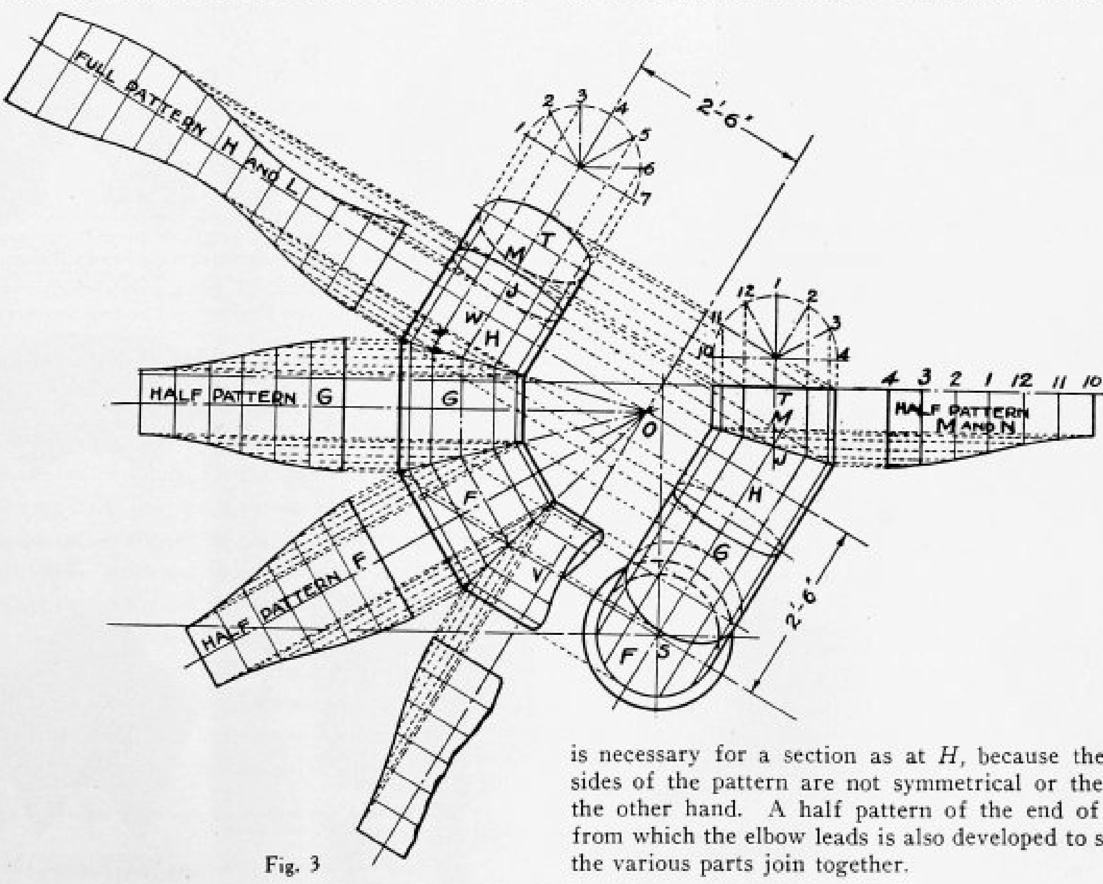


Fig. 3

is necessary for a section as at *H*, because the ends or sides of the pattern are not symmetrical or the same to the other hand. A half pattern of the end of the pipe from which the elbow leads is also developed to show how the various parts join together.

In order to develop the section leading into opening *D*, Fig. 1, we must also develop the intersection made by the elbow and the pipe itself, requiring only one extra operation compared to that already described. The end view and the view at right angles to it are laid out in Fig. 2 in exactly the same manner, only that at *R*, Fig. 2, we have a circle of 24 inches diameter instead of 20 inches as at *S*, and we have one less section of elbow due to the increased diameter of the pipe and because it does not lead from the end of the pipe. The point *P*, Fig. 2, corresponds to *O*, Fig. 3, and is used as a center for curve of the elbow.

The intersections are obtained in the same manner as before and should offer no difficulty except that between sections *E* and *K*. The elements, laid out as previously described, intersect the circle about *R*. These are projected over to section *E* and drawn as elements of that section. As before, corresponding elements intersect each other in the points giving the outline, as shown between *K* and *E*. The patterns for *N* and *L* are exactly the same as those for *M* and *H* and need not be again developed.

The pattern for section *K* is laid out as shown, but need not be drawn as a full pattern.

To develop the hole in *E* for the intersection or end of section *K*, we must roll out that part of it, including the hole together with the included elements. The horizontal axis through *R* is used as a reference line from which to lay out the hole, since we must not only know the shape of the hole, but we must also know where it is to be cut. Let *a* be the point where this axis cuts the circle about *R*, or the surface of the pipe. This is represented by *m-n* in the other view, Fig. 2. In the pattern draw *x-y* to represent *m-n* and on a line at right angles to it lay off the various elements as shown by transferring points *b*, *c*, *d*, etc., from the circle in the end view to this line at right angles to *x-y*. Draw lines parallel to *x-y* through the points thus found and project corresponding points down from the curve of intersection between *K* and *E*. This will give the pattern for the hole in *E*.

Now the distance of the edge of the hole from the axis *x-y* can be found by transferring from the end view and equals *a-b* in this case about ¾ of an inch. The parts are easily joined together, as the elements throughout correspond for each section.

Heating Surface and Length of Tubes*

Some few years ago, when large boilers were designed, the tendency was to make the ratio of the firebox heating surface to the total heating surface less than 6. This practice resulted in locomotives which, while efficient in evaporation, were not free steaming, as they lacked capacity unless very heavily drafted. Firebox heating surface should be at least 7 percent of the total heating surface of the boiler. When this ratio is attained good results will follow provided the tube heating surface has been properly proportioned. It should be realized that firebox heating surface is of comparatively greater effectiveness at mean and low rates of working than the remaining surface of the boiler. When working at high rates of evaporation the tube surface is fully as effective as firebox surface, and for large capacity a large tube heating surface is necessary.

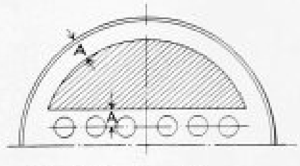
Beyond a certain length of tube there is too great a sacrifice of boiler capacity in the interest in economy in coal. The long tube presents a very serious resistance to the flow of the gases, and beyond a length—which appears to be about 100 internal diameters—this resistance increases without a corresponding increase in evaporation. The locomotive with a long tube is a slow steamer and a higher draft must be furnished in order to create an active fire. This rule—length of tube to be 100 times the internal diameter—has been applied to three new classes of Pennsylvania locomotives with exceedingly gratifying results; and confirms the earlier experiments made by the Pennsylvania Railroad upon this subject, as well as those made by M. A. Henry, of the Paris, Lyons & Mediterranean Railroad of France.

* Extract of discussion by C. J. Young of paper on "Steam Locomotives of To-day," presented at last annual meeting of the American Society of Mechanical Engineers.

Table of Allowances

BY WILLIAM A. MELLOR *

The table of allowances given below has been figured from the formulæ prescribed by the Ontario Boiler Rules, which are likely to become uniform throughout the Dominion of Canada. The table has been arranged in convenient size, so that it can be cut out from the magazine, or copied and placed in a loose-leaf pocketbook. It will be found useful by inspectors, draftsmen and boiler makers in general.



Sketch Showing Allowance

The formulæ used in figuring the allowances given in the table were as follows:

(I) For allowance in inches from flange of head =

$$\frac{1}{2}\sqrt{\frac{112 \times t^2}{P}}$$

(II) For allowance for support given by tubes =

$$\frac{1}{2}\sqrt{\frac{112 \times t^2}{P}} - \frac{d\,r}{2}$$

Formula I may be used instead of Formula II with reference to tube support by measuring from the center of the tubes instead of the edge.

112 = a constant,
t = thickness of head in sixteenths of an inch,
P = working pressure in pounds per square inch,
$d\,r$ = outside diameter of tubes in inches.

Thickness of Heads, Inches.	Working Pressures, in Pounds per Square Inch.													
	50	60	70	80	90	100	110	120	130	140	150	160	170	180
5/16	3.74	3.42	3.15	2.95	2.79	2.65	2.52	2.42	2.32	2.24	2.16	2.10	2.03	1.97
3/8	4.05	4.10	3.79	3.54	3.34	3.71	3.03	2.90	2.78	2.68	2.53	2.51	2.43	3.27
7/16	5.20	4.78	4.42	4.13	3.91	3.75	3.54	3.39	3.45	3.13	3.03	2.93	2.85	2.76
1/2	6.00	5.45	5.07	4.71	4.47	4.23	4.02	3.86	3.71	3.57	3.45	3.34	3.25	3.15
9/16	6.75	5.81	5.70	5.32	5.03	4.75	4.52	4.33	4.16	4.02	3.89	3.75	3.66	3.54
5/8	7.45	6.48	6.32	5.93	5.59	5.29	5.04	4.83	4.64	4.48	4.32	4.20	4.06	3.95
11/16	8.23	7.52	6.97	6.51	6.14	5.84	5.75	6.23	5.12	4.92	4.75	4.61	4.49	4.35
3/4	8.95	8.22	7.58	7.12	6.60	6.28	6.06	5.80	5.75	5.36	5.18	5.03	4.88	4.73
13/16	9.70	8.87	8.23	7.69	7.24	6.88	6.58	6.28	6.04	5.82	5.63	5.43	5.28	5.13
7/8	10.47	9.58	8.80	8.30	7.85	7.42	7.08	6.78	6.50	6.25	6.06	5.85	5.68	5.52
15/16	11.22	10.25	9.50	8.86	8.35	7.95	7.73	7.25	6.96	6.70	6.48	6.26	6.09	5.91
1	12.00	10.92	10.12	9.48	8.94	8.47	8.07	7.73	7.43	7.13	6.95	6.69	6.50	6.31

In practice, ta'e the nearest eighth below the above figures, as 3.91, take 3⅞"; 4.10, take 4", and so on.

* Draftsman with E. Leonard & Sons, Ltd., London, Ontario, Canada.

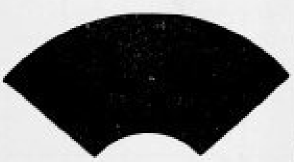
Lennox Serpentine Shear

SERPENTINE CUT

SIDE OF GEAR GUARD.

DEVELOPMENT OF CONE SHEET.

DEVELOPMENT OF SHEET FOR TAPERING BODY WITH OBLONG BOTTOM & ROUND TOP.



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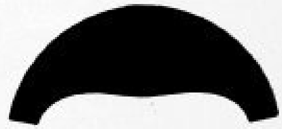
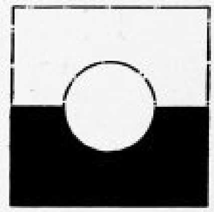
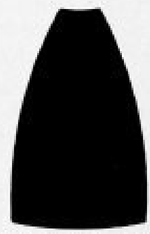


DEVELOPMENT OF CONE CUT ELIPTICALLY.

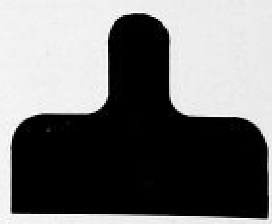


CULVERT SHIELD



SECTION OF HEMISPHERICAL TANK BOTTOM

OVAL SHEET



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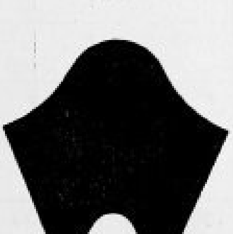
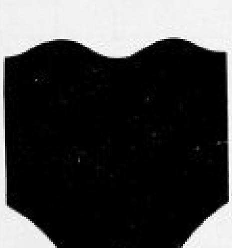
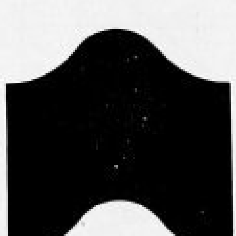


DEVELOPMENT OF OBLIQUE CONE SHEET



DEVELOPMENT OF SHEET FOR SLANTING TEE



DEVELOPMENT OF OBLIQUE CYLINDER SHEET.

DEVELOPMENT OF TAPERING ARM OF Y-CONNECTION.

Computation of the Thickness of Plates for Cylindrical Water Tanks, Standpipes, etc.

In the December, 1914, issue of THE BOILER MAKER there was given the derivation of the formula for the thickness of the plates in a tank or boiler to withstand any given pressure. This formula is:

$$t = \frac{W \times d}{2 e s}, \qquad (1)$$

in which t = thickness of plate,
W = safe working pressure,
d = inside diameter of boiler or tank (in inches),
e = efficiency of the joint,
f = factor of safety,
s = tensile strength of plate per square inch.

This formula applies to the calculation of the thickness of shell plates for a tank containing water or any other liquid, as explained below.

The pressure or load which tends to burst the plates of a cylindrical water tank is caused by the hydrostatic head of the water and the pressure exerted on any square inch of the inside surface of the tank is proportional to the height of the surface of the water above the particular unit of area under consideration.

A cubic foot of water weighs nearly 62.5 pounds, and if it is to be confined in any vessel, it will exert on each square foot of the bottom and sides of the vessel a force of 62.5 pounds for every foot in height that the surface of the water is above the area under consideration.

It is more convenient to consider the intensity of pressure in pounds per square inch, which can be done by dividing the pressure per square foot by 144. If we let h = height in feet of water, then the pressure per square foot

$$= P = h \times 62.5$$

and pressure per square inch

$$= p = \frac{h \times 62.5}{144} = .433\ h. \qquad (2)$$

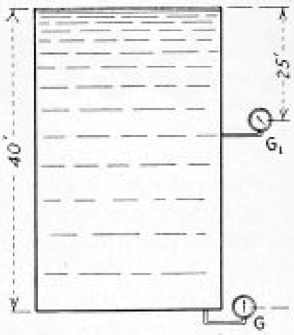


Fig. 1

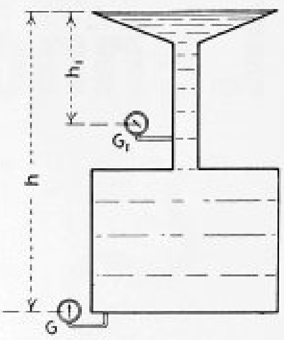


Fig. 2

To better illustrate the use and the meaning of this formula we can refer to Figs. 1 and 2, which represent cylindrical tanks containing water. These tanks are of different shapes, but of the same height. Pressure gages G and G_1, the same as used on a steam boiler, are shown connected to each tank at the same heights, h and h_1, from the center of the gage to the surfaces of the water. The

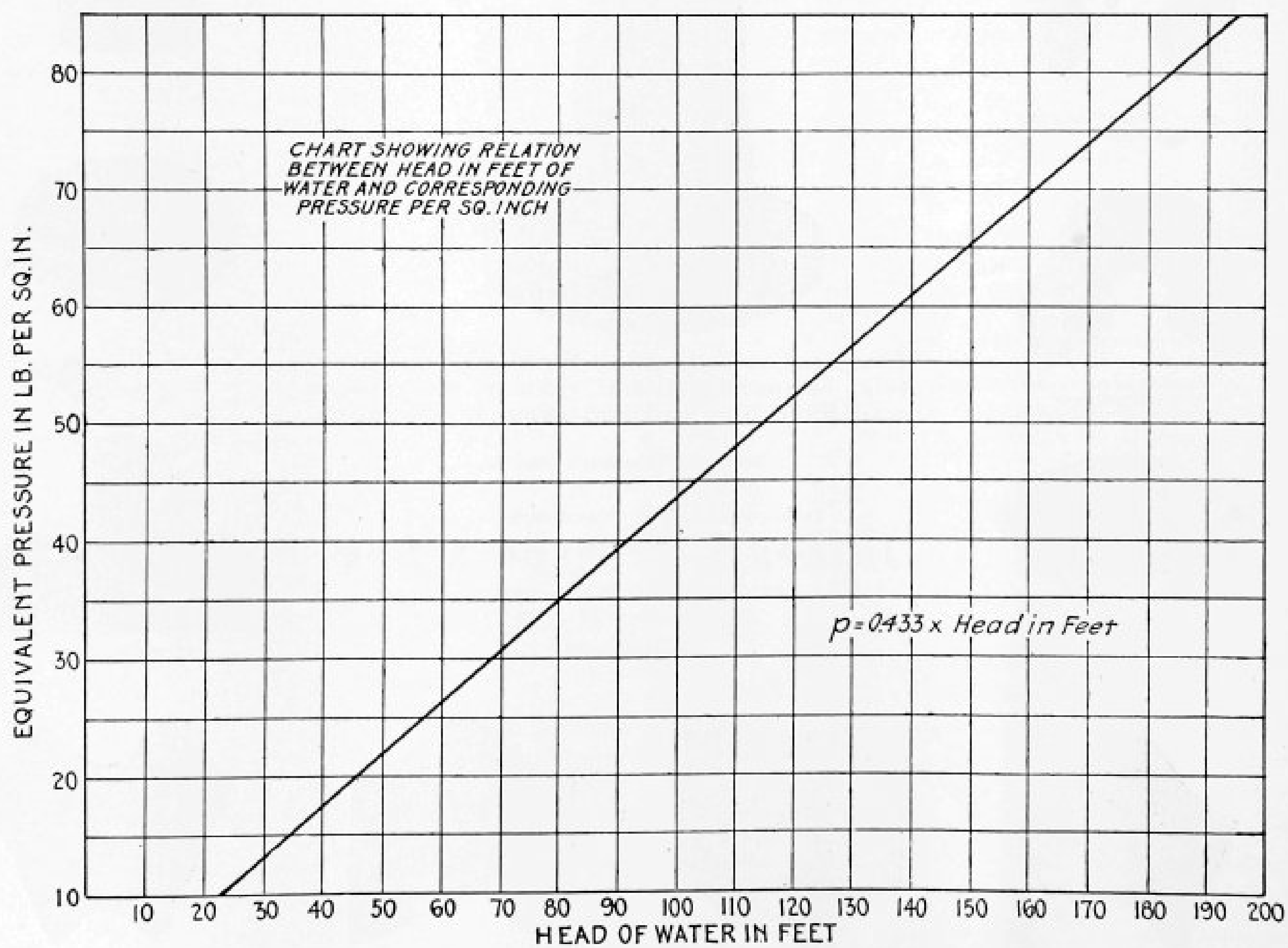


Fig. 3.—Chart I

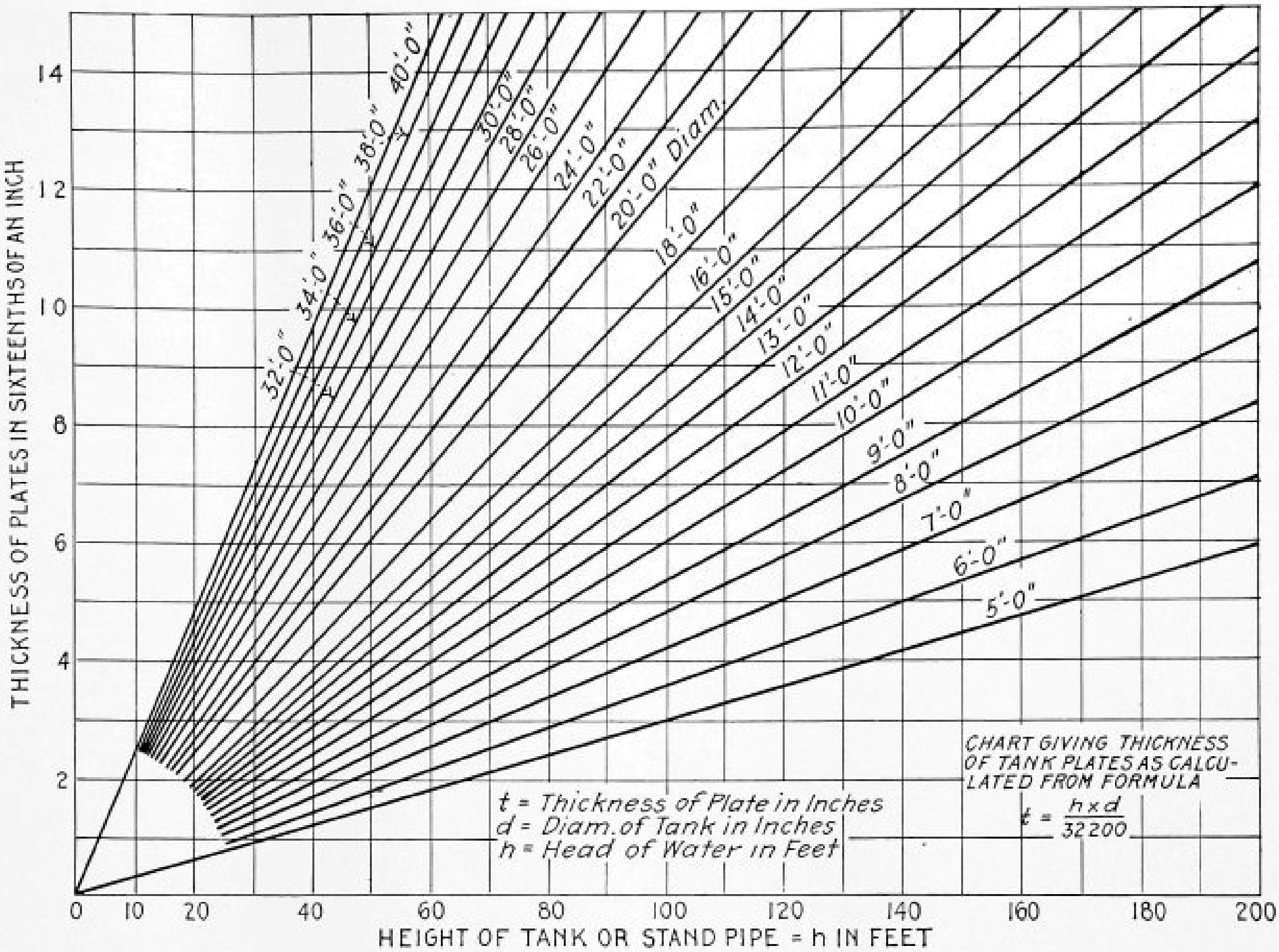


Fig. 4.—Chart II

reading of the gage G_1 will be $.433h_1$ pounds, and that of the gage G will be $.433h$ pounds. Though the shapes of the tanks are different, the reading of the two similarly located gages will be the same, which means that the pressure per square inch which is exerted by a body of water depends only upon the height of the water and is in no way affected by the shape of the containing vessel, nor upon the area of the surface exposed to the atmosphere. If h and h_1 in Figs. 1 and 2 are equal, respectively, to 25 feet and 40 feet, as noted, then the reading of gage $G = p = .433h = .433 \times 40 = 17.3$ pounds per square inch, and the reading of gage $G_1 = p = .433h_1 = .433 \times 25 = 10.82$ pounds per square inch.

If in equation (1) we put in place of W (safe working pressure) its equivalent for tank work, which is $.433\,h$, this equation becomes

$$t = \frac{.433\,h\,f\,d}{2\,e\,s}, \qquad (3)$$

from which formula the thickness of the plates for any given height of tank can be found.

Tanks are usually made in courses 3 feet to 5 feet high, and the height of the water above each course varies, so it is evident that the pressure exerted by the water grows smaller from bottom to top of tank. For this reason the thickness of the plates in the various courses can be decreased from bottom to top, each course being designed (with a factor of safety $f = 4$ to 5) to resist the pressure due to the head of water above the plates.

By inserting in formula (3) the following values, which are satisfactory for first-class tank jobs,

Factor of safety, $f = 5$.
Efficiency of joint, $e = .70$.
Tensile strength, $s = 50{,}000$.

The formula then becomes

$$t = \frac{h \times d}{32{,}200}.$$

By aid of Chart 1, the relation between head of water in feet and corresponding pressure per square inch can be ascertained at a glance. Chart 2 gives the thickness of plates for various tanks from 5 feet to 40 feet diameter.

To illustrate the use of the charts, let it be required to find the pressure per square inch on the bottom and the thickness of the shell plates in a tank 20 feet diameter by 40 feet high, made up of 5-foot courses. The head of water on the bottom and the lowest course of plates can be taken at 40 feet, which from Chart 1 gives a pressure of nearly 17.5 pounds per square inch of surface. By finding the line corresponding to a head of 40 feet on Chart 2 and following it vertically until it intersects the radial line for 20 feet diameter tank, we read off at the left of the chart the value of the thickness of plate = 4.8 sixteenths of an inch, or about 9/32. The plate would be amply strong if made of ¼-inch stock, though to allow for corrosion it would be better to make it of 5/16-inch material. The thickness of the second course from bottom can be found in the same manner for a head of 35 feet, which gives a thickness of about ¼ inch.

For liquids heavier than water, the pressure at any point due to hydrostatic head will be greater than that of an equal head of water and will be in direct proportion to the specific gravity of the liquid. Thus, if a tank 40 feet high, as assumed above, contains salt water having a specific gravity = 1.2, the pressure on the bottom of the tank will be $1.2 \times 17.5 = 21.00$ pounds per square inch, and the equivalent head of water would be $40 \times 1.2 = 48$ feet head. By using the equivalent head, the thickness of the tank sheets can be found in the same manner as for a water tank. G. M. K.

Syracuse, N. Y.

For the Benefit of Young Boiler Makers

BY E. WILLIAMS

I started in the boiler making business in a position that suited me splendidly. I was blessed with good health and strength and liked to handle a hammer and sledge. By taking good care of myself, hard work at that time did not bother me, as I took pride in it, and it developed me physically, so that I began to develop strength in my arms. I have never forgotten, however, what my father used to tell me; that is, always use your head and save your shoulders.

After being in the boiler shop for a year or so I became what they called a good helper. On account of my willingness to work both in the shop and outside, I was often sent out with the older boiler makers. I was always anxious to learn and was willing to take up any kind of work they would put me on. I never butted in, however, and gave no back talk.

After going out with the older boiler makers for some time, they began to jolly me about getting married. I told them that I would not get married until I made $3.50 or $4 a day, but they told me it was only layer outs that got that much money, so I said its the laying out for me then. I asked the superintendent what was the best way to start in to learn laying out. He asked me if I had any money to buy a complete outfit of drawing tools, including a board and T-square. I said I thought so, but, nevertheless, he invited me to go over to his house and afterwards took me downtown and bought me a first-class set of drawing tools at a lower price than I could have bought them for. He also advised me to subscribe for the *Sheet Metal Worker*, a magazine which was out at that time, and which gave a lesson every week on laying out tin plates. This was all right for the tinsmiths, but the articles in this magazine never dealt with heavy iron work or boiler work.

After a little time I learned how to lay out almost any kind of elbow, cones, Y-breechings, etc., but I was anxious for more than one lesson a week, so I joined the International Correspondence School at Scranton, Pa. At that time they did not have a boiler makers' course, so I went to the Y. M. C. A. They did not teach developing surfaces of heavy plates, but I took two courses there just the same. Just as I began to think there was no hope, as I had never seen any books on boilers, THE BOILER MAKER, or *Motive Power*, as it was first called, came into existence, and this braced me up better than a gusset brace would strengthen a return tubular boiler. I was fortunate enough to get the first number published, and, after going over it very carefully, I found advertised in it "The Boiler Makers' Assistant" and the "New Sheet Metal Worker Pattern Book," price $5. This book, however, was worth more than five times the price to me, so between THE BOILER MAKER and the books that I bought I was kept fairly busy for a long time.

After going through the "Metal Worker" I started in to study the bursting and collapsing pressures of boiler shells, and also how to figure out the safe working pressure of boilers, staybolts, braces, etc., and the horsepower of different boilers. This gave me so much information that, when I went out on any kind of a job, I always tried to figure out the allowable pressure for the boiler, especially on the staybolts and fireboxes. I knew that I was the only one in the shop studying this kind of work, so I used to ask the older boiler makers some of these questions.

They did not know really why they spaced the rivets in a patch just so far apart; that is, whether it should be 2⅛ or 2¼ inches between centers for any particular pressure. All they did was try to make the spaces so that they would look right after the patch was riveted up. They could never tell just what the spacing should be, but they would start off laying out the first holes at the calking edge, and mark all around the patch until they came to the last two or three holes; then they would have to rub all the marks off and go over the same performance three or four times until they finally got equal spacing for the rivets. That taught me that a pair of dividers was needed for repair work and I immediately bought a pair for fifteen cents. They always came in mighty handy.

After reading THE BOILER MAKER I learned that a tape was the handiest tool for circular measurements, and also that it did not take up any room in your pocket. As the tape cost $2.25 it was not to be lost through carelessness, and so it was always carefully taken care of.

One day the superintendent asked me if I was doing anything in the line of drawing. I showed him the drawings that I had made, and also the calculations that I had worked out. He gave me a good word of advice, and I have always stood by it. He said, "Never give up!" So I bought more books, such as "Mechanical Arts Simplified"; a course of engineers' books, published by the International Correspondence Schools; Audel's books, and many others, including Perkins' Tables for calculating the bursting pressures, strength of riveted joints, etc. No boiler maker that is interested in his trade should be without this book of tables, as it saves a lot of figuring, which is very tedious in calculating riveted joints, butt straps, etc. Using these tables also eliminates a lot of mistakes that are apt to be made in this kind of calculations.

Fifteen years ago they used to say that boiler making was in its infancy. To my mind it is still in its infancy to-day, for there are many things that we discover almost every day, and, unless a boiler maker keeps up with his studying he will soon drop far behind. If you are far behind, either try to catch up or else drop out; for, in the writer's opinion, there is no pleasure in being too near the bottom of the ladder. If you advance a step, hold on tight and get your wind, and try for another step. There's a song called "It's a Long Way to Tipperary but My Heart's Right There"; that is the way I feel about climbing the ladder in the boiler-making business. It's a long, long way to the top step, but, if my wind holds out I will try to reach it, for I find it a pleasure to study not only about boilers, but about everything connected with it from the time the water leaves the hydrant to the superheated outlet and still a little further.

If anyone is sufficiently interested to take up this study, he will find that there is a lot of work ahead, but it is well worth all the time anyone can put into it, as it places him in a position to talk with engineers and understand what they are saying when they are talking about such things as gases, pyrometers, calorimeters, thermometers, superheated and saturated steam, evaporation of water in the boiler and heat transmission. If you are familiar with such subjects as these, you will find that the people with whom you come in contact besides engineers will feel that they are not wasting their time talking to you. They will soon find that you know something about your business.

To-day I am studying more than I was fifteen years ago. In fact, I find that anyone who is willing is never too old to learn, so my advice to both young and old is to keep right at it, for you never know what there is in store for you. Mr. Wagstaff once said that it was thought by some people that boiler makers' brains consisted only of old rivets and broken staybolts. If that is so, they can be melted up and made good again. I must admit that the hard work and studying that a boiler maker must do before he can get fairly good pay is a hard road to travel. No one, however, will pay you wages for learning. The proper thing to do is to learn first and expect the pay afterwards. That is the trouble with lots of men to-day; they seem to think that the man who has climbed up to the top of the ladder is very lucky. They do not stop to think how many nights and Sundays he spent studying while they were seeking amusement.

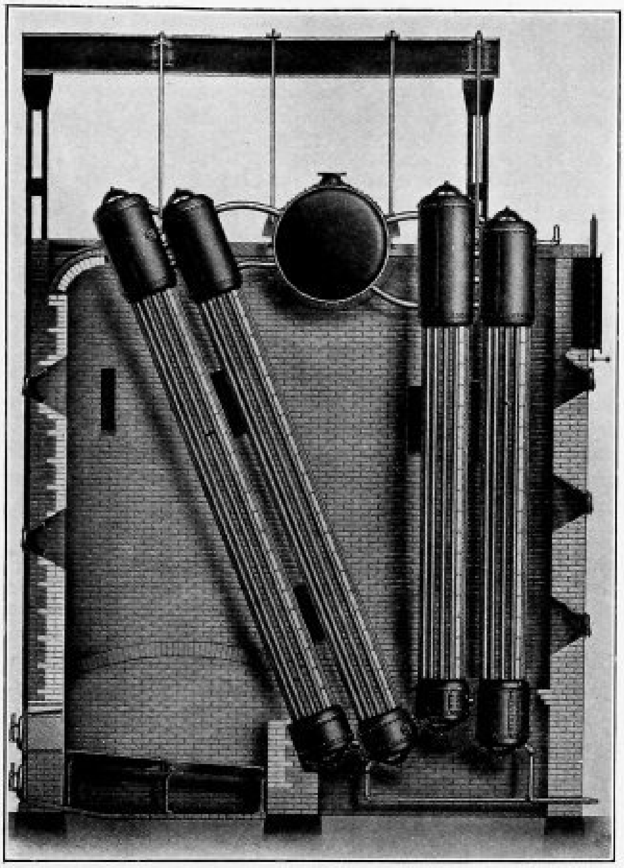


Fig. 1.—Bigelow-Hornsby Watertube Boiler

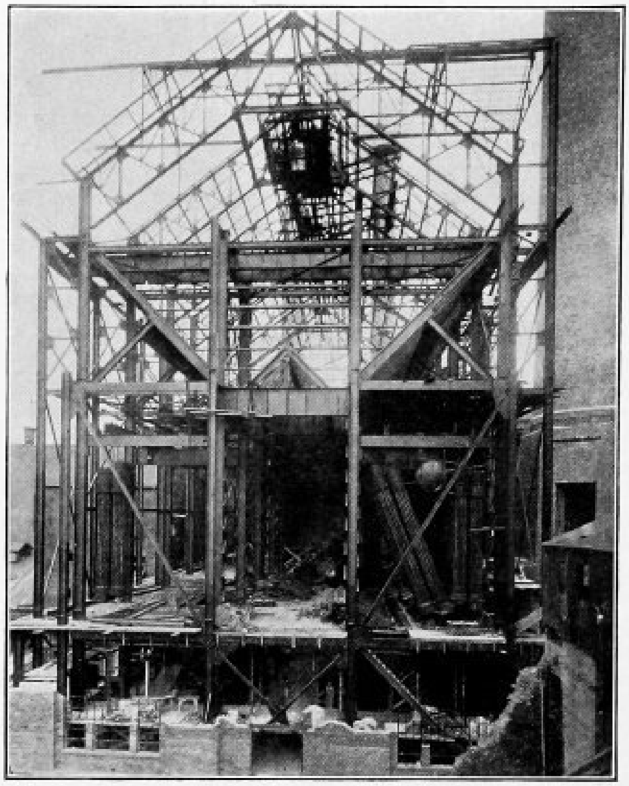


Fig. 2.—Erection of Bigelow-Hornsby Boiler

In the writer's opinion it pays to study an hour or so at night, as it will make the next day's work just so much clearer. If a man has to start the first thing in the morning to study out what both himself and his helpers must do to carry out the work, it will be all the harder for him mentally than if he had spent a few minutes the night before in planning everything out. Sometimes, of course, the best schemes and plans cannot be carried out the next day just the way you planned them. But it does pay just the same to make the plans. In fact, it is a money-saving and money-making way of doing the work. The writer has done his work in this way for years, and finds it a great help both in the shop and outside, not only to plan out the day's work ahead, but also to try to carry the work out in accordance with your plans. It also pays to think of more than one way of doing things, as the second thought may save time, expense and worry afterwards.

After starting in the boiler making trade I worked for the Bigelow Boiler Company of New Haven, Conn., for seven years, but at the end of that time I made up my mind to go West. First I went to Milwaukee, Wis., and I have always been glad that I did, as it pulled all my scattered senses together. I found out that the first thing I must do was to get a job.

The first firm I worked for was the Logerman Boiler Works, as no one else needed any boiler makers at that time. This concern was very good to me, and I started in doing a little chipping and calking with the air machine. The work was done, however, with square tools, whereas I had always been used to round-nosed tools. Next I was put on work prossering tubes. I was more used to the roller expander, but no one interfered with me and I got along finely. I then put in an application for a job as boiler maker at the Milwaukee Boiler Shop, a plant which had about the same equipment as the Bigelow Company, only the equipment was not so extensive.

I finally secured a position with them, and, after a few days' working in the shop, I was put on a piece of peculiar construction work. After going home I figured out the plates that were cut at the mills. They were all marked to be punched, but I found out that if the plates were punched as they were marked two-thirds of them would have been ruined. The next day I spoke to the layerout and told him that although I might be wrong I wished he would look over my figures and see if there were any mistakes. He was very much pleased and told the superintendent, and they gave me lots of credit for it. After that I became familiar with both the layerout and the superintendent, and they gave me lots of encouragement with a good share of the outside work.

A little later on I found a better job at the Illinois Steel Mills at Bayview, Milwaukee, as a repair man. This paid good wages and there was plenty of overtime, which suited me at that time. Their boilers consisted of return-tubular boilers, Heine & Sterling watertube boilers, large locomotives, small dinkey engines and small upright boilers. There was plenty of work to be done, not only on boilers, but also on blast furnaces and gas plants, all of which was very interesting and instructive. Although the "boss" could lay out, nevertheless he was willing to let anyone try it that understood such work. I was very fortunate in getting an opportunity to do the laying out on this work.

In 1907, when there were dull times all over the country, my old superintendent from the Bigelow Company happened to be out West and called to see me. He offered good inducements to work in New Haven again at the old stand, and so I have been with them ever since. I am an outside foreman boiler erector, erecting what is known as the Bigelow-Hornsby watertube boiler. This is one of the foremost watertube boilers on the market to-day for all purposes in mills, factories or large power plants. These boilers can be built from 125 to 2,500 horsepower and can be built to carry any pressure up to 200 pounds or over. Superheaters are connected with the boiler, if necessary, the superheater having been designed by the Foster Superheater Company.

The Bigelow-Hornsby type of boiler can be installed in almost any kind of space, and where it is necessary large units can be installed on very small floor space. To show the extent to which these boilers are used, there are over 20,000 horsepower in plants of the New York, New Haven & Hartford Railroad Company; there are 8,750 horsepower in the Cos Cob power station, consisting of fourteen boilers of 625 horsepower each. At Rochester, N. Y., there are six boilers of 875 horsepower each. In this case the boilers are 97 feet high from the ground line, or basement, showing that they can be installed in any place where it is possible to install any type of boiler. At Providence, R. I., there is a double-decked arrangement of eight boilers, four being on the first floor and four on the floor below. The boilers are placed directly underneath one another in order to economize floor space. The Bigelow-Hornsby boiler is a good boiler to take care of peak loads. They are baffled in such a manner that all of the gases pass over all of the tube-heating surface.

As a final word of advice to the younger boiler makers, I would say that there are lots of positions open at almost any time for the man who is trying to keep up to date and who attends to his own business. My advice to the young man is: Do not expect to advance to the top in a week or so, as most expect to do, but keep plugging away and you will find out some day that there will be a demand for your services. Study a few hours a week and follow up such articles as are contributed to THE BOILER MAKER by Mr. Forbes, Mr. Hobart and many others. I have profited greatly by these, and I wait anxiously for THE BOILER MAKER every month, and, no matter in what part of the country I may be, I have it sent from my home, and would feel lost without it. I have been a subscriber to THE BOILER MAKER ever since it was published, and would not be without it.

AN INTERESTING CAREER.—A man whose rise in the Pennsylvania Railroad service has been marked with a demonstration of unusual ability is A. D. MacCorkingdale, recently promoted to the position of foreman at the Meadow Repair Shops of that company. Born in Scotland, Mr. MacCorkingdale, at the age of 15, began his apprenticeship in the shops on the historic river Clyde. From there he entered the Technical College, where he gained distinction by winning numerous prizes and diplomas at the Sciences and Art Examinations held in London. Leaving school he completed his training in marine and locomotive work, including shipbuilding, following this occupation in different sections of the British Isles and on the continent. In the Fall of 1907 he came to the United States and began work with the Chesapeake and Ohio Railroad. From there he came to the Pennsylvania Road in April, 1908, commencing at the bottom of the ladder and advancing to the positions of inspector, gang foreman, assistant foreman and then foreman of his department, filling a very important position as expert.

Firebrick Arches*

About ten years ago very few railroads were consistently using brick arches. A number of roads were tolerating them in a very small percentage of their engines, and a large number had discarded them entirely.

As the locomotive itself has been greatly improved during the last ten years, so has this particular device. It has been shorn of many of its original faults, leaving its never disputed virtues standing out all the more prominently.

Briefly, the arch insures more nearly complete combustion. The combustion of high volatile coal at the rapid rates necessary to meet the demands for large hauling capacity is fraught with considerable losses due to incompleteness. That represented by the CO content in front-end gases is only a part. Losses from incomplete combustion of hydro-carbons may easily be four times that represented by the CO percent in the gas analysis. Anything that will mitigate these losses without introducing too high air excess reflects at once in higher furnace temperatures. Combustion chambers help by lengthening the flame travel, but the arch, especially the arch on watertubes, not only doubles the average length of the flame travel, but in addition possesses the more important virtue of a mechanical mixer.

By enhancing combustion over the fuel bed considerable more heat is evolved and higher firebox temperatures result. Authentic tests have shown that with certain coals this increase in temperature may be 15 percent. As a rule, these higher firebox temperatures are not accompanied with higher front-end temperatures. Thus the double result of creating more heat and causing it to be absorbed is accomplished.

Circulating tubes or arch pipes not only present the most effective heat transmitting surface, but the circulating effect is very important, especially at high rates of combustion. As the particles of gases must quickly touch the heat absorbing surface and give way instantly to other particles, so must the water on the opposite side of these surfaces, if a high rate of heat transfer is to be accomplished. Expedited circulation will insure this favorable condition. A locomotive boiler cannot give high duty per square foot of surface when the gases move leisurely.

Arch tubes, as they are now, give much aid, but there is still more to be done in this direction. Arch tubes or circulating watertubes through the firebox may be used in still greater number with good results, if properly arranged and disposed so as to aid in mixing mechanically and in circulating without too quickly lowering the temperature of gases.

* Extract from discussion by J. P. Neff of paper on "Steam Locomotives of To-day," presented at last annual meeting of the American Society of Mechanical Engineers.

The Boiler Maker

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We have an average of 2.31 paid subscribers per boiler shop (railway, contract and marine) in North America. More than half of these subscribers are either owners, managers, superintendents, foremen or layer-outs.

Our subscription books are always open for inspection.

5,300 copies of this issue were printed.

NOTICE TO ADVERTISERS

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

At the meeting of the Ohio Board of Boiler Rules, held on March 25, the new A. S. M. E. Boiler Code was put in force in the State of Ohio by the adoption of the following resolution:

"Until further notice an inspector holding a certificate of competency and a commission authorizing him to inspect steam or hot water boilers which are to be installed within the State of Ohio, is hereby authorized to inspect during construction and on completion stamp Ohio STD with serial number any boiler constructed in accordance with the rules formulated by the Boiler Code Committee as submitted to the Council of the American Society of Mechanical Engineers on February 13, 1915.

"(Signed) Ohio Board of Boiler Rules,
"H. V. Neff, Chairman."

Considering the fact that the State of Ohio has had in force for some time a code of boiler rules which have been very satisfactory, this action is certainly a very strong endorsement of the work done by the A. S. M. E. Boiler Code Committee, and it should assist very greatly in securing the adoption of the A. S. M. E. Code throughout the United States.

Further endorsement of the A. S. M. E. Boiler Code has also come from a meeting of representatives of the American Boiler Manufacturers' Association and of the National Tubular Boiler Association, held in Pittsburg on March 29, where the report and specifications of the A. S. M. E. Boiler Code Committee were unanimously adopted and ways and means were discussed for promoting the adoption of the standard specifications by the various States. This meeting gives to the A. S. M. E. Boiler Code an enormous impetus, as it puts back of it the endorsement of practically the entire boiler manufacturing industry. Not only does it emphasize the fact that the Boiler Code Committee of the American Society of Mechanical Engineers has done its work well and faithfully, marking the climax of a continuous effort for twenty-five years to get a standard specification that would be acceptable to engineers, manufacturers and users of boilers and boiler insurance companies, but it also shows that the A. S. M. E. Code is in itself as nearly right from a mechanical and engineering standpoint as it is possible to construct such a code. As both the Boiler Code Committee and its advisory committee have been continued by the Mechanical Engineers' Society, boiler users can be assured that such additions and corrections as time and the use of the Code may seem to justify will be made.

In addition to the official endorsements of the code that have been made, a number of prominent boiler manufacturers have announced that in future all their boilers will be made to correspond with the A. S. M. E. Code, regardless of whether they are required to do so by State legislation or not. Moreover, the representative of one of the most prominent boiler inspection companies in the United States has stated that hereafter all their specifications will be drawn to conform to the A. S. M. E. standard code. This in itself denotes the wonderful progress the code has already made, and it has been confidently predicted that within two years' time the A. S. M. E. Boiler Code will be a standard throughout the United States. The care that was used in its construction, and the authorities consulted and the fact that it has its conception in the greatest engineering society of its kind in the world, seem to justify this prediction.

One feature of the Code should not be overlooked, and that is that every boiler built to A. S. M. E. standards will be stamped with the A. S. M. E. seal. This seal is in the shape of a four-leaf clover, at the center of which is an "S," the bottom of the "S" being larger than the top, denoting stability. The idea of stamping boilers with this seal was that a man could remove his society pin, which is of the same shape and size as the seal, and thus check any boiler so stamped. When this stamp is placed on a boiler it shows that the boiler is constructed letter-perfect to the Code, and by one blow of the hammer and seal one hundred and fourteen pages of the Boiler Code Committee's work is vouched for.

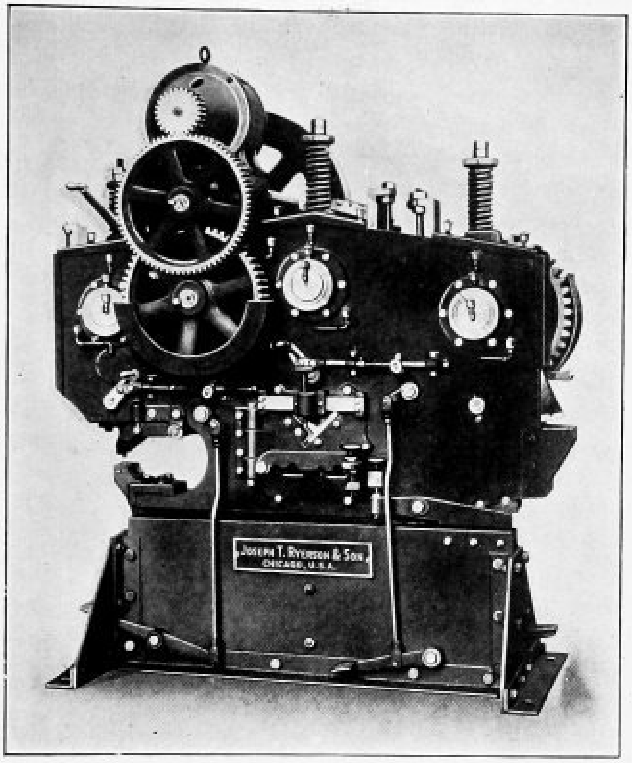
Another important result of the promulgation and adoption of this standard Code is the fact that boiler manufacturers in the United States, wherever the Code is adopted, are in a position to charge more money for their product than ever before, as the product carries with it a guarantee of safety and perfection entirely independent of the manufacturers' own claims in this respect, and therefore the net earnings of boiler manufacturers should be greater.

Engineering Specialties for Boiler Making

New Tools for the Boiler Shop and New Fittings for Boilers—Safety Appliances for Practical Use

Ryerson Quintuple Combination Punching and Shearing Machine

The quintuple combination punching and shearing machine illustrated, which has just been placed on the market by Joseph T. Ryerson & Son, Chicago, embodies five metal working machines in one, handling the punching, shearing, coping and notching work on plates, bars, angles, tees, beams and channels without the necessity of interchanging any attachments for the various operations. The punch or bar cutter and splitting shear can be operated independently by automatic clutches which can be thrown in either by hand or by foot levers.



Five Metal Working Machines Embodied in One

The frame of the plate shear consists of a solid steel offset shear body which permits the cutting of plates of any width or length. A hold-down which can be adjusted vertically and horizontally is provided with the splitting shear.

By an important arrangement of the bar-cutting device, angles, tees and round and square bars can be cut without any change of shear blades. The particular blade for shearing angles and tee-bars is of right angle shape which, it is claimed, produces a perfect cut without bending even the smallest and lightest sections. The shear blades are fastened to the slide in a simple manner, and are made in four pieces instead of one. Stationary blades are mounted on a hinged steel frame which enables the easy removal and grinding for any part of the shearing blades. Adjustable hold-downs permit the cutting of various materials to a perfect right angle and a special arrangement is furnished with the machine which allows the cutting of angles in miter up to 45 degrees.

The punching machine is equipped with a standard architectural jaw permitting the punching of I-beams, channels and similar sections in flange and web. A patented centering device is furnished with each machine, allowing the centering of the punch to the full length of the stroke of the plunger. A universal hold-down takes care of stripping any material to be punched.

In the coping and notching machine the heavy head of the splitting shear is provided with an extension to receive the die block for coping and notching work. This die block is of rectangular shape, permitting not only the standard coping of light I-beams and channels, but also the notching of angles, tees, Z-bars and other shapes.

The combination machine is equipped with steel gears with cut teeth throughout and can be furnished either for belt or motor drive. All gears are well covered with cast guards so as to insure safety and to conform to state laws for the protection of workmen. The machine is manufactured in four different sizes, the smallest weighing 3,000 pounds and requiring from 2 to 3 horsepower for operation, and the largest weighing 25,000 pounds and requiring 10 to 15 horsepower for operation.

A New Line of Cutting Tool Holders

J. H. Williams & Co., Brooklyn, N. Y., has placed on the market a complete line of metal-cutting tool holders, the distinctive feature of which is a cam lock for holding the cutting tools. This cam lock, shown in Fig. 1, provides a rapid and convenient adjustment and offers many distinctive advantages over old-style set-screw fastening types. It is claimed that the cam lock provides an increase of 75 percent in the holding efficiency. A small swing of a wrench, approximately 30 degrees, brings the lock into full and positive engagement from a loose fit and vice versa. Both countersunk and hexagonal nut type of cams are provided. It is obvious that this cam type of lock tends to eliminate the frequent damages that occur from twisting off a set-screw head or other holding device.

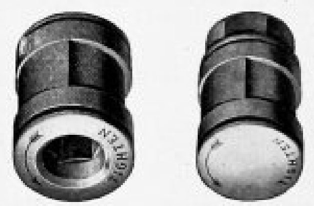


Fig. 1—"Agrippa" Cam Locks

The cam lock is applied to a number of different metal-cutting tool holders, a few of which are illustrated on page 127. Fig. 2 shows the Williams "Agrippa" turning tool holder furnished with either the countersunk or hexagonal nut cam lock. The cam fastener offers full freedom for operation without removal from the tool post and imposes no obstruction to cutting facilities. Fig. 3 shows the Williams "Agrippa" boring tool holder on which a universal cap affords a means for holding all intermediate size of rounds, hexagonal or octagon rods or bars within the limits of its capacity without the use of bushings, shims or other fillers. Two tightening nuts or screws are provided to secure greater rigidity and to divide the strain rather than apply it to a single bolt. On the boring bar a universal sleeve is used, making it suitable for either straight or angle cutters without the use of any additional parts.

Fig. 4 shows the Williams "Agrippa" planing tool holder, which has 28 adjustments as compared with seven in the standard tools commonly used. It will be noted

Fig. 2.—Turning Tool Holders

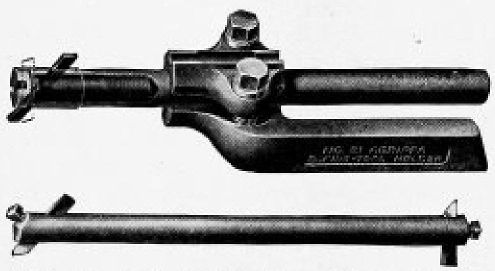


Fig. 3.—Boring Tool Holder and Boring Bar

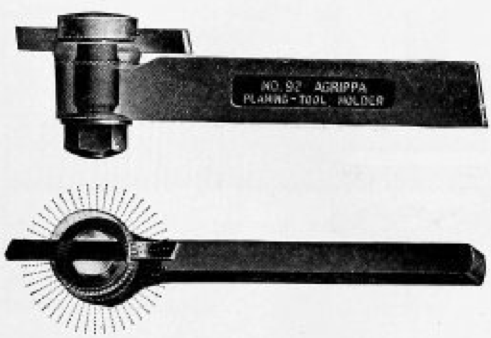


Fig. 4.—Planing Tool Holder

that there are 28 radiating serrations corresponding to similar ones in the washer, or adjustment ring. This ring is hardened in order to prevent wearing down of the cutter seat. The locking nut has a hemispherical seat which allows the nut to adjust its seat in line with the strain, thus eliminating side strains in the bolts.

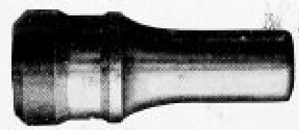
A complete line of cutters is provided for each different holder and for each special purpose.

New Pneumatic Hammer

An improved form of the Boyer Hammer has just been placed on the market by the Chicago Pneumatic Tool Company, 1026 Fisher building, Chicago. This hammer, which is No. 11, has a piston diameter of 1 3/16 inches, with a stroke of 11 inches and a capacity for putting down 1½-inch rivets. It strikes 700 blows per minute and weighs 31½ pounds. Owing to the extremely heavy blow of this hammer and the unusually severe blow it inflicts on the rivet sets, the so-called Parker set is used. The Parker set has a wide, tapering shoulder which, it is claimed, enables it better to absorb and withstand the effects of the heavy blows.

In common with the standard form of the Boyer hammer, this tool is divided into three distinct members—handle, cylinder and valve—which make for quick examination and economical upkeep and repairs. In each

No. 11 Boyer Hammer



"Parker" Rivet Set

of these members there is a moving part subject to wear, but in varying degrees. It is frequently possible to replace but one of these members and obtain a comparatively new hammer as a result. All parts are made interchangeable on jigs and templates.

The Never Slip Safety Clamp

One of the most valuable safety devices for use in a boiler shop is the "Never Slip" safety clamp, manufactured by the Never Slip Safety Clamp Company, 141 Broadway, New York city, for handling boiler plate. These clamps are made in two styles, one to handle horizontal plates (Fig. 1) and one to handle plates in a vertical position (Fig. 2). They are made of high-class openhearth steel and are annealed. The design provides for great strength, so that the clamps are practically indestructible, and consequently the first cost is the last cost. These clamps were patented May 31, 1904.

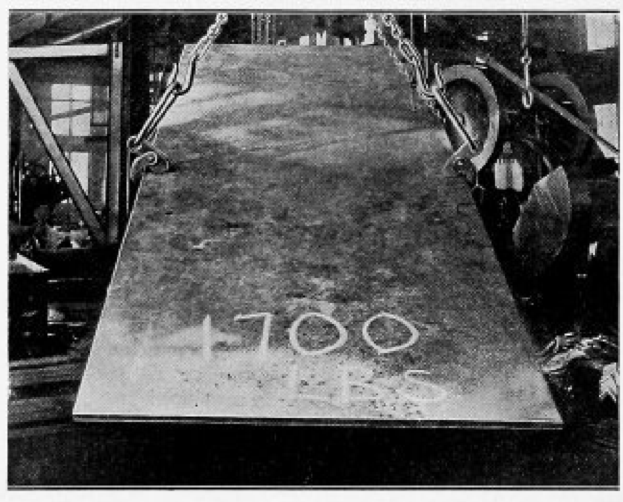


Fig. 1

The clamps consist of a heavy hook, in the eye of which is a short lever, one end of which bears against the plate and grips it securely against the jaw of the hook, while the other end of the lever is attached to the chain by which the plate is hoisted. The clamps are so designed that the point of pressure of the lever against the plate, whatever the thickness of the plate handled, is always over the center of the bearing surface of the hook or jaw. It is also always the same horizontal distance from the axis of the lever in the horizontal type of clamp, and the same vertical distance from the axis of the lever in the vertical type of clamp. Thus the ratio of the lever arms about the axis of the lever is constant, whatever the thickness of the plate handled.

This design gives the clamp the same strength for all thicknesses of plate; distributes the weight evenly on the jaw, and enables the clamp to withstand shocks from constant changes in load, etc. Furthermore, the crotch of the hook of the clamp, which in an ordinary hook of

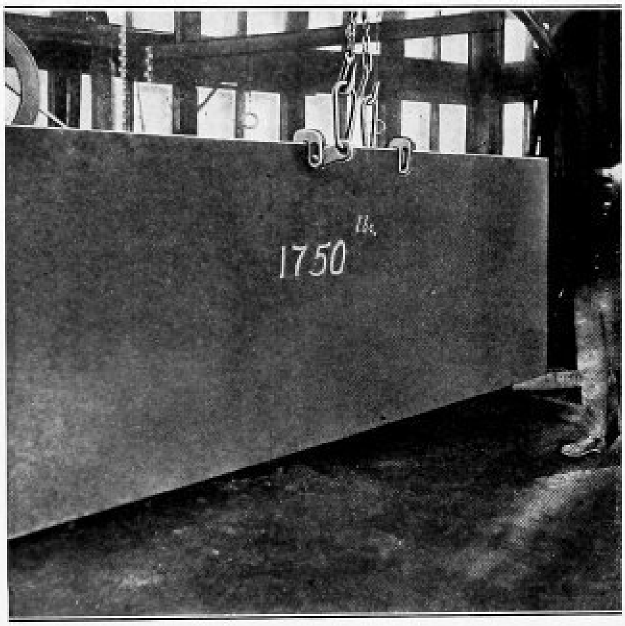


Fig. 2

this kind is usually the first part to break and is known as the dangerous section, is made very strong, so that it is practically unbreakable with any loads which can be handled. The slot for the lever is also brought entirely out of the dangerous section.

Of the horizontal type of clamps size No. 1 lifts plates up to ¾ inch thick and has a capacity of 6 tons per pair, or, in other words, is able to lift 400 square feet of plate with absolute safety. The weight of the clamps of this size per pair is 10 pounds.

Size No. 2 of the horizontal clamps will lift plates from ¾ inch to 1½ inches thick, and has a capacity per pair of 9 tons, or can lift 300 square feet of plate with absolute safety. The weight of this size per pair is 30 pounds.

Size No. 3 horizontal clamp will lift plates from 1½ inches to 2 inches thick, and has a capacity per pair of 12 tons, thus lifting 300 square feet of plate with absolute safety. The weight per pair is 72 pounds.

Size No. 1 of the vertical clamps will lift plates up to 1 inch thick and has a capacity of 4 tons per pair. The weight per pair is 56 pounds. Corrugations are provided on the jaw of the clamp.

Size No. 2 of the vertical clamps will lift plates from 1 inch to 2 inches thick, and has a capacity of 9 tons per pair, the weight per pair being 84 pounds. Corrugations are provided on the jaw in this case also.

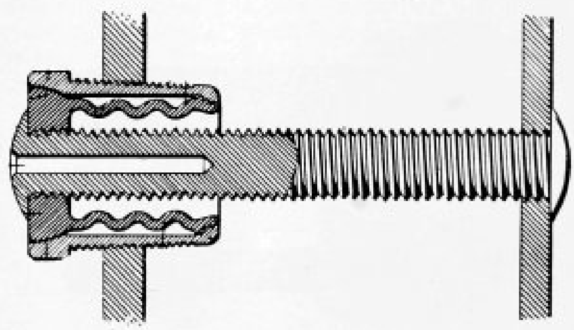
The vertical clamp, it is claimed, is the easiest and quickest attached and detached clamp for lifting plates in a vertical position that is made.

These clamps are adapted to lifting a number of plates at the same time, if they are of the same width. They are also adapted to lifting long plates without buckling when placed diagonally. For handling round plates only two of these clamps are required instead of three of the ordinary hooks, which are apt to slip. These clamps give a strong, tight grip and are very easily attached and removed. Their use saves considerable money by the avoidance of costly accidents, and adds materially to the safety of handling work over the heads of workmen.

The Never Slip Safety Clamp Company was awarded a bronze medal by the First International Exposition of Safety and Sanitation, held in New York under the auspices of the American Museum of Safety in 1913, and was also awarded a gold medal at the second American Exposition of Safety and Sanitation in 1914.

A New Type of Flexible Staybolt

The illustration shows a new type of flexible staybolt invented by Harry A. Lacerda, foreman of boiler work in the tank department of the West Albany Shops of the New York Central Railroad. The staybolt consists of an ordinary threaded solid staybolt driven by hand at both ends. The outer end of the bolt, however, engages a compensating tubular sleeve nut rigidly connected at the inner end with a plug screwed into the outer sheet. The outer end of the sleeve forms with the outer end of the plug a ball and socket joint of which the ball member is preferably on the nut and the socket member on the plug as indicated in the drawing. The inner end of the sleeve



may be screwed to the inner end of the plug, as shown in the illustration, or these ends may be welded together, or fastened by any other suitable means.

By the ball and socket joint connection between the sleeve nut and the plug in the outer wrapper sheet, the unequal expansion of the inside and outside sheets is compensated for by the movement of the ball member, which is free to turn in the socket, and also by the corrugated sleeve which yields sufficiently so that the ordinary staybolt is free to expand and contract in the direction of the axis of the staybolt, thus preventing undue straining of the inner and outer sheets.

The outer end of the bolt is provided with the usual tell-tale hole, and as both ends of the bolt can be headed up by hand, and as, after installation, the bolt can be tested by the ordinary hammer test, the bolt fully meets the requirements of the Federal Boiler Inspection laws, and can be installed and tested as easily as the ordinary rigid staybolt. It is claimed that the cost of manufacturing the corrugated sleeve nut does not exceed 8 or 9 cents per sleeve, as the work is done on an ordinary threading machine.

Letters from Practical Boiler Makers

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

Location of Blow-off

In the March issue of THE BOILER MAKER, on page 72, Mr. N. G. N. describes what appears to him a logical scheme for applying feed water connections to boilers through the blow-off. At the close he states that if there is a better scheme he would like to know about it. Therefore I submit the following:

All schemes whereby feed water is entering the blow-off or anywhere where the feed water is exposed to the bottom of the boiler, where the heating surface is, is a mistake on account of the variation of temperature from that of the plate where the gases come in contact.

Having had forty-four years of practical experience in both boiler making and engineering, my experience has taught me to agree with a good many thousands of engineers who have changed their blow-off to be attached somewhere near the front end on the top of the shell of a tubular boiler. This pipe leads from the top through the steam space sufficiently below the average waterline in the boiler without any tee attached at the bottom, but, on the contrary, with a straight opening downward. At the upper end a tee is attached, placing the side opening on the tee for feed water to enter and the top of tee to be provided with a brass plug so that at any time when cleaning the boiler, if necessary, this plug can be removed and the pipe cleaned at the bottom, where it naturally becomes clogged with scale. The cleaning apparatus commonly used is a tool similar to a flat or twisted drill, which has always proven to give the best results. Practical experience has demonstrated that feed water at all times should be fed in that portion of the boiler where the least evaporation takes place.

With reference to the construction of the blow-off pipe, this should not be more or less than 3 inches, of good extra heavy pipe with an extra heavy malleable ell at the bottom, well protected and kept free at the bottom to allow free movement to prevent springing to suit expansion and contraction conditions.

J. H. OPTENBERG.

Optenberg Iron Works,
Sheboygan, Wis.

Beginners at Laying Out

When people begin to do things in this world, almost immediately they begin to make mistakes, and one of the first mistakes most beginners make in sheet metal drafting is that they try to learn as little as possible instead of trying to learn as much as possible.

I wish to state here that the entire field should be thoroughly covered and the utmost pains should be taken to consider the problems from the standpoint of the best practice in modern shops. It is good for one to be original these days, but it is possible to go too far with this idea, as it has been found to be better and more sensible for us to profit by the experience of others. Every possible avenue should be explored and methods should be practiced to cover every case that we can imagine.

Most books published for layerouts seem to try to eliminate mathematics as much as they possibly can. This idea may have a place, but I have failed to find it yet, and I believe that every first-class layerout will back me up when I say that the very highest branches of mathematics would prove valuable to him, if he only possessed such knowledge.

There are many things young men get into their heads sometimes which should not be tolerated one moment. One is that they see no advantage in studying because they have no pull in the shop. This idea looks bright when you look at it from one side, and see the number of hours you would have spent at study and imagine somebody with a pull stepping in ahead of you, but it looks very dark when you look at it from the other side, when you look back and see that you have done nothing toward getting ahead in the shop, and when an opportunity presents itself you can only say: If I had only studied in the past and become proficient along this line, I would be able to accept this offer. On the other hand, if you had studied and become proficient in this work, then even if you did not get ahead, you would have the satisfaction of knowing that you have done your part, which is worth its weight in gold.

If after due consideration you find that under the existing circumstances, sheet metal pattern drafting would be the best step for you to take towards getting ahead, then I would advise you to make up your mind to be a first-class layerout and work to that end by starting at the bottom. It would be possible for a man to put up a few bricks here and there and build a house on them which would stand for a time under certain conditions. Likewise with the layerout; he can reach down and get a few of the foundation principles of laying out that would hold him up for a while, but let the hard knocks come and very likely he will fall. Let us build upon a good foundation; the more stones or bricks in this foundation, the stronger the structure will be, and each stone or brick in this foundation is just a little line, circle, triangle, point or any of those little things that go to make up the many exercises that we must practice if we wish to build a structure that will stand under any condition. In other words, we must either let the job master us or we must master the job.

Louisville, Ky. CLARENCE REYNOLDS.

Boiler Inspection

I see that the question has come up as to whether the railroads should inspect their stationary boilers or whether this inspection should be done by outside inspectors. In my opinion the railroads should by all means make these inspections. Also the government should have inspectors see that the work reported is done. The fault with the locomotive boiler rules at present is having the railroad company do the bulk of the inspecting on their own power. Every railway boiler inspector knows how hard it is to get all the work done which is reported. Some of the foremen are candid enough to say that, as they do not sign the papers, all they care about is to get them out. "Getting by" the district inspector is all they care for.

There is no question but what the law is a good thing, but, as most of the railroads are trying to make a record for themselves, it simply comes down to getting the engines out. Should the shop inspector raise too much trouble about the way the engines go out, he probably would not stay there long. Should he tell the district inspector about it, he is "in bad" with the district inspector, who will ask to have him removed, and, consequently, out he goes.

All shops are not the same, however, and some of the railroads are living right up to the letter of the rules, while others are doing just as little as they can and "get by." If the officers in charge show that they wish to have the rules lived up to, all of the men under them will get busy and do the work, but, should the officers show that they are lax in this respect, the men under them will be lax also.

The way to get all the work done is to have a government inspector for every shop of any size who will say what work shall be done and what work shall not be done, and also see that the work is done. Have him report direct to the district inspector, and receive his pay from the railroad company and make it so that he cannot be removed without an investigation. Then the excuses of no money, no men, short time, small appropriation, or light repairs will be over with. J. A. C.

Rolling Boiler Flues

I read D. G. Young's letter on "Rolling Boiler Flues" with great interest, inasmuch as he states that my method must be "slow." His method is doubtless much faster, and since he has had much more experience, I do not doubt but that he can judge with extreme accuracy just when he has rolled the tube enough. However, it is evident that a novice could hardly tackle the job of rolling flues with no other instructions before him than Mr. Young's description of his method. Experience is the thing that is necessary for rapid work.

I admit that I am dissatisfied with my own method. It *is* slow and it is not absolutely dependable, especially for the apprentice. And since air motors are so much used nowadays, anyway, it is a rather antiquated method.

The thing I would like to get hold of is a *sure* method that can be described in words and would not depend so much upon experience. I can see no reason why a good gage method could not be worked out—a method that would automatically give the diameter of the flue while rolling is in progress. Every flue would thus be given the same internal diameter, the stretch would be the same, the pressure against the tube sheet the same, and the danger of tube sheet deformation would be considerably reduced. I would be pleased to know if there is such an instrument in use, its design, and the service it gives.

Good judgment is all right, but certainty is much better.

New York. N. G. Near.

Rolling Boiler Tubes

I have read with much interest and some surprise the communications of Messrs. Near, Mason and Young on the above subject in the December, 1914, and January and February, 1915, issues of The Boiler Maker. The kink of which Mr. Near speaks, of feeling the tube, is a very old one, and well known to boiler makers, but the feeling is usually done after the flue is rolled, and the rolls are never removed until the flue is properly rolled, when the boiler maker does the feeling act, not to satisfy himself that the flue is properly rolled, but more from force of habit.

There have been given from time to time in this journal many ways of setting flues, but very few of your contributors have given the secret of good flue setting, *which is the fit of the flue in the flue sheet.* Mr. Young's comment on the removal of the rolls from the flue to feel if the flue has been rolled enough is good, but, as he says, would never be tolerated in an up-to-date shop, but I would like to ask the readers of The Boiler Maker what kind of a shop it is that tolerates the insertion of flues in a boiler with an eighth of an inch play between the flue and flue sheet?

To quote his own words: "In most cases the flues have a full eighth of an inch clearance in the flue sheet, and must, of course, stand the strain of being rolled out that much and after that, as much as the boiler maker thinks enough to make it tight." There are many articles in The Boiler Maker of recent date bearing on this subject. The editor's comment on a paper written by Mr. Kelly in The Boiler Maker, January, 1911, says in part: "No one branch of railroad management can be held responsible for flue failures; the designer of the boiler, the one who is responsible for maintenance, and the operating engineer, all have something to do with it," and I may add, so has the boiler maker. In The Boiler Maker for July, 1911, Mr. L. A. Barneman says the boiler maker is the man who has it put up to him, etc. If we look at this subject in the proper light I think that the readers will all agree that Mr. Young has sounded the keynote of flue failures on many, if not all, of our railways, when he says that they tolerate such a fit between the flues and flue sheet on the Southern Railway.

Referring to my letter on flue setting in The Boiler Maker, page 397, December, 1913, I will quote a few passages coming down to the present day. I find that there are shops whose practice is very little better than that used forty years ago. Notwithstanding an abundance of modern tools, modern methods are lacking. Again, there is one system of flue setting that has been used by one firm of locomotive builders for the last forty years, which is well worth knowing. This firm, like the early builders, use the straight flue. *The holes in the front flue sheet are cut 1/64 inch large.* For a 2-inch outside diameter flue the hole would be 2 1/64 inches in the front end, while the hole in the firebox flue sheet would be 1/8 larger, or 2 1/8 inches. In the large holes at the firebox end is inserted a copper ferrule 1/16 inch by 5/8 inch by 2 1/8 inch. These ferrules are given a light tap on a mandrel or pin with the hammer. This insures the ferrule taking hold of the flue sheet, while being driven in preparatory to being rolled, which is done lightly enough to allow the flue being driven in place.

During my experience of some thirty-seven years, handling flues of various kinds (brass, copper, iron and steel) and in large quantities, I have made it a practice to always have a tight fit between flues and flue sheets in the new work. The drill press hand was given standard copper ferrules, also a short end of flues of different diameters, and it was his duty to see that his cutter did not cut large and there was no excuse for doing so. Excuses were not tolerated, and on old work the same care was exercised in procuring a tight fit. Where flue holes in the firebox end had been rolled large, copper ferrules of extra heavy wire were used and rolled until the proper fit was obtained. The front end was treated in the same way, all holes that had been cut (or rolled) large for the removal of flues during repairs were ferruled with heavy coppers to get the requisite fit. All other flues were lined (or shimmed up) tight with some soft iron before a roll was applied, so that when the work of expanding was started the work was easily and quickly done, and the tread of the rolls left a slight impression easily felt and understood by the boiler maker.

The secret of good flue work is a good, tight fit, and it is not necessary to drive the pin in the rolls with all a man's strength, for if half our boiler makers realized the enormous pressure exerted by the rolls upon the flue, they would hesitate before doing so. Now I have found it good practice in flue setting to use a sectional expander to fasten the flue in the sheet, and with a tight-fitting flue this can be done easily with a staybolt hammer of about 3 pounds weight; then bead the flue and finally roll, giving the rolls about two complete turns (now I mean the rolls, not the rolling pin), and when striking the pin to tighten the rolls, there will be a clear metallic ring, clear as a bell, unmistakable to the boiler maker of wide experience, which tells him the flue is tight.

Of course, we meet with different conditions in different shops, and there always will be a difference of opinion as to the proper method of flue setting, and to the young boiler maker those differences are confusing, but there is one thing sure, and should be insisted upon by all steam users, and all foremen, or others in charge of repairs, that there should be a tight fit between flue and flue sheet, for what good is a flue that is ⅛ inch smaller than the hole it is to fit, after it is rolled out to make the fit, and then some?

Like Mr. Mason, I have had experience on marine and other kinds of boilers, and have always insisted, whether doing the work myself or overseeing it done by others, that the flue was properly lined or shimmed. I think it is the sheerest folly to swag the flue down and then pin or expand it with the sectional expander, and again roll it out until it is larger than the body of the flue. Yet this is done daily, to my certain knowledge, in shops that you would think that the men in charge would be quite up-to-date, but are really away behind the age. It pays to look after the installation of flues, for by so doing we will overcome much of the flue troubles.

Referring again to Mr. Near's letter, he says it is not uncommon to hear of tubes that are rolled so much that the roll cuts through the tube or tubes that are rolled too thin and too weak. What wonder is there that flues are cut through or rolled too thin, when there are shops in this great country of ours that make a common practice of allowing so much space in their flue sheets, and then expect flues to stand expanding to one-eighth inch larger than the original size of the flue. I am aware that there are flues that will stand battering about in a most extraordinary way and never show a crack, but this is done to show the quality of the material in the flue, and to show the purchaser of flues that they are getting something good for their money, but it was never intended that the boiler maker should take advantage of this good quality, to slight his work and shorten the life of the flue, and cause a continued bill of expense, in removing the diaphragm and netting from the front end of a locomotive or tear down and replace brick work on a stationary boiler to remove defective flues. Flex Ible.

Pittsburg, Pa.

Oxy-Acetylene Welding

I have followed with great interest the various articles on oxy-acetylene welding appearing in The Boiler Maker from time to time, giving the experience of those who have used it with varying success or failure.

The want of some such form of welding in the boiler trade has long been felt. Samuel Nicholls, in his book "The Theoretical and Practical Boiler Maker," speaks of the want of some kind of welding of boiler seams to overcome the uncertainty of the riveted joint. During the mechanical exhibition at London, England, in the early eighties there was to be seen a marine boiler of large dimensions, every seam of which was welded. There was not a single rivet in the whole boiler, and the work was done by the Whitworths, of engineering fame.

My own experience has been confined to the last three years, but during that time it has been found, I think, that it is one of the greatest things that we have had for many years, when properly and intelligently handled, and may be put to many uses.

I have seen some very nice work done in the flanges of flue sheets of locomotive boilers that had become cracked (always giving trouble), and were put in good condition in short order by cutting away the old sheets around the cracks and filling them up, making a solid sheet, so that it was almost impossible to detect the weld. On the other hand, I have seen complete failures to make a weld on some fireboxes, the cause of which I do not understand. Evidently something occurred in the chemical composition of the sheets, or the operator was unable to properly control the flame of his torch. I have found that to make a proper weld the flame must be a neutral one—that is, the flames must be equal or other chemical action takes place in the material being worked. I have seen the attempt to weld locomotive frames fail time and again, although experienced men were employed, but to no purpose. There is something, no doubt, in the chilling of the cast steel frame that changes its make up, that makes the job of welding a difficult one, yet I have seen a blacksmith do the trick with a natural gas furnace built around the broken frame and, with a large bobbing tool fitted in a long-stroke pneumatic hammer, put a piece in and hammer it up, making a good job.

I do not know that it is profitable to weld the flues in boiler heads, on account of the cost of removing the flues when they are old, or burst during service; for, to remove them without damaging the flue sheet, they must be drilled out. Of course in bad water districts and with flues of known good quality, the troubles of leaking flues are overcome.

On locomotive tank work the welding torch can be used to advantage in welding the angle iron frames, so that the entire frame is welded into one solid piece, doing away with the unsightly shoe that it is the custom to cover angle-iron joints with. In doing a job of this kind the frame must be fitted up in the usual way, but a space of about ¼ inch should be left between the bars. The entire bar can be bolted down in its place, but the ends to be welded must be raised off the sheet at least ⅜ inch, and both ends bolted in this position until the weld is made, when they should be unbolted and allowed to cool and contract, and then can be fastened down in their proper place and the rivets driven. This makes a very strong frame, and, at the same time, removes all anxiety as to leaking joints. The whole job of welding the frame can be done in a little over an hour by a quick operator.

Sometimes you want a sheet of iron much larger than the stock usually carried. Here again the welder can work to advantage. In doing this work it is necessary to keep the sheet level and apart. I have found that ¼ inch to the foot is about the proper distance, one end to be almost touching. With a sheet 6 feet long the extreme ends should extend 1½ inches apart, and be clamped together by flat iron clamps to retard the closing motion caused by expansion. It is surprising to see the power shown here, and, if the clamps do not hold good, the ends will meet and pass each other before the job is completed. With a quick operator this job can be done very quickly. I have tested a job of this kind with heavy sledges and I failed to fracture or in any way impair the weld.

For removing old fireboxes the cutting torch can be used to advantage again, but in doing this kind of work great care must be taken by the operator that his flame is not too large and that the torch does not get hot and back fire. I have repeatedly seen the cutting torch red hot in the man's hands before he was aware of it, being intent upon his work. If the torch is working well and all the valves are in good shape, it is possible to make a very clean cut, but, should the flame be allowed to get too large, the material will melt before cutting, leaving an unsightly looking job.

In small shops that are poorly equipped with modern machinery to handle large sheets that have to be cut, the welding machine is of great service, doing in a few minutes a job that would take hours with the air hammer. On repair work, and in places that it is impossible for men to work with ordinary tools, the work can now be done in a very short time.

I remember some few years ago a boiler being badly cracked at the mud-ring on the wrapper sheet. Plugging was out of the question, for the crack extended above the bar, and patching would have revealed the defect. Not having a welding plant at the works, there could be no weld, so finally the boiler was turned on its side, a small furnace of firebrick built around the crack, and a charcoal fire started with the coppersmith in charge, who succeeded in brazing the crack, which stood the test some short time after. Now had the firm owned a welding plant of some kind, how easily that little job could have been done without the risk of the brazing giving out and the owners of the engine finding out the fraud that had been practiced upon them.

As to the operator himself, there are good men who follow this kind of work, who have had lots of experience on machine work in some manufacturing shop, who, when they are put to work on a boiler, are lost, not knowing anything about a boiler. They are liable to do more harm than good, and it is a hard matter to try and instruct them, for they know all about welding and they think that you want to teach them. It has always been my belief that a man to do welding on a boiler should be a boiler maker, a man that knows what he is up against and how various jobs should be done. It would pay any firm to have one of their good, reliable men instructed in the use of the welding torch or the electric arc; for then, if there was not enough work welding, the man could be used to advantage on boiler work in his usual capacity and work then would be done with less failures than there are at the present time. FLEX IBLE.

Pittsburg, Pa.

Handling Plates While Drilling

In nearly all shipyard work and in other places where plates are holed or countersunk under a radial or other drill, much unnecessary labor and effort is required to position the plates dealt with. After the crane has deposited the plate adjacent to or upon the machine bed, the driller, using a pinch bar or by main strength, has in the case of a plate of considerable size to adjust this to position. When a position of the plate has been dealt with the same brute effort is needed again.

If a couple of rollers are used beneath the plate, these require continual adjustment and the bending and spring of the plate under the pressure of the drill, together with the need for lifting the end of the plate and readjustment of the rollers, make these an ineffective assistant.

It is a question of prime cost possibly, but the practice of the saw mill and sheet lead rolls might lead to an improvement in the type of drill bed. It should be possible, especially for shipyard work, where large quantities of punched plates subsequently countersunk are dealt with, to utilize a long roller bed to facilitate handling. The type of bed can be made of a less expensive character than either of the precedents above cited. For instance, the bed might consist of two or three ordinary H or I type joists or larger angles laid fair in concrete with rollers between fairly close in pitch. The rollers would, of course, be just proud above the structural steel members; then the awkward and heavy flat plate could be efficiently shipped by the easy effort of one man and a short bar.

Another simpler device, not absolutely unknown for the purpose, utilizes the existing cast iron bed. An edging of angles or flats is fitted to the extreme edges of the existing bed and a quantity of balls (these need not be very accurate) are simply placed on the surface and retained by the edge. Cast iron balls simply rumpled in a tumbling barrel are sufficiently accurate, and the diameter of these, say, ⅛ inch greater than the height of the fitted retaining edge.

This latter method has the merit of very low cost, while its efficiency is undoubted. The number of balls necessary should leave about, say, one-third of the entire area of bed exposed.

It would, of course, be preferable to place the balls in single rows between retaining strips across the width of bed, when a really efficient rolling surface would be provided.

Nothing exact or accurate is required for the purpose of countersinking flat plates, but a saving of labor cost and effort in handling are a real and desirable economy at small cost and little trouble. A. L. HAAS.

London, England.

An Improved Tube Expander Mandrel

Figs. 1 and 2 show an improved tube expander mandrel, made in accordance with the writer's ideas, which has been in use for a considerable length of time in the locomotive boiler shop of the Southern Pacific Railway Company at San Francisco, Cal. This mandrel has demonstrated its worth as an article of serviceable merit and of economical value while expanding boiler tubes as compared to the ordinary methods used. The improved mandrel dispenses with the ordinary method of banging out expander mandrels by side blows from a hand hammer. It also reduces the breakage of expander sections and mandrels.

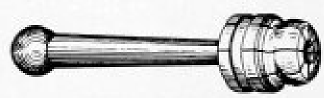


Fig. 1

Fig. 2

To loosen and extract the mandrel after the tube is expanded, the operator merely shifts the point of application of the air hammer from the back of the mandrel to the side of the spherical projection, which loosens it almost instantly and causes it to creep back quicker than it entered, doing so with greater convenience and safety to the operator.

With this type of mandrel or pin one man can expand more tubes perfectly in a given time than two men with the ordinary tool, and, furthermore, the danger of accidents to the operator is practically eliminated.

J. B. Becker,
General Foreman Boiler Maker, Southern Pacific Railway Company.
San Francisco, Cal.

Old Boilers Should be Scrapped

About the most pitiful spectacle for the average boiler maker is the sight of a second-hand boiler offered for sale.

It is not uncommon for discarded boilers to be "picked up" by second-hand men and sold for years of further service without so much as a decent overhauling. The inspector may say, "She's all right for a hundred pounds pressure" after the usual examination, and the boiler is then installed without further ado. Usually the boiler "makes good" and the buyer compliments himself on his ability to drive a bargain. Sometimes, again, the boiler fails and the event is merely chronicled as a "failure" without giving the past history of the boiler.

Some of these boilers look "pretty tough" to the boiler maker, as I have already said. Heavy patches of rust are visible all over and can be pryed loose with the thumb nail. Many tubes are badly burned. There are evidences of one-time bags. The inside is full of scale, rust, oil and sediment. Grooving has occurred. Yet the buyer takes the chance rather than spend a few hundred dollars more for a new boiler. "The interest on my saving," he says, "will pay for my insurance."

To be perfectly frank, this is not a "deplorable state of affairs." Many of us do things that are just about as bad as buying second-hand boilers. The buyer has a legal right to buy and use anything that is pronounced "safe" by the inspector.

However, even if the boiler is safe for a couple of years, what then? Discard it? Sell it to the second-hand man again? Install it again somewhere else at a decreased working pressure? Tear it out after a couple of years? And so on ad infinitum?

It has seldom been proved to me that it pays to install second-hand machinery. Although the first cost is not great, it costs just as much to install and just as much to take out again, and the cost of maintenance is greater. The efficiency is less. The cost of insurance is more. The danger is greater. And, besides, when it becomes known that a firm makes a habit of buying second-hand boilers and other machinery, a deleterious advertising influence sets in and the firm lowers itself in the esteem of its neighbors, patrons and competitors.

Let's scrap most of our discarded boilers.

New York. N. G. Near.

Personal

Charles D. Wilder has been appointed foreman boiler maker of the Staten Island lines of the Baltimore & Ohio Railroad at Clifton, Staten Island, N. Y.

J. D. Osborn has been appointed foreman boiler maker of the Atchison, Topeka & Santa Fé Railroad at Richmond, Cal., succeeding Thomas Purcell.

Robert Joy, of Oswego, N. Y., has been appointed fourth vice-president of the American Boiler Manufacturers' Association, vice L. E. Connelly, resigned.

Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
Millerton, N. Y.

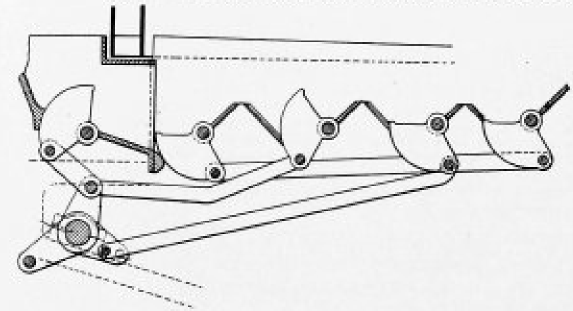
Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

1,118,568. LOCOMOTIVE-BOILER FURNACE. CHARLES B. MOORE, OF EVANSTON, ILL., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 7.—A locomotive boiler firebox in combination with a plurality of water circulating tubes extending longitudinally therein and arranged in substantially a single plane, a refractory arch supported on said tubes and comprising a plurality of transverse rows of refractory bricks provided with tube receiving grooves on their longitudinal medial lines and having their side portions curved upwardly and outwardly, and the several bricks of each transverse row being adapted to have their lateral edges in contact, said bricks forming relatively wide longitudinal grooves in the under surface of the arch extending between the tubes, and transverse partitions on the lower sides of said bricks dividing said longitudinal grooves into relatively small pockets. Thirteen claims.

1,119,927. DAVID F. CRAWFORD, OF PITTSBURG, PENNSYLVANIA. STOKER.

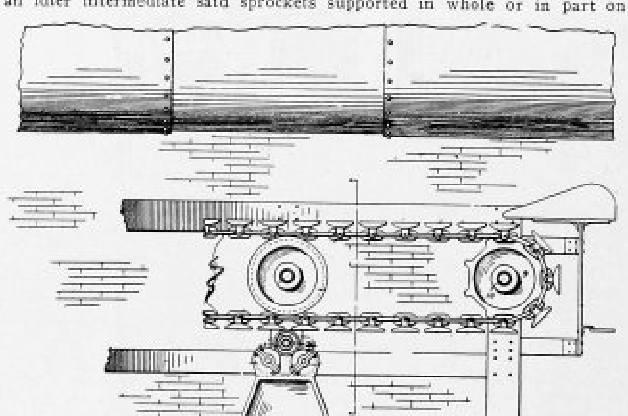
Claim 1.—In an underfed stoker, a feed trough provided with a series of transverse ridges each comprising a pair of oppositely inclined walls,



a series of movable feed members between the ridges for feeding the fuel upwardly from the depressions between the ridges, and means for operating the said members. Three claims.

1,120,445. FRANCIS MORTON CLARK, OF GARDEN CITY, NEW YORK, ASSIGNOR TO MULTIPLE-GRATE-BAR ENDLESS CHAIN STOKER COMPANY, A CORPORATION OF NEW YORK. MECHANICAL STOKER.

Claim 1.—In a mechanical stoker, the combination with an endless traveling grate, of front and rear sprockets over which said grate travels, an idler intermediate said sprockets supported in whole or in part on



the lower run of said grate and supporting the upper run thereof, a shaft upon which said idler is mounted, bearings guiding said shaft but permitting a vertical movement therof, a roller below and supporting the lower run of said grate, bearings guiding said roller but permitting vertical movement thereof, a standard, and roller bearings interposed between said standard and said roller. Five claims.

1,118,676. WATER-TUBE BOILER. FREDERICK P. PALEN AND WILLIAM BURLINGHAM, OF NEWPORT NEWS, VA.

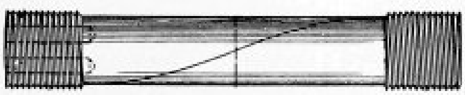
Claim 1.—In a water-tube boiler, an upper steam drum, lower water drums, nests of tubes connecting the steam and water drums, a set of baffle plates extending from the steam drum toward the water drums and located near the lower portion of the tube nests, whereby an opening is provided between the end of the baffle plates and the water drums for the admission of the hot gases to the tube nests, a second set of baffle plates located in the tube nests and extending from the water drums toward the steam drum, whereby an opening is provided between the ends of the baffle plates and the steam drum for the passage of the hot gases, and a third set of baffle plates extending from the steam drum toward the water drums and located still higher in the tube nests, whereby an opening is provided between the ends of the latter baffle plates and the water drums for the passage of the hot gases. Seventeen claims.

1,118,346. WATER-GLASS. LESTER B. HOWELL, OF WILMINGTON, N. C.

Claim 1.—The combination with a gage having a closure at its upper end provided with an opening and with a passage communicating with the interior of the gage, and a pipe leading from said passage; of a float within the gage, a stem rising from the same through said opening and having a longitudinal groove whose lower end is adapted to enter the gage when the water therein falls, a cap screwed upon the closure and having an opening through which said stem passes, said cap also having an internal chamber, and a pipe leading from this chamber, for the purpose set forth. Two claims.

1,121,173. ETHAN I. DODDS, OF CENTRAL VALLEY, NEW YORK, ASSIGNOR TO KERNER MANUFACTURING COMPANY, OF PITTSBURG, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA. STAY-BOLT.

Claim 1.—A stay bolt having solid integral end heads and a body portion, the latter comprising two separate members integral with said heads and extending from head to head, said members having adjacent faces which extend the full diameter of the body members and contact



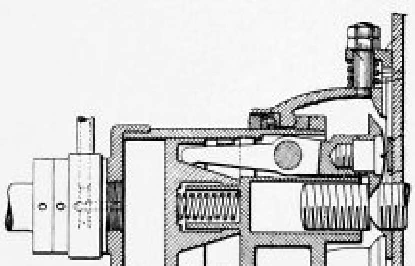
with each other, the body members being twisted at least 90 degrees to give the bolt flexibility to resist strains due to relative movements of the plates which it connects while retaining sufficient resistance for other strains, the heads being so threaded as to allow engagements with the threaded portions of successive separate plates which the stay bolt is to connect. Three claims

1,122,216. JOHN NICHOLSON, OF CHICAGO, ILLINOIS, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO THE NICHOLSON FURNACE COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS. GRATE.

Claim 1.—In a forced-draught furnace, a plurality of hollow grate bars having a top and end walls and downwardly and inwardly tapering side walls, the latter being provided with outwardly extending longitudinal flanges, there being a narrow rectangular opening between the side walls, the top wall having a plurality of jet openings in the top wall so shaped as to impart a whirl to the air as it enters the fire box, for the purpose set forth. Five claims.

1,122,364. WALTER BROWN, OF WEBSTER GROVES, MISSOURI, ASSIGNOR OF ONE-HALF TO ARTHUR B. BIRGE, OF ST. LOUIS, MISSOURI. STAY-BOLT-CUTTER CLAMP.

Claim 1.—In a rotary tool, the combination of cutters, means for moving the cutters into engagement with work presented to the action of the tool, a clamping device adapted to engage work presented to



the action of the cutters, said clamping device and said cutters having relative rotary movement, the construction and arrangement of parts being such that the engagement of the cutters with the work forces the work into engagement with the clamping member, whereby the work is held against movement relative to the clamping member. Thirteen claims.

1,118,137. METHOD FOR THE MIXED FIRING OF BOILERS. ERNST KOERTING, OF PEGLI, ITALY.

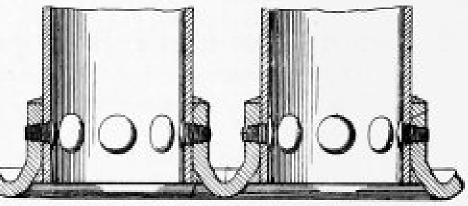
Claim 1.—The method of securing an energetic combustion of oil without excessive formation of smoke in a boiler fire-box containing a grate supported fuel bed of burning coal, which consists in introducing the oil to the fire-box in the form of a spray of a finely divided mist of oil particles and simultaneously introducing air for the combustion of the oil, a part of which is introduced into the fire-box in the form of a flat layer intervening between the fuel bed and the oil spray and separating the oil spray from the fuel bed and its products of combustion. Three claims.

1,122,912. DAVID H. GRIFFITH, OF WILMINGTON, DELAWARE. SAFETY DEVICE AND DRAIN ATTACHMENT FOR LOCOMOTIVE-SUPERHEATERS.

Claim 1.—In a locomotive engine, the combination with a boiler, a superheater therein, and a steam supply pipe, of a header having a horizontal chamber with a flat bottom having the supply pipe connected to the rear portion thereof, superheater units connected to the flat bottom of the horizontal chamber of the header and extending downwardly and entering the front extremities of the boiler flues, cylinders for driving the engine having feed pipes extending from the upper portions thereof upwardly to and directly attached to the front wall of the horizontal chamber on opposite sides of the center of the header, drain pipes connected to the said flat bottom of the horizontal chamber between points of attachment of the superheater units to said bottom and the front wall of the chamber so that the chamber may be drained at a point between the superheater units and the feed pipes leading to the cylinders, the drain pipes extending outwardly, the said drain pipes extending out laterally through opposite intermediate side portions of the boiler and then downwardly exteriorly of the latter to a point below the same between the cylinders, valves in the lower exterior ends of the drain pipes, and mechanism for simultaneously operating the valves to open and close the latter and the said pipes, the exterior location of the drain pipes facilitating the condensation of residual steam permitted to escape therethrough that may pass off with the moisture drained from the header. Two claims.

1,122,900. PETER F. GALLAGHER, OF BALTIMORE, MARYLAND, ASSIGNOR OF FORTY-NINE ONE-HUNDRETHS TO PHILIP CONNIFF, OF BALTIMORE, MARYLAND. MEANS FOR CONNECTING SUPERHEATER-FLUES TO FLUE-SHEETS OF LOCOMOTIVES.

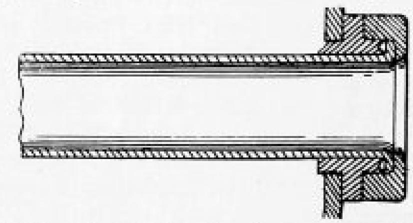
Claim 5.—A flue sheet having an opening therein, a circular flange, a corrugation pressed with the flange out of the sheet and joining said flange at its base to the sheet, said flange and corrugation being offset



from the plane of the sheet and said corrugation flared at its junction with the flange, a tube having its end inserted through the flange and projecting into the flared portion of the corrugation to provide an intervening angular recess, and a filter inserted into said recess and welded to the corrugation and projecting end of the tube. Six claims.

1,125,063. FLUE-ATTACHING DEVICE. FRANK J. COLBERG, OF CAPE GIRARDEAU, MO.

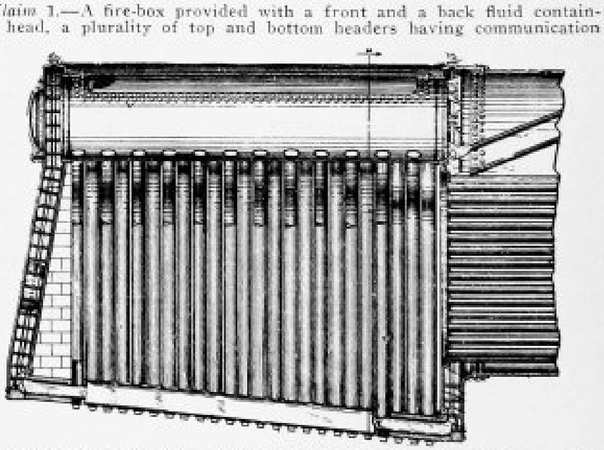
Claim 1.—The combination with a boiler head, a flue-attaching device comprising an exteriorly threaded ring having a flange intermediate its length, one end of the threaded portion adapted to be positioned in an opening in the boiler head with one side of the flange engaging the boiler head and the outer end of said threaded ring having a recess,



a flue having its end projecting through the flue-attaching device and provided with a flanged end bearing against the end of the flue-attaching device, and a ring nut having an opening substantially the size of the opening of the flue and having a flange adapted to bear against the flanged end of the flue, said nut being threaded on the outer end of the flue attaching device for clamping the flanged end of the flue into the recess of the flue-attaching device One claim.

1,125,106. FIRE-BOX FOR BOILERS. FRANK M. JACOBS, DECEASED, LATE OF ATCHISON, KAN., BY HENRY JACOBS, ADMINISTRATOR, OF ATCHISON, KAN.

Claim 1.—A fire-box provided with a front and a back fluid containing head, a plurality of top and bottom headers having communication



with said front and back fluid containing heads, and fluid conveying means intermediate of the top and bottom headers, said means being arranged in series disposed longitudinally of the fire-box, with alternate portions of said means connecting with a different top header. Twenty-six claims.

1,125,544. MECHANICAL STOKER. HARVEY ISERMAN, OF NEW HYDE PARK, N. Y., ASSIGNOR TO MULTIPLE GRATE BAR ENDLESS CHAIN STOKER COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—An interchangeable grate bar section provided near each end with means for attaching the section to a conveyor and elements of an attaching means adapted to co-operate with similar elements on an adjacent section, the first attaching means being adapted for use when the section is attached to an outside conveyor and the second attaching means being adapted for use when the section is attached to an intermediate conveyor. Ten claims.

THE BOILER MAKER

MAY, 1915

Locomotive Equipped with Riegel Firebox

Delaware, Lackawanna & Western Railroad Experiments with Engine Fitted with Special Type of Firebox to Improve Evaporation

The Delaware, Lackawanna & Western Railroad received on December 17, 1914, an experimental engine, No. 1171, which is one of a lot of fourteen built by the Lima Locomotive Corporation, Lima, Ohio. This engine differs from its mates in that it is fitted with a boiler equipped with a special form of firebox devised by S. S. Riegel, mechanical engineer of the Delaware, Lackawanna & Western Railroad Company at Scranton, Pa.

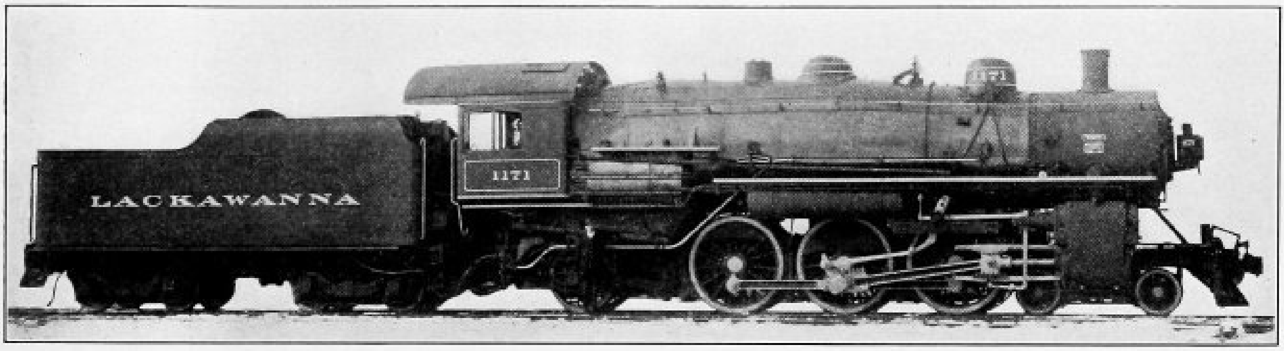


Fig. 1.—Experimental Engine No. 1171, Built by the Lima Locomotive Corporation for the Delaware, Lackawanna & Western Railroad

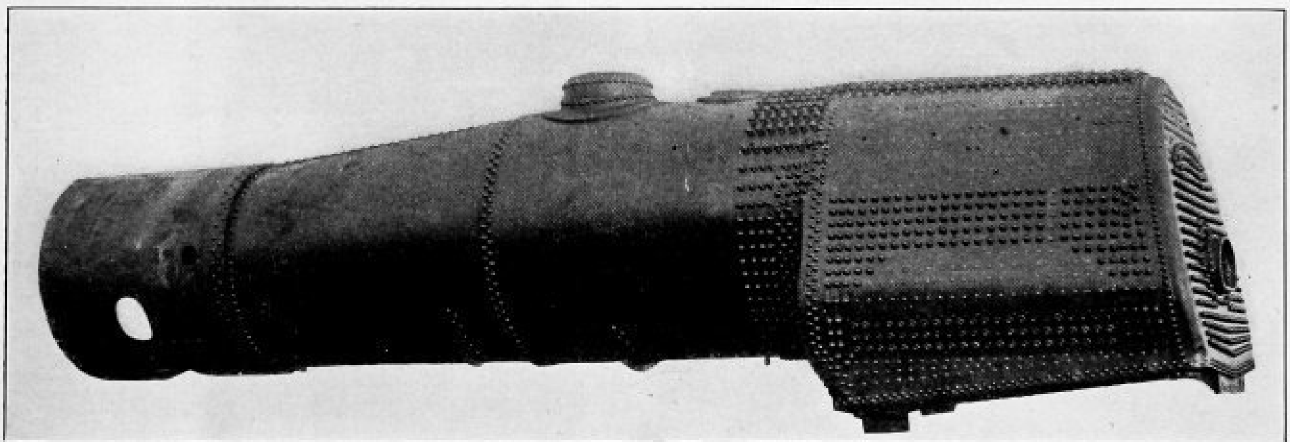


Fig. 2.—Boiler for Engine No. 1171, Equipped with Riegel Type of Firebox

As shown in the illustrations, the boiler consists of a combination of a standard type of firebox and shell with a watertube construction in the firebox designed to introduce a definite water circulation system. This improved construction consists of the installation of two nests of watertubes, consisting of sixty-six tubes each, placed on each side of the firebox over the grates, thus taking advantage of the watertube method of circulation with the object of providing definite cycles of circulation of water through the zones of greatest heat intensity and also locating the heating surfaces in the best possible manner.

Altogether these tubes afford 471 square feet of heating surface, but, as this heating surface is exposed to the highest temperature attainable in the firebox it, by virtue of its position, greatly increases the steaming capacity of the locomotive beyond what would naturally be expected from the addition of this amount of heating surface. It has been found by an experimental model of this type of boiler, and also from the experiments carried out at Coatesville, Pa., several years ago to determine the relative value of firebox and tube heating surfaces, that one square foot of firebox heating surface is at least equivalent to 7 or 7.5 square feet of tube surface. On this basis a locomotive boiler with the limited amount of additional firebox surface afforded by the watertube construction is capable, when given a proper supply of heat, of greatly increasing the steaming capacity of the present form of boiler without appreciably increasing its size or exterior dimensions.

The shape of the firebox in this experimental engine differs slightly from that in an ordinary radial-stayed locomotive boiler. The centerline of the crown sheet is horizontal and the side sheets are so arranged that their elements are parallel to those of the crown sheet. By this

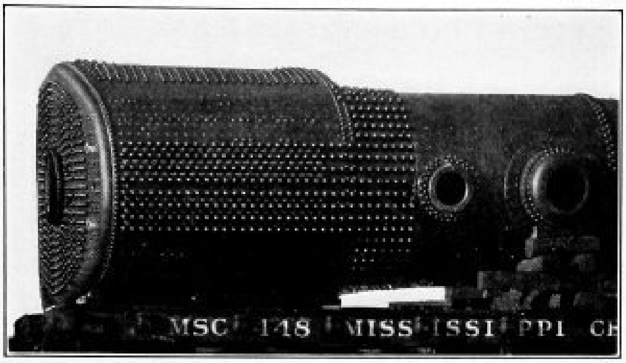


Fig. 3.—Top View of Firebox

arrangement, it became necessary to provide only three patterns of watertubes.

As the watertubes lead from the lower part of the side sheets to the center of the crown sheet, another feature was introduced to relieve the necessity of sharp bends in the lower ends of the tubes. This consists in widening the firebox at a point about 2 feet above the bottom of the mud-ring at the rear and 34 inches above that point at the forward end of the firebox. With this arrangement, the width over the mud-ring is only 103⅛ inches, while

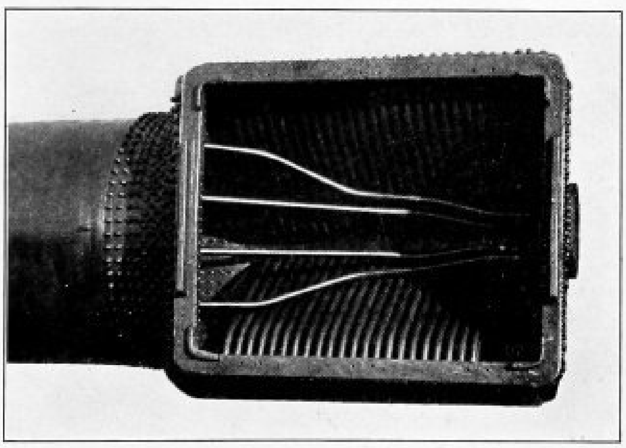


Fig. 4.—Interior of Firebox

the outside dimension at the point of greatest width of the firebox is 113⅝ inches. This construction involves the use of an ogee form of side sheets.

The curvature in the watertubes at the ends where they join the sheets amounts to about 30 degrees at the lower ends and over 40 degrees at the upper ends. The tubes have been given an easy curvature at these points not only to reduce the friction of the rapid circulation of water through them, but also to facilitate the passage of tube-cleaning apparatus, which can be introduced through an opening opposite each tube end at both the top and bottom. These openings are stopped by means of taper plugs.

Among the benefits derived from the increased circulation of the water around the firebox is the fact that

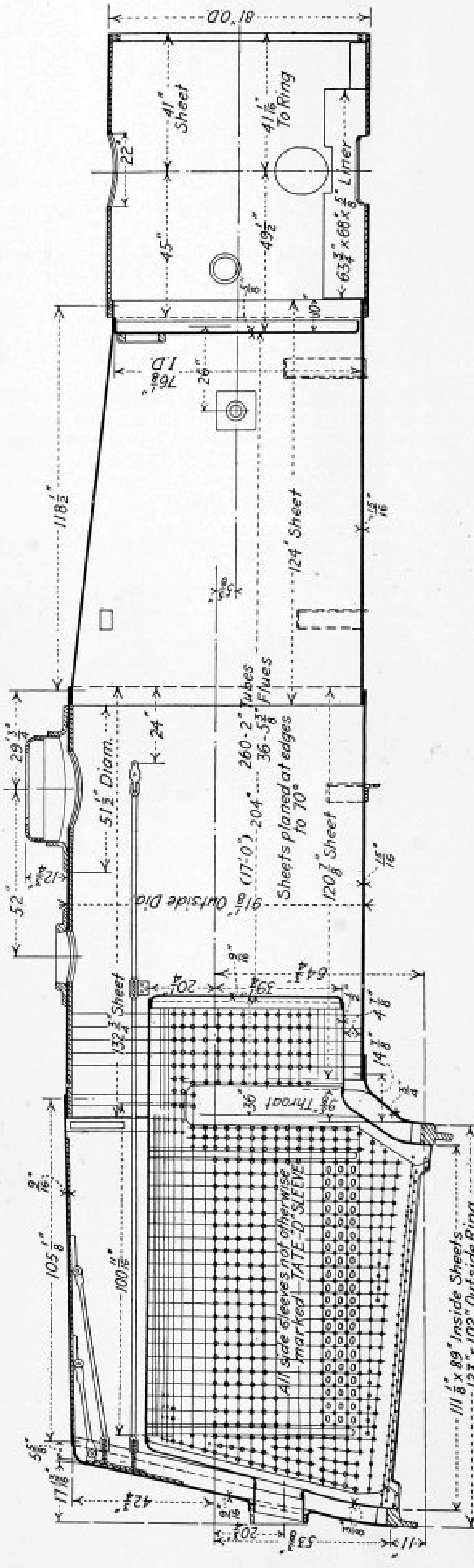


Fig. 5.—Longitudinal Section of Locomotive Boiler Equipped with Riegel Type of Firebox

even though the water may be evaporated so that the fire tubes in the barrel of the boiler are above the water, the intensified circulation, or up-draft, through the water-tubes in the firebox will continue to flood the crown sheet, thus making it virtually impossible to burn the crown sheet except in cases of extreme negligence. This feature, therefore, adds to the safety of the boiler and, besides this, it has been found that the positive circulation set up in the boiler excites the whole mass of water to action to such an extent that the sheets surrounding the firebox are kept free and clean from scale deposits. Due to the more intensified circulation throughout the entire boiler, an influence is exerted which will tend to overcome the distortion of various parts of the boiler on account of unequal expansion and contraction due to currents of

Total weight of engine in working order...297,600 pounds
Coal capacity of tender..........................10 tons
Water capacity of tender..................9,000 gallons
Total weight of tender loaded...........165,500 pounds
Total weight of engine and tender........463,000 pounds
Boiler pressure ....200 pounds
Grate area ....69 square feet
Diameter of boiler...........................78 inches
Firebox ....89 by 111 inches
Factor of adhesion 4.39
Heating surface, firebox and combustion chamber, 288 square feet
Heating surface, watertubes.............471 square feet
Heating surface, fire tubes............3,177 square feet
Heating surface, arch tubes...............24 square feet

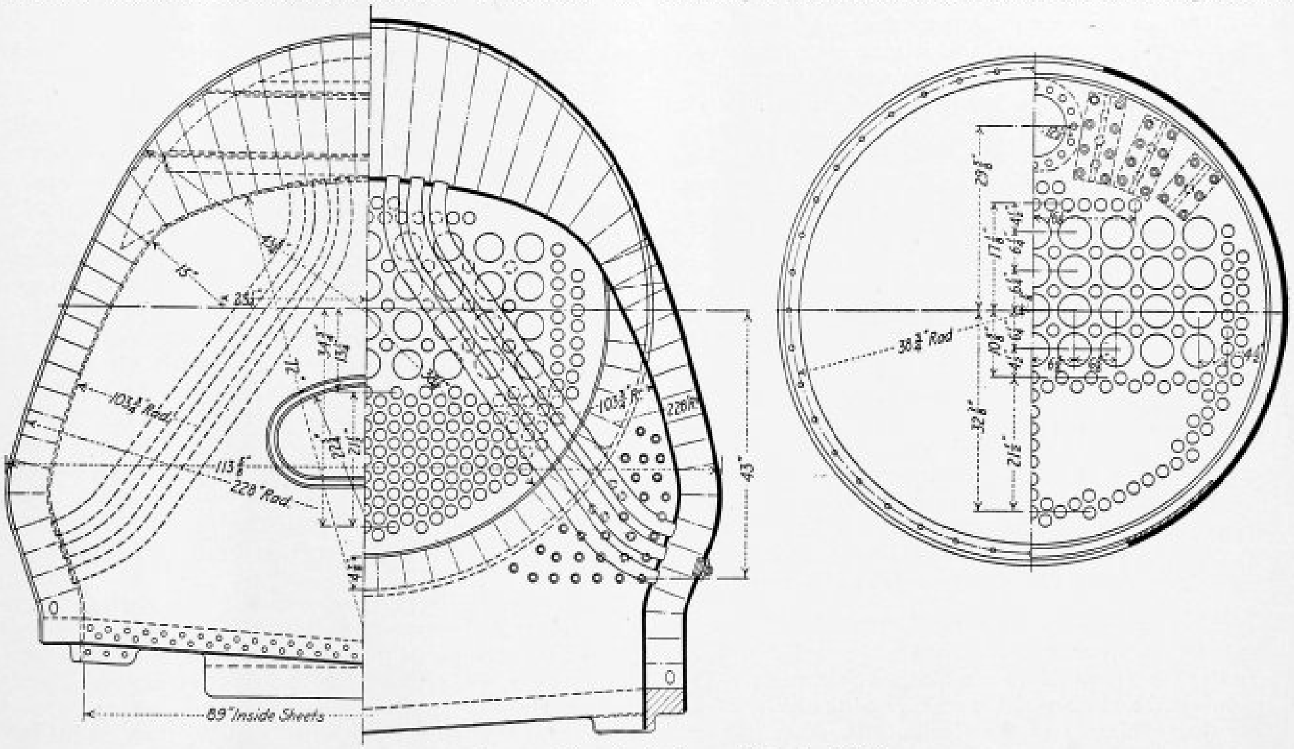


Fig. 6.—Sections Through Firebox and Barrel of Boiler

water of different temperatures. Any tendency to overcome the damaging distortions in and around the firebox, particularly around the side sheets, should tend to prolong the life of the firebox.

The firebox is also fitted with a brick arch, the upper ends of the arch tubes at the back sheet being converged so as to permit a full installation of watertubes in the nests on each side of the firebox. While this arrangement of the brick arch restricts the arch in size as compared with the usual practice, nevertheless it serves to deflect the hot gases and force them to travel through the nests of watertubes. A 30-inch combustion chamber is also fitted in which a complete installation of Tate flexible staybolts is used. Tate flexible staybolts are also extensively used for staying the back head, the crown sheet and the side sheets.

The main particulars of this engine are as follows:

Class 4-6-2
Gage ....4 feet 8½ inches
Diameter of driving wheels ....69 inches
Tractive power ....43,200 pounds
Cylinders ....25 by 28 inches
Weight on trucks in working order........50,000 pounds
Weight on drivers in working order......189,600 pounds
Weight on trailer truck in working order...58,000 pounds

Total heating surface of firebox.........783 square feet
Total heating surface..................3,960 square feet
Superheater heating surface.............740 square feet

Since its receipt in December this locomotive has been in successful use with both bituminous and anthracite coal, and very thorough tests are being conducted to determine the exact results obtained by the installation of this new type of firebox. The tests will show to what extent the sustained hauling power of the locomotive has been improved.

INFORMATION ON OXY-ACETYLENE WELDING.—Some idea of the wealth of published material relating to oxy-acetylene welding may be obtained from a 34-page pamphlet that has been issued by the New York Public Library. This contains a list of works on this subject that may be found in the library, and includes books, articles from periodicals, pamphlets and other literature that is readily accessible. The arrangement is chronological by date of publication from 1893 to October, 1914, and contains a list of 487 books, pamphlets, magazine articles, etc. An index which is arranged by subjects and authors is included. For references to acetylene other than in its relation to welding, readers should consult the various periodicals related to the industry.

"Speed Up!"

How to Improve the Output of the Shop in Quality and Quantity

BY JAMES FRANCIS

What's the matter in your shop? Have things stopped going through as well as they used to? Does business seem to hang and drag and things have to be forced along in order to get them through the shop on time? And collections, too? Are they "hung up" together with new business—"on account of the war?"

Yes, I know the signs very well. I have been through all this, and there is one mighty good way of getting out of it—a way by means of which you can bring work through the shop on time again, bring collections in on the minute, and make new business sit right up and take notice!

Speed Up! That's the way to do it. Start something—and everything—to moving faster. The shop has gotten into a rut, that's all the trouble, and you can do one of just two things—either pry things out of the rut or fill the rut until there isn't any rut! New business is a pretty good way of filling the shop rut, but sometimes it is necessary to pry the wheels out a bit in order to get the filling down under the rims, where it will do some good.

Once I saw the complexion of things changed all through the shop and office by merely giving the engine a few more revolutions per minute. This "speeded up" things all through the shop from air compressor to metal saw, and the men all followed the machinery and "speeded up" in sympathy therewith. Another shop "speeded up" by simply changing a single pulley on a line shaft. It made things run faster in one department and that was all the impetus needed in this particular instance.

Causes of Stagnation

But take a trip around the shop and see for yourself where the drag lies. Here are the power-bending rolls—only one fixed and no variable speed, and the rolls moving slower than molasses at the North Pole, when they are moving at all! Have to look twice at a sheet, don't you, to see which way it is moving in the rolls? Well, that's the way it looks to the beholder, and the onlooker usually sees pretty straight when he looks around the shop.

"Speed Up! and things will be all right again. Take a look at the workmen when they are not looking at you and see if the foreman and gang bosses are not letting things go a bit easy. See if they are holding things right up to concert pitch, or letting one thing and another "go as you please." Ten to one you'll find this to be the trouble, and a sharp pull at the foreman or gang boss will stop the slump and put the shop back on full speed ahead again.

But sometimes you have to go much deeper than is indicated above. Sometimes it is necessary to "clean house" pretty thoroughly, and let out enough of the shop people and get in new ones, to break up the old cliques and to establish new methods, new routine work, and, in fact, to give the shop force a complete overhauling or shake-up.

In more than one instance it will be necessary to begin with the general manager or the superintendent, and in a couple of cases the writer has seen the "house-cleaning" necessarily begin with the board of directors. Two or three of them were quietly worked out of office and a new board in sympathy with "High Speed Ahead" was elected. Then the rest of the matter followed naturally. Seemingly the inertia which held the shop down had disappeared and things went ahead with a rush and with a profit.

Sometimes you will find the "slow speed" germ in the office force, with a hard-working superintendent and shop foreman. It's queer how quickly slow-speed contagion spreads to the shop, once the office is infected with it! A slouchy, dawdling time-keeper or a lazy, purchasing clerk often carries the trouble to the far ends of the shop, and things slacken down to the inertia point.

Both Office and Shop to Blame

At times the trouble runs in the opposite direction and the shop inoculates the office. I once saw an instance where a single workman caused a whole establishment to "hit the toboggan" so hard that the utmost efforts of the management were required to set things aright again. This man operated the sheet planer and one or two other power tools. He was a good workman, but got into a rut and seemed to pull everybody and everything in with him. He took all the time he needed, and a lot he didn't need, when setting up a job on his machines, and then he worked on the slowest speed and feed the machine afforded. "Waiting for Tim" was the frequent excuse given when work didn't come along on time, and "waiting for Tim" soon began to be the excuse of men who did not handle any of Tim's work. They were delayed indirectly by Tim and got into the habit of killing time while waiting for work from the men who had been directly delayed by Tim.

Now, it's utterly impossible for one man in a boiler shop to "sojer" without affecting other workmen by his pernicious example, and thus the infection spreads like circles on a mill pond when you drop in a pebble—and spreads about as fast, too.

Couldn't the thing have been stopped before it got all through the shop?

To be sure it could have been stopped, and that is where the foreman and the superintendent made the mistake which it took months of hard work to rectify. They should have stopped Tim instantly, warned him a couple of times, and then "tied a can to him" if he persisted in slowing up and didn't get into high speed again. It was only after three months of hard work, the changing around of three work gangs, the dismissal of Tim, a gang boss and four other men that the slow-speed infection was finally eliminated from this shop and things ran at normal speed again.

Does the "slow speed" trouble always break out in a workman or an office man?

Not by a long shot! Sometimes it breaks out in one place, sometimes in another. There is not a man in the shop who is immune from the "slow-speed danger," or who cannot give the disease to all the others, once he is inoculated. But the infection seems to strike deeper and be more troublesome to eradicate when an official, or a semi-official, "catches" the infection and gives it to his shopmates. One of the very worst cases I ever fought was imparted to the shop force, and then to the office, by the head layer-out. And a good man he was—before he went bad.

How did it work in his case? What happened in the shop?

Why, everything mostly. First there would be delay in getting work laid out. Then there would be errors, due to procrastination in the beginning and a hustle to make up time when men were waiting for the layer-out to have done. And so it went from bad to worse, even the office force being badly affected through the foreman and the time and stock clerks. Nobody brought them up with a sharp turn, until one of the directors "smelled a rat," investigated, and found a whole elephant—a white one at that—and then tore things wide open before they got the shop put together in good running order again.

How did they go to work to fix things up? Issue a lot of orders and then spend hours and days trying to have the orders obeyed?

No. They called the superintendent, manager, foreman and the gang bosses into the office, one at a time, and told them frankly and plainly just what the trouble was and what it was proposed to do in the matter, viz., to cure the trouble. They made it very plain to the officers in question just what results must be obtained, and then they gave the officers their choice to resign or to produce the desired results within the specified time, which was, I believe, three months in this case. The officers decided to "stick" and took council together and mapped out a line of procedure, then went quietly around to the men, told them what had to be done, and gave them their choice of coming immediately under the new arrangement or of taking their time the coming Saturday night. A few of the men took their time, the rest "stuck" and the officers proceeded to reorganize the working force almost exactly as though they were starting a new shop with entirely new and strange workmen.

How did it work out? Did the men break into the new régime readily?

Effect of "Speeding Up"

Most of them did. There were a few who let themselves out, rather than take a place in the new "speed-up" arrangement, but it proved that the ones who dropped out were the least desirable men in the bunch and their places were soon filled with better men.

Just what effect did the "tear-open-and-shape-up" have on shop matters? How did it work out in the end?

It proved to be a case of "speed up," for things went very smoothly after the change had been made and everybody had gotten used to their new duties and surroundings. There was very little tendency to "slowing down," as, under the new arrangement, things were so fixed that the foremen and bosses could keep a close eye upon the daily progress of all work which was going through the shop much better than before the change was made.

And then there was another change to the better from the tendency of the men to get together and talk over certain pieces of work. Something came up which Bill was uncertain about. Instead of taking the matter to his gang boss or to the foreman, Bill calls Tom, tells him about it, and then Jim, going past, gets into the discussion, and Sam and Hen go over to see what the matter is. Many a time I have seen a bunch like this talking from three to thirteen minutes concerning some trivial matter which the foreman—who is paid for that work—could have disposed of in thirty seconds.

This sort of thing is about the worst form of "slow speed which can get into the shop, and it is entirely done away with under the new manner of working, for the gathering together of two or more men to talk during working hours is not tolerated in the shop now—not for an instant—and a man who shows a tendency to pull off the "gossip act" is given a quiet warning twice, then if he persists in it, he is quietly laid off—and never reinstated. Another man is put in his place. The result was that the "gossip habit" was pretty thoroughly discouraged, and never got a foothold in the shop again.

What are the other common causes of "slow speed" in the shop besides those mentioned above?

Well, it's hard to name all of them offhand, but there are two in particular which are very bad, and which should be rooted out of the shop at once and forthwith, as the boiler shop lawyer stated his case at the dinner court around the rivet heater. The worst of these is the littered, cluttered-up shop, with all sorts of odds and ends of stock piled or standing in corners, and oftentimes in the body of the shop. The other great cause of "slow speed" is the lack of a tool-room and tool-room facilities.

Well, what was done to take care of these matters? Anything but talk about it a little? Perhaps move some of the stuff from one end of the shop to the other, and clear out a corner for all the tools to be left in—when they were not anywhere else? That's usually the way of house-cleanings and tool-rooms in the boiler shop!

Cleaning House

No, Mr. Boiler Maker; that old method didn't go this time—not a little bit! Everything was rooted out of the corners and out of the shop. Each piece was sent either to the stock department, to the tool room or to the scrap heap, and a mighty fine lot of stuff went to the latter place, I tell you. It made me feel sorry to see such nice pieces of steel going to scrap, but what else could be done with it? Odd pieces are of little use in the boiler shop, save to prove a source of expense and to cause "slow speed" somewhere. It doesn't take very long to spend thirty cents' worth of time hunting out a thirty-cent piece of scrap, and when twenty cents more is expended in getting the scrap piece into shape to be used, it don't take a very high-priced accountant to demonstrate the fact that fifty-cent scrap used in place of forty-cent new stock isn't a paying method! Add to this loss the five cents which the material would have brought for scrap, and the shop is ten and five, a total of fifteen cents "out" on account of using scrap. And we can well add to that amount of loss as much more to pay for the housing of that scrap—for the good shop room it has occupied for eight or ten years, and for the many, very many, handlings which the piece of scrap has received when men were hunting something else! No! scrap in the boiler shop don't pay. Put it in the stock room or in the scrap heap, forthwith—never in the boiler shop!

Well, what did that tool room amount to, and how did you make out with it? Did it pay and last, or was it just a short spurt, like a mushroom?

Well, Mr. Boiler Maker, the tool room in question is still in evidence, still used, and you can no more get a tool in that shop without a check to give in for said tool, than you could get a dollar from a bank without a proper check for the same. Yes, there is one way. In emergency the workman is allowed to give a signed slip of paper, containing a description of the tool. Printed blanks are provided for this purpose and used occasionally.

How is the tool-room cared for? Keep a man there all the time and charge up his time against "profit and loss"?

No, not a bit of it! We have a small lathe in the tool room and keep a good man there—an elderly man who is a good machinist. We also keep a boy there, when he is not running errands. The man keeps track of every tool, keeps it in repair and in working condition. The boy attends the check window, runs errands, etc., and while the boy is on duty the man is making or repairing tools, or he is operating one of the two or three manufacturing machines which we keep in the tool-room for that purpose. In this particular tool-room there is a pipe-cutting machine and we do a lot of outside work which the tool-room man and boy attend to almost entirely. And say, talk about tools! You ought to have seen the assortment of tools which we found in and under the scrap when we cleaned 50 tons of it out of the shop! Tools? Why we've got "tools to burn" since that clean-up! Try it yourself and see!

Layout of Locomotive Fireboxes

Method of Laying Out Firebox for Belpaire Boiler with Wrapper Sheet Made in One Piece

BY C. F. AXELSON

Until lately the fireboxes of radial stayed boilers have been built in three sheets with the crown and side sheets separate, but, as the side sheet seams are apt to give trouble by cracking, whenever a boiler needs a new firebox it is generally made in one sheet.

In the drawings in Plate I is shown a new firebox for a Belpaire boiler made in one sheet. This differs from the old firebox in that it has a round corner instead of a flange. As there is a large radius in the crown sheet, which gives a rise of 2¼ inches, it will be noticed that the radius in the flange is about as small as in some crown bar boilers. The layout of this firebox is explained in the following:

Firebox for Belpaire Boiler

Fig. 1 represents a half end view of the firebox, which is all that is necessary. Line *A* is drawn as the base line for the front end of the firebox, and line *B* for the back end. Line *C*, which is perpendicular to lines *A* and *B*, represents the centerline of the box.

On lines *A* and *B* mark off the width of the firebox at the mudring. Draw line *D*, which is the lower flat part of the firebox. The height of the firebox is measured off on line *C* from line *A* to 1′, using the neutral line of the plate for all measurements. Next draw the crown of the firebox, or the top curve, and then the curve R_1; also draw the small radius connecting the two large curves. In this case the radius was 4 inches for the front and 3¾ inches for the back. Draw the last curve R_2 and then complete the outline of the front end by drawing in the straight line 9′-10′.

The back end of the firebox will be drawn in the same order as the front end by shifting centers for the various curves. This firebox is 5 inches lower and 10 inches narrower on the back than at the front end.

The profile thus formed will be divided into three sections and these sections subdivided, as it will be seen that the curved line from 1′ to 9′ cannot very well be divided into equal spaces. The first division 1′ to 4′ is divided into any number of equal spaces, and also the distances 4′ to 6′ and 6′ to 9′. Lines are drawn connecting the points as indicated by 2′ 2, 3′ 3, 4′ 4, etc. 9′ 10′ is the flat part of the plate. 10′ 11′ is a curve and 11′ 12′ is the lower flat part of the plate.

Side View, Fig. 2

To locate the side elevation of the firebox, line *A* is extended to 12′, Fig. 2, so as to give the full length of the firebox. Line 12′ 1′ is drawn at right angles to *A*. Lay down the length of the firebox on line *A* and draw line *G*-12-1. This line should be set in 1 inch at the top, as the water space is 5 inches wide at this point and 4 inches wide at the mudring. In this drawing, however, it is shown square at both ends in order to give a better clearance through the diagram of triangles. Otherwise each element would have its own height and, as there are twelve elements to deal with, the lines would run into each other and the result would be practically a solid line for 1 inch. On a small drawing it would be a hard matter to distinguish each point, and therefore for this problem we will make it square at both ends.

To transfer the division points from Fig. 1 to Fig. 2 we may say there is more than one method. The simplest one would be to lay a straight edge on line *C*, Fig. 1, and, as the two views are close together, lay a square with one blade against the straight edge. As the other blade of the square, however, may not reach all the points, lay a light straight edge against the square on 1 in the curve of the back end of the firebox. Mark 1 on line *G*-12-1, Fig. 2; move the square to point 2 and in a similar manner mark the point 2 on line *G*-12-1, Fig. 2; then move the square to point 3 and so on until all points have been lifted over to Fig. 2.

To get the points for the front end, proceed with the square as before. All points are marked on the straight edge and are transferred to line 12′-1′, Fig. 2. Set down all the points from the straight edge. Beginning on line 12′ draw lines connecting all points marked off as shown in the drawing. This will serve as a guide in the following operation.

Diagram of Triangles

The diagram of triangles must now be constructed in Fig. 3. Draw the base line *E-F* and the perpendicular *X-X*. With dividers set from 2 to 2′ on the solid line, Fig. 1, with point *X*, Fig. 3, as a center, describe an arc cutting the line *E-F*. Take all the solid lines 3-3′, 4-4′, 5-5′, etc., and lay them out in the same manner in Fig. 3. The distances 10-10′, 11-11′ and 12-12′ are solid lines and these are also set out in Fig. 3. On the other side of the vertical line *X-X*, with *X* as a center, set off the dotted lines 1′-2, 2′-3, 3′-4, etc., in Fig. 3. The distances 10′-11 and 11′-12 are also dotted lines, and should be set off in the same manner in Fig. 3. The height of the triangles, Fig. 3, will be taken on line *A* from *G* to 12′, Fig. 2, which is the full length of the firebox in a straight line, thus finishing the diagram of triangles.

Development of Plate

With trams set to the distance 1-1′, the centerline in the crown, which is shown in true length in Fig. 2, set this down as the centerline in the plate, Fig. 4. The next step is to set the trams on 1 and the vertex point for the dash lines Fig. 3. With one point of the trams on 1′ in Fig. 4, describe an arc at 2 on each side of the centerline. With the dividers already set to the spaces 2, 3 and 4 on the back end of the firebox, Fig. 1, with 1 as a center, Fig. 4, strike an arc on each side cutting the arc struck from 1′. Step back to Fig. 3, take the solid line 2, set the trams on

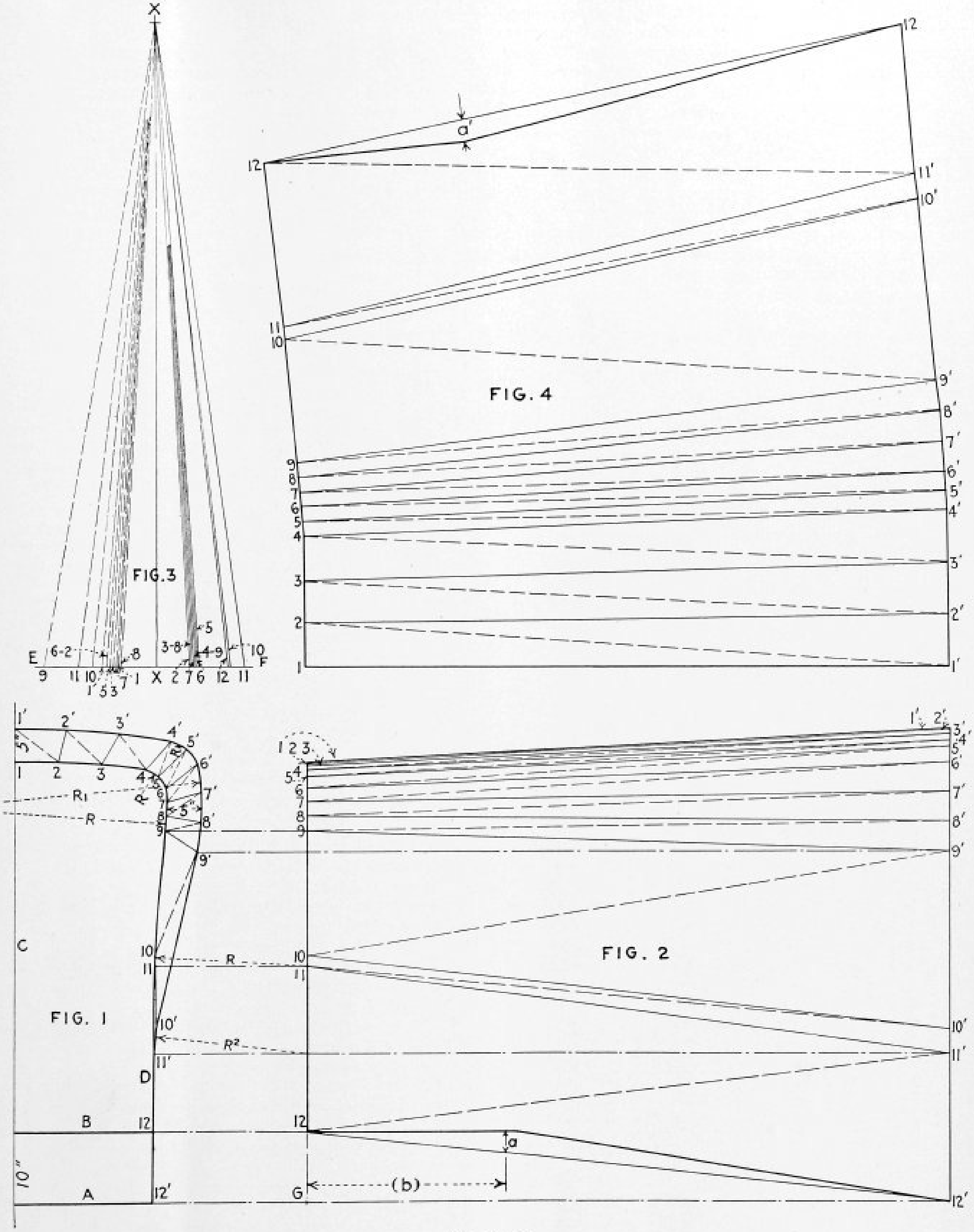


Plate No. I

2 in the pattern and describe an arc at 2'. With the dividers set to the spaces 2', 3' and 4' in Fig. 1 with 1' in the pattern as a center, describe the arcs at 2' and 2'. Continue this with alternate lines.

When the dash line 4 has been taken down, we have shorter spaces at 5 and 6, Fig. 1. With the dividers adjusted to these spaces and with 4, Fig. 4, as a center, describe an arc at 5. As point 6 is reached, we are now in the third division. With the dividers adjusted to the spaces 7-8-9, Fig. 1, proceed as in the preceding sections up to the point 9 and the dash line 9. Take the distance 9-10, which represents the flat part of the back end, Fig. 1, and with 9 as a center in the pattern, Fig. 4, strike an arc at 10, cutting the one previously struck at 9′. Next, take the solid line 10, Fig. 3, and set it off from 10 to 10′, Fig. 4. Take the distance 9′-10′, Fig. 1, and on 9′ in the pattern cut the arc drawn at 10′, which is the flat part of the front end of the firebox. Take the dash line 10, Fig. 3, and, with 10′ in the pattern as a center, describe an arc at 11. Take the space 10-11, Fig. 1, and, with 10, Fig. 4, as a center, strike an arc at 11. With the solid line 11, Fig. 3 and with 11, Fig. 4, as a center, strike an arc at 11′. Then take the space 10′-11′, Fig. 1, and, with 10′ in the pattern as a center, cut the arc previously drawn at 11′.

Next comes the last dash line, 11, Fig. 3. With 11′, Fig. 4, as a center, strike an arc at 12 and lay off the space 11-12, Fig. 1. With 11 in the pattern as a center, strike an arc at 12, then step back to Fig. 3 and take the space 11′-12′, Fig. 1, and with 11′, Fig. 4, as a center, strike an arc at 12′. Draw the line 12-12′ and at right angles to the line 11′-12′ draw a line from 12 and at a distance (b), Fig. 2, set off on this line as at (a) and with the required radius describe an arc and draw the line at 12′. Add for the lap and the plate is ready.

(To be concluded.)

Adjusting the Deflector Plate

BY GEORGE SHERWOOD HODGINS *

The problem presented by hard-steaming locomotives is a most practical one on a railroad, and it is usually not easy to solve. The ideal fire is one which burns brightly and evenly all over the grates, with just sufficient air to insure good combustion. It was often noticed, in former days, when a petticoat pipe was used in the front end, that an alteration in the height and direction of this pipe produced very differing results. In order to secure a good steaming engine it is always necessary to have the nozzles or the blast pipe so arranged that the jet of exhaust steam shall be shot out of the smokestack without striking the inside of the stack more at one point than another. The jet must be central.

The modern arrangement, where a deflector plate is used, is such that the plate is fastened to the round-head above the flues and slopes downward toward the front. The lower part is made so that the outer edge can be moved up and down. The hot gases from the fire pass from the back of the firebox through the upper flues, and the gases from the front of the box pass through the lower flues. The central gases go through the center flues.

If no deflector plate was used, the position of the smokestack is such that the upper flues would naturally do all the work. The flow of gas would be like that of water in a wash basin, where the water close to the waste pipe would flow out first, when the stopper was withdrawn. If water was continuously supplied below the water level, it is quite conceivable that the surface water would not move out at all, and in time the formation of scum on the top would attest the fact.

The object of the deflector plate is to equalize the flow of gases from different parts of the firebox. The plate forces the gases from the back through top flues, to travel a longer distance than they otherwise would. The plate thus interposes a frictional resistance to these gases, and, as it were, places an artificial handicap on the easy passage of the top flue gases. The movable lower edge of the deflector plate allows of the adjustment of this interposed handicap, and when properly adjusted the deflector plate causes the fire to burn evenly on all parts of the grates.

If it is found that the fire in the front part of the firebox burns more brightly than that at the back of the box, it proves that the lower flue gases have too much draft, or, in other words, that they escape more easily than the top flue gases escape. In this case the deflector plate must be raised, in order to give the top flue gases an easier exit. If, on the other hand, the flow of heated gases from the back part of the firebox and through the upper flues is sharper than that through the lower ones, it is evident that the deflector plate must be lowered to restrict the top flue gases and give the lower flue gases a more equal chance to escape.

A careful examination of the flues, when the fire is out, will reveal the conditions present when the locomotive is being worked. The flues in which the flow of gas is most sluggish will be found to contain, to a greater or less extent, cinders, ashes or soot, and those in which the flow of gas is most free will be comparatively free.

The whole process of adjustment is one of "cut and try," and may require several experiments before practical equality in the passage of smoke and gas, as between top and bottom flues, is secured. The principle, however, is simple, and although it may, for convenience, be reduced to an easily stated general rule, it is so obviously based on what one would naturally expect, under the circumstances, that if the principle be learned the rule for adjustment of the deflector plate may be called to mind at any time.

When the flow of gas through the flues is properly regulated, the fire will burn evenly over all portions of the grate. In making the examination and in effecting the adjustments, care must undoubtedly be taken to see that there are practically no leaks along the sides of the ash pan, and no entrance for air permitted except past the dampers. The fire door should also be tight, and the smoke box itself should be unable to draw air.

* Formerly Consulting Mechanical Engineer, National Transcontinental Railway.

When two men boss a job there is sure to be trouble.

Poor tools or tools in bad order do not impress a customer favorably.

It is easier to turn a flange with several light blows than by one smashing one.

A force pipe with a leaky valve and connections is a thief of time and money.

A drill ground with uneven lips cuts harder, makes an oval hole, and so does a poor job.

A tap or a reamer works easier and does a better job when well oiled. Then, too, they last longer.

Oatmeal and potatoes are a mighty poor substitute for a well calked seam or a properly driven rivet.

When you ask the tool keeper for an inch drill, measure it to be sure that you can get what you asked for.

Feed slow when your drill begins to break through the plate. This will save drills and you will get a better job.

A badly battered chisel or calking tool is a dangerous thing to use. Last year a number of men lost eyes on account of this condition, and it cost the bosses a lot of money.

Programme of Master Boiler Makers' Convention

The ninth annual convention of the Master Boiler Makers' Association will be held at the Hotel Sherman, Chicago, Ill., on May 25, 26, 27 and 28. Registration will begin at 9 A. M. Monday, May 24. Each member should report promptly after his arrival for himself, ladies and guests, and receive convention badges with such instructions as may be of value during the progress of the convention. The official programme is as follows:

TUESDAY, MAY 25 (MORNING SESSION)

Invocation by the Rev. Rufus A. White, of Chicago.

Addresses by the Hon. William Hale Thompson, Mayor of Chicago, and Mr. D. R. MacBain, of Cleveland, Superintendent of Motive Power, the New York Central Railway Company.

Responses by Mr. James T. Goodwin, Past President, and Mr. Charles Hempel, Past President.

Annual address by Mr. James T. Johnson, President of the Association.

Routine business: Annual report of the Secretary, Mr. Harry D. Vought; annual report of the Treasurer, Mr. Frank Gray.

Miscellaneous business.

WEDNESDAY, MAY 26 (MORNING SESSION)

Address by Mr. Frank McNanamy, Chief Boiler Inspector, Interstate Commerce Commission.

Response by Mr. P. J. Conrath, Past President.

Committee reports:

"What are the Advantages or Disadvantages of Using Oxy-Acetylene?" T. F. Powers, chairman.

"What are the Advantages or Disadvantages of Using Electric Process for Boiler Maintenance and Repairs?" John Harthill, chairman.

"Which Firebox Steel Gives the Best Results in Locomotive Service, the Basic or the Acid?" John Holt, chairman.

"What Can the Association Do to Get a Uniform Rule Regarding the Load Allowed on Staybolts and Boiler Braces?" Charles P. Patrick, chairman.

Routine business.

THURSDAY, MAY 27 (MORNING SESSION)

Address by Prof. Lawrence W. Wallace, M. E., Associate Professor, Railway and Industrial Management, Purdue University.

Response by Mr. M. O'Connor, Past President.

Committee reports:

"What Should Be the Standard Slope for a Crown Sheet in a Locomotive Firebox: Its Advantages or Disadvantages?" M. J. Guiry, chairman.

"What Benefit Has Been Derived from Treating Feed Water for Locomotive Boilers Chemically, etc.?" C. N. Nau, chairman.

"What are the Advantages of Cross Stays Above the Inside of Firebox: Has Their Introduction Brought About Failures at Other Locations, and If So, Where?" J. J. Davey, chairman.

"Best Method to Determine the Reduced Percentage of Strength in a Shell of a Boiler Occasioned by Pitting or Corrosion." Henry Raps, chairman.

Announcements.

(AFTERNOON SESSION)

Committee reports:

"What Method of Driving Staybolts and Radial Stays Gives the Best Results and Service in Locomotive Boilers?" B. F. Sarver, chairman.

"What is the Most Economical Method for Constructing New Locomotive Tanks and What Advantages Have the New Designs Over the Old Style of Tanks?" W. H. Laughridge, chairman.

"Which is the Most Economical Method of Removing and Replacing New Fireboxes in Wide Firebox Locomotives; Taking Out the Head or Cutting Back End Off at the Connection or Taking the Boiler Off the Frames and Removing Old Box and Replacing New One Without Removing Back Head or Connection?" A. M. Baird, chairman.

FRIDAY, MAY 28 (MORNING SESSION)

Committee reports:

"Law." J. T. Goodwin, chairman.

"Topics for Convention of 1915-1916." James Crombie, chairman.

Unfinished business.

The election of officers.

Good of the Association.

Announcements and closing exercises of the convention.

Superheating*

The locomotive boiler presents many limitations that have an important bearing on the design and construction of the superheater. The development of the locomotive, within certain fixed clearances, has been dependent upon the size of the boiler. As the boiler increased, wheels have been added to obtain proper weight distribution Consequently, the boiler is no larger than is absolutely necessary, and in the majority of cases it is insufficient in evaporating surface.

The application of a superheater to this boiler necessitates a reduction of about 15 or 20 percent in the tube heating surface. Furthermore, a certain percentage of the gases, which formerly was available for evaporation of the water, must now be used for superheating the steam.

Taking this boiler with its deficiencies, the superheater has produced an economy of 25 percent in fuel as a direct result of saving 33½ percent of the total water evaporated per unit of power. As a result of this fuel economy greater capacity of the locomotive has resulted.

If cylinder tractive power in percent is plotted against piston speed it will be seen that the average modern superheated steam locomotive, using between 200 and 250 degrees of superheat, has a greater available tractive power. This is due to the fact that a longer cut-off is possible with the superheater engine at comparative speeds. The limiting factor at the usual speeds is the ability of the boiler to furnish steam.

These results have been accomplished in the face of boiler limitations, parts of the locomotive being not adaptable to the use of highly superheated steam, and lack of experience in the organization which must handle the locomotive. The problems incident to these conditions are rapidly being worked out, and results shown by the superheated steam curve will soon be as basic as the saturated steam curve was a few years ago. The future holds a possibility for further saving by increasing the degree of superheat. For some time past large passenger locomotives have been operated very successfully with steam chest temperatures between 750 and 800 degrees. This corresponds to 350 to 400 degrees of superheat.

The superheater engineer has only made use of the same variety of flue sizes as was used by the locomotive designer for tube sizes. If the superheater designer should

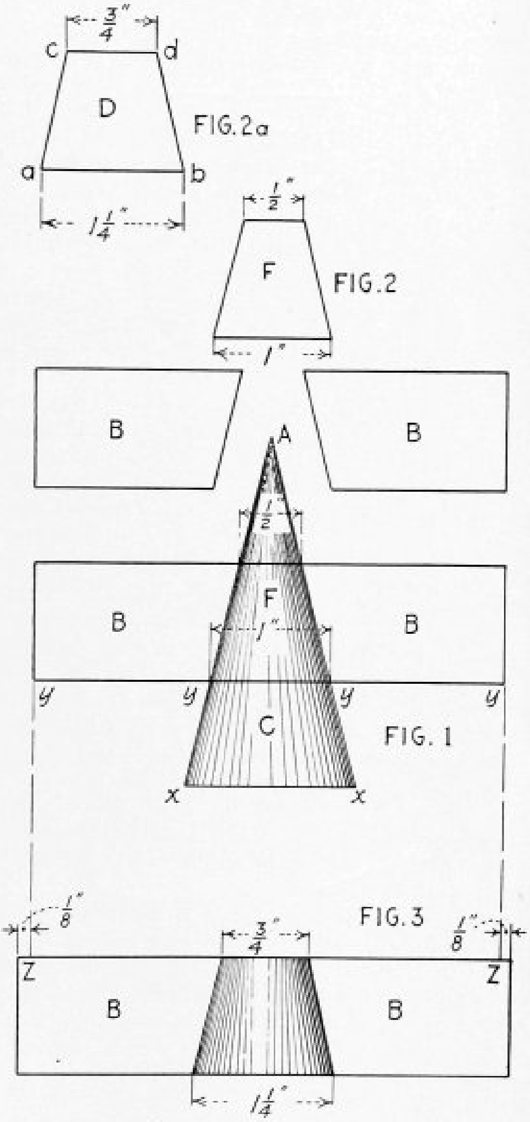
* Extract from discussion by H. B. Oatley of paper on "Steam Locomotives of To-day," presented at the last annual convention of the Society of Mechanical Engineers.

be permitted the use of a size different from the two present standards, it would be possible to obtain in a superheater boiler evaporating surface practically as great as in the saturated steam boiler. In this case the superheating surface would be a distinct net gain to the heat-absorbing surface of the boiler. With a boiler and superheater thus arranged, greater capacity may reasonably be expected.

Adjustable Flanging Dies

BY C. W. R. EICHHOFF

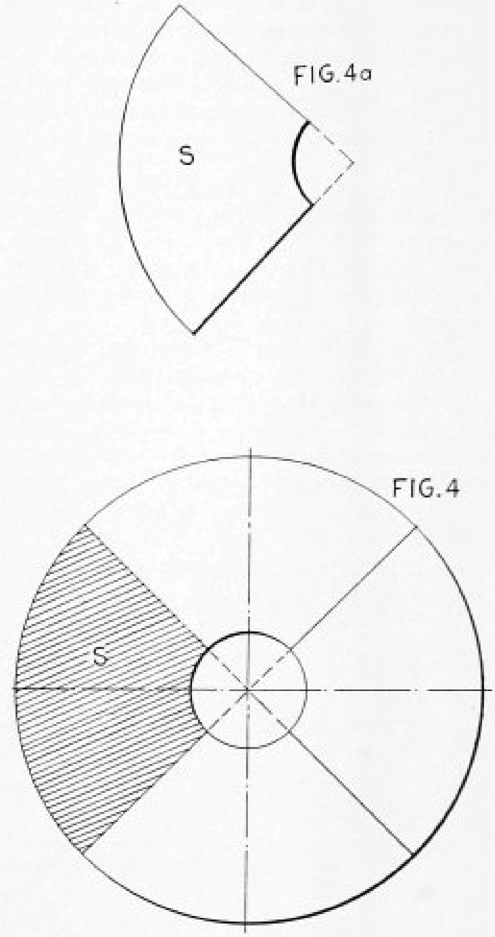
A subscriber of THE BOILER MAKER has asked for some information in regard to adjustable flanging dies, such as were mentioned in a former article published in the July,



Figs. 1, 2, 2a and 3

1914, issue of this paper. For the benefit of those not familiar with these dies, I give the following explanation:

In Fig. 1 is shown a cone, *C*, with two plain blocks, *B. B*, on each side of the cone. For the sake of simplicity, and to better explain the proposition involved, solid blocks are shown. These blocks, *B, B,* which represent a circular ring, can slide along the axis of the cone. For a better understanding of this, draw the figure on a sheet of paper and cut out the blocks, *B, B,* with a pair of scissors, and then cut out the middle part, or the frustum of a cone, *F,* as shown in Fig. 2. In place of the original frustum cut out another one, as shown at *D,* Fig. 2a, whose bases *a-b*



Figs. 4 and 4a

and *c-d* are ¼ inch larger in diameter or ⅛ inch larger in radius than those shown in Figs. 1 and 2. Using this new frustum, *D,* and the original blocks *B, B,* we will get Fig. 3. It can be seen that the dies, *B, B,* are moved out ⅛ inch on each side. The relation of the new arrange-

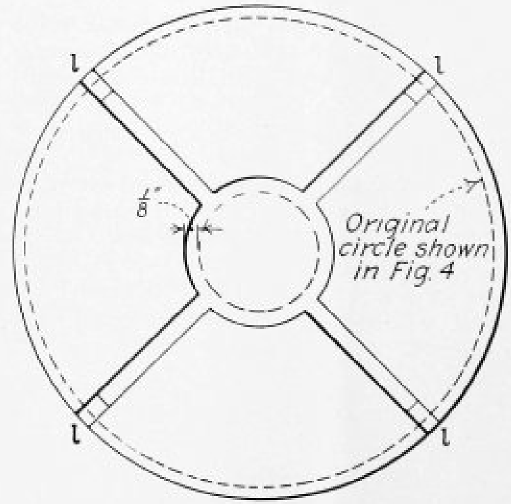


Fig. 5

ment, Fig. 3, to the original one, Fig. 1, is plainly indicated by the projecting lines *Y-Z*.

This principle can now be applied to the construction

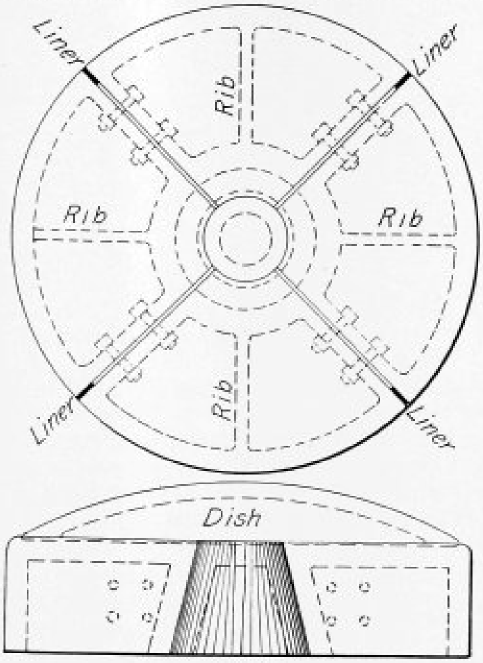


Fig. 6

of adjustable die blocks by using a different cone for each thickness of head, but using the same dies, *B, B.* Now let us see what the result of this will be on the circumference of the blocks, *B*.

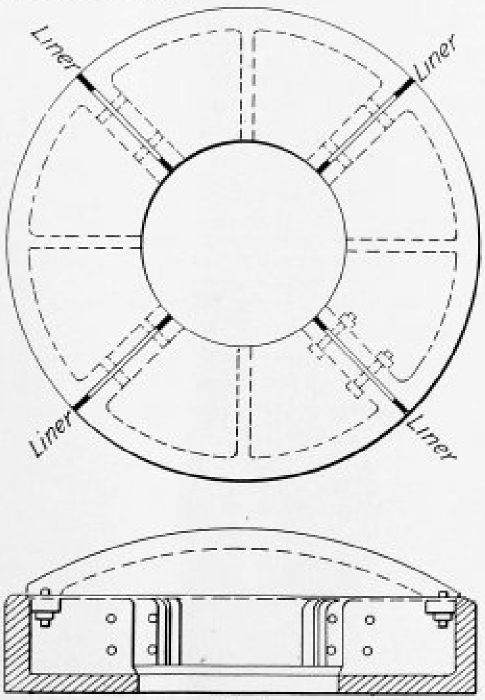


Fig. 7

The original sections, in this case four, are shown in Fig. 4. This condition would answer for the heaviest plate to be flanged. Now let us cut out one section, *S*, as shown in Fig. 4a, and move it out a distance of ⅛ inch, as indicated in Fig. 5. We will find that there is practically no variation in the curvature of the circumference, but we have, by filling in the spaces between the four segments with liners, *l, l,* a circumference with a larger diameter, obtained with the same blocks, *B, B,* representing a circle which is true enough for all practical purposes within the

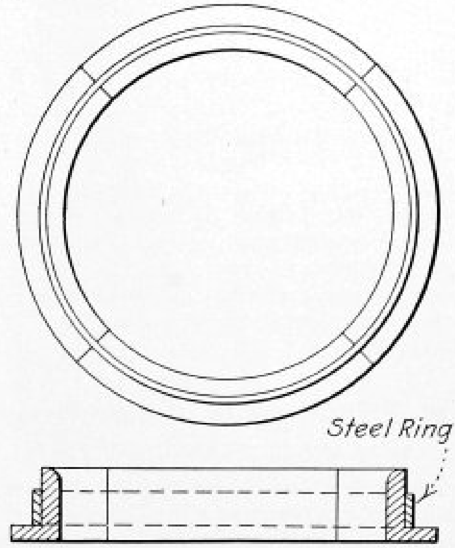


Fig. 8

limits of the rather small variations of diameters corresponding to the different thicknesses used for heads of the same outside diameter. It can be seen that a great saving of material, as well as floor space for storing dies, can be effected by using such adjustable dies instead of having a different male die for each thickness of head.

In Fig. 6 is shown a die with four sections bolted together and ready for operation. By inserting different thicknesses of liners, we can adjust the four sections for different thicknesses of plate by applying the proper cone for the corresponding thickness. Each thickness has its own cone. The same cones, or better, frustums of cones, can be used again for blocks of larger diameter.

From Fig. 6 it can also be seen that we can use only

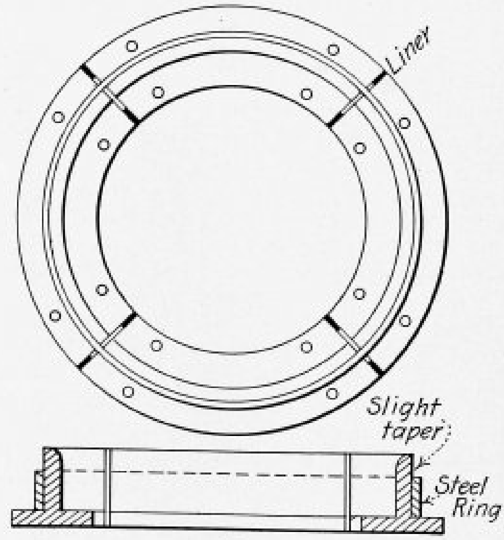


Fig. 9

one dish answering for the different thicknesses of plate for the same diameter of head. The dish block is not sectional and consists of one piece only. The great advantage of the cone is its releasing capacity, as I have explained in the former articles on "Hydraulic Pressing."

Not having a complete description of the machine which the subscriber, referred to above, is using, but only that it is a press of the overhead plunger type, a type not much used in the United States, but found abroad, it might be possible to use such cone dies by placing the same on a plate supported by the four columns, and move it upward, having the matrix attached to the upper platen, moving downward. If this should not be convenient, the die shown in Fig. 7 can be used, as is frequently done on a sectional flanging press. Of course there is only one dish necessary to dish the heads of the same outside diameter, but of different thicknesses.

Sectional matrices can also be designed by using liners and a strong forged ring. Such dies will answer for the heads of a large and small course. Fig. 8 shows such a female die for a small course head to rest on the lower platen of the press, and Fig. 9 one for a large course head fastened to the upper platen of the machine. The figures are self-explanatory.

Some Principles of Boiler Design—III

BY GEORGE SHERWOOD HODGINS *

We now come to what is called the triple riveted butt joint in boiler construction. This consists in the butting together of the two plates with the customary welts above and below the joint. The arrangement of the rivets is such as to permit of an extra row being placed on each side of the butt joint—that is, one more row on a side than appeared in the form of joint dealt with in the April issue of THE BOILER MAKER. This joint is spoken of as triple riveted because there are three rows of rivets on each side of the butt joint of the main boiler plate. There are, in fact, six rows of rivets, but three lie on each side of the joint.

In this joint the upper welt takes two rows of rivets, usually staggered, on each side of the joint. These rivets pass through the lower welt, the boiler plate and the upper welt. These rivets are, in consequence, in double shear. The lower welt extends out farther on each side of the butt joint than the upper one, and not only takes the two central rows of rivets just referred to, but takes one row of rivets which passes through the lower welt and the boiler plate. These outer rivets are therefore in single shear. In assuming a typical case, the spacing of the rivets may be taken as follows: The outer row, in single shear, may be supposed to be 6¾ inches apart, center to center, and the inner rows, or those in double shear, may be taken as spaced 3⅜ inches apart, center to center. The rivets themselves are one inch in diameter. The distance between the rows of staggered rivets is about equal to, or a little less, than the spacing of the rivets in these rows, but this figure does not appear in the formulas and need not be specifically assumed. The tensile strength of the plates is taken at 60,000 pounds to the square inch, and the value of the resistance to shear of rivets at 45,000 pounds. The plate is 7/16 inch thick.

Such a butt joint as is here set forth may, like the double riveted joint considered last month, fail in any one of five ways. In the first place the joint may give out by the tearing apart of the plate along the line of the outer row of rivets. Taking the unit width between two of these rivets, 6¾ inches apart, the resistance to failure may be stated in the form of an equation:

$$R = (P' - D) \times T \times Ts$$
$$R = (6\tfrac{3}{4} - 1) \times 7/16 \times 60{,}000$$
$$R = (6.75 - 1) \times .4375 \times 60{,}000$$
$$R = 150{,}937.5 \text{ pounds}$$

where R is the resistance,
P' is the pitch of 6¾ inches.
D is the diameter of the rivets.
T is the thickness of the plates.
Ts is the tensile strength of the plates.

The joint may also break up by reason of the shearing of all the rivets. Here there are two rows in double shear, and this, in the calculation, may be taken to equal, in the unit strip, four rivets in double shear, equaling eight rivets in single shear. The outer row contains two half, or equal to one rivet, in single shear. This must be added, so that the entire set of rivets in the unit strip, 6¾ inches wide, is equal to nine rivets in single shear. The equation may be stated as below:

$$R = 9A \times S$$
$$R = 9 \times .7854 \times 45{,}000$$
$$R = 318{,}087 \text{ pounds}$$

where A is the area of a rivet,
S is the shearing strength of a rivet.
R is the resistance.

It is possible for the rupture of the plate to take place along the line of the middle row of rivets, and in order to have the joint open up completely, the single outer row of rivets might shear off. In this case the plate tears at the center row and shears the outer row. The statement of this condition, in mathematical form, is by the equation,

$$R = (P' - 2D) \times T \times Ts + A \times S$$
$$R = (6.75 - 2) \times 60{,}000 \times .4375 + .7854 \times 45{,}000$$
$$R = 124{,}687.5 + 35{,}343$$
$$R = 160{,}030.5 \text{ pounds}$$

where R is the resistance,
P' is the pitch (6¾ inches).
T is the thickness of the plates.
Ts is the tensile strength of the plates.
A is the area of a rivet.
S is the shearing strength of a rivet.

The joint may fail by the crushing of the plate in front of the two rows of rivets in double shear, and the shearing of the single outer line of rivets. The equation for this state of affairs is:

$$R = 4D \times T \times C + A \times S$$
$$R = 4 \times 1 \times 7/16 \times 90{,}000 + .7854 \times 45{,}000$$
$$R = 4 \times 1 \times .4375 \times 90{,}000 + .7854 \times 45{,}000$$
$$R = 157{,}500 + 35{,}343$$
$$R = 192{,}843 \text{ pounds}$$

where R is the resistance,
D is the diameter of the rivets.
T is the thickness of the plates.
C is the resistance to crushing of the plate.
A is the area of a rivet.
S is the shearing strength of rivets (each).

A complete destruction of the joint may take place by the crushing of the plates in front of each of the rivets. This is a contingency to be provided against, though it is not likely to happen just in this way. The equation, however, to be used here is:

$$R = 5\,D \times T \times C$$
$$R = 5 \times 1 \times .4375 \times 90{,}000$$
$$R = 196{,}875 \text{ pounds}$$

where R is the resistance,
D is the diameter of the rivets.
T is the thickness of the plates.
C is the resistance to crushing.

Now in order to ascertain the percentage of strength of this joint, we look over the results obtained, and find that the possible failure which involves the tearing of the plate along the outer line of rivets, shows that it is the one in which the power of resistance is the lowest, viz., 150,937.5 pounds. The plate itself, taking the unit strip 6¾ inches wide and 7/16 inch thick, has a resistance of 177,187 pounds. These figures show the full strength of the unit strip and the others show the weakest condition of the joint. In order to find the percentage of strength, the employment of the simple "rule of three" gives us the formula as follows: $150{,}937.5 \times 100 \div 177{,}187 = 85.2$.

* Member of the American Society of Mechanical Engineers, and formerly Consulting Mechanical Engineer of the National Transcontinental Railway.

The joint has, therefore, an efficiency of 85.2. Our previous example, given in the March issue, showed a percentage of 79 for the single riveted butt joint. This one, the double riveted butt joint, is 85.2.

The demand for higher pressures, which now shows a slight tendency to diminish owing to the increasing use of superheated steam in locomotive boilers, requires higher efficiency in the joints, as these are necessarily the weak points in boiler design. A form of joint intended to secure this higher percentage of strength may be had by increasing the width of the lower or inner welt and the addition of an outer, widely spaced row of rivets, which leaves the general form of the joint similar to that just described.

Taking this new form of joint let us suppose the extreme outer row of rivets to be spaced 15 inches apart, center to center, the next row 7½ inches apart and the two inner rows 3¾ inches, center to center, as in the joint previously considered. The thickness of the sheets is ½ inch and the rivets are 1 inch in diameter. The two inner rows pass through both welts and the boiler plate which they unite. The two outer rows 15 and 7½ inches, center to center, respectively, pass through the boiler plate and the inner or lower welt. The pitch of the inner rows is 3¾ inches the next outside row has twice the length of pitch, or 7½ inches, and the outermost row twice the pitch of the one behind it, or 15 inches. This joint may fail in any one of four ways.

In the first place, the plate may tear apart along this new widely spaced row of rivets. The equation representing this form of failure is:

$$R = (P'' - D) \times T \times Ts$$
$$R = (15 - 1) \times .5 \times 60{,}000$$
$$R = 420{,}000 \text{ pounds}$$

where P'' is the pitch (15 inches),
D is the diameter of the rivets.
T is the thickness of the plates.
Ts is the tensile strength of the plates.
R is the resistance.

The second kind of failure might result from the shearing of all the rivets. The two inner rows are in double shear and are thus equal to sixteen rivets in single shear, as in the unit strip, 15 inches wide; four such rivets are arranged in each row. The three outer rivets in the unit strip are in single shear. There are, therefore, the equivalent of nineteen rivets in single shear, and the resistance to single shear is taken at 45,000 pounds per square inch. The equation is as follows:

$$R = 19A \times S$$
$$R = 19 \times .7854 \times 45{,}000$$
$$R = 671{,}517 \text{ pounds}$$

where R is the resistance.
A is the area of the rivets.
S is the shearing strength of the rivets.

Another form of failure might occur by the plate tearing along the inner row of rivets and shearing the three outer rivets in the unit strip. The equation for this would be:

$$R = (P'' - 4D) \times T \times Ts + 3A \times S$$
$$R = (15 - 4) \times \tfrac{1}{2} \times 60{,}000 + 3 \times .7854 \times 45{,}000$$
$$R = 436{,}029 \text{ pounds}$$

where R is the resistance,
P'' is the pitch (15 inches).
D is the diameter of the rivets.
T is the thickness of the plates.
Ts is the tensile strength of the plates.
A is the area of the rivets.
S is the shearing strength of the rivets.

The fourth way in which this joint may give out is by tearing along the second of the outer rows of rivets where the pitch is 7½ inches and the shearing of the one outermost row of rivets with the 15-inch pitch. The equation for this is:

$$R = A \times S + (P'' - 2D) \times T \times Ts$$
$$R = .7854 \times 45{,}000 + (15 - 2) \times .5 \times 60{,}000$$
$$R = 425{,}343 \text{ pounds}$$

where A is the area of the rivets.
S is the shearing strength of the rivets.
P'' is the pitch (15 inches).
D is the diameter of the rivets.
T is the thickness of the plates.
Ts is the tensile strength of the plates.

Among these different forms of failure is the one where the sheet tears along the outer and widely spaced row of rivets. This is the weakest of all, and is 420,000 pounds. The strength of the unit strip, 15 inches wide, half an inch thick, and with a tensile strength of 60,000 pounds, is 450,000 pounds. This becomes the divisor, when ascertaining the efficiency of the joint, and 420,000 × 100 or 42,000,000 is the dividend.

$$420{,}000 \times 100 \div 450{,}000 = 93.3.$$

The percentage of strength of this joint when compared with the tensile strength of the solid plate is 93.3 percent, and this makes a good substantial joint.

Important Convention of Boiler Manufacturers to be Held at Erie, Pa., on June 21-23

The 1915 convention of the American Boiler Manufacturers' Association will be held at the Lawrence Hotel, Erie, Pa., on June 21, 22 and 23. All boiler manufacturers throughout the United States and Canada are requested to be in attendance.

This convention will be held for business purposes only, and much of the time will be devoted to the discussion of ways and means for the adoption in all States of the uniform boiler code as drafted by the American Society of Mechanical Engineers with the assistance of a committee representing boiler manufacturers. In addition to other reports relative to the activity of the boiler manufacturers' committee in the redrafting of the A. S. M. E. boiler code, and getting same adopted at once by several States, a most important report will be presented by a committee on the drafting of a uniform clause pertaining to "Guarantee on material, workmanship and terms of payment," which will be offered to all boiler manufacturers for use in their standard specifications.

Papers will be presented discussing the proper methods of arriving at "Costs" and a report on a "Uniform Cost System" will be made. Several committees will present reports on other subjects and a number of very important matters will be brought up for discussion.

Entertainment features, which have played an important part in former conventions, will be omitted this year in order that all the time may be devoted to business matters. The Erie City Iron Works and the Union Iron Works Company have stated that the courtesy of a visit through their plants will be extended to all visiting boiler manufacturers.

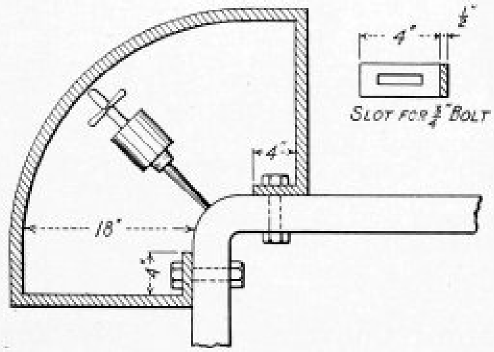
Boiler manufacturers contemplating attending this convention are requested to write at once to J. D. Farasey, secretary, East 37th street and Erie railroad, Cleveland, Ohio, in order that the committee in charge of the convention may know how many manufacturers to expect.

Hooks on crane chains should be annealed now and then or replaced; a broken hook generally means damage and often broken bones.

A Handy Tool

Many boiler shops are equipped with tools for almost every purpose that a man can think of, but very seldom is any provision made for drilling corner bolt holes. The illustration shows a tool for that particular job, and when bolted to the corner of the mudring it is possible to make very quick time. In fact, we have had a man drill, tap and plug corner bolts at the rate of three per hour and that without any great effort.

The tool can be made to suit any shape of corner and is made of ½-inch by 3-inch iron. It can be handled



Support for Drilling Corner Holes

easily by one man and can be attached to the boiler in a few minutes. The ends of the clamp are turned inwards so that they will clear the rivets driven in the mudring and so that they can be bolted to one of the holes which cannot be reached by the hydraulic riveter.

Pittsburg, Pa. FLEX IBLE.

What a Manufacturer of Electrical Machinery Has to Say of Electric Arc Welding

Arguing that electric arc welding is one of the greatest labor-saving processes which have come into the field of the iron and steel industry, J. F. Lincoln, vice-president of the Lincoln Electric Company, manufacturer of motors, generators, lifting magnets and voltage regulators, Cleveland, Ohio, recently had the following to say:

The electric arc may be applied to practically all metals which are to be welded. There are several difficulties which must be encountered, notably expansion and contraction, which is likely to leave internal strains if not compensated for.

There are two methods of applying the arc, and both of these methods have considerable to do with the speed of operation. The first and easiest method of application is with an arc formed between the piece to be welded and a carbon electrode. In such a weld as this, the amount of heat which can be liberated is unlimited, therefore the rapidity of melting is also unlimited. In any steel casting or in some boiler plate, this scheme can be used and will result in very high speed of operation, enormously faster than it is possible to get with any other method of working.

WELDING SHEET METAL

For thin sheet metal the method used is that of the metallic electrode arc, in which the electrode used is a piece of soft metal which of itself becomes the filler and is melted off of the electrode by the formation of the arc. This scheme has a very great advantage in that the heat will travel but a very short distance from the weld and the weld itself outside of the one spot where it is being welded remains at a low temperature, thus eliminating warping of the piece and internal stresses. The speed of this, however, is not nearly as high as it is possible to get by the use of the carbon arc, but is favored on account of the fact that it eliminates warping and makes a softer weld than is possible with the carbon arc. It also eliminates almost entirely all oxide in the weld.

Electric arc welding in its application is comparatively new and, like any new process, has been hedged about by the manufacturers of arc welding machines with a great deal of mystery, which has resulted in a very slow application. This process is becoming increasingly popular, however, and is being rapidly adopted.

Another feature which has contributed to the slow application is the fact that the few manufacturers of welding apparatus have placed ridiculous prices on the welding machines and have cast around them as many supernatural qualities as possible.

TWO CLASSES OF ARC WELDING MACHINES

The one and only function of the welding machine is the saving of the power which is wasted by using resistance in series with any direct current standard voltage. The voltage across the arc in arc welding will vary from 15 to 50 volts, depending on the length of the arc, the amount of current flowing and also the electrode used. It is self-evident, therefore, that if this current is taken from a 250-volt direct-current supply from 200 to 230 volts must be dissipated in a resistance in series with this arc. A machine to save part of this wasted power is the application of all arc welding machines. The arc welding machines which are manufactured are divided roughly into two classes, the one known as constant-voltage machine and the other known as drooping characteristic machine.

The ordinary constant-voltage machine is a motor generator set which will take current from the supply line at the voltage of the supply line and operate a constant-voltage compound wound machine at 75 volts for the welding circuit. It is necessary, of course, to have a resistance in series with this 75-volt machine in order to get the voltage down to the voltage required by the arc. A machine of this kind, however, generally is a good investment, as it will show a considerable saving when continually used over the resistance in series with the 250-volt supply line. Any motor generator set of which the generator would give a voltage of approximately 75 with a piece of fence wire for resistance to use in series with the arc will give results equally as good and be just as economical.

The other type of machine and the machine which ought to be used if saving is the idea, is a drooping characteristic machine which will generate a voltage exactly the same as that required at the arc. In other words, if the arc is short circuited, the voltage will drop to zero and, as the arc is drawn, whatever voltage is required across the arc will be the voltage of the machine. A machine of this kind will pay for itself within a very short time after being put into operation and is the only machine which will show maximum economy in work of this kind. Machines of both classes are being manufactured at the present time.—*The Iron Age.*

Have you ever met a boss who didn't think, or at least say, that the time any gang spent on a boiler repair job was twice too long?

Now that we have a standard code for boiler making there is some hope that the gage nuisance can be done away with and the thickness of all boiler tubes be designated in thousandths of an inch.

Boiler Inspection*

Qualifications of an Inspector and How the Inspection Should be Made

BY S. F. JETER †

The present-day "safety first" movement has apparently taken all by storm, but if full credit is to be given where credit is due, it must be remembered that boiler inspection was the first "safety first" movement placed on a business basis. Before telling you how inspections are made, it will be in order to briefly describe the qualifications required of boiler inspectors.

It is the first duty of the boiler inspector to prevent accidents to the boilers under his care, and after that to give such advice as will prolong the life of the boilers, reduce the operating costs to the owner and become a general instructor and walking encyclopedia for the plant operatives, particularly in mechanical matters, but often required to give advice in connection with family troubles. A good boiler inspector to a casual observer is an ordinary mortal, but in reality he is a wonderfully constructed being. He must possess a large assortment of apparently contradictory virtues. The layman naturally assumes that if a man knows boilers and can tell when repairs should be made and how to determine safe pressure, he is fully equipped as an inspector. If this were true, the insurance companies would have to hire a corps of bouncers to get rid of the applicants for inspectorship.

Knowledge of Boilers Essential

An inspector must, of course, know boilers thoroughly; in fact, he must know them so well that he feels confident that his recommendations or demands are absolutely right. On the other hand, he must be anything but bull-headed, and always open to argument, and be broad-minded enough to at once admit error if he finds he has taken an incorrect view owing to a lack of knowledge of all the facts or from any other cause. The inspector must be a close student of human nature, and know just how to approach an assured in order to get desired repairs made. Some people can be handed an idea, metaphorically speaking, on a silver waiter and assimilate it at once, while others require the use of an axe in order to make an impression. The inspector must be fully capable of deciding at once whether the silver waiter or axe is to be used, and if the wrong vehicle is employed no end of trouble results, and often a good risk is lost for the want of a little tact.

The inspector must have a backbone without joints when it comes to arguing a case with an assured who demurs regarding changes that are necessary for safety. The inspector is often given honeyed words and false praise in an endeavor to cause him to recede from demands for changes or recommended condemnation of unsafe apparatus, but if he knows he is right he must turn a deaf ear to all such blandishments.

The inspector must be physically robust, for boiler inspecting is no child's play, but is one of the most fatiguing of occupations. The inspector is often required to undergo severe temperature changes; notwithstanding, the inspection of boilers is a very healthful occupation, owing to the exercise and outdoor nature of the work. The boiler inspector should be gastronomically built like a camel and learn to eat and drink when he reaches a point where food may be obtained. These gastronomic requirements do not particularly apply to New England inspectors, but in the West and South it is a real and necessary qualification. The inspector must be capable of expressing himself well, both orally and in writing, for it is only by properly presenting the findings of his inspection that he can hope to impress the assured with the value of his work.

The inspector must be cosmopolitan in every sense of the word, for while he necessarily comes in contact and must treat in a manner to retain the friendship of the lower grade employees in a plant, he must also be capable of meeting the higher officials on an equal footing.

Boiler inspections are divided into two general classes, usually termed external and internal inspections, but the names would better designate the nature of the inspections if they were called operating and general inspections. The external inspection is usually made without any previous notice to the assured, and the inspector's duties in connection with this inspection are such that the operation of the plant is in no way interfered with, providing, of course, everything is found in order.

Internal Inspection

To make an internal inspection of a boiler it is necessary that it be idle and empty and the manhole and handhole plates removed, as well as otherwise prepared for examination. I will first describe the internal or general inspection because the first of such inspections is the one required for the approval of the risk for insurance.

It will be assumed that an application for insurance on a plant consisting of boilers of the horizontal return tubular type has been secured and the inspector is assigned to make the inspection and report fully, giving the highest pressure for which these boilers are insurable. We will leave out the details of how he reaches the plant, assuming that he has been given definite directions in regard to its location, but I can assure you that finding the boilers is sometimes no mean part of the inspector's task.

On arriving at the plant the inspector should endeavor to see the owner, or the one highest in authority. It is best to do this even if nothing more is done than to shake hands and let the owner know that the inspector is on the ground. First impressions are the most lasting, and it is very essential that the boiler inspector makes a good first impression on the management of a plant before offering criticisms which the inspection may disclose as necessary.

From the office the inspector is directed to the boiler room, where he usually meets the chief engineer and other plant attendants. At this meeting the inspector's ability to size up his man is most required, because the plant employee can make his task difficult or otherwise, as he may see fit, and he also can be of inestimable value in imparting information regarding operating conditions which the inspector could not hope to obtain in any other way.

After disrobing, the inspector puts on his special suit

* From a lecture delivered before the Insurance Institute of Hartford, April 7, 1914.

† Supervising Inspector, The Hartford Steam Boiler Inspection and Insurance Company.

of overalls and usually a hood and work shoes. Boiler inspecting is very dirty work, unless the inspector is properly equipped; but with such equipment and reasonable washing facilities, the inspector can keep his personal appearance when not actually engaged in work beyond reproach.

Routine to be Followed

In making the inspection it is important that a fixed scheme be followed—that is, each inspection of a return tubular boiler should be made in the same way. The particular routine observed is not of great importance, but sticking to the same routine for each inspection is very necessary; otherwise some points are very liable to be overlooked. On reaching the boiler room containing the boilers to be inspected, the logical procedure is to first make a general survey of the surroundings to ascertain how they affect the risk. Often an accident of a minor nature has resulted in the injury or death of an employee—causing mental anguish as well as physical pain, and besides an expense to the assured or insuring company which could have been prevented by providing reasonable means of exit. The blow-off connection is a fruitful source of such accidents. The blow-off valve is often located so that the man operating it is in a closely confined space 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 required to prevent such an occurrence. The inspector should examine the location of the boilers with a view of determining the probable damage to surroundings should an explosion occur. This is particularly important in case of very large coverage, or use and occupancy insurance. While the foretelling of the damage likely to result from an explosion is practically impossible, the general exposure of machinery and employees can be more or less well determined.

Piping

The steam and water piping as a whole has to be carefully considered to see that there are no connections that may lead to accidents or dangerous conditions of operation. The feed appliances, such as pumps, injectors, etc., and the piping between them and the boilers must be inspected for safety as well as general plan and capacity, so that the boilers may at all times be supplied with an abundance of water to meet the maximum capacity they are capable of delivering.

The blow-off piping outside of the boiler setting must be thoroughly inspected, for notwithstanding the fact that the coverage of a boiler insurance policy usually ceases at the blow-off valve, the arrangement of piping beyond this point is often such as to produce conditions which may react on the parts included within the coverage. With separately set boilers the connecting pipes to the water space of the boilers must be examined to see that it is separate and distinct, with check valves properly arranged to prevent the transfer of water from one boiler to another. In some cases with heating plants working on very low pressures and gravity returns, it is found best to do away with check valves between the boilers. The steam pipes must be so arranged that no pockets will be formed to trap condensation, and it must also be connected so that the movement due to the expansion and contraction of the pipe can take place without undue strain on any of the parts. Many lives have been sacrificed owing to a lack of precaution and forethought in suitably arranging steam piping.

An examination of the connections and attachments for determining the water level must be made, for it matters not how strongly a boiler is built if the water line is continually carried below the fire line, even a small amount, disaster is almost certain to follow sooner or later. Water columns are frequently found set so low that the safety of the boiler is endangered. The blow-off or drain 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 must be inspected, to see that there are no connections on this pipe that are required to furnish a supply of steam for any other apparatus, or that water can be trapped in the pipe. Either of these conditions will render the indications of the water level inaccurate. Whether the location of the steam gage is correct or not must be determined; frequently a gage is so connected to a boiler that the steam comes in direct contact with the spring or the gage is fastened so that it is exposed to heat from some part of the boiler or smoke flue, either of which conditions renders its indications inaccurate. The safety valve is a very important attachment and deserves the closest scrutiny to determine its condition. The escape pipe from a safety valve is often a source of danger and the inspector must see that it is properly drained and well supported to prevent undue strain on the valve.

Supports

If the boilers are of the suspended type, the ability of the supports to safely carry the load must be determined. This usually requires complete data of columns and supporting members as well as sizes of hangers, etc. The determination as to whether each support is carrying its proper proportion of the load is necessarily made, for the proper support of a boiler is just as important as regards its safety as is its strength in any other respect.

The inspector after writing the answers asked on his data slip regarding the various parts examined so far, enters the top manhole of the boiler, with light, rule, calipers, hammer and usually a depth gage. He first carefully examines the condition of the parts. The shell may show evidences of pitting, especially along and just below the water line. The tubes may be pitted, or thin from general corrosion. The braces may be weakened by corrosion or they may be loose, due to strain or improper fitting. The soundness of the braces is usually 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 shell material. Many of the rivets are sounded for tightness. The condition of the upper portion of the boiler as regards scale or oil deposits is ascertained, and it is not uncommon to find the spaces between the tubes against the rear heads completely stopped with scale for a distance of a foot or more. Such conditions are very likely to lead to serious trouble, if not explosion. Any indication of oil in a boiler is a serious matter, for there is no substance likely to reach the interior of such a vessel that can produce an effect at such wide variance with the apparently harmless nature of the cause.

All openings to outside attachments or connections are examined to see if they are free; many boiler explosions have been caused by a stoppage of the water column connection. Where connections are supplied with a pipe screwed into a part of the boiler, or into a flange riveted to the shell, the inspector must note whether the screwed joint has been fully made up. Since this inspection is assumed to be the first one made of the boilers under question, the inspector must obtain the necessary data for calculating the strength. He must know the distance between the shell and tops of tubes to correctly estimate the amount of bracing required. He must know the number and size of braces at their least section on each head. The number and size of rivets attaching the braces to both the head and shell must be known 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, and to judge whether a suitable bearing surface has been supplied against which the tubes were expanded. The pitch and size of the rivets must be obtained, as well as the design of the joint, 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. The thickness of the shell is necessary; this can usually be measured by means of a depth gage applied along the edges of the plate at the girth seams, and it can often be calipered at an opening in the shell. If there is a dome on the boiler, the details regarding the bracing of the head as well as those of the connection to the shell must be secured, also the dimensions of the reinforcement around the opening from the boiler to the dome, should this opening be of large size.

Upon coming out of the boiler the inspector can place the data obtained on the data slip, but he usually waits until after completing his inspection to do so. The layman might think it a difficult feat to commit all of these measurements to memory, but the average inspector can generally repeat offhand the principal data of a boiler several weeks after taking it.

The next point to be examined is the interior below the tubes, if the boiler is supplied with a manhole communicating with this part of the structure. The usual points to be given attention here are the soundness of the bracing, condition of the shell as regards corrosion or other defects, also heads and tubes, and note the quality and quantity of the scale attached to the surfaces. Quality of scale is just as important as quantity in regard to its ability to injure a boiler or detract from its economical operation. The tube cleaner salesman, and the boiler compound man, frequently quote tables giving the different efficiencies of operation due to fixed thickness of scale in boilers. While there is more or less regular change in the efficiency of a boiler with varying thicknesses of scale of the same quality, it is pure buncombe to state that a given thickness of any kind of scale will reduce the efficiency a fixed amount.

Proper make-up of the blow-off pipe is determined while the inspector is in the lower part of the boiler. If there is no manhole below the tubes, the information specified above is determined as well as possible while in the upper part of the boiler and also through the hand holes which are usually supplied in the front and rear heads of such boilers.

External Inspection

After completing the internal inspection, the inspector should examine the front heads externally. Here corrosion of the head and tube ends is very likely to occur, especially if the boiler 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 deposit in the stack and on the head from the surfaces gases, combined with the moisture, causes extremely rapid corrosion. The inspector must next examine the front especially, to determine that no weight of the boiler is carried on it, unless it should happen to be one of the type that is rapidly disappearing, which is especially designed to carry the weight of the front end of the boiler.

The inspector now enters the furnace and notes the condition of the fire sheets and seams, and should make a careful examination of the surfaces to locate any brands or stamps which are placed on the sheets by the manufacturers of the material, and from which the tensile strength of the plate can usually be obtained. If rivets leak, it is the outside of the boiler that usually reveals this fact, and when leakage is discovered its cause has to be ascertained, so that necessary recommendations can be made. Leakage of the girth seams can be caused in many ways; if from scale or oil deposit the inspection of the interior already made will generally reveal the cause. Poor workmanship in making the boiler will usually be evident to the experienced inspector.

The location, shape and size of the bridge wall which forms the rear limit of the grate surface is often the cause or contributes to leakage at the girth seams. In many types of boilers the improper support is a contributing cause to such trouble. Feeding in the bottom of the boiler through the blow-off connection is a very fruitful source of such trouble. The inspector must examine into all of these phases of the case, and recommend the necessary changes to relieve the trouble.

The inspector must keep a sharp eye for evidences of leaks coming from the vicinity of longitudinal seams. Any leak from such a location must be regarded with the gravest suspicion, for the cause is likely to prove a hidden crack. This defect has caused some of the worst explosions in the history of steam-boiler insurance, and no leak at a longitudinal seam should be considered harmless until it has been proven to be so.

Condition of Setting Walls

The condition of the setting walls must be noted by the inspector, particularly with respect to their ability to properly support the boiler. The blow-off pipe should be examined to see that it is sound and free at the bottom—that is, that no weight is resting on it, as this is a very common source of accident. The freedom of the blow-off pipe where it passes through the setting wall is also essential to safety, as is the proper protection of the pipe from the direct impingement of the flame and highly heated gases from the furnace.

The rear tube ends must be examined for leakage and corrosion, and if such defects are disclosed the cause must be determined and proper recommendations made. The condition and position of the covering over the rear combustion chamber must be examined into; the arches generally used at this point are frequently located so high as to cause the overheating of the head above the waterline. The fusible plug, which is located in the rear head, must be inspected to see that the fusible metal is in proper condition to respond to an increase in temperature should low water occur. After examining the blow-off valve and outer portion of the pipe, the inspector is ready to test and, if necessary, to correct the steam gage, and the inspection is completed.

The inspector, after completing the inspection, usually discusses the various points revealed by his examination with the chief engineer, and directs him in regard to the making of repairs or the betterment of 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 due consideration in fixing the maximum pressure to be allowed. The inspector, before leaving the plant, should endeavor to see the highest one in authority that can be reached, and discuss with him fully all the facts developed by his inspection. In the average case the inspector is able to state at once whether or not a suitable pressure can be allowed on the boilers inspected.

REPORT OF INSPECTION

The report of the examination is usually prepared after the inspector returns to his hotel or office, and it is reviewed by his chief inspector, or someone under his direct supervision, who edits the report and makes any changes that may seem necessary. If changes to be made are of any importance, the report is held up until the subject can be discussed with the inspector or taken up by letter. The report, after receiving the approval of the chief inspector, is typewritten and mailed to the assured. The written report being the official statement of the insuring company with regard to the condition of the boilers inspected, must always contain all the facts discussed between the inspector and plant management.

The external or operating inspection, as previously indicated, is generally made without any advance notice to the assured. The inspector arrives at the plant and usually visits the office before proceeding to the boiler room. The exact manner used to obtain admission depends on the plant rules in regard to such matters. While the external inspection is not nearly so complete as the internal, it is, notwithstanding, a very important inspection. Operating conditions can be observed at such an inspection, and dangerous practices stopped before it is too late to check their effect on the boilers. The inspector has a card or list indicating the allowed pressure on the boilers to be inspected, and on entering the boiler room he should note the gage pressure carried, also the fact as to whether all the gages register alike or not.

The water column must be blown down to determine the freedom of the connections leading to the column, this being made readily 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 operating condition. An examination is next made of the fire surfaces of the boiler and the conditions of the furnace walls as far as can be ascertained from the furnace doors. Also notice is taken of any tendency towards leakage or bagging or blistering of the plates. The front flue doors are opened in order to view the tube ends, which can be examined for leakage and general conditions.

The rear of the boilers is now to be visited and the condition of the blow-off valve and connection is determined as far as their operating condition is concerned. There is frequently a cleaning door located in the rear setting wall in such position that the fire surfaces, and possibly the rear tube ends, may be examined from this point.

The inspector next visits the top of the boilers and, ascertaining the steam pressure at the time, he tries the safety valves or has the engineer try them. With a safety valve of either the spring loaded type or of the ball and lever design, 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 a safety valve will operate can be obtained by testing the freedom of the valve by hand. If the safety valve does not appear to be properly adjusted, the inspector requires that steam be raised until the valve operates in the regular manner or until the increase in pressure positively demonstrates that it is set for a pressure in excess of the limit allowed by the policy.

One of the most important features regarding the external inspection is the discussion of plant conditions with the employees, for information of the greatest value both to the assured and insuring company is often obtained in this way.

Layout of an Elbow

BY P. W. MC DONOUGH

Perhaps the simplest object met with in laying out is the elbow. The usual procedure is to lay it down and develop it entirely by projection. When the elbow is of large size, however, this method requires a great amount of space for making the drawings and does not easily permit of accuracy. In this article it is proposed to explain the laying out of elbows with the use of a table of tangents.

Familiarity with this method will bring about a degree of rapidity and accuracy that cannot possibly be attained by the customary method of laying out an elbow entirely by projection. Furthermore, it will obviate the use of the large space required for drawing the patterns by projection. As the radius of an elbow can often be chosen at the discretion of the layer out, it also permits the layer out to vary the radius so that the elbow can be cut advantageously from the material in stock. The simplicity of the use of the tables of tangents is such that it is within the grasp of almost any person. No trigonometary is needed; all that is required is to be able to multiply.

To proceed with this method, a regular 90-degree elbow made up of ten sections is shown in Fig. 1. Its diameter is 96¾ inches and the radius of its centerline 192 inches. A cursory study of Fig. 1 will show that the first dimension required is the length of a tangent subtended by an angle of 4 degrees 30 minutes on a base of 192 inches.

To obtain this dimension refer to the table of tangents, where it will be found that the tangent of 4 degrees 30 minutes is .0787. All that remains to be done is to multiply .0787 by 192, the product of which is 15.11047, which is the required length, as shown at *A* on Fig. 1, section 1, It is plain that *B*, section 2, is $2 \times A$, or 30.22.

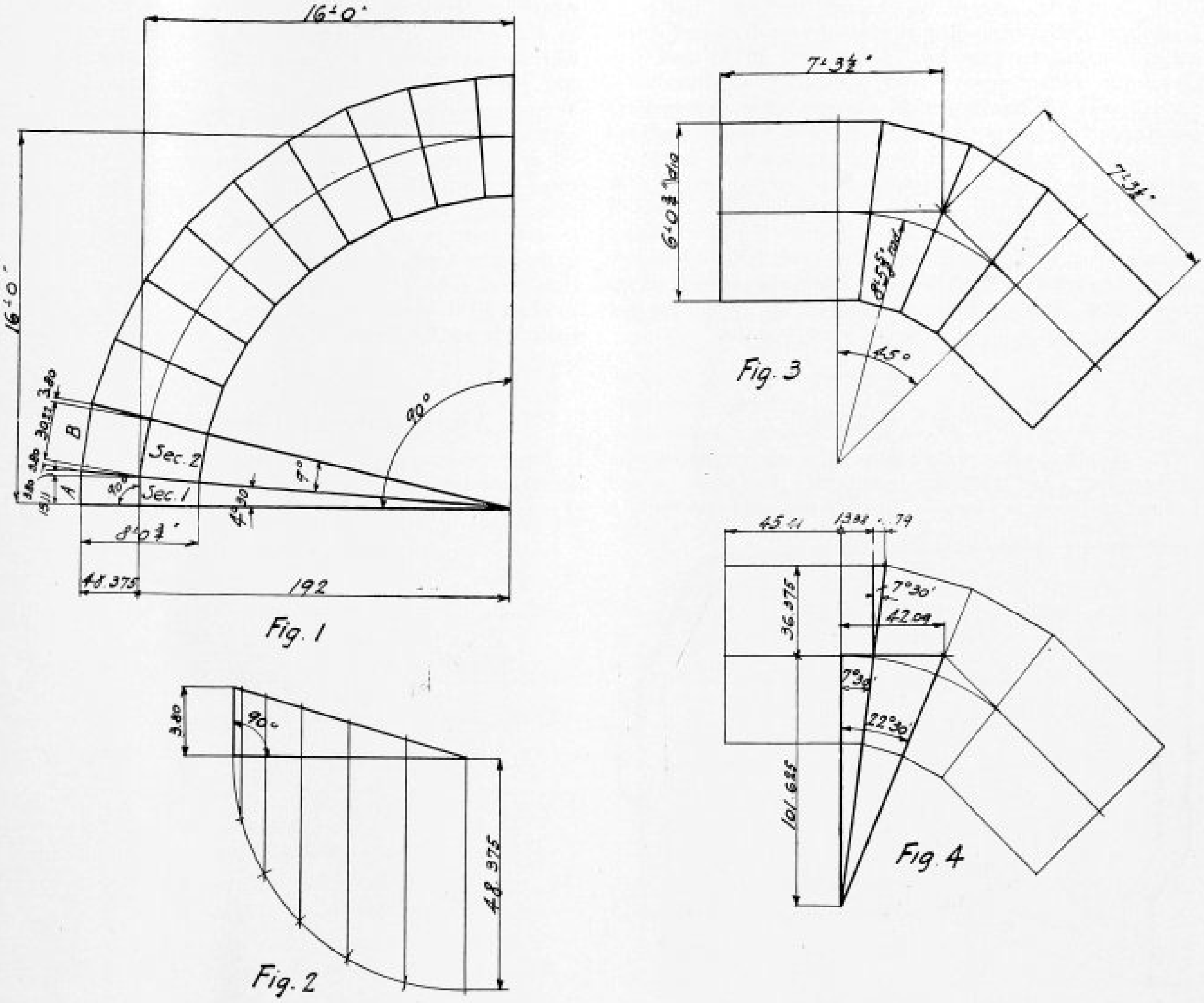
The next dimension required is the length of the tangent subtended by an angle of 4 degrees 30 minutes, the base of which is equal to the radius of the pipe. In this instance the radius of the pipe is 48.375 inches. Proceeding as before, the tangent of 4 degrees 30 minutes equals .0787 and $.0787 \times 48.375 = 3.8071$. With this all the necessary calculations are completed.

The only drawing required is that shown in Fig. 2. A right angle is laid down, the base of which is equal to the radius of the pipe, or 48.375. The height is equal to the tangent of 40 degrees 30 minutes, or $.0787 \times 48.375$, or 3.80. It is presumed that the reader understands the further development of the elbow.

Fig. 3 shows an elbow in which the angle is 45 degrees. The distance from the end to the center is 7 feet 3½ inches, the radius of the centerline is 8 feet 5⅝ inches and the diameter of the pipe 6 feet ¾ inch. To complete this elbow the only additional calculation required beyond that of the preceding example is the computation of the tangent of half the angle of the elbow (in this instance 22 degrees 30 minutes) with a base equal to the radius of the elbow.

Proceeding as before, the tangent of 22 degrees 30 minutes is found to be .4142. Then $.4142 \times 101.625 = 42.09$, as shown on Fig. 4. To complete the layout of the elbow, the only drawing required is one similar to Fig. 2, the base of which is 36.375 and the height 4.79.

A study of Fig. 4 will show that the dimension 45.41 is the remainder obtained by subtracting 42.09 from 87.5, also that the dimension 13.38 is the product of 101.625 multiplied by the tangent of 7 degrees 30 minutes, and that 4.79 is the product of the tangent of 7 degrees 30 minutes, or .1375 times 36.375, which is equal to the radius of the pipe.



Layout of Elbow by Using Table of Tangents

Another New York Explosion Serves as a Second Warning

Several years ago a boiler in the basement of a cold storage plant on Greenwich street, New York City, exploded, wrecked the power plant and ripped up the entire street in front of the building. Recently a boiler in the basement of a hotel on Broadway at Forty-first street, New York City, exploded, fatally injured two men and seriously injured two others. Both explosions were due to the same cause. The first explosion was pointed to as a warning against the dangerous practice of improperly rolling the tubes in the tube sheet. The second explosion served as a second warning, because the tubes of the second boiler were rolled in exactly the same manner. How many such warnings are necessary?

When tubes are installed in a boiler there are three ways of rolling them in. The tubes may be expanded in the tube sheet and then beaded over. They may be expanded in the tube sheet and then flared. They may be merely expanded in the tube sheet without being either beaded or flared. The pressure of steam against the tube sheet tends to force the sheet off the tube ends, and it should be obvious that this tendency cannot indefinitely be resisted by tubes, the ends of which are neither beaded nor flared.

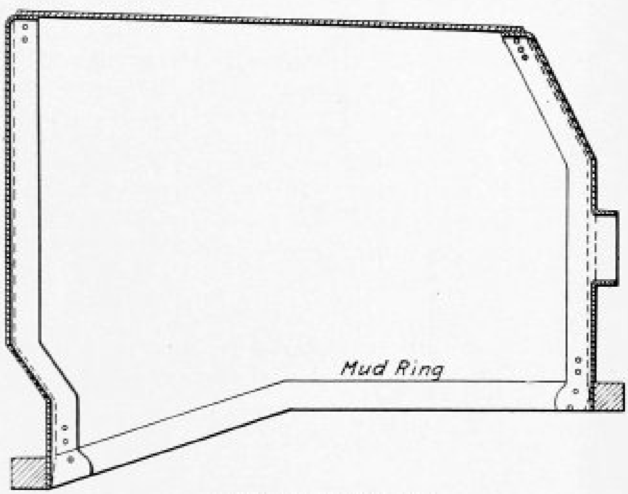
In the case of the second explosion here referred to, the boiler recently had been retubed, and after the work was completed the boiler was subjected to a hydrostatic test of 188 pounds per square inch, or 63 pounds more than the normal steam pressure of 125 pounds to which the boiler was subjected when in service.

But the tubes were neither beaded nor flared, and in course of time the gripping power between the tube and the tube sheets was weakened by expansion and contraction, as a final result of which explosion occurred.—*From the Monthly Bulletin of the Fidelity and Casualty Company of New York.*

NEW BOILER COMPANY IN INDIANAPOLIS.—A new boiler company, known as the Weil Boiler Company, was organized in March under the laws of Indiana, and has established a plant at Draper and Van Buren streets, Indianapolis, on the site of the Hoosier City Boiler Manufacturing Company. An addition 250 feet long has been made to the old plant of the Hoosier City Boiler Manufacturing Company, making the new plant 400 feet in length. The new company, which was formed by Mr. B. Weil and Mr. I. Weil, of Chicago, and Mr. Charles T. Kingston, of Detroit, will manufacture a full line of steam boilers for heating purposes as well as a full line of steel tanks for water storage and pneumatic water service. Mr. Charles T. Kingston, who is secretary and general manager of the plant, was for twenty years with the firm of John Brennan & Co., of Detroit, having been secretary of that company for the past ten or twelve years. Mr. M. M. McCallister, formerly superintendent of Brennan & Co., Detroit, is now superintendent of the Weil Boiler Company, at Indianapolis. The company has its Chicago outlet through the Weil Bros., of Chicago, and it is reported that already orders are booked that will keep the plant in operation for the next twelve months.

Layout Wanted

The accompanying sketch shows the side elevation of a firebox with a partly sloping back head. The writer would be glad to have readers of THE BOILER MAKER give an



Irregular Shaped Firebox

explanation of how to lay out the wrapper sheet for this firebox. Layouts of wrapper sheets have been published in which the front and back heads were straight, but in this case there is a break in the front head and a partly sloping head, making the problem more complicated.

SUBSCRIBER.

Economy Due to Superheating*

The economy due to superheating increases almost directly with the degree of superheat; and the usual type of fire-tube superheater produces its maximum superheat only when it is forced to the limit of boiler capacity.

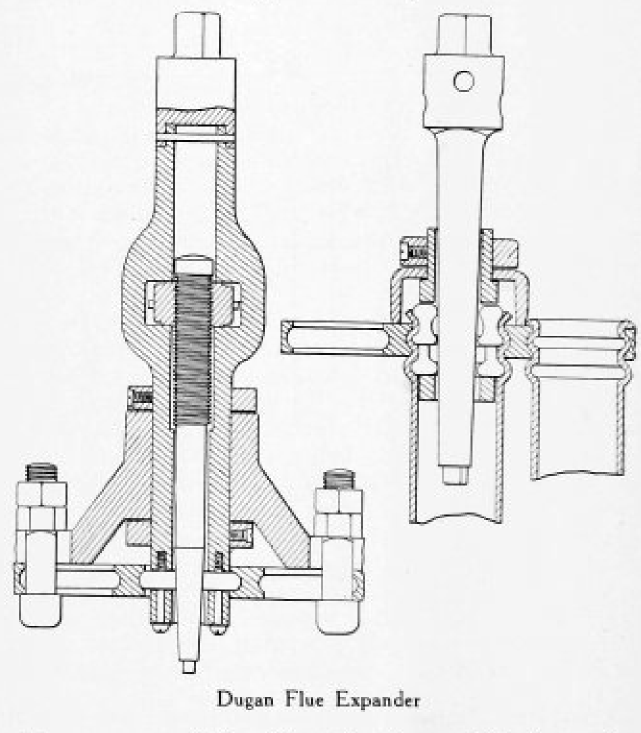
This condition is not altogether desirable, as the maximum economy should be obtained when the locomotive is working under moderate or average conditions and at an economical cut-off. A superheater that would give a uniform superheat under all conditions of working would apparently produce ideal results.

If our materials, in valves, cylinders and packing, as well as the lubrication, will withstand a certain high degree of superheat, there is no reason why we should not furnish this degree of superheat regardless of the boiler rate, in order to effect the greatest economy in steam. With the usual Schmidt superheater we have observed steam temperatures as high as 670 degrees, corresponding to a superheat of 291 degrees at a steam chest pressure which was 180 pounds, while the boiler pressure was 206 pounds. With these conditions the steam rate per horsepower was 19.3 pounds, the speed 47 miles per hour, and the cut-off 50 percent. With this superheat and cut-off at 25 percent, it is reasonable to suppose that a water-rate approximating 15 pounds could be obtained. For this reason the desirability in future designs of superheaters is to produce, if it is possible, a superheater that will give us a uniform superheat regardless of the evaporation of the boiler. Until such a superheater has been produced the maximum economy and capacity from the boiler cannot be obtained under all working conditions.

* Extract from discussion by C. D. Young of paper on "Steam Locomotives of To-day," presented at the last annual meeting of the American Society of Mechanical Engineers.

An Improved Flue Expander

Improvements in the construction of rollers for flue expanders have been patented by S. A. Dugan, Galveston, Texas. Instead of using the ordinary straight rolls, the



Dugan Flue Expander

rollers are provided with projections which force the wall of the flue into grooves cut in the tube sheet, and which also form a groove in the tube behind the tube sheet, thereby, it is claimed, making a tighter and stronger joint between the flue and the flue sheet. These rolls can be used in any roller frame.

BUSINESS ANNOUNCEMENT.—The Vulcan Iron Works, Inc., of which A. J. Grymes is president and L. S. Parker vice-president, acquired on May 1 the entire plant and business of Alex. Miller & Bro., Inc., at the foot of Morris street, Jersey City, N. J., and is prepared to do all classes of boiler and machine work and repairs to steel and wooden vessels.

The Boiler Maker

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Our subscription books are always open for inspection.

5,400 copies of this issue were printed.

NOTICE TO ADVERTISERS

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

Master boiler makers throughout the country should make every effort to be in Chicago during the last week of this month to attend the ninth annual convention of the Master Boiler Makers' Association. As can be seen from the programme printed elsewhere in this issue, addresses will be made at each session of the convention by men prominent in the railway field, and the committee reports that have been prepared during this year cover a wide range of subjects on which every boiler maker should have something to say and something to learn.

There is one subject, however, that does not appear on the programme, but which is of such great importance to the boiler-making industry in general, and to the citizens of this country, that we believe it should be brought before this convention for action, and that is the movement for the adoption in State legislation and elsewhere of the uniform boiler code compiled by the American Society of Mechanical Engineers. While the A. S. M. E. boiler code applies only to stationary boilers, nevertheless it should be remembered that the Master Boiler Makers' Association, when it was formed, was intended to cover the stationary and marine boiler fields as well as the railway field, and for this reason the opportunity should not be lost for the association to go on record with some expression of approval of the A. S. M. E. boiler code. Further than this, a splendid opportunity is given to the association to get into the work which is rapidly being taken up by other organizations looking towards the adoption of this uniform boiler code in the laws of every State in the country.

The convention of boiler manufacturers, which will be held in Erie, Pa., on June 21-23, will be of especial importance, as it will be a joint meeting of the American Boiler Manufacturers' Association and the National Tubular Boiler Makers' Association. Its object will be first, to get final action on the movement for the adoption in the laws of various States of the uniform boiler code compiled by the American Society of Mechanical Engineers, and, second, for the amalgamation of the two boiler manufacturers' associations, so that an organization will be formed which will more adequately represent the boiler making industry. It is believed that a strong, effective, growing association will be the result, and that the present movement for the universal adoption of the uniform standard boiler code is only one of the many important movements which will grow out of it for the betterment and dignity of the boiler making industry at large. The meeting at Erie should mark an era of advancement in which every boiler manufacturer should have a part.

"Clean boilers mean, in addition to increased efficiency, a saving in the cost of fuel, as well as in the cost of repairs."

The above remark was made by Mr. Frank McManamy, chief inspector of locomotives of the Interstate Commerce Commission, Washington, D. C., in a paper presented at the March meeting of the Western Railroad Club. Leading up to this statement, he said:

"Failure to properly wash and scale boilers is another evil which has grown to alarming proportions, due perhaps to the fact that washing or scaling a boiler is among the most disagreeable tasks around a shop, and the job is too often performed by incompetent or indifferent labor not properly supervised. In addition to being one of the chief causes of leaky crown and staybolts, tests have shown that one-eighth inch of scale on heating surfaces results in a loss of approximately 15 percent of the value of the fuel."

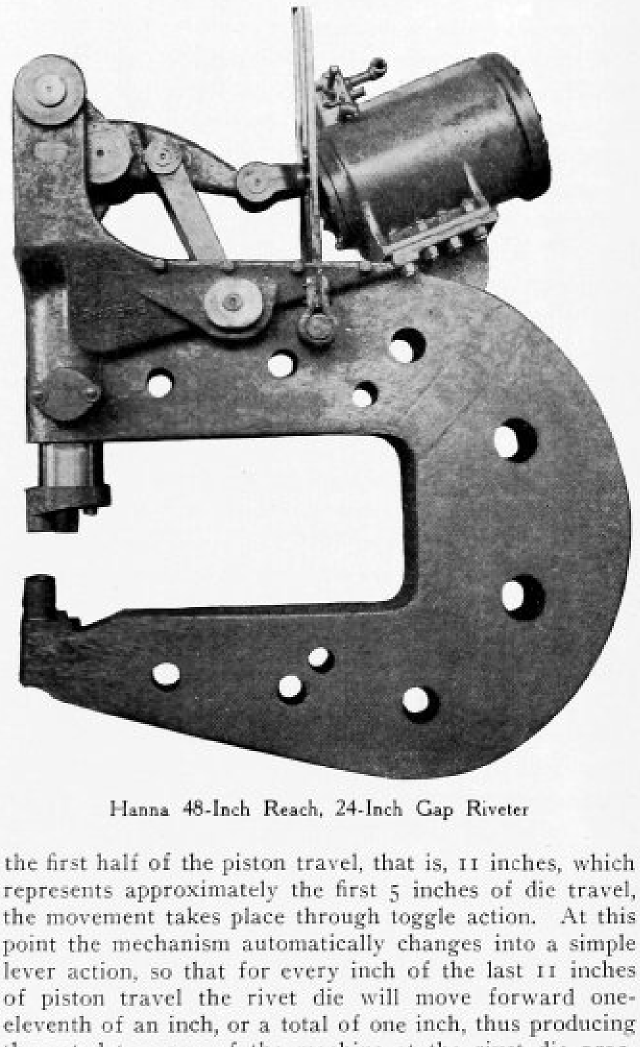
To overcome such conditions, the washing and scaling of boilers should be given the most careful attention and with proper supervision there is no excuse for slighting this part of the work. A more desirable cure, however, is the prevention of the formation of scale in the boiler, and in this direction the treatment of feed water, either chemically or otherwise, has been found effective, and also the development of effective water circulation systems in the boiler. An efficient circulating system, in addition to improving the steaming capacity of the boiler by making the heating surfaces more effective and reducing the unequal stains in various parts of the boiler, tends to prevent the formation of scale around the fireboxes and with proper blowing off keeps the boiler comparatively clean, which means, as Mr. McManamy has said, a saving in the cost of fuel and a saving in the cost of repairs.

Engineering Specialties for Boiler Making

New Tools and Appliances for the Boiler Shop and Improved Fittings for Boilers

One Hundred-Ton Hanna Type Pneumatic Riveter

A 100-ton, 48-inch reach, 24-inch gap pneumatic riveter, manufactured by the Hanna Engineering Works, has recently been placed on the market by the Vulcan Engineering Sales Company, Chicago, Ill. This heavy duty riveter is furnished with a cylinder having a 22-inch piston stroke with a relative travel of 6 inches of the rivet die. During



Hanna 48-Inch Reach, 24-Inch Gap Riveter

the first half of the piston travel, that is, 11 inches, which represents approximately the first 5 inches of die travel, the movement takes place through toggle action. At this point the mechanism automatically changes into a simple lever action, so that for every inch of the last 11 inches of piston travel the rivet die will move forward one-eleventh of an inch, or a total of one inch, thus producing the rated tonnage of the machine at the rivet die practically uniform for the last inch of die travel.

On account of the considerable distance through which the rated pressure is exerted, careful adjustment of the die screw is unnecessary, consequently there is no necessity for striking a rivet more than once. With each stroke of the machine, the rivet is set with a predetermined tonnage which is produced irrespective of the judgment of the operator and leaves no uncertainty as to whether or not sufficient pressure has been given to the rivet.

Owing to the fact of the slow movement of the die during the lever action, ample time is given for the metal in the rivet to flow and fill the hole completely. Also an opportunity is given for the rivet to set before the pressure is completely released on the return stroke of the lever. This scientific distribution of power and speed, it is claimed, makes the motion particularly useful for driving cold rivets, since the motion automatically slows up during the lever action and gives the metal time to flow under full pressure, thus avoiding crystallization.

A novel feature of the machine illustrated is the flush top, which permits riveting angle connections on plate work as close up as 2 inches.

"Dittman" Safety Locomotive Cold Water Sprinkler

The McKee Company, 416 Wood street, Pittsburg, Pa., his developed a safety locomotive cold water sprinkler which, it is claimed, will furnish an abundant supply of water on a locomotive at a useable temperature. The sprinkler is so constructed that it will not discharge steam or hot water, and provision is made so that the pipes cannot freeze.

The general arrangement of the installation is shown

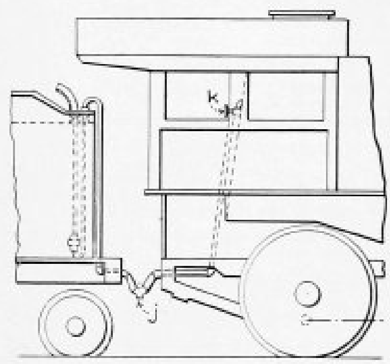


FIG. 1

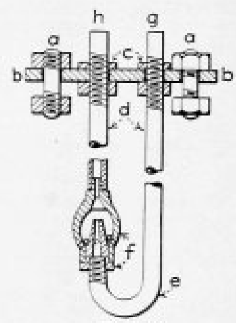


FIG. 2

FIG. 3

in Fig. 1, the control valve, *k*, being located at a convenient point on the boiler head and an automatic bronze drain valve, *j*, is placed at the lowest point in the steam supply pipe, or hose. In Fig. 2, *f* is a bronze delivery apparatus, the steam entering at *g* and the water being delivered at *h*. Pipes, *d*, are furnished to fit any depth of tank necessary. The apparatus can be removed and replaced in a few minutes without draining the tank, and the arrangement is such that there is no water in the pipe between the locomotive and tender.

McCabe Pneumatic Flanging Machine

To meet the demand for a machine powerful enough to flange, while cold, boiler plate such as is used in the average plate-working establishment, the McCabe Manufacturing Company, of Lawrence, Mass., has introduced the pneumatic flanging machine illustrated. This machine was designed for flanging boiler plate, while cold, up to and including ½-inch thickness. It is self-contained, requires no foundation, and can be placed anywhere about the shop without even lag-screwing it to the floor. It is operated by compressed air, and all that is necessary to put the machine into running order is to connect it to the shop air system (100 pounds pressure) with an ordinary ¾-inch air hose. It is also necessary to place the machine within range of a traveling or jib crane for handling plate.

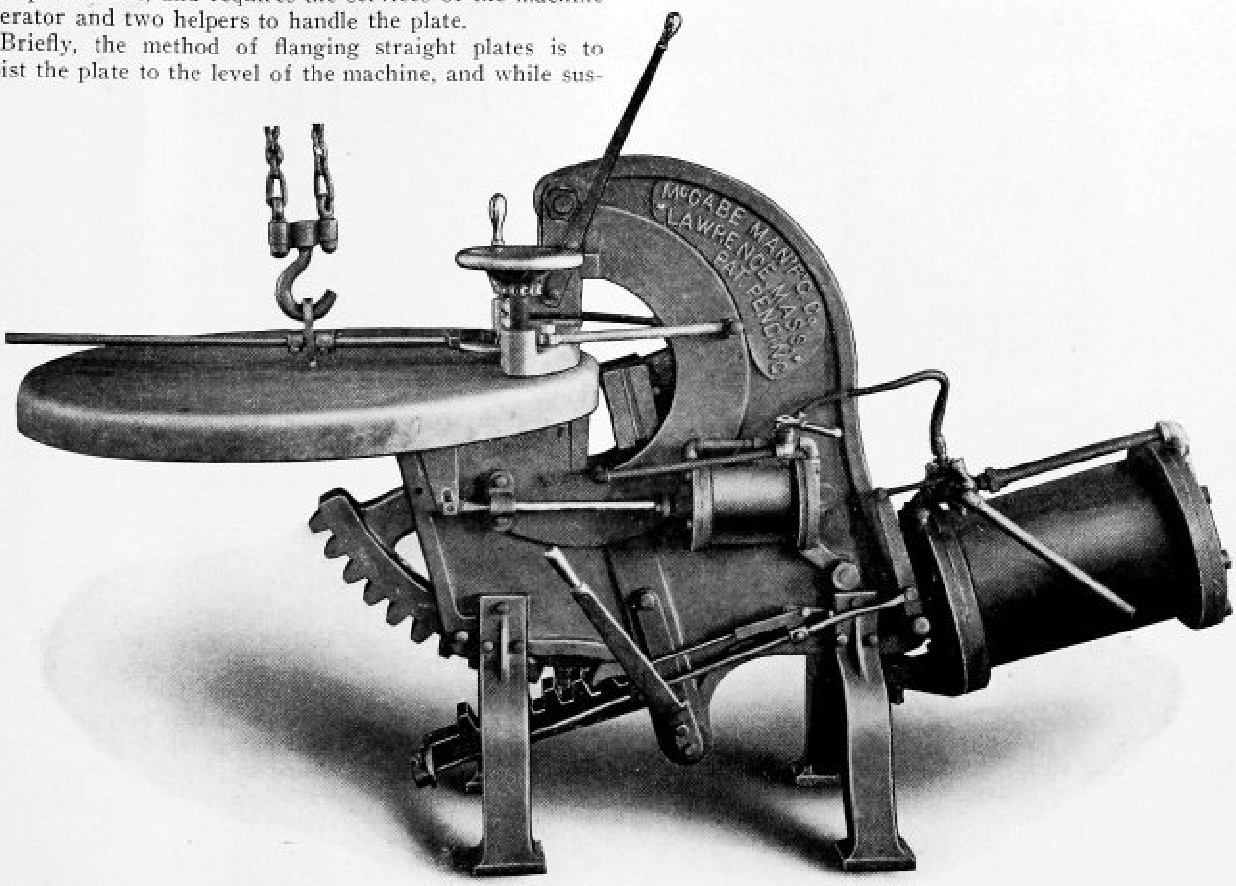
The machine is adapted for flanging rectangular plates of any length or width, on any one or all four sides. The fact that the plate is flanged cold makes it possible to punch the holes before the sheet is flanged, and when more than one plate of a size is required, a pattern sheet can be punched and used for a template. The regular working force of any shop, it is claimed, can readily and successfully apply the machine to the work at hand. On straight work the flanging is done at the rate of about one foot per minute, and requires the services of the machine operator and two helpers to handle the plate.

Briefly, the method of flanging straight plates is to hoist the plate to the level of the machine, and while suspended it is inserted into the machine, the amount being determined by the depth of flange required; then starting from or near the end, the plate is fed back and forth, step by step. At each step the portion of plate under the bender is clamped, flanged, then released and fed a step further. The operation is repeated until the whole or desired length has been flanged. The flange may be bent to any angle desired up to 90 degrees from the straight.

The illustration shows the method of suspending a round head while it is being flanged. With this method complete circles, half heads, dished heads, and segments of circular heads up to ½ inch in thickness are flanged cold. On one set of flanging forms, heads 48 inches in diameter and larger can be flanged. The method of flanging circular work is practically the same as that employed in straight flanging. An adjustable sizer is provided for guiding and obtaining the desired diameter. On heads having the ordinary flange, work can be done at the rate of about 6 inches per minute, and requires the services of the machine operator and one helper. On segments and large diameter heads the rivet holes can be punched before the plates are flanged and can be used as a template whenever more than one head or sheet of a size is required.

The flanging of cone heads up to and including ½ inch in thickness while cold, is another machine operation made possible by this tool. Owing to the fact that this work is done cold, rivet holes can be punched while the plates are in the straight, consequently when a bottom is made up of a number of pieces a pattern sheet can be punched and used as a template for the rest of the plates.

Round and square corners varying from 1-inch radius up to 8-inch radius are flanged in one heat and with one stroke of the bending ram. Six sets of forms are furnished with each machine for the various classes of work met with in the ordinary practice.

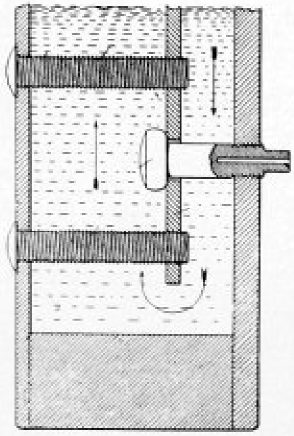


Flanging Round Head in McCabe Pneumatic Flanging Machine

A Flexible Staying and Water Circulating System for Boilers

A novel arrangement, providing for a flexible connection between the two sheets of a boiler waterleg, and at the same time providing an arrangement for increasing the circulation of the water in this part of the boiler, has been patented by D. J. O'Brien of Jerome, Ariz. As shown by the illustration, a partition plate is placed between the inside and outside sheets of the waterleg. The partition plate, however, does not extend to the bottom of the water space. It is secured to the fire sheet by ordinary screwed stays and to the outside sheet by bolts, the heads of which are rounded where they come in contact with the partition plate. The opening in the partition engaged by the bolts gives the partition plate freedom of movement laterally to the bolts, the outer ends of the bolts being screwed into the outer sheets, a projection at the end being provided so that they can be screwed into the sheet by a suitable wrench. This arrangement gives an opportunity to control the tension on the bolts. The bolts are also provided with the telltale holes.

It is claimed that the rigid staybolts, connecting the partition plate with the firebox sheet will be relieved of any strain that may be caused by the expansion of the firebox sheet, as the partition is free to follow the expansion



Flexible Connection in Water Leg

of the firebox sheet on account of its flexible connection through the loose-fitting, round-headed bolts with the outer sheet. In view of the fact that the partition does not reach the bottom of the boiler, it is claimed that a rapid circulation of water will be established in the water-leg, the direction of the circulation being indicated by the arrows in the illustration.

This arrangement can be applied to any locomotive boiler when either renewing the firebox or side sheets.

Imperial Combination Oxy-Acetylene Welding and Cutting Torch

The Imperial Brass Manufacturing Company, Chicago, Ill., has put on the market an all-around combination outfit that affords the three functions of welding, cutting and decarbonizing in one convenient combination. The general features of the Imperial oxy-acetylene equipment were described on page 95 of our March issue, but in Figs. 1 and 2 is shown the welding torch supplied with this

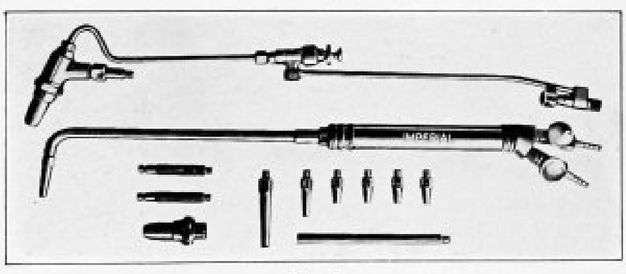


Fig. 1

outfit, which is provided with a removable attachment for cutting iron and steel up to 4 inches in thickness, thus making it unnecessary to buy a separate cutting torch. Fig. 1 shows the torch arranged for welding with the cutting attachment removed. To change the torch from a welding to a cutting torch it is simply necessary to remove the welding head and put in its place the cutting attachment, as shown in Fig. 2. With these exceptions, the torch illustrated is the same as the standard Imperial torches.

In Imperial welding and cutting torches a new principle is used for mixing the oxygen with the acetylene. Before entering the mixing chamber of the torch the oxygen under high velocity passes through a spiral groove which imparts to it a whirling motion. The whirling motion of the oxygen, it is claimed, causes it to mix thoroughly with the acetylene, with the result that a uni-

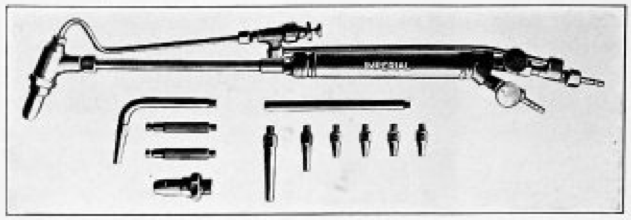


Fig. 2

form mixture is obtained before the gases reach the combustion point. In this way a saving of oxygen is obtained, together with an increase of intensity in the welding flame and greater efficiency in cutting. Due to the thorough mixing and accurate regulation of the gases, the welding flame generated is a long, white, incandescent jet, free from carbons and oxides. The cutting flame is a very closely confined and accurately proportioned jet designed to make a clean, quick, narrow cut with a minimum consumption of gas.

Betterman Improved Staybolt Tap

A tool for rapidly tapping all staybolt holes in internal firebox boilers, and one that is especially adapted for installing radial stays in locomotive boilers, has recently been placed on the market by Reinhold Betterman, of Johnstown, Pa. All boiler makers are familiar with the difficulties encountered in tapping the holes for these stays, and especially in getting the holes in perfect alinement. An ordinary radial staybolt tap long enough to

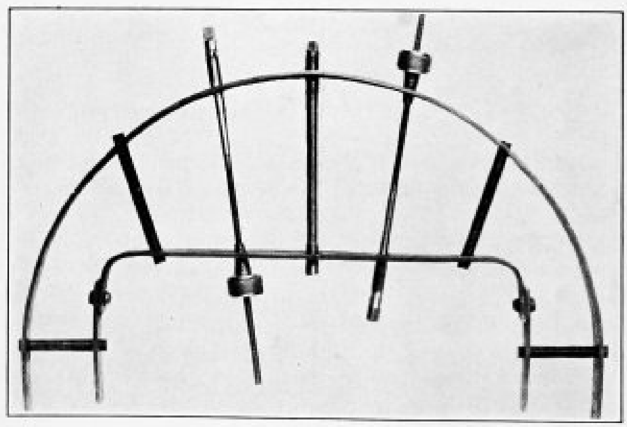


Fig. 1.—Applying Radial Stays with Betterman Tap

tap the holes for the longest stay is not easy to handle without danger of breakage, and it is an expensive tool and short-lived. It was to overcome these disadvantages that the Betterman tapping device was brought out.

The tool consists essentially of the tap, threaded for a short distance on the end, which is attached to a threaded spindle by means of a coupling so constructed and fitted that the spindle and tap are identical in pitch and lead. The spindle can be of any length desired and all sizes of taps can be used, as all are made to fit the same coupling. An adjustable nut, or chuck, is provided which has a long, tapered projection, the diameters of which from point to heel vary sufficiently to accommodate all sizes of staybolts in general use. The jaws of this chuck are adjusted by means of a knurled collar and are threaded the same pitch identical in lead with the tapered projection.

After inserting the spindle of the tap through both sheets to be tapped, the end, or chuck, is slipped over the end of the spindle and up close to the sheet. A turn of the knurled collar clamps it on to the spindle, and a few turns screw it into the staybolt hole. The spindle operating in this nut leads the tap into the flue sheet absolutely in line. With this arrangement, it is claimed that there can be no stripping of the thread nor enlarging of the hole, as is so often the case when the old style tap is used. When one sheet is tapped the device is inserted from the other side and the operation repeated for tapping the other sheet.

The advantages claimed for this tool are that the same device can be used for tapping holes in sheets a few inches or several feet apart, it will tap holes at any angle and keep them in perfect alinement, its cost of maintenance is small, and it is readily adjusted to work of any kind.

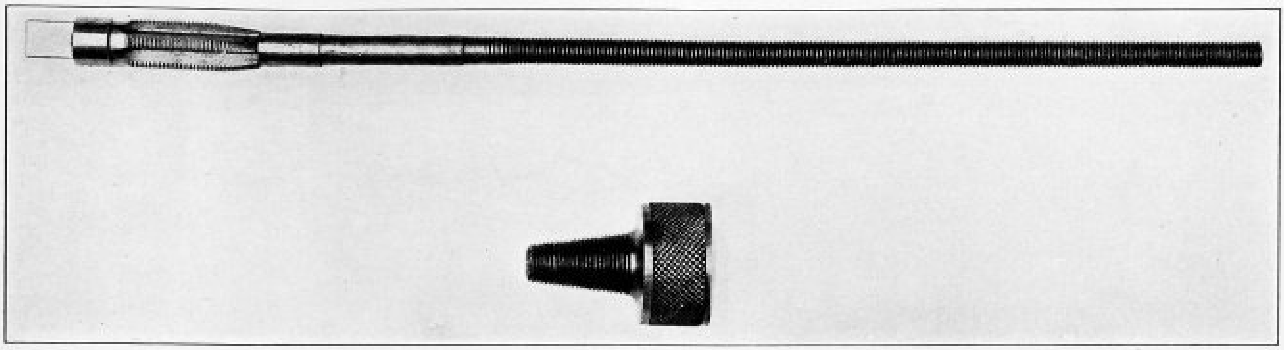


Fig. 2.—Staybolt Tap with Threaded Spindle and Adjustable Nut

The Wickes Continuous Electric Blue Printing Machine

Wickes Bros., Saginaw, Mich., has placed on the market a small, compact, electric blue printing machine which will print continuous rolls or separately cut sheets of any desired length and any widths varying from 2 inches up to and including 48 inches. The blue print paper travels over a feeding belt on an incline with the tracing, and is carried to a feed roller and around a printing cylinder in which is mounted the lighting element. The blue print paper is then delivered to a light-tight storage compartment and the tracing is delivered back to the operator.

The light is obtained from a mercury vapor lamp of standard pattern which is very rich in chemical light, practically all of the energy being given out in actinic rays. The lamp requires 3½ amperes at 110 volts and is automatic in operation. The total current consumption of the machine, including the lighting element and the motor at 110 volts, is only 5 amperes.

The printing cylinder which surrounds the lighting ele-

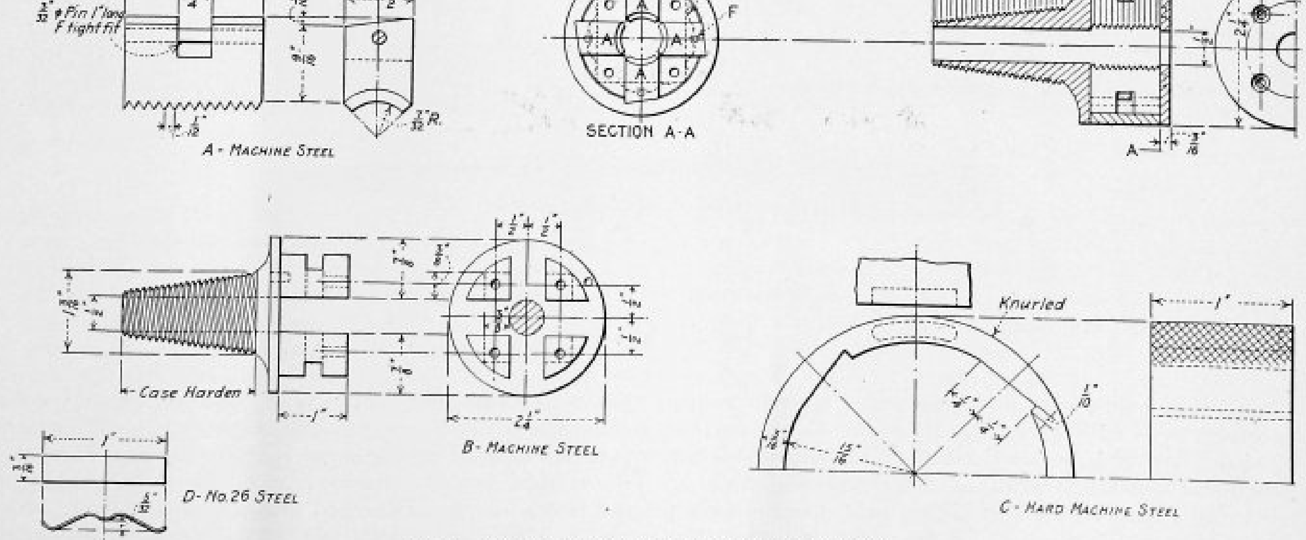


Fig. 3.—Details of Betterman Improved Staybolt Tap

ment is composed of longitudinal and spirally-disposed wires woven right-handed at one side of the center of the machine and left-handed at the other side. This, it is claimed, gives a very desirable ironing or spreading effect to each side of the tracing, and gives an absolutely perfect contact between the tracing and the paper. The spirally-disposed wires of the cylinder offer much less actual obstruction to the light than would a glass cylinder,

Wickes Blue Printing Machine

the distance from the light to the paper being only 2 inches around its entire circumference. No ventilating fan is necessary, as the heat from the lighting element passes off rapidly through the open grill work of bronze wires.

Two Handy Tools

The tools illustrated in Figs. 1 and 2 are the first of a line of small, moderately priced tools for mechanics to be put on the market by W. D. Forbes, New London, Conn. Fig. 1 shows in full size a center punch which is carefully made with both ends hardened. As the material is of the best and the workmanship accurate, this center punch will be found to be all that a center punch should be.

In Fig. 2 is illustrated a surface gage which stands 9 inches high and has a base of 2¼ inches by 2¼ inches. The needle is 9 inches long. Vertical adjustment is quickly made either by sliding the arm carrying the beam up and down on the column, or by tilting the beam which carries the needle on the arm. Micrometer adjustment of the needle is obtained by turning the knurled nut which is fitted into the jaws of the beam.

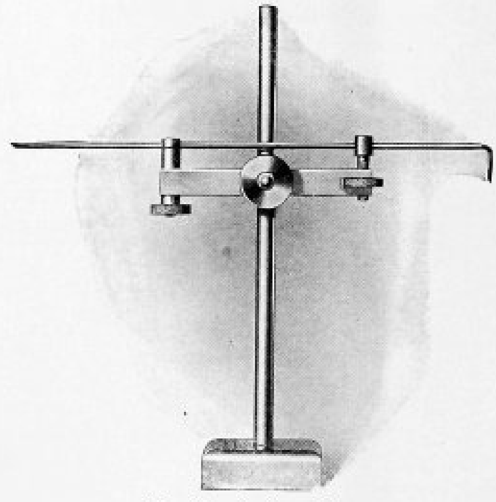


Fig. 2.—Surface Gage

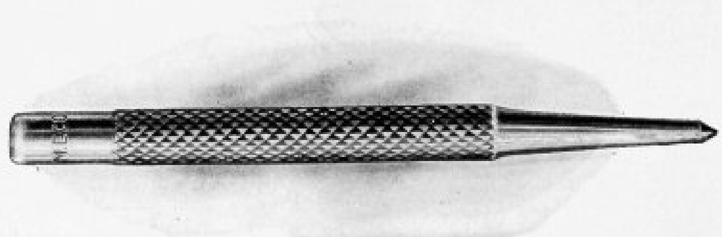
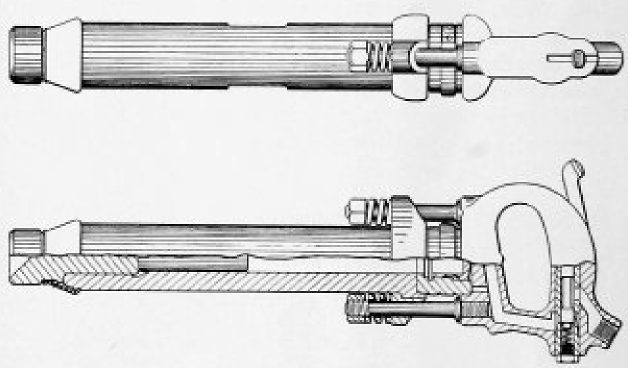


Fig. 1.—Center Punch

New Style Riveting Hammer

George Oldham & Son Company, Frankford, Philadelphia, Pa., has placed on the market a new style riveting hammer which is built in three sizes, 6, 8 and 9 inches.



New Style Oldham Riveting Hammer

This hammer is a radical departure in construction from the old type riveting hammers manufactured by this company. It embodies many novel features, conspicuous among which is the method of clamping the handle which prevents it from coming loose. As can be seen from the illustration, springs are used to absorb the shock from the blows of the hammer, so there is comparatively little reaction, thus minimizing the strains on the more vital parts of the hammer. With the old style rigid construction with threads on the cylinder engaging those on the handle, there was danger of the threads stripping, whereas in the new style tool the full shock of the hammer blows is absorbed by the springs. The throttle construction of the new style hammer is also a decided improvement, increasing, it is claimed, the efficiency of the hammer, and reducing to a minimum the possibility of leakage. Although 1½ pounds lighter than the average hammer of corresponding piston stroke, nevertheless it is claimed that this tool is just as powerful and fast and much more durable.

Wiegand Chain Screen Door

Everyone who has had any experience with firing a steam boiler is well aware of the inefficiency and discomfort existing whenever the fire door is thrown open either for stoking or for breaking and cleaning the fire. A solid column of cold air sweeping in at the open furnace door suddenly chills the highly heated brick work and crown sheet, causing the exposed parts of the firebox to contract on account of the immediately lowered temperature. To overcome this drawback the E. J. Codd Company, Baltimore, Md., has recently perfected and placed on the market a simple and inexpensive device, known as the Wiegand auxiliary chain door, designed to prevent the inrush of cold air into a furnace on opening the door and also to prevent the loss of heat from the furnace by radiation through the open door, consequently making the work of the firemen more endurable, as, with the furnace opening protected, he is not subjected to excessive temperatures.

The Wiegand auxiliary chain door consists of a large number of separate, freely hanging strands of small steel chain suspended from a cylinder extending across the top of the furnace door with the chains spaced as closely together as possible, thus forming a continuous sheet of chain similar to the familiar Japanese door screen. The cylinder carrying the chain screen is supported above the furnace opening in suitable brackets. When the fire door is closed this sheet of chain is rolled up on the cylinder. The act of opening the fire door automatically unrolls the chain from the cylinder and covers the furnace opening, shutting off the escape of heat and checking the entrance of cold air. The only air that can then enter the firebox must pass through the holes in the chain, which split it up into small streams, producing a better mixture with the hot gases arising from the fire bed, thereby promoting instead of hindering combustion.

An idea of the effectiveness of this device can be obtained from experiments made by placing a thermometer 10 inches in front of the furnace opening (a position usually taken by the fireman in stoking or cleaning the fire), showing that when the furnace door is open without the chain screen interposed the temperature immediately rises to about 400 degrees Fahrenheit. On covering the furnace opening with the auxiliary chain door the temperature at once falls to about 135 degrees Fahrenheit, making it possible to expose the unprotected hand anywhere in front of the screened opening without discomfort. The heat intercepted by the chains comprising the screen is returned to the furnace instead of being wasted, as any air that enters the furnace in passing through the holes in the screen takes up the heat that has been absorbed by the chains from the fire bed and carries it back into the combustion chamber.

As shown by the illustrations, this steel chain screen forms a flexible, penetrable transparent screen which does not interfere with a thorough inspection of the interior

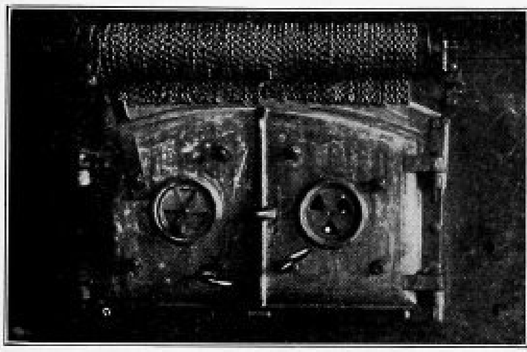


Fig. 1.—Furnace Doors Closed; Chain Screen Rolled Up

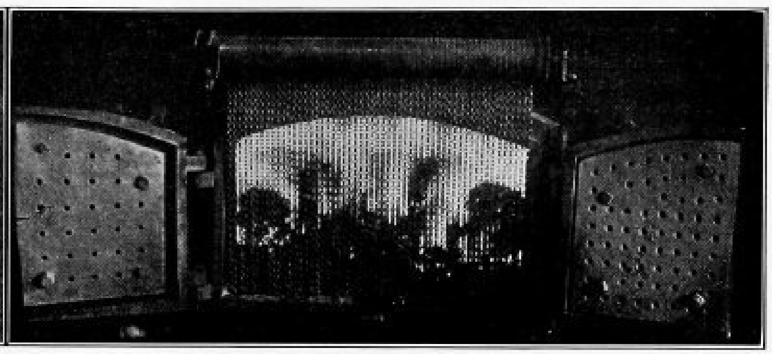


Fig. 2.—Furnace Doors Open; Chain Screen Lowered

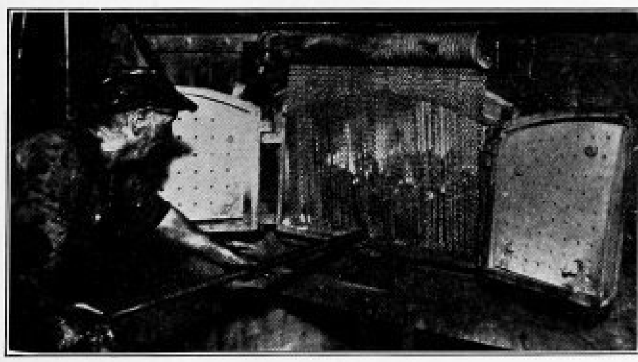


Fig. 3.—Cleaning the Fire Through the Screen

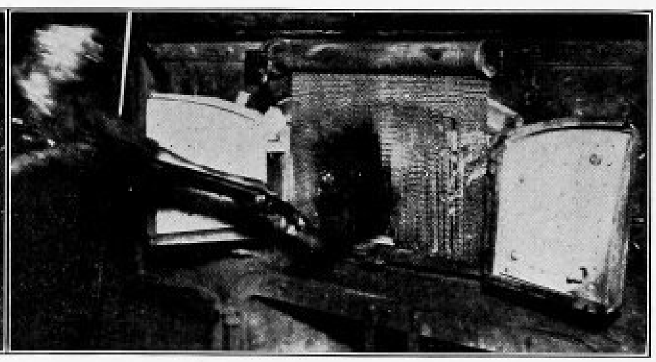
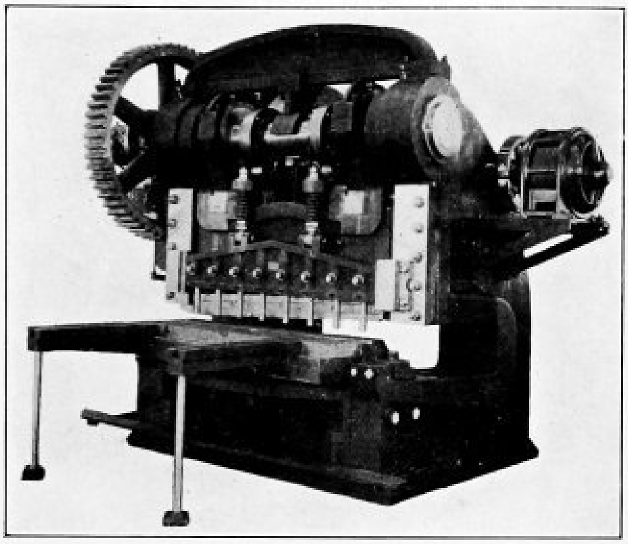


Fig. 4.—Stoking the Fire Through the Screen

of the furnace. In fact, a better view of the fire is obtained through the links in the chain than when the entire fire bed is exposed, as the strong glare is toned down. Furthermore, the screen offers no obstruction to handling the fireman's tools, for the flexibility and lightness of the chains enable the firemen to stoke the furnace or clean the fire directly through the screen.

Heavy Gate Shear

The new heavy gate shear illustrated, which has recently been designed and built by Bertsch & Co., Cambridge City, Ind., has 72-inch blades and a capacity for cutting 1¼-inch plates the full length of the machine. It is of extra heavy construction throughout and all gears,



Bertsch Gate Shear

shafts and bearings are of liberal proportions. The machine is held together rigidly by means of a bed, a cross-tie piece in the rear of the gate and a cross-tie piece overhead, all substantially bolted to the housings. An important feature of the machine is a new toggle joint clutch, for which the builder is applying for a patent. This clutch, it is claimed, is positive, noiseless and automatic. It is actuated by means of the well-known toggle joint principle, which increases the engaging pressure against it as it engages, thereby insuring full contact of the jaws. It is disengaged by means of a hardened steel roller acting against a renewable cast steel switch ring or sleeve.

Something New in Temper in Staybolt Taps and Reamers

Boiler makers will find it worth while to investigate the new temper that W. L. Brubaker & Bros., New York, are now putting in their staybolt taps. This special temper, it is claimed, brings out the best qualities of the steel, and as the result of tests and experience it has been shown to outlast other tempers. It is also claimed that the special tempered tap is practically unbreakable in service, a feature which alone, it is claimed, will reduce the cost of staybolt taps by 25 percent in a year's supply. Along with this special temper, the Brubaker taps are "relieved," which, it is claimed, adds at least 40 percent to the life of the tap, due to the fact that friction is less and makes the tap cut easier, thereby cutting more holes per tap per hour than with the "unrelieved" tap.

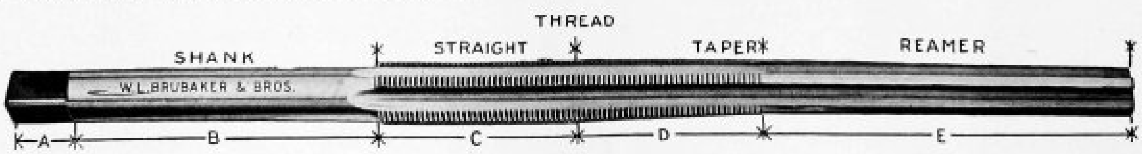


Fig. 1—Staybolt Tap

Another tool which should attract the attention of boiler makers has also been put on the market by W. L. Bru-

Fig. 2.—High-Speed, Spiral-Fluted Reamer

baker Bros. This is known as a high-speed spiral-fluted reamer (Fig. 2), which, from the shape and method of grinding and tempering, has been shown to be exceptionally durable. The reamer is constructed in such a way that the chips are readily thrown out of the work, and, it is claimed, the reamer has yet to find a hole that it will not go through, whatever the depth. It has been used very successfully on 4- to 5-inch mud-ring work, and recently one of the largest railroads in the country gave a report of 5,000 holes on one reamer in general boiler work, stating that this was the hardest service any reamer ever gets. Another railroad has given a report of 10,000 holes.

Technical Publications

OIL FUEL FOR STEAM BOILERS. By Rufus I. Strohm. Size, 5 by 7 inches. Pages, 140. Illustrations, 63. New York and London, 1914: McGraw-Hill Book Company, Inc. Price, $1 net; 4/2 net.

This book is one of the series, called the Power Handbooks, which is frequently referred to as the "Best Library for the Engineer and the Man Who Hopes to be One." The purpose of the volume is to describe the underlying principles in the use of oil as a fuel for steam boiler practice. The construction and operation of various types of burners, together with their arrangement in different boilers and the operation of pumps, heaters, etc., are described clearly and in many cases by excellent illustrations the practical application is made clear.

STEAM POWER PLANT ENGINEERING. Fourth edition. By G. F. Gebhardt. Size, 6 by 9 inches. Pages, 989. New York, 1913: John Wiley & Sons, Inc. Price, $4.00 net.

Although primarily intended as a text-book for engineering students, the new edition of this large volume will be found of interest to practicing engineers, as it is thoroughly up to date and covers every feature of a steam power plant from the fuel used to the minor auxiliaries. The chapters on fuels and combustion, engines, turbines, condensers, finance and economics have been entirely rewritten and many other chapters have been revised and enlarged. Of special value to the practicing engineer will be found the chapter on finance and economics, as it contains many operating charts, showing current practice in power plant cost accounting and typical load curves.

Letters from Practical Boiler Makers

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

Rolling Boiler Tubes

I have followed with great interest the articles on tube and flue setting and rolling, published in previous issues of THE BOILER MAKER, and wish to state that, with the exception of one operation, I agree with the statements made by "Flex Ible" in the April issue. From my experience I have learned that if a tube or flue is rolled after being completely beaded, the bead will expand as well as the tube, therefore causing the *edge* of the finished bead to loosen and creep away considerably from the sheet. In some instances, where brick arches are not applied, the flames in the firebox striking the flue sheet are apt to burn the extending edge of the bead, destroying the bead.

To overcome this trouble I would advise in setting or rolling tubes or flues in locomotive boilers that the tubes should be made a tight fit, as "Flex Ible" stated, but, instead of beading the tube first and then giving it a final rolling, I would apply the tube with a tight fit and expand with sectional expanders, then laying over the bead with a ball hand hammer of sufficient weight to work with ease, or by a compressed air hammer, using a special laying over tool. After this, apply the roller expander and give it two complete turns of the body, holding the rolls in place, and then give the tube a final beading and finish.

By finishing the tube or flue in the above manner, the boiler maker and foreman may feel confident that the bead of the flue is perfectly tight and snug to the flue sheet. This operation does not take a minute longer than that described by "Flex Ible" and, at the same time, it eliminates leaky flues and burned beads, and insures the advantages of roundhouse and hot work. TAD TULIN.

Jersey City, N. J.

Having read many letters in THE BOILER MAKER on rolling boiler tubes, I wish to give the results of my experience.

I never make a practice of putting my finger in a flue to tell whether it is sufficiently rolled or not, as I consider this a waste of time. When I roll a flue in a new tube sheet I always notice that little scales will form on the tube sheet, and, when a tube is rolled tight enough to break these scales off, the flue is rolled hard enough. If the flue is rolled any more, it will be noticed that the end of the flue stretches, which must come from the part of the flue in the tube hole causing unnecessary thinning and weakening of the flue. After watching this action on the first few flues rolled, and watching the expander pin, every flue in the boiler can be properly rolled by letting the pin go in just the same distance on each flue. This can be judged accurately enough with the eye, as I have found working in up-to-date shops and putting in a great many flues, always having good success and making good time on my work.

I think a flue should fit tightly enough in the tube sheet at the back end of a tubular boiler, so that, after it is driven in slightly with a maul, it will require very little rolling. If a sectional expander is used, the flues ought to be rolled slightly before beading. If the flue is beaded and then rolled, you can watch closely and see the bead spring away from the sheet, whereas the bead is supposed to stay tight against the sheet to brace it.

A fault sometimes found in flue expanders is that they feed too rapidly, and when the motor is reversed it releases so suddenly that a small crease is left in the tube just where the rolling was stopped. Others will have so much taper on the pin that in a case where the flue sheet is of much thickness when the outside of the tube is rolled the inside will hardly be tight in the hole.

Bay City, Mich. GLENN LACEY.

As usual, I have read the interesting contributions in the "Practical Letters" department of the April issue of THE BOILER MAKER. One in particular attracted my attention at this time, that by "Flex Ible" entitled "Rolling Boiler Tubes," pages 130-131. I quite agree with the writer of that article that tubes should fit the holes in which they are to be expanded, if satisfactory results are to be expected. I have known cases where tube ends were split in the attempt to expand them in holes that were ⅛ inch larger in diameter than the outside diameter of the tube. As the tube end was ruined, as far as the boiler for which it was intended was concerned, experiments were made to see just what could be done in such a case.

The tube with the split end was taken out and the other end was heated in a charcoal fire until it just began to show red, and then quickly placed in the tube sheet and the expander applied while the end was still hot. But even then the end split just about the time the tube appeared to get tight in the hole. The tube referred to was one of a number that had to be obtained to retube, entire, two boilers. The tubes were bought from a reputable firm and were first class in every respect, and it was not reasonable to expect that they could be expanded into holes that were ⅛ inch larger than the tubes themselves. It may be possible under certain conditions that occasionally a tube may be expanded in a hole that much larger than itself without splitting, but it seems to me little short of criminal carelessness to let such work go.

In the case to which I refer, when it was found that most of the holes had become enlarged from frequent expanding of the old tubes, it was decided not to risk splitting any more than the one tube, which served the purpose of a warning as to what not to do with the rest. So strips of sheet iron a little longer than the circumference of the tubes, and a little wider than the thickness of the headers into which the tube ends were to be expanded (watertube boilers), were made. The ends of these strips were hammered tapered on an anvil so that they could be lapped and maintain an even thickness of metal all the way round the outside of the tubes. One of these strips was placed around each tube end, forming a sleeve or thimble between the tube and the header hole in which it was to be expanded. The thickness of the strips was such that they could be pushed in around the tube ends by hand. When ready, the tube ends, header holes and sheet metal strips were given a coat of thick red lead paint and then expanded in the usual manner without any further trouble. Personally, I know those tubes lasted for many years, and to all intents and purposes seemed to be just as good as though no occasion had arisen for using the home-made ferrules at all. Of course, it goes without saying that it would be better for the tubes to fit the holes at first without the intervention of ferrules. But much better to use ferrules than to risk splitting tube ends, or to risk the job at all, by expanding tubes into holes that are much larger than the tubes. Rolling tubes is a nice job, and if properly done, and if the boiler is taken care of, they will remain tight for a long while. CHARLES J. MASON.

Scranton, Pa.

After reading in the April issue of THE BOILER MAKER the comments of N. G. Near and "Flex Ible" regarding my letter in the February issue, relative to the rolling of flues, I wish to explain more fully my statements on that subject.

N. G. Near states that no doubt my method is much faster, and that I can judge with extreme accuracy just when the flue has been rolled, but that it is evident a novice could not handle the job of rolling flues with no other instructions before him than what I gave in my letter.

In the first place, no one in the world would expect a novice to be able to handle a job successfully on any kind of work unless he has had some experience. I cannot understand why N. G. Near should think that a man can start right in on a job after reading a little about it in THE BOILER MAKER, or in any other publication. Theory is all right, but in my opinion it is of absolutely no use without practice.

N. G. Near states that he would like to get hold of a sure method that can be described in words and would not depend so much upon experience. It would not be worth while for anybody to serve his time as an apprentice if all we had to do was to carry a book with us and look it over before starting on the job, and then carry out the job according to the directions in the book. It would certainly be a strange sight to have the master mechanic or foreman boiler maker come around and see a man on the job with a book in his hand, and, upon asking what the book was for, to have him say that he had it as a reference in case he forgot how to do the work, as he had had no experience and was obliged to do just as the book told him.

We boiler makers serve our apprenticeship of four or five years, as the case may be, just to learn that "sure" method or a method as sure as education and experience can teach us. Right here on the Southern Railway we are sure when a flue is rolled, but we cannot guarantee it to last for any certain length of time. This is right where the trouble starts, as flues may last for five or six months without a leak and then suddenly start leaking, due in most cases to extra stresses being put on the boiler.

"Flex Ible" says he would like to ask the readers of THE BOILER MAKER what kind of an up-to-date shop it would be that would tolerate the insertion of flues in a boiler with an eighth of an inch clearance between the flue and the flue sheet. Apparently "Flex Ible" has not taken everything into consideration in this matter. In the first place, in making this statement, I was referring to old work, and, in the second place, I was referring to the front end. Readers of the THE BOILER MAKER who are boiler makers will grant me that in the front end an eighth of an inch clearance is not an extraordinarily large amount, as it leaves only one-sixteenth of an inch on each side of the flue all around. In the case of the one or two large holes through which the flues have been taken out, we always put in a copper liner, or shim, either before the flue is put in (rolling it in position then), or by slipping it over the flue after the flue is in position.

Now in the firebox end we always have a neat fit. If we did not, we could not hold our jobs for a day, as any boiler maker knows that the firebox end is where the most particular care must be taken. I do not think that anyone will contradict me when I say that all of the flue troubles from which any railroad suffers are in the firebox, as there are no troubles worth speaking about at the front end.

We have many different sizes of copper ferrules, and when we get ready to put the coppers in the flue sheet we get a size as nearly as possible to what the flues were when they were first put in. Possibly two different sizes will be used, as in the first seven or eight rows from the bottom up the holes may need reaming on account of the fact that the flues have been worked so frequently that it caused the outside edge of the hole to burr up so that it would be impossible to make a very good job unless the holes were reamed out, as the burr on the outside edge would cut the flues when rolling. The boiler maker has a hard job to get the copper ferrules just right, as the ridge around the edge of the hole makes them slip back too far. Now when we put the copper ferrules in the sheet, we do not have them flush with the sheet, but we always set them back one-sixteenth of an inch. When the flue is in position and set the right length for beading, we roll the flues, and in doing so roll the copper out until it is barely flush with the sheet, which is just the way we want it. On the other hand, by leaving the copper flush with the sheet in the first place the copper would stick out around the flue, and not make nearly as good a job, as it would be harder to bead over.

After rolling, we "bell" the flues out with a special tool for that purpose, which we use in a long-stroke hammer. This does away with the old-time method of "lipping" the flues, or turning them over with a hand hammer. After belling the flues out, we prosser them. Some roads designate their prossers by numbers, such as Nos. 1, 2, 3, 4, 5, etc., while others designate them by the size as 1¾ and so on up. For the most part we use the 1¾ rolls and 1¾ prossers in the firebox and 1⅞ rolls in the front end. Where the hole may be a little large, we use the 2-inch rolls. As all our flues are annealed before being put in, they are rolled out very readily, very seldom bursting. If any flues split or burst when the pressure is put on, it is nearly always in the weld, for which the boiler maker is not responsible.

I wish to state to "Flex Ible" that I have rolled many hundred sets of flues with lots of clearance in the front end, and after a couple of years have taken the same sets out, finding that the front end would be in as good condition as the day it was put in. This was not the case with the firebox end, however, which has to stand all the hard work of the flue. In every set of flues that I have taken out in my experience as a boiler maker, I have never seen one taken out on account of leakage at the front end. In my letter published in the February issue, I forgot to mention that after all the coppers are in the firebox flue sheet we use a short end of a flue that has been swagged down until it fits neatly in those coppers. Then all the flues for that boiler are made according to that gage.

On new work, where we renew a front and back flue sheet, we have absolutely no trouble at all, and always have a perfect fit at both ends. I fail to see what excuse could be found in any shop for not having a perfect fit. "Flex Ible" says the secret of good flue work is a good tight fit. I agree with him as far as the firebox is concerned, but it is not necessary to have the flues a tight fit in the front flue sheet in order to make a good job, as the tedious work of lining all flues up in the front flue sheet is something that the railway companies do not wish to stand for, if they can get as good a job in half the time and at half the expense.

"Flex Ible" tells us not to drive the pin in the rolls with all a man's strength. Whoever heard of a boiler maker (and when I say a boiler maker I mean a *boiler maker* and not one that thinks he is a boiler maker) driving a pin in with all his strength! Any reader of The Boiler Maker who has ever rolled a flue knows that by driving the pin in with all his strength he would spread the flue out at the three points where the rolls are situated and make the flue triangular in shape, so that it would be impossible to turn the rollers one way or the other. The rolls would have to be taken out and the flue pinned out again until it was practically round before any further work could be done on the flue.

"Flex Ible's" remarks about driving the pin in and ascertaining by the clear metallic ring when a flue is right is very good, and coupled with other ways which an experienced boiler maker knows, he can be positively certain that the flue will not leak when the pressure is put on.

I hope that the foregoing will be of interest and help to all readers of The Boiler Maker, and that they will not hesitate to discuss the subject further.

Salisbury, N. C. D. G. Young.

The Happy Medium of Scientific Management

Scientific management applied to the making of boilers involves time study of operations the same as in other manufacturing work. It is an interesting study that often proves of value to the manufacturer, although the writer does not like to see a superintendent or foreman go at it in a way that is too cold-blooded. I like to see workmen handled as though they were what they are—human beings possessed of human weaknesses—and not like machines that are compelled and expected to work in strict accordance with science's most definite laws.

In my mind the best way to make a time study on a man in any kind of work is to get the co-operation of the man. Get him interested in the time study. Show him where it will be of benefit to him to do quicker and better work through fewer and faster motions. Don't go at it as though you were trying to "put something over."

And then, after securing the co-operation of the man, do the square thing. Pay him in accordance with the new amount of work he turns out. In that way both you and the workman will benefit financially and there will be a closer mutual feeling. No danger of labor troubles then.

I know of instances where an "efficiency engineer" was put on the job to increase production, and he went at it as though he were "the meanest man in the world." Sympathy and sentiment were unknown to him. But he was bright, brilliant and a hard worker. He managed to show the workmen that they could work faster by curtailing a few motions. He showed them by actual demonstration, but in a bullying manner which the workmen resented—justly, I believe. Production actually increased in that plant without paying the men a cent more, but there was a downward change in quality at the same time because the workmen lost interest, and before the experiment had finished labor troubles were encountered. Skilled workmen are justified in demanding a reasonable amount of freedom. Every man is endowed with judgment and his own ideas as to right and wrong. In national life he is given an equal voice in the government of the country with efficiency engineers, foremen, superintendents and owners. If he is given these privileges in big national affairs, why not in the affairs with which he is even more familiar? Workmen usually have very good judgment when applying same to work about which they know to the minutest details. As for politics, they more frequently know very little.

There is, therefore, a "happy medium" in scientific management that is well worth striving for. It is the most economic point, the happiest, the most humanitarian. The problem is to attain that point by proper co-operation. It cannot be done by compulsion. To do it by co-operation requires a certain amount of education. Call your forces together and tell them plainly and in detail what you propose to do. Get them interested. If you honestly intend to improve conditions all around, you will have no difficulty in interesting them and securing their enthusiastic support. Scientific management will then enter your shops of its own free will—naturally, not artificially.

New York. N. G. Near.

Learning to Weld with the Oxy-Acetylene Torch

I have read with pleasure the many articles in The Boiler Maker on autogenous welding, and I have decided to take a hand in the discussion, as it seems to me that there are a few things that I have learned from experience that I have never been able to get from any book or article I have read. The following is told, therefore, in shop style by a boiler maker that has gained his knowledge of oxy-acetylene welding in a small shop by his own incentive.

I am employed by a small railroad as foreman boiler maker. In the spring of 1914 the company decided to purchase a welding outfit. They selected the apparatus manufactured by the Oxweld Company, of Chicago, and secured the "Prest-O-Lite" service and the Linde Air Products oxygen. Both of these are giving the very best satisfaction. Arrangements were made with the Oxweld Company for our master mechanic to go to their shop and receive instructions. This was done because, never having used a torch, it was very hard otherwise to get the information necessary to use the torch properly.

Two days after the outfit was delivered to our shop, an engine came in which was pitted and cracked through at the top of the mudring about the middle of the firebox for a length of 6 inches. I first cut out the mudring rivets and the master mechanic and I went at the job with the welding outfit. We worked about two hours building up the plate and filling in holes that we burnt in, as the plate was very thin. We finally got it filled in, but there was not a dry thread on either one of us. I drove the rivets, calked the edge and tested the boiler, and it has proved much better than it looked, I can assure you.

My next experience was welding cracks in a side sheet. The cracks were about 1½ inches long on each side of the staybolts. I cut these out with a diamond point and ran a ripper through them, making an opening about ⅛ inch wide. I welded four of these at one corner about four rows of bolts high and four from the flue sheet. Then I waited until the next day and started to cut out another one about one foot from the first one. The sheet, however, cracked in a circular direction 26 inches long from where I had just started to cut, which was one foot from where I had done the welding the day before. That was rather discouraging, but I cut out the crack as I had done on the others and welded it up, being careful to run back with the torch, keeping the weld hot as well as the sheet at the end of the crack. This engine has been running for eleven months without giving the least sign of trouble. You could not even locate the place where the crack was.

My next job was on a small passenger engine, on the bottom of the side sheets of which were five patches. I cut off the side sheets with the cutting torch about 2 feet up and took out the flue sheet which had bad holes. This also enabled us to weld in the throat sheet from the inside. I cut off the outside throat sheet 24 inches up even with the top of the frame to take out a bad patch where an eccentric strap had gone through at some time. I cut toward the center about 8 inches, then down at an angle of about 45 degrees to within about 6 inches of the mud-ring in order to avoid taking off the other frame, also to do away with a patch over a washout hole. We had trouble with expansion here. The weld was in ½-inch plate and it was very hard to get it wide enough apart to allow for the expansion. We finished the weld about half-way and found that all the room we had left for expansion was taken up, so we brought the weld to an even heat and then left it so that it would cool over night. Then we chipped out more space for the rest of the weld and went back and warmed up the part we had welded the day before and finished the job. This engine has been running eight months without a leak in any of the welding. The engine came into the shop with seven patches and went out without any patches.

The foregoing are a few of my experiences in the first three months of using the welding outfit. In welding anything taking over thirty minutes I always have another man help me, as it is very tiresome.

I have also been very successful with cast iron welding, and will tell about that at some future time.

Manistee, Mich. G. Dohm.

The Lap Joint

In spite of all that has been preached and written condemning the old trouble-producing lap joint, it is still being used and made. A writer in The Boiler Maker recently criticised the committee of the A. S. M. E. for permitting the lap joint to continue. I believe he was right. Engineers, boiler makers, legislatures—everybody who has to do with boilers—should unite against the lap joint.

Perhaps one reason why the lap joint is not entirely ousted is that it is not yet well understood. Education will do more toward eliminating bad things, usually, than will laws. That is the new doctrine that is being preached all over the world. I will, therefore, contribute my mite herewith toward information on the lap joint.

In Fig. 1 I show the lap joint as it is usually made. In drawings on the drafting board it looks good. I presume the first joint ever made was a lap joint because it is the easiest to make and the first that comes to mind. However, the plates do not lie in the same plane as they do in butt joints, hence as soon as tensional forces are applied a bending stress is created at the joint and Fig. 2 results. It is very natural that the two plates will tend to aline themselves in a straight line as indicated. Both plates are bent, are subjected to combined tensile and bending stresses, and the rivet is subjected to combined tensile and shearing stresses.

The mere fact that this distortion is created is not the whole cause for condemnation of the joint, though. The worst part of it is that boilers are not under constant pressure. The pressure varies from zero to over a hundred pounds per square inch, very often. And with every increase and decrease in pressure the joint bends one way or the other. The bending occurs and reoccurs until rupture is inevitable. No metal can withstand constant bending of this sort, be it ever so slight, without some harm being done to the crystalline, fibrous or molecular structure. This is an old established fact. Therefore, why the lap joint should at all be permitted in a vessel so dangerous as a steam boiler, is beyond me.

This constant bending and movement at the joint are also the cause of the dangerous grooving so frequently found—another reason why the lap-riveted boiler should be tabooed.

Should any boiler maker wish to compute the bending stress in the plate of a boiler of this kind, due to the improper construction, he can do so by using the following formulas as given by Prof. Goodman:

The maximum bending moment on the plates is $\frac{Pt}{2}$, where P is the total load on a strip of width w; t is the thickness of the plate in inches. The bending moment

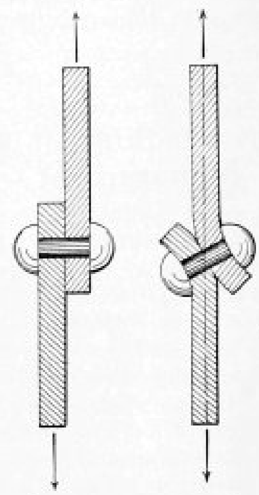


Fig. 1 Fig. 2

decreases as the plates bend. Then, f_t being the stress in the metal between the rivet holes, the stress in the metal where there are no holes is $f_t\left(\frac{w-d}{w}\right)$; d is the diameter of the rivet. Hence,

$$P = w\ t\ f_t\left(\frac{w-d}{w}\right)$$

and the bending moment $= \frac{t^2 f_t\ (w-d)}{2}$.

The plate bends in two places along lines where there are no holes; hence the modulus of the section $= \frac{2\,w\,t^2}{6} = \frac{w\,t^2}{3}$, whence the skin stress due to the bending is

$$\frac{3}{2} f_t\left(\frac{w-d}{w}\right)$$

According to this formula, then, the factor of safety employed for butt joints should be multiplied by somewhat over 3/2 where the design is lap-riveted, and even then the joint is not safe.

A lap-riveted plate should be 3/2 times as thick, or even more, according to the above theory. This would make the boiler more expensive—considerably.

No matter how you look at it, the lap-riveted joint is a bad investment. N. G. Near.

New York.

Selected Boiler Patents

Compiled by

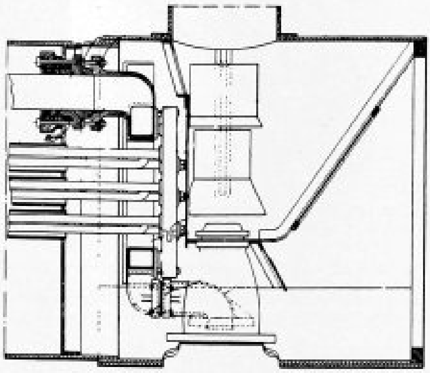
DELBERT H. DECKER, ESQ., Patent Attorney,

Millerton, N. Y.

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

1,124,446. SUPERHEATER. SAMUEL JAMES HUNGERFORD, OF WINNIPEG, MANITOBA, CAN.

Claim 1.—In a superheater the combination with a main top header and a main bottom header, of complementary pairs of saturated and superheated steam auxiliary headers, the saturated steam auxiliary headers being detachably secured to the top header and the superheated steam auxiliary headers being detachably secured to and opening to the



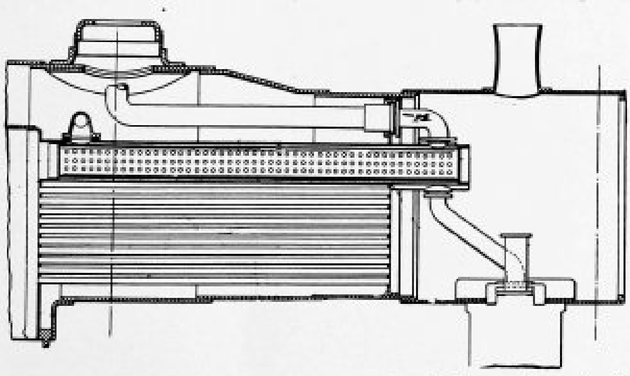
interior of the bottom header, means spacing the auxiliary headers of each pair, means slidably connecting the auxiliary header of each pair and extending superheating coils connecting the saturated steam auxiliary header of each pair with the superheated steam auxiliary header of that pair, as and for the purpose specified. Four claims.

1,120,764. PETER THOMSEN AND EGMONT DOETTLOFF, OF CASSEL, GERMANY, ASSIGNORS TO SCHMIDT'SCHE HEISS-DAMPF-GESELLSCHAFT MIT BESCHRANKTER HAFTUNG, OF CASSEL, GERMANY. LOCOMOTIVE-BOILER WITH SMOKE-TUBE SUPERHEATER.

Claim 1.—In a locomotive boiler provided with a plurality of normal diametered smoke tubes arranged in horizontal rows, a plurality of superheater units each constituted of a plurality of U-shaped loops, one loop to a tube, the unit ends projecting from the smoke tubes being so bent as to lie in horizontal planes the number of which corresponds to the number of the horizontal smoke tube rows which are provided with units, the unit ends of a given row constituting and lying in a single plane containing only the unit ends proceeding from said given row, and a laterally disposed steam header arranged perpendicularly to the planes of the unit ends and of the smoke tube rows. Two claims.

1,125,849. SUPERHEATER. HENRY W. JACOBS, OF TOPEKA, KANSAS.

Claim 1.—A superheater for locomotive boilers, comprising an intermediate and two adjacently placed shells or units adapted to contain steam, said shells having their rear ends secured in the fire-box flue sheet, while the forward ends extend through the front flue sheet and into the smoke box of the boiler, a series of oblong gas-conveying flues



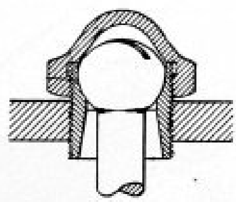
extending longitudinally through the respective shells or units, whereby flat sides or walls are presented to the steam in the shells, the flues being so arranged that the steam is compelled to pass through the shells in thin sheet-like form from end to end, a steam pipe or conduit communicating with the forward end of the intermediate shell or unit and with the steam dome of the locomotive, a branched connection or pipe intermediate of the rear or fire-box ends of the respective shells for conveying the steam from the intermediate shell to the adjacently placed shells, and a steam pipe or conduit connected to the foreward or smoke box end of the two side shells whereby the superheated steam is conveyed to the steam chests of the cylinders. Two claims.

1,125,592. LOCOMOTIVE FIRE-BOX CONSTRUCTION. LE GRAND PARISH, OF NEW YORK, N. Y.

Claim 1.—A locomotive fire-box comprising in combination water walls, side sheets, a plurality of circulating tubes connecting water walls and extending in planes which are spaced apart substantially vertically, and a refractory arch comprising a central row of bricks supported at the ends on tubes in substantially the same plane, a row of bricks adjacent each end of said central row of bricks having one end supported on the same tubes as the central row but having their opposite ends supported on tubes of a different plane, and end rows of bricks supported at one end on said last mentioned tubes and having their other ends engaging the side sheets. Four claims.

1,127,325. JOINT. CHARLES PARRY VAUCLAIN, OF ROSEMONT, PA., ASSIGNOR TO THE BALDWIN LOCOMOTIVE WORKS, OF PHILADELPHIA, PA., A CORPORATION OF PENSYLVANIA.

Claim 1.—The combination of a threaded socket member having an annular tapered rib at one end and a cap having a thread adapted to the thread of the socket member and having an annular flat surface



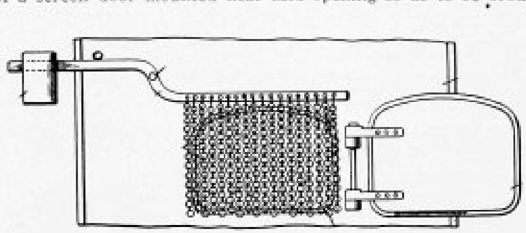
alining with the annular rib, the metal of the cap being of a hardness at least equal to the hardness of the metal of the socket member so that when the cap is screwed onto the end of the socket member the rib rib will be broken down and compressed and will form a fluid tight joint between the two parts. One claim.

1,124,392. WATER TUBE BOILER. WILFRED D. CHESTER, OF SEWICKLEY, PA., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claims.—A water tube boiler comprising a bank of inclined generating tubes, uptake and downtake headers into which said tubes are expanded, a furnace below the uptake ends of the tubes, a bridge wall for said furnace extending upwardly to the lowermost row of tubes of the bank, said lowermost row consisting of short tube lengths extending from the uptake header to a point immediately back of the bridge wall, a transverse box to which the ends of said tubes are connected, a second transverse box below and nippled to the first-named box, and tubes connecting said second-named box with the downtake headers, said boxes being provided with hand-hole fittings opposite the tube ends for accessibility to the tubes and for use in expanding the tubes. Four claims.

1,128,206. FURNACE SCREEN. HENRY H. WIEGAND, OF BALTIMORE, MD.

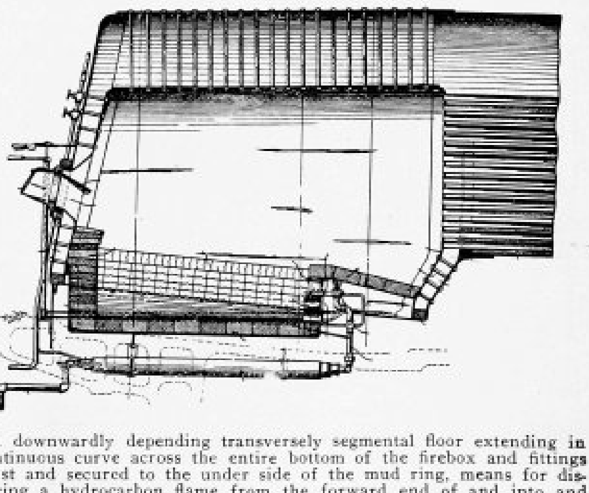
Claim 2.—The combination with a furnace having a door opening through which the furnace is stoked and the usual door for said opening, of a screen door mounted near said opening so as to be brought in



position to cover said opening, or removed from said position, and means to automatically operate the screen door through the movement of the usual furnace door. Four claims.

1,128,444. OIL-BURNING FURNACE. TAYLOR W. HEINTZELMAN, OF SACRAMENTO, AND JAMES G. CAMP, OF OAKLAND, CAL.

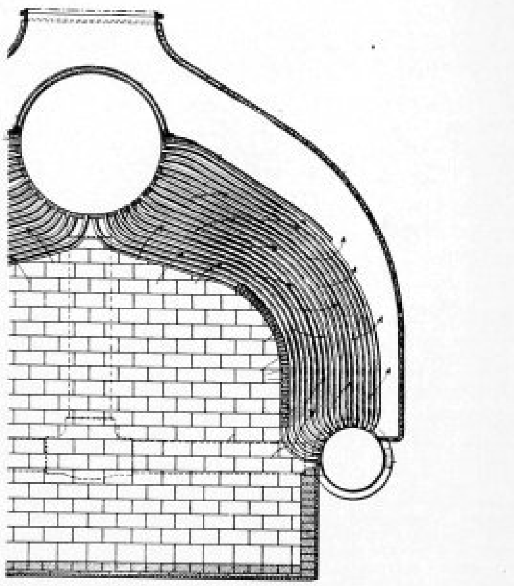
Claim 1.—The combination with a steam boiler firebox of increasing cross sectional area from its top to the bottom, of a bottom pan hav-



ing a downwardly depending transversely segmental floor extending in a continuous curve across the entire bottom of the firebox and fittings against and secured to the under side of the mud ring, means for discharging a hydrocarbon flame from the forward end of and into and parallel to the bottom of the pan, and means for admitting air into said bottom pan. Three claims.

1,128,700. STEAM-GENERATING BOILER. LUTHER D. LOVEKIN, OF PHILADELPHIA, PA.

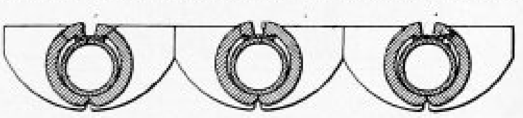
Claim 1.—A boiler comprising a pair of spaced apart water drums and a steam and water drum located above and between the water drums, two outwardly bowed groups of water tubes, one connecting one and the other the second of said water drums to the steam and water drum and uniting to form the top wall of a combustion chamber, return connections between the ends of the steam and water drum and the ends of the water drums, a baffle arranged along the lower portion of the inner side of each group of water tubes, the lower edge of said baffle being some-



what spaced away from the adjacent water drum, a baffle arranged along the upper portion of the outer side of each group of water tubes whereby a relative large portion of the hot gases from the combustion chamber is caused to enter the spaces between the tubes in each group adjacent the upper end of the latter and then pass down by the second mentioned baffle, and a relatively small portion of the hot gases is caused to enter the spaces between the tubes in each group adjacent the lower end of the tubes, the tubes in each group being spread apart adjacent their upper ends whereby the volume of inter-tube space in each group diminishes as the distance from the steam and water drum increases Two claims.

1,129,313. TILE FOR COVERING TUBES. MINOTT W. SEWALL, OF NEW YORK, N. Y., AND DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNORS TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

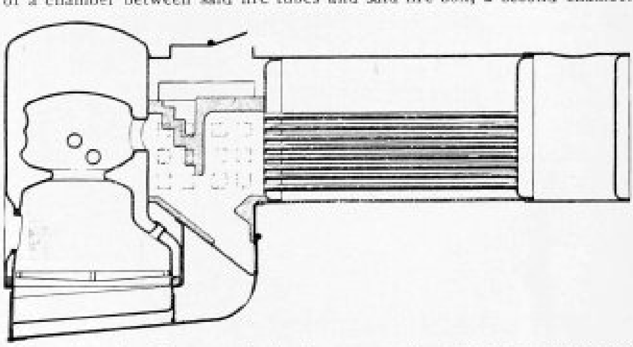
Claim 1.—A tile construction for the purpose described comprising tiles having substantially semi-circular inner faces and a locking rib, a tube,



and means on said tube co-operating with the ribs of a pair of said tiles to hold them in place about the tube. Seven claims.

1,129,600. STEAM GENERATOR. EDUARD PIELOCK, OF BERLIN, GERMANY.

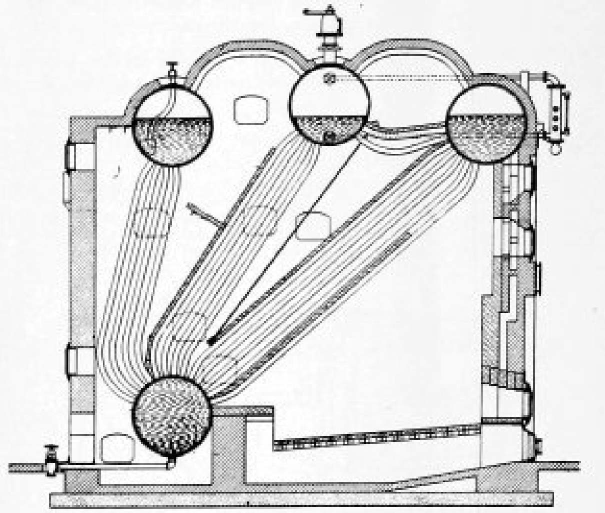
Claim 1.—In a steam generator of the fire tube type the combination with a fire box and a fire tube boiler lying in spaced relation thereto, of a chamber between said fire tubes and said fire box, a second chamber



surrounding the first named chamber, means for supplying outside air to the last named chamber and connections leading from the last named chamber to a point beneath the grate. Four claims.

1,129,538. WATER TUBE BOILER. JOHN E. BELL, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

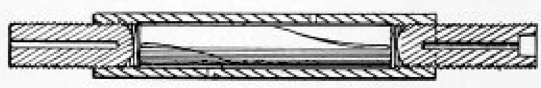
Claim 1.—The combination of a steam boiler furnace having a combustion chamber at the front thereof and a drum in the lower portion thereof, series of tubes extending upwardly from the drum, the front series being located at the rear of the combustion chamber with the front setting wall facing it, a baffle extending upwardly from the drum at the front of the front series of tubes and constituting the back of the combustion chamber, and alternately downwardly and upwardly projecting



baffles behind the first mentioned baffle and providing means for directing the products of combustion longitudinally of the series of tubes behind the first mentioned series, the last heating surface over which the products pass consisting of a water heating surface. Seventeen claims.

1,131,342. STAYBOLT. ETHAN I. DODDS, OF ZELIENOPLE, PA., ASSIGNOR TO KERNER MANUFACTURING COMPANY, OF PITTSBURG, PA., A CORPORATION OF PENNSYLVANIA.

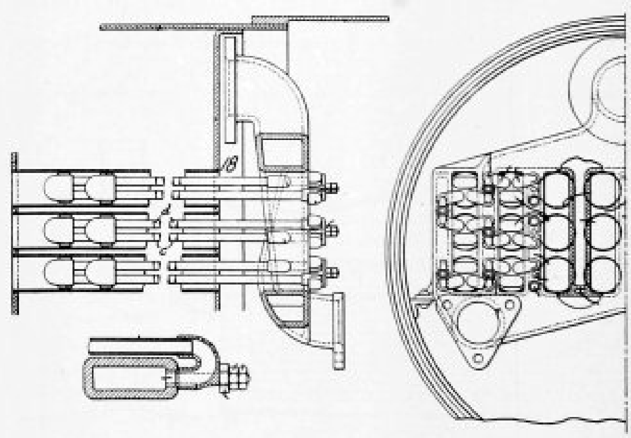
Claim 1.—A bolt having an internal and an external body portion connected to each other at the ends but separated between the ends, the



outer body portion having a plurality of members connected to each other at the ends but separate between the ends. Three claims.

1,132,069. STEAM SUPERHEATER. WILLIAM F. J. CASEY, OF KINGSTON, ONTARIO, CANADA, ASSIGNOR TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim 1.—In combination with a locomotive boiler provided with a plurality of flue tubes arranged in spaced vertical rows, saturated and



superheated header branches alternately and vertically disposed in front of the tube sheet in the spaces between said rows of flue tubes, openings in the front of said branches, and superheated elements in the smoke tubes, said elements having ends formed as reserve bends and adapted to be detachably engaged with openings in adjacent header branches. Two claims.

1,120,071. JOHN W. F. MACDONALD, OF SOUTH FRAMINGHAM, MASSACHUSETTS, AND DAVID W. ROBB, OF AMHERST, NOVA SCOTIA, CANADA, ASSIGNORS TO INTERNATIONALfy ENGINEERING WORKS, LTD., OF MONTREAL, CANADA, A CORPORATION OF CANADA. STEAM-BOILER CONSTRUCTION.

Claim 4.—In steam boiler construction, a cylindrical drum having an elongated aperture therein with its major axis in the direction of the curve of the wall of the drum, a circulation duct with which the aperture communicates, and a reinforcement for the wall around the aperture embodying an inwardly extending flange around the aperture, said flange having its edge curved in an opposite direction to the curve of the wall of the drum. Eight claims.

THE BOILER MAKER

JUNE, 1915

A Few Facts About Inspecting Boilers

Qualifications of a Competent Inspector—Equipment Required and Methods of Procedure

BY JAMES FRANCIS

To become a good boiler inspector does not require any especial gifts or qualifications. About all required is the necessary "know-how" and some horse sense, and the more of it the better for both inspector and boiler. The good inspector must know enough about boiler design to tell when a boiler is safe or not under the pressure desired to be carried. He must also be enough of a boiler maker to know when work is well or poorly done, and must be able to recognize errors and omissions in boiler construction as well as in its design.

The boiler inspector must have one faculty well developed, which is born in some people, can be cultivated by others, but which must be part of the mental make-up of every successful boiler inspector. This faculty is the faculty of seeing things—not those things with green eyes and blue wings, with too many feet and horns, which are seen by the man who has looked too well upon the wine when it is red, but the chap who can take one look into a window and then describe to you more things than you thought it possible to be placed into a room, much less a shop window.

Ever try that stunt? Well, it's great! Just line up the candidates for a position as boiler inspector, take them one at a time to a window, light closet, or a bank of shelves, upon which you have arranged in plain sight one hundred different articles—tools, bolts, nuts, familiar things pertinent to the boiler shop and its surroundings.

Testing Powers of Observation

With one hundred articles in plain sight, bring each candidate in front of the window or cabinet which is covered by doors or by a curtain. Tell each man that you are going to show him the things inside the cabinet for exactly ten seconds, and he is to name each thing he sees after he has spent ten seconds in looking. Draw aside doors or curtain, give each man ten seconds and then immediately let him name the things he has seen and let a stenographer take down the names he mentions of things he has seen during his ten seconds of observation.

If you don't have a stenographer handy, let somebody take down the names of things seen in long hand. If the man is not unusual, or trained in using his eyes, he won't see so many things in the cabinet that you can't write them all down in a few minutes. Sometimes, as in the case of candidates who are a bit diffident and apt to become confused, just give each man a pad of paper and let him write down the names himself. He can usually remember more of them when treated in this way.

Did you know that this training in the "art of seeing" is mighty good practice for any man, be he boiler inspector or boiler maker? Just try it yourself a few times and see how you average up with the other men. You can make as many tests as you choose, but of course the articles should be arranged differently for each test. For purposes of amusement, this may be made very interesting by arranging a shelf or box, open on one side only, with ten articles arranged therein, each article in plain sight; then arrange a shutter actuated by gravity or by clockwork, which will open after a warning stroke on a little bell, remain open one or two seconds as arranged, then close automatically at the end of that time.

Try this arrangement and see how many of the boys can name all ten of the articles after they have been visible one second. This is mighty good practice, too, and it does not take as long to rearrange the cabinet of ten articles as it did to rearrange the one hundred, and as the time of observation is cut down in the same ratio as the number of articles, the results obtained are practically the same in either case.

Clothes and Tools

Having picked the men for boiler inspectors, rig them out with the necessary outfit of clothing and tools, with one-piece overalls and jacket combined, with a cape hood which fastens snugly under the chin, and with wrist and ankle fastenings whereby the one-piece suit may be fastened tightly around each wrist and ankle to keep out the fine dust and dirt. Unless a suit is provided of thick enough, closely woven material to keep the dust from working through, then the inspector will come from each job several shades darker than when he went to it.

All kinds of light have been tried by the inspector, and the time-honored candle still holds its own, although the pocket flash light is useful and the small incandescent light on the end of a strong, flexible cable with a wire cage around the lamp, is very useful indeed, and is favored by many inspectors for use whenever possible to obtain current, and there are very few boilers nowadays which do not have an incandescent lamp hanging in front of the water gage glass.

The tools required for the inspector who travels include a small, accurate pressure gage for comparing with the gages he finds attached to boilers to be inspected. The inspector's bag—and a good, stout bag it should be too—should also contain a test pump for applying pressure to the two pressure gages. The regulation pump of the olden times used to weigh about six pounds and carried a screw piston, the barrel of the pump being filled with water and both gages attached to a wide tee at the far end of the pump barrel. A more modern outfit is a little hand bicycle pump, and the necessary attachment to a bit of brass tubing at the ends of which, by means of adequate fittings, the two gages are attached. An outfit of this kind need not weigh two pounds.

The inspector's bag should always contain candles. They are not always to be had on the spot, therefore have a few in your grip. Put in also a light hatchet-pene hammer and a small cold chisel. I find the latter very handy sometimes, if for nothing more than for prying up an obstinate window in a hot steam car.

There should also be included an outfit for adjusting steam gages, a small screw driver, pliers and a little screw jack for pulling the hand off the gage stem. Never use a screw driver for this purpose, as by so doing you are almost sure to bend the shaft which carries the hand or pointer. Use the little screw jack, which should be purchased for this purpose.

In addition to the above-mentioned outfit, I always carried in my kit two light but strong steel chains and two small Yale padlocks. Whenever I had to go into one of a battery of boilers, I always made sure that the steam valve and the feed valve which prevented hot water or steam from reaching me from adjacent boilers were so chained and locked that they could not be opened while I was inside the boiler to be inspected. It doesn't do a man's nerves any good to hear a laborer working around the valves which cuts his boiler from those under pressure on either side of him. But the little chain and padlock does ease a man's mind wonderfully while he is inside.

Preliminary Arrangements

Upon arrival at the plant where inspection is to be made, the experienced man will at once introduce himself and get turned over to the engineer or to some one in authority, and escorted to the boiler room. If you don't like the looks of the engineer, go back to the office and have them take charge of your watch and money while you are inspecting. Don't strip and leave your wad in your clothes, for some people are not quite honest, I am sorry to say.

Arrange with the engineer for a place to change clothes in, also for a chance to wash after making the inspection. I am sorry to be forced to state that very many places have no better facilities for washing up than a bucket of cold water on the head of a barrel! And as for a dressing room, the corner of a shed in a brick yard, with wind and snow blowing around the bucket full of ice-filled water, is what I have found time and again during boiler inspecting trips.

If you are working for an inspection and insurance company, the boilers you visit will divide themselves into two general classes—old risks and new risks. The first comprise boilers which have been insured and inspected, and their "pedigree" is of course known. The second consist of "new risks," and nothing is known of their condition. With an "old risk" the inspector will familiarize himself before leaving the office of all that pertains to the boiler he is to visit, and as all the data regarding strength and condition have already been obtained and tabulated, the inspector has nothing to do with measurements, etc., and can read the reports of previous inspections and therefore know just what conditions and weaknesses, if any, to look for.

But with a "new risk," or when you are inspecting for other than an insurance company—say for some one who desires to purchase the boiler upon its merits—then you must take all the data and make the necessary calculations to determine the safe working pressure the boiler will carry. When you do this for the insurance company, they furnish a "data slip" containing blanks for all the figures necessary, and it is only necessary to determine the figures for filling out this blank and you are in possession of all the necessary data for calculating the net rivet and plate sections, the seam efficiency, and then the bursting strength of the boiler, the bracing of the heads and all other necessary things for determining just what the boiler is good for structurally.

The Actual Inspection

The above having been determined, or it may be determined during the process of examination, then don the inspector's suit and "crawl" under the boiler, also inside the shell, and look at each and every square inch of shell, head rivets and tube ends, and note the workmanship and the physical condition thereof. And if there be any defect in that boiler, be sure you find it. That is what boiler inspection is for. It does no good to look into, over and under a steam boiler and not see everything there is to see there. And here is where the training of looking at the articles in windows or cabinet comes into play, for the man who sees the most things in the cabinet can see the most things about a boiler, and, be these things good or bad, it is the inspector's business to see all of them.

"Whenever you see a head, hit it," is the only safe rule. Take absolutely nothing for granted. See everything and see just what condition everything is in. Perhaps you have gone all over a boiler and have found nothing wrong and you are at the front end, inside, with your head poked in among the braces, looking after the fastenings of the braces to the shell. Perhaps you have examined and sounded all the braces but one, and to get at this one you have to back out from your position among the braces, work your way around to the other side of the boiler and worm yourself in among the tubes again on that side of the boiler. In a case of this kind the temptation is very great to say: "There's nothing wrong with that brace—no use bothering to look at that one, for I have looked at every other brace in the boiler and they are all O K; probably that one is all right too, so I won't bother to crawl in and look at it."

Don't you ever do such a thing, for if you do so you will be no good as a boiler inspector and might as well quit the business. There was a possibility that the brace you didn't look at might have been defective. That the boiler had carried its pressure safely thus far, even with a defective brace, is no evidence that it will do so any longer, for to-morrow the pressure might be allowed to run up for some unforeseen reason, and the defective brace not being able to carry its load, the stress was carried by the adjacent braces, but when the pressure climbed too high, they were unable to carry their own load and that of the defective brace, so pretty soon one of the overloaded braces gave way, throwing more and more load on the other braces, then another one was torn off and then things happened.

The head bulged out, the tube ends were started from the head, the flanges were strained and possibly their rivets started, and well indeed was the end of the matter if the trouble was discovered in time to prevent a disastrous accident through the head of the boiler blowing out, sweeping all before it, and perhaps, by reaction, sending the boiler shell in the opposite direction, through buildings and other valuable property, for many feet. The above is no fancy sketch. It has happened many times, and it *may* happen again if any opportunity be left for such a disaster through the overlooking of a defect by the inspector.

Therefore, don't overlook anything purposely. We all overlook some things, for the human machine is not infallible, and for that reason we should be all the more on the alert that nothing gets away which we have not seen and fully looked into when inspecting a boiler.

To emphasize the necessity for being always on the lookout and never slighting even the smallest thing in a boiler, for you won't be a real boiler inspector if you do slight even the smallest thing, I want to tell about one thing which happened to me which led me to be even more wide-awake ever afterward. It led me to do more hammering and more poking around in corners where I couldn't see very well, and where there *might* be corrosion or cracks or deposit or some other weakening action going on in its hidden way.

But this was what happened to me: I had been all through, inside and outside, of a large return tubular boiler and had found nothing wrong, but intended to report adversely regarding the covering of the boiler, which was of brick, laid in arched form over the top of the boiler—a very bad arrangement, as will be shown later, but one which was largely in use in cold latitudes several years ago, but happily seldom seen nowadays.

I was inside the boiler, had looked at both heads and had worked my way back to the manhole, in readiness to come out of the boiler. From some cause or other, not clear to me even now, I rolled over on my back and laid there a few seconds, looking around at everything I could see, and apparently everything was in good shape. I was just going to swing myself up into the manhole when a streak on the boiler shell about two feet from the manhole happened to catch my eye, and from force of habit, the streak of rust being a trifle different in color from the rest of the boiler shell, I struck the spot with my hammer from mere force of habit. But that blow started something. I did not like the ring from that blow and struck the shell many times around and in that streak of rust; then I got out of the boiler, located the spot on top and tore off a section of the brick covering and laid bare the shell.

I did a deal more hammering there and dislodged a great mass of rust and corrosion where water from a leaky pipe overhead had been seeping down through the brick work upon the boiler shell for several years. When the boiler was shut down there was no water in the pipe and no leakage, hence no inspector had caught the fact.

After digging and hammering all the rust away the shell at the rusted place was found so very thin that a well-directed blow from the pene of my hammer went right through the shell! Since that occurrence, which happened many years ago, when it seemed as if manholes were larger than they are now, I have never been inside or under a boiler without making the most of my time and of every faculty to see that nothing escaped observation which might in the least hide some little defect—little then, but which might some time, if left to itself, become dangerous.

In the course of a great many inspections, I have found quite a number of defects which would have slipped past me had I ever taken anything whatever for granted. A certain well-known patriot once said: "The price of liberty is eternal vigilance." The inspector of boilers may well paraphrase the saying and very aptly put it: "The price of *safety* is eternal vigilance!" I have found it so ever since I drove my hammer through the shell of what a little before had seemed to be a perfectly sound boiler—and I have kept up the vigilance act during inspection ever since. This is something that you will do well to remember and act upon.

But as greatly as I was surprised over the boiler in question, my company was even more surprised a short time afterwards when they received a bill for repairs from the owner of the boiler in question. The bill was accompanied by a very short letter, requesting immediate settlement of the bill, and stating that it was sent to the insurance and inspection company for the reason that *their inspector broke the boiler!*

Pitches for Screwed Stays

The following table gives the pitches for screwed stays for supporting flat plates, as worked out according to the United States Government rule in which the following formula is used:

$$\text{Pitch} = \sqrt{\frac{112 \times T^2}{P}},$$

where T = thickness of plate in 16th of an inch,
P = working pressure in pounds per square inch,
112 = constant for plates 7/16 inch and under.

The same formula is used for plates 15/32 inch and over by substituting 120 as the constant in place of 112 used in the above formula.

The areas and pitches in this table will be found to be correct, or, in some cases the pitches may be a little small, which favors the work. JOSEPH G. SEYBOLDT.

Titusville, Pa.

TABLE OF PITCHES FOR SCREWED STAYS SUPPORTING FLAT PLATES (U. S. GOVERNMENT RULES)

PLATE	1/4		9/32		5/16		11/32		3/8		13/32		7/16		15/32		1/2		17/32		9/16		5/8		11/16	
W.P.	AREA	PITCH	AREA	PITCH	AREA	PITCH	AREA	PITCH	AREA	PITCH	AREA	PITCH	AREA	PITCH	AREA	PITCH	AREA	PITCH	AREA	PITCH	AREA	PITCH	AREA	PITCH	AREA	PITCH
50#	35.84	5.98	45.36	6.73	56.00	7.48																				
60	29.86	5.46	37.80	6.14	46.66	6.83																				
70	26.60	5.06	32.40	5.69	40.00	6.32	48.40	6.95	57.60	7.58	67.60	8.22	76.98	8.77												
80	22.40	4.74	28.35	5.32	35.00	5.91	42.35	6.50	50.40	7.10	59.15	7.68	67.35	8.20												
90	19.92	4.46	25.20	5.02	31.11	5.57	37.64	6.13	44.80	6.69	52.58	7.25	59.86	7.73												
100	17.92	4.23	22.68	4.76	28.00	5.29	33.88	5.82	40.32	6.35	47.32	6.87	53.88	7.34	67.50	8.21	76.80	8.76	86.70	9.31	97.20	9.86	120.	10.95	145.	12.34
110	16.29	4.03	20.62	4.54	25.46	5.04	30.80	5.55	36.66	6.05	43.00	6.55	48.98	6.99	61.37	7.83	69.82	8.35	78.82	8.87	88.36	9.40	109.	10.44	132.	11.49
115	15.59	3.95	19.72	4.44	24.35	4.93	29.46	5.42	35.07	5.92	41.15	6.41	46.85	6.84	58.69	7.66	66.79	8.17	75.40	8.68	84.53	9.19	105.	10.24	126.	11.23
120	14.94	3.86	18.90	4.34	23.34	4.83	28.23	5.31	33.60	5.79	39.44	6.28	44.88	6.69	56.25	7.50	64.00	8.00	72.25	8.50	81.00	9.00	100.	10.00	122.	11.00
125	14.33	3.78	18.14	4.26	22.40	4.73	27.10	5.20	32.26	5.68	37.86	6.15	43.11	6.56	54.00	7.34	61.44	7.83	69.36	8.32	77.75	8.81	96.00	9.79	116.	10.77
130					21.54	4.64	26.06	5.10	31.02	5.57	36.40	6.03	41.45	6.43	51.92	7.20	59.08	7.68	66.70	8.16	74.77	8.64	92.00	9.59	112.	10.58
140					20.00	4.47	24.20	4.92	28.80	5.36	33.80	5.81	38.49	6.20	48.22	6.94	54.86	7.40	61.93	7.87	69.43	8.33	86.00	9.27	104.	10.19
150					18.66	4.32	22.58	4.75	26.88	5.18	31.54	5.61	35.92	5.99	45.00	6.70	51.21	7.15	57.80	7.60	64.80	8.05	80.00	8.94	97.00	9.85
160									25.20	5.02	29.56	5.43	33.68	5.80	42.19	6.49	48.00	6.93	54.19	7.36	60.75	7.79	75.00	8.66	90.00	9.52
170									23.72	4.87	27.83	5.27	31.70	5.63	39.71	6.30	45.18	6.72	51.00	7.14	57.18	7.56	71.00	8.42	85.00	9.22
180													29.94	5.47	37.50	6.12	42.66	6.53	48.17	6.94	54.00	7.35	67.00	8.17	81.00	9.00
190													28.36	5.32	35.53	5.96	40.43	6.36	45.64	6.75	51.16	7.15	63.00	7.93	76.00	8.71
200													26.94	5.19	33.75	5.81	38.40	6.19	43.35	6.58	48.60	6.97	60.00	7.74	72.00	8.47

Layout of Locomotive Fireboxes—II

BY C. F. AXELSON

In the last issue, a method was described of laying out a firebox for a Belpaire boiler with a wrapper sheet made in one piece. In the following is given a method for laying out in one piece the wrapper sheet of another class of firebox.

First, construct the half end view, Fig. 1. The base line is *a* and the line 8′-9′ is drawn at right angles to it. Point 8′ is connected by the slant line 7′-8′ to the curved line from 1′ to 7′. This curved line is in two divisions; one from 1′ to 4′, which in this case is divided into three equal spaces and the second from 4′ to 7′, also divided into three equal spaces. Mark off the height for the door sheet from 1′ to 1 on the center line.

To construct Fig. 2, draw the line *O-O′* at right angles to the base line *a-d*. Connect the points 1′-*O′*, giving the height of the flue sheet. Finish the lower corner of the mudring to suit the offset in the flue sheet. As a rule the flange is wider at the mudring which may run as shown at 13-14. Draw lines as indicated to points 12 and 14 on the base line. From *O* mark off the length of the firebox at *d* and also lay off the distance *O-e*, which is the length of the centerline on the crown sheet. From points *d* and *e*, draw lines at right angles to the base line. Lay off from *d* to *f* the distance *a-b*, Fig. 1, and lay off from *e* the distance *e-g*, equal to the height 15-1, Fig. 1. Draw the lines *O′-g*, *g-f* and *f-h*-10, completing the outline of the firebox wrapper sheet. Also locate the point *X* at the center of the line *g-O′* and drop the line *X-k* from this point at right angles to the line *g-O′* and mark the point *X′* on the line 7-7′.

To construct Fig. 3, draw the centerline parallel to the line *f-g*, Fig. 2. Then draw the lines *f-l*-8 at the bottom and *g*-1 at the top, completing the outline by drawing the curved line from 1 to 4 and 4 to 7, using the same radii as in the flue sheet and dividing these curves into the same

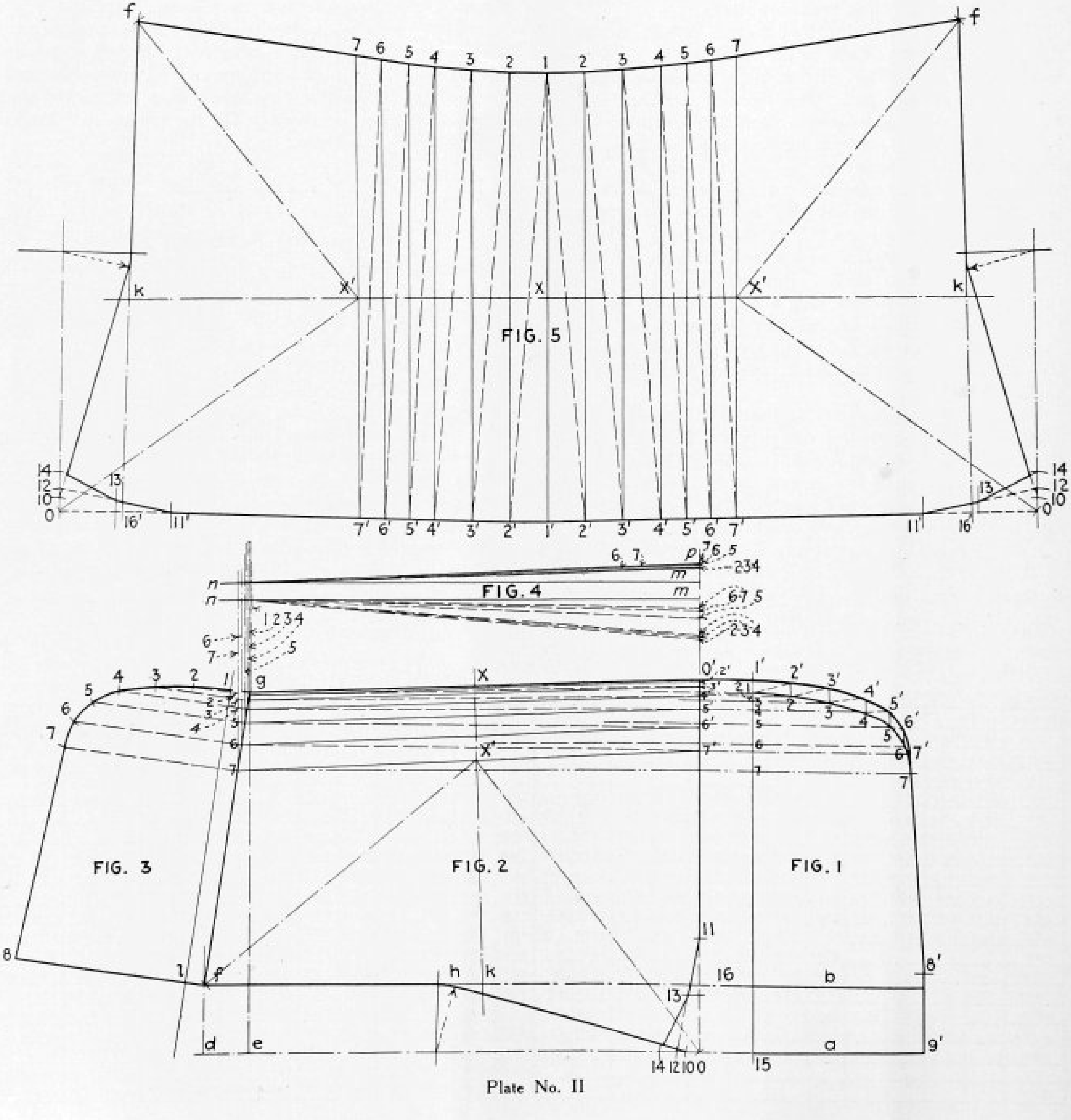


Plate No. II

number of equal spaces. Finally draw the line from 7 to 8. From each of these divison points, draw lines at right angles to and intersecting line *f-g*. These same intersections should be transferred to the front view, Fig. 1, by the same method given in the layout which the author described in the May number.

As the points have been set down on the centerline, Fig. 1, draw lines from same at right angles to the centerline. The curved line 1 to 7 is found by the length of the lines in Fig. 3. Draw the curved line through the various points from 1 to 7, connecting them with the solid and dotted lines as shown on the drawing.

The next operation is the construction of Fig. 4, or the diagram of triangles. Draw two horizontal lines *m-n*, extend the line *O-O′* to p; also from the intersections on the inclined line *f-g* draw lines from points 1 to 7 parallel to *O′-p*. Step off the spaces 2′-2, 3′-3, etc., to 7′-7, Fig. 1, on the line *O′-p* Fig. 4; also check the dotted lines 1 to 2′, 2 to 3′, etc., to 6-7′ and draw lines between corresponding points with dotted lines on one side and the solid lines on the other side of the parallel lines *m-n*.

Development of the Pattern

Draw the line 1-1′, Fig. 5, for the centerline. With the trams set to the line *g-O′*, which is the centerline in the crown sheet, Fig. 2, lay off the distance between 1′ and 1, Fig. 5. Next, taking dotted line 1-2, Fig. 4, and with 1, Fig. 5, as a center, describe an arc at 2′ on each side of the centerline, then with dividers set to the spaces 2′, 3′, 4′ and with 1′ as the center, describe an arc intersecting the arcs previously drawn at 2′ and 2′. Next from Fig. 4, taking solid line 2-2 and with 2′, Fig. 5, as center, describe arcs at the points 2 on each side. With dividers set to the spaces 2, 3, 4, Fig. 3, and with 1, Fig. 5, as a center, describe arcs intersecting the arcs previously drawn at the points 2 and 2. Continue laying off the dotted and solid lines until corresponding points are located in Fig. 5. It should be remembered that when line 4 is reached, the dividers should be adjusted to the spacing 5, 6, 7.

To lay out the flat part of the wrapper sheet, draw the line X-X′, Fig. 5, at right angles to the line 1′-1, through the point X′ the same being exactly midway between points 1′ and 1, as in the line *g-O′*, Fig. 2. With trams set to the distance *X′-O′*, Fig. 2, and with *X′*, Fig. 5, as a center on line 7-7′, describe an arc at *O′* on both sides. Then with the trams set to the distance *X′-f*, Fig. 2, and with *X′*, Fig. 5, as a center, describe an arc at the point f, Fig. 5.

Before laying out the end lines and the depth of the flat surface in the plate, it will be found on looking over the end view, Fig. 1, that the plate line from 7′ through 8′ to 9′ is a little longer than the distance 7′ to 15 on the centerline for the front and 7 to 8 for the back end, if the plate is to come even with the ring. There will be, however, more stock than necessary outside the center of the rivet line. Therefore, the distance *7′-O* is sufficient. Therefore, taking the distance *7′-O*, Fig. 2, and with *7′*, Fig. 5, as a center, describe an arc at *O*. Draw lines as indicated by the dash and dotted lines at right angles to the line *7′-O*. Again set the trams to the line *7-f*, Fig. 2, and with point 7, Fig. 5, as a center, describe an arc at *f*. Then with space *O*-16, Fig. 2, and *O*, Fig. 5, as a center, describe an arc at 16. Draw the line 16-*k-f* and where the line *X-X′* intersects the line 16-*f* at *k*, Fig. 2, set the trams to *k-f* and with *k*, Fig. 5, as a center, describe an arc at *f*, in order to prove that the three points coincide.

To finish the front corners, point *O* is used as the center and distances *O*-11 and *O*-13, Fig. 2, are transferred to corresponding points in Fig. 5. In a similar manner, the points *O*-10, *O*-12 and *O*-14 are located. Draw lines connecting the points thus found and add for the lap at the front and the back, completing the template.

Boiler Manufacturers' Convention

At the close of the convention of the American Boiler Manufacturers' Association in New York City last September, the members of the association then present agreed to adjourn subject to the call of the president, and in the interval determine just what future course should be pursued for the passage of a uniform code or specifications for the construction of boilers throughout the different States.

On September 29 a meeting of forty representative boiler manufacturers interested in the adoption of a uniform code or specifications met at Pittsburg and appointed a committee to represent the boiler interests to co-operate with the A. S. M. E. in the draft of same. The committee consisted of the following boiler manufacturers: Mr. T. E. Durban, of the Erie City Iron Works, Erie, Pa., representing the Tubular Boiler Manufacturers' Association; Mr. Isaac Harter, of the Babcock & Wilcox Company, representing the A. B. M. A.; and Mr. H. P. Gooding, representing the Thresher Association's interests, the members present agreeing to an assessment to defray the expenses of this committee.

The committee spent twenty-one days' time in New York City with the committee of the A. S. M. E., the outcome being the compilation of a uniform code. On March 29 a report of this committee was received during a session in Pittsburg, at the Fort Pitt Hotel. After receiving the report a unanimous vote of thanks was extended to the committee for the labor performed and the committee was requested to continue its work until the annual meeting of the A. B. M. A.

Some of the members present were anxious to form an association, giving it a name and showing just what association this committee would represent, but after some discussion it was unanimously agreed that the committee continue until the convention of this association. The presidents of both the A. B. M. A. and the Tubular Boiler Manufacturers' Association thought best to consolidate under one head, and in so far as possible arrange to have associated in one body all parties interested in the new code. After some debate it was decided to have the next meeting at the Lawrence Hotel, Erie, Pa., on June 21.

The code, or uniform specifications, has already been recognized by some of the States, and its adoption in every State is what is desired. To do this, a large attendance is urgent at this convention, so that by united action and in as large a representative body as possible, such arrangements can be made as will accomplish this purpose in as short a time as consistent with properly doing the work to produce the desired results. The convention will be in continuous session for two days and will not be interfered with by any social features in any manner, with the possible exception of a visit to the interesting plants of the Erie City Iron Works and the Union Iron Works.

The programme for the convention is as follows:

Monday, June 21 (Morning Session)

Registration.

Report of Committee on Uniform Boiler Laws. L. E. Connelly, chairman.

Report on same subject by committee representing A. B. M. A., National Tubular Boiler Manufacturers' Association, and Threshing Machine Manufacturers' Association. Thomas E. Durban, chairman.

Addresses by representatives of Ohio Board of Boiler Rules and Massachusetts Board of Boiler Rules.

MONDAY, JUNE 21 (AFTERNOON SESSION)

Nomination of Auditing Committee.

Report of Committee on Clause for Uniform Guarantee pertaining to Material, Workmanship and Terms of Payment. E. R. Fish, chairman.

Annual address by the president of the A. B. M. A.

Appointment of nominating committee.

Appointment of committee to report on change of annual dues.

Report of treasurer.

Report on membership.

Miscellaneous business.

TUESDAY, JUNE 22 (MORNING SESSION)

Report of Committee on Uniform "Cost-Keeping" System. H. D. MacKinnon, chairman.

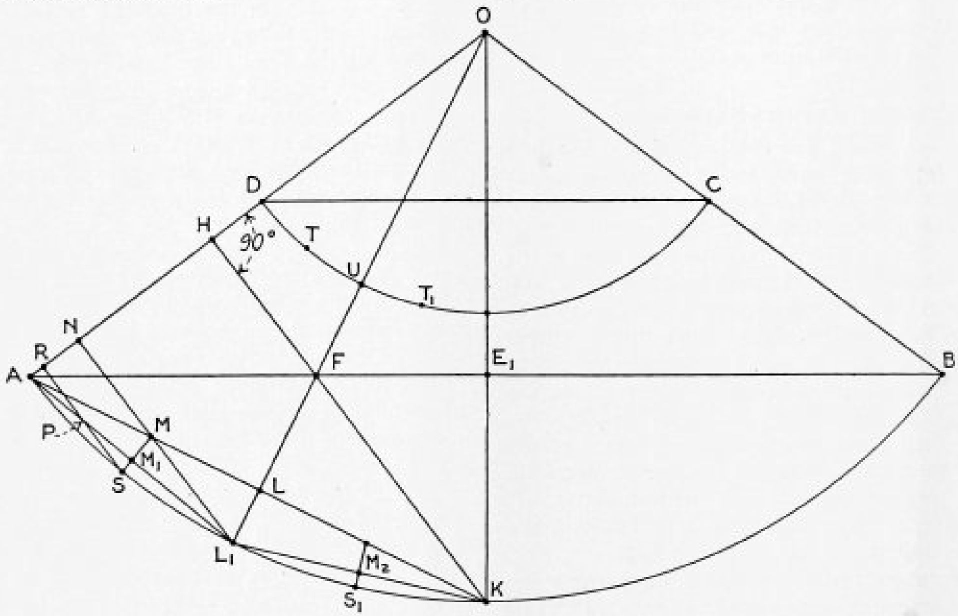
WEDNESDAY, JUNE 23 (MORNING SESSION)

All delegates assemble in main corridor of hotel in order to proceed to waiting street cars, for visit to plants of Erie City Iron Works and Union Iron Works.

The Layout of Cones with a Large Radius

With the following method cones with either a large or a small radius can be laid out accurately.

First lay out the line *A-B* equal in length to the circumference of the large end of the cone. Square up the plate and draw the line *K-O* perpendicular to the line *A-B* at its center. Lay out *D-C* equal in length to the circumference of the small end of the cone, making *A-D* and *B-C* each equal to the slant height of the cone.



Layout of Sheet for Frustum of Cone with Large Radius

This report will be followed with a full discussion on this subject.

Report of Committee on Topical Questions. Isaac Harter, Jr., chairman.

Address by a member of Boiler Code Committee, A. S. M. E.

Report of audting committee.

Miscellaneous business.

TUESDAY, JUNE 22 (AFTERNOON SESSION)

Report of committee on change in amount of annual dues.

Report of any other committees not already heard.

Ballot as to time and place of next convention.

Report of nominating committee.

Election of officers.

Installation of new officers.

Miscellaneous business.

TUESDAY EVENING (BANQUET)

Opening remarks by toastmaster.

Address by William T. Stern, Mayor of Erie, Pa.

Address by W. Pitt Gifford, President Erie Board of Commerce.

Address by Col. Henry P. Bope, Vice-President and General Manager of Sales, Carnegie Steel Company.

Now make the perpendicular distance *H-F* from the line *A-D* equal to the distance E_1-*F*, continuing line *H-F* perpendicular to *A-D* to the point *K*. Also draw the line *A-K* and in the center of line *A-K* locate the point *L*. Through *L* and at right angles to *A-K* draw the line *L*-L_1. Now make the distance *M-N* perpendicular to the line *A-D* equal to the distance *L-M*. At right angles to the line *A-D* and through the point *M* continue the line *N-M* to the line *L*-L_1 and locate the point L_1. Now draw the lines *A*-L_1 and L_1-*K*.

In the center of *A*-L_1 locate M_1 and in a similar manner locate the point M_2. At right angles to the line *A*-L_1 and through M_1 draw the line *M-S*. At right angles to the line L_1-*K* and through point M_2 draw the line M_2-S_1. Now make the distance *R-P* perpendicular to the line *A-D* equal to the distance M_1-*P*. At right angles to *A-D* and through *P* continue the line *R-P* to the line M_1-*S* and locate the point *S*. Now take the distance M_1-*S* and transfer it to M_2-S_1. A neat curve drawn through the points *A-S*-L_1-S_1-*K* completes one-half of the bottom.

The other half, *K* to *B*, is exactly the same as the half already obtained.

Now with trammels set to *A-D*, the slant height, and with points *S*, *L'* and *S'* as centers, strike arcs at *T-U*-T_1 and *E*. Now from *D* and *E* strike an arc and locate point

U on the arc struck from L_1. Locate T and T' in the same manner and draw the curve D, T, U, T_1, E. From E to C is the same distance as D to E. Check up the circumference from E to C and E to D as the points D and C may have to be drawn in a little. Also check the distance K to B and K to A. This completes the pattern.

If the plate is very long and more points are needed on the large end, they can be obtained by going through the same operations as were used in locating the points already found. Also note that if the lines M-S and M_1-S_1 were continued upward they would also pass through the points T and T_1 and meet at the apex, O, the same as the line L_1-L shown on the drawing, which helps to prove the accuracy of this method. GEORGE A. JONES.

Some Results from the Working of Steel Plate

We have two very unusual illustrations, from widely different sources, showing interesting results which followed the working of the plate in the boiler shop.

Fig. 1 is a photograph of a portion of a large plate of open hearth steel from a well-known maker. The plate was 80½ inches wide, 105 inches long and 1 inch thick. It was punched with four groups of 10 holes each, arranged so that there was a group of holes near either end of each long edge, one group showing in the photograph. These holes were 1 inch in diameter and were pitched 3 inches apart. After the completion of the punching operation, a 2¼-inch flange was turned along each of the short edges, and a portion of one of these flanges is also shown in the illustration. A close study of the picture will disclose the line of heating back of the turn of the flange, and will show that it did not extend very far back into the plate. The flanging was completed at just about six o'clock in the evening, and so the plate was set aside over night. In the morning, when the workmen started to resume operations on this particular job it was discovered that during the interval a crack had developed, as is shown in our view. This crack extended from the third rivet hole, which was 12 inches back from the turn of the flange, 34 inches into the plate, terminating at a point 22 inches back from the flange. The crack stood open at the plate edge about ¼ inch, and the portions of the plate were sprung so that the two edges of the crack were separated about ¼ inch in a direction perpendicular to the surface of the plate. The plate appeared and worked like good, soft material. The buttons punched from the holes stood up well when they were hammered down flat, both endwise and sidewise, and under this flattening showed no undue tendency to crack or crumble.

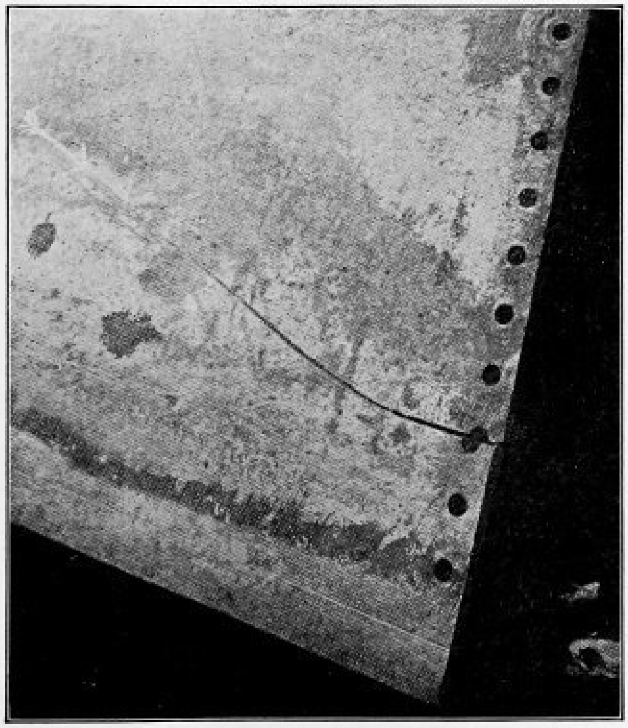


Fig. 1.—Cracked 1-Inch Plate

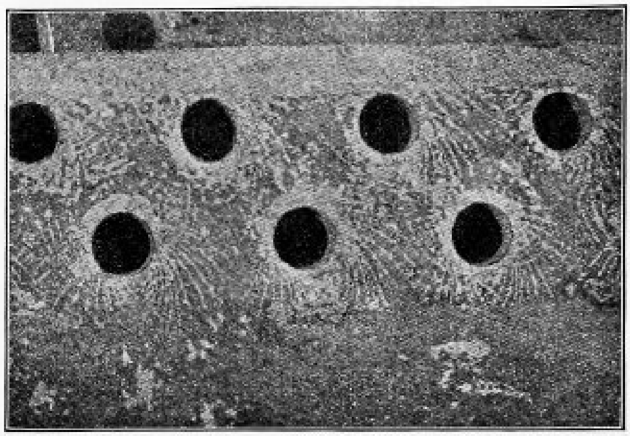


Fig. 2.—Surface of Plate Disturbed by Stresses from Punching Holes

Several possible causes for such a behavior suggest themselves, but in the absence of information which could only be arrived at by a careful microscopic and chemical study of the material in the neighborhood of the failure, we hesitate to pronounce an opinion, preferring to leave the matter open to the discussion of those interested.

Fig. 2, reproduced from the *Zeitschrift für Dampfkessel und Maschinenbetrieb*, shows a difficulty of another sort. It illustrates the disturbance of the mill scale on a piece of boiler plate due to punching holes for a double riveted seam. This is a particularly good illustration of the disturbance of the metal caused by punching, and merits careful study, especially as to the direction and grouping of the radiating lines. The plate was 0.47 inch thick, the holes 0.87 inch in diameter, pitch 2.8 inches, distance between rivet rows 1.77 inches, and the distance from the edge of the plate to the first row of rivets was 1.34 inches. The length of the longest radiating line was about 1.2 inches.—*The Locomotive of the Hartford Steam Boiler Inspection and Insurance Company.*

Rope slings do not cost much, but they do wear out. Bosses seem to forget this.

Grate bars are not parlor ornaments, but some foundry men think that the rougher they are the better. It is time that people get over the idea that anything is good enough for a boiler or a boiler maker.

Corrugated flues have the advantage of increased heating surface. They take care of expansion better than the straight flue. They add to the life of a boiler and to its steaming qualities, but they are not found on the bargain counter. Try to make one and you will find out why.

Master Boiler Makers' Association Assembled at the Hotel Sherman, Chicago, Ill., May 25, for Its Ninth Annual Convention

Master Boiler Makers' Annual Convention

Wide Range of Important Subjects Discussed at Four Days' Convention in Chicago—Leading Boiler Makers Meet and Exchange Ideas

The ninth annual convention of the Master Boiler Makers' Association was held at the Hotel Sherman, Chicago, Ill., May 25 to 28. The first session opened at 9:30 A. M., May 25, with President James T. Johnston, foreman boiler maker of the Santa Fe Railroad at Los Angeles, Cal., in the chair. After an invocation by Rev. Rufus A. White of Chicago, Mr. E. W. Pratt, assistant superintendent of motive power and machinery of the Chicago & Northwestern Railroad, was called upon for an address.

Abstract of Mr. Pratt's Address

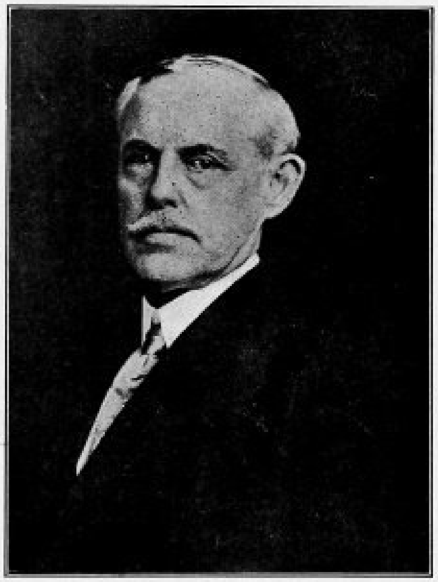
Federal legislation on locomotive boiler inspection has been met fairly and squarely and openly by the members of this association and by the railroad companies which they represent. Those who opposed this work for the betterment of boilers were the rare exceptions. Locomotive boiler makers of this country, the railroads and the public have worked together. They have been equally interested and it has been a mutual work as between the public and the owners of property.

There has been during the past decade a great deal of railroad legislation and legislation intended to correct the activities of large corporations and large capital interests. There is no doubt but that at each inauguration of this era of legislation there is good reason for much of it, there is no doubt but much of the legislation, as far as the public has been able to digest it, has been beneficial; neither is there any doubt in the mind of any fair-minded man that the thing has been overdone and that what the patient needs most of all is a little quiet rest.

Turning to mechanical details we have found that great benefit is brought about by frequent inspection of the beading tools, having a standard for making the beading tool and frequently comparing the tool that is in the hands of the men with the standard, so that it can be dressed if it is out of that standard. It is also necessary to take good care of the ash pan and the front end and of everlastingly keeping after the details back of the side bars of the grates. We have had a great deal of trouble with corrosion, leaking of the side sheets until we patched the full length of the mudring. We overcame that largely by packing in between the side bar and the side sheet some suitable material that would keep the ashes and cinders away from the side sheet. That is one of the smaller matters, but there are many others that can be overcome by careful attention to details.

In speaking about the railroad legislation, I intended to say a word with regard to politics—clean politics, of course, for any other kind of politics is going out of custom to-day. It is up to everyone interested in the welfare of the railroads to see that the revenues of our companies are not depleted by legislative action, and that one set of men does not receive an undue wage to the detriment of others. Another matter of detail is that instead of going to the State Legislature or City Council, as we often have to do, each of you should go to the primaries, put up good men and make them know where they stand when it comes to voting.

Andrew Greene, President-Elect



Harry D. Vought, Secretary

In closing, I want to urge upon each one of you to keep close to the men, remember that it is only by being fair and honest with the men and having them recognize your proficiency that you will be advanced. I think that the cases are very rare where we men are advanced very far without the backing of the rank and file of the men we have worked with in the shop, at the bench, or with the hammer and chisel.

Mr. James T. Goodwin, past president of the association, responded to Mr. Pratt's address.

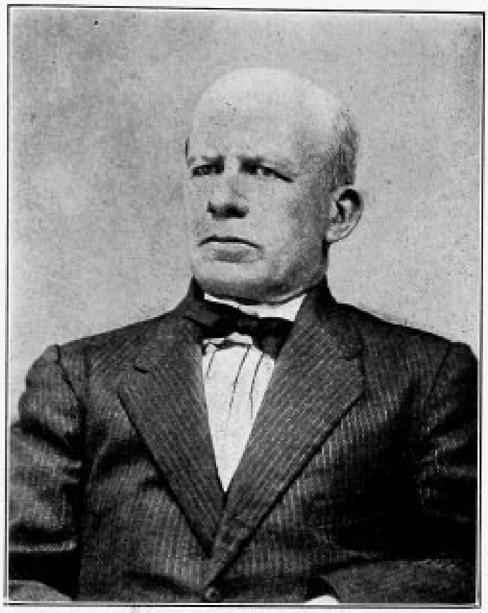
Following Mr. Goodwin's response, the president of the association read his annual address, which consisted chiefly of a review of the progress of the association.

The report of the secretary showed that during the year the association lost one member by death, 132 members were suspended for non-payment of dues, and 30 members were reinstated during the year, leaving the number of members in good standing on March 31, 1915, 370.

The treasurer's report showed the total receipts during the year, including the balance from the past year, of $1,842.26; the total disbursements, $955.29, leaving a balance in the treasury on March 31, 1915, of $885.97.

WEDNESDAY MORNING SESSION

The first speaker at the second day's opening session was Mr. Frank McNanamy, chief federal inspector of locomotive boilers, who presented a tabulated statement of the work which has been done by the locomotive boiler inspection department of the Interstate Commerce Commission during the first nine months of each of the fiscal



John B. Tate, Second Vice-President

years 1912-1915 inclusive, showing the results which have been obtained from this work. While satisfactory progress has been made in the substantial reduction of accidents and casualties resulting from locomotive boiler failures, Mr. McNanamy pointed out several causes of accidents in the prevention of which satisfactory progress is not being made. These included arch tube failures, due principally to improper application or failure to keep the tubes clean; accidents due to improper flue welding and failure of injector steam pipes.

Mr. P. J. Conrath, past president of the association, responded to Mr. McNanamy's address, and it was voted that Mr. McNanamy be admitted as an honorary member of the association.

What are the Advantages or Disadvantages of Using Oxy-Acetylene Process for Boiler Maintenance and Repairs?*

The oxy-acetylene welding and cutting torches have become so valuable in the boiler shop to-day and can be used to such an advantage that they are used in most of the large railroad shops and are no longer an experiment, but a necessity. To deprive the majority of the shops that have used oxy-acetylene of this process, would be as great a handicap as the taking away of pneumatic tools. Some of the uses which oxy-acetylene can be put to in repairing and maintaining boilers are:

Welding in side sheets and patches. When welding in side sheets, some boiler foremen make an allowance for contraction by dropping one end of the sheet, while others get good results by not making any allowance for contraction. The welding in of side sheets, instead of riveting them, has been made a standard practice by some railroads; in fact, one railroad is now cutting the side sheets off just above the mudring and also at the seam at the crown sheet. In this way they save taking out the mudring rivets and do not disturb the corners.

When welding patches in side sheets, good results have been obtained by putting in round or oval patches. Other roads disk or make box patches for welding. It is necessary to do this to take care of the contraction.

Building up washout plug holes around the firebox or front flue sheet.

Welding cracks in side sheets, door and crown sheets.

Welding up cracked bridges in flue sheets. One method used in welding cracked bridges is to cut out the crack, then hammer ends of the bridge in and weld. After it is welded and while hot, it should be hammered back straight. This takes care of the contraction. There are some welders who can weld broken bridges without doing this.

Welding seams in door holes instead of riveting or plugging. This is done in two ways. One is to make the lap of the door flange long enough to cover the holes in the back head and weld what would be the calking edge, if rivets were used. The other is to cut the flange in the back head off just back of the rivet holes and butt the door flange to it; then weld it the same as welding in a patch or side sheet.

Welding in flue sheets and door sheets. This is now being done by some railroads. In fact, fireboxes are now being applied and the only rivets used in them are those in the mudring.

Welding cracked and broken mudrings. The general practice in welding cracked or broken mudrings is to cut a piece out of the firebox sheet, then cut a V shape out of the mudring and weld the ring from the top side, although some successful welds have been made by cutting out a V shape and making the weld from the bottom.

Welding flues in back flue sheet. The welding of flues in back flue sheets does not seem to be as successful with oxy-acetylene as with the electric process. It is also slower. Some success has been reported where copper ferrules are not used.

Welding up pits in flues. Large savings are reported by some railroads doing this.

Welding safe ends on superheater flues. In doing this, two methods might be mentioned; one is to butt weld by placing the flue and safe end in an angle iron, spot weld it in four places, then turn the flue while the operator welds it. The other way is to bell the flue if the weld is made on the firebox end and insert the safe end, leaving a lap of ½ inch. The weld is then made at the edge of the flue. If the weld is made on the front end of the flue, the safe end should be belled. This is done so the edge will not obstruct the flow of gases or the flames get under the flap. The claim made for welding flues in this manner is that in case the weld should fail, the danger of breaking off is removed by the lap holding the flue.

Welding up staybolt holes in side and crown sheets. This saves bushing holes and sometimes patching.

Some of the uses for the cutting torch are: Cutting out shell sheets, cutting out firebox sheets, scrapping boilers, cutting out superheater flues, cutting out countersunk

* In connection with this report a special paper was submitted by Fred S. Graife on "Factors of Economy in Oxy-Acetylene Operations." An abstract of this paper will be printed in a later issue.

rivets, cutting off rivets on shells and mudrings, cutting off staybolts and radial stays, cutting off staybolt ends for driving. In fact, the cutting torch can be used for so many things in the boiler shop that it would be useless to try to enumerate them.

In order to use the oxy-acetylene process to the best advantage, the shop should be equipped with an acetylene generating plant and piped throughout.

When portable outfits are used, time is lost and it is also necessary in most cases to send a helper with the operator to help with the tanks. When very many welders are used, one good operator should be advanced to chief welder and his duties should be that of an instructor when breaking in new welders, and to see that torches, hose and gages are kept in shape at all times, and that work is properly prepared for welding, as many failures in welding can be traced to the work not being properly prepared. An accurate check should be kept to show the cost of every job of welding that is done, as there is danger of doing work with oxy-acetylene torch that could be done cheaper some other way. Men should be picked for welders with care and instructed for a time by a competent welder.

In conclusion, there are new uses discovered every day for the oxy-acetylene torch, and no doubt each member of this association whose shop is equipped with an oxy-acetylene plant is doing something that others do not know of, and it is hoped that these new uses for the oxy-acetylene will be brought out in the discussion.

T. F. POWERS, chairman.

D. A. Lucas: In so far as reclaiming materials of all kinds is concerned, its advantages are unlimited. We do all kinds of reclaiming—steel castings, forgings of all kinds, besides considerable firebox work, cutting off radial stays. It does it very nicely; cutting staybolts faster than a machine almost; flexible bolts were applied on the inside of the flue sheet and we nip them off with the oxy-acetylene. There are a hundred ways that you can make use of it; you can save both time and money.

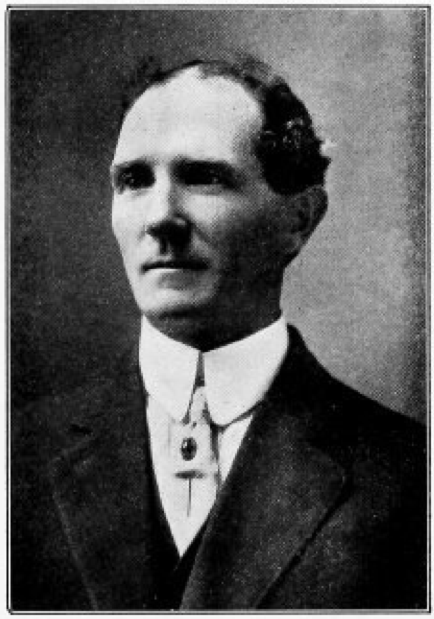
Mr. Harthill: I have used oxy-acetylene for about four years and I find the greatest number of failures in welding, due to not getting the sheet hot enough. Another thing is to have a good operator; you must have the right proportion of oxygen and acteylene, otherwise the weld will be brittle. If you start to put in the wire before the two sheets fuse together, you will have failures. You ought to get 3,000 miles out of your weld; the engine should last two shoppings.

In welding the mudring corner—it is indispensable—you can do it in ten hours; cut the mudring out at the door sheet and cut it up higher than the side sheet. You can weld it and rivet it in from eleven to twelve hours. I know that the leakage of the mudring corner is eliminated; it is reduced to a minimum by welding with acetylene. In four years we have welded over a thousand mudring corners on inside and outside fireboxes and they are holding up in good shape.

Mr. Hodges: I want to tell you what the Frisco system is doing with it. We have one boiler maker from Springfield who is cutting out fireboxes. The engine comes in for repairs and before you know it he has the firebox out, and while the machinists are about half done, he has got the boiler ready and he is welding the seams, and putting in half side sheets and new flue sheets. An engine will come back in about ten days and have a new flue sheet applied; he cuts the flue area out and the mudring is put in good condition. Then he welds the new sheet in and it is practically new. He welds patches on the side sheet and cracks and door corners and uses it for cutting, and it is absolutely indispensable for reclaiming. I cannot see how a road can dispense with it.

C. R. Bennett: We flange the sheet a little; you must do this to allow for expansion, and we feel that we are able to weld our horizontal cracks, but we are not able to weld our perpendicular cracks, and in putting on side sheets we cannot weld our perpendiculars unless we take out the staybolts. Some say they can put on a patch without its "crawling," by tacking here and there, but we have not been able to do anything of that kind; we are not able to do it because of the expansion and contraction. I think it is due to the operator.

Mr. Lewis: We have in service to-day an engine that had a firebox applied (similar to model exhibited), in which there were no rivets except in the mudring. The back flue sheet was riveted in and the door sheet was welded just the same way, but at that time the fire-door hole was not welded, but to-day we are welding all the fire-door holes. We have had better success in welding the fire-door hole than any other part of the firebox. When we apply a new firebox or half a door sheet, we cut the old flange off the back head. You bring the new sheet on the door holes to about a quarter of an inch of meeting the hole in the back end and we weld them together, and I don't know that we have ever had a failure in connection with the firebox holes.



C. P. Patrick, Third Vice-President

There are numerous advantages, I believe, in a firebox of this construction. You can readily observe that there is nothing there for scale to adhere to; there is nothing to obstruct the flow of the water as there would be if we had applied cone headed rivets. On the fire side there is no flange to get hot and burn, we do away with fire cracks that you and I have had to contend with for the last thirty years. I believe in a clear, plain surface for the gases, or the flame of the fire in the firebox; I believe in a clear, plain surface for the water to circulate on the water side; I believe these are essential.

Mr. Bennett: When we first started to put in side sheets, we used to leave them loose; but now we put all the staybolts in and leave it open a quarter of an inch, and if the operator knows how to fill that, the shrinkage will be small.

Mr. Green: In working on those fireboxes, while in service, do you weld from one side or have an operator on the inside and another on the outside?

Mr. Lewis: Just on one side; I think the operator should weld on one side and then go on the other and clean up.

Mr. Powers: How often do you have to expand your flues?

Mr. Lewis: I make a practice of going over the flues when the engine is washed, every ten days, or not more than thirty days.

Mr. Murphy: What is the average life of a flue and the firebox?

Mr. Lewis: They run about a year; the flue sheet has got to be removed every two years and the firebox removed between four and five years.

D. A. Lucas: We have nine oxy-acetylene plants at the present time. Since April, 1910, I have not riveted in a side sheet or a half side sheet, and I would like to make it clear to this convention that from actual experience, and trying out, there is nothing in this dropping of the sheet, or leaving the sheet loose, or putting an offset on the patch to weld it. I put the side sheet in, rivet it to the flue sheet and door sheet, run in the staybolts, put the bolts in the mudring, through the mudring, and do my welding; leaving an opening after the two sheets are beveled, from 1/8 to 3/16 inch, and have never had a failure or any trouble from that practice. We weld in patches and the secret of welding in a patch is to get the radius at the end; don't get inside of the radius. In welding vertical cracks, I tried that in several different ways and I believe it is nothing more nor less than a temporary job.

Thomas F. Madden, Fifth Vice-President

Mr. Harthill: Mr. Lucas has a very different method of welding in side sheets and three-quarter door sheets than I have. I have made numerous experiments and I find the best results are obtained by dropping the sheet one-eighth of an inch, per foot. When I get the side sheet in place I apply a clamp at the mudring, leave enough space for the mudring hole and weld gradually, and when the sheets come together the welder starts to weld and never stops welding, and the heat is never taken off until it is finished. Now, in welding the sheets the way Mr. Lucas does I experienced a great deal of trouble. I have eliminated all of this and on my division I now have over 600 plates welded in side sheets; I also weld crown sheets, patches, door sheets and side sheets. If I could weld side sheets the way Mr. Lucas does, it would save me a lot of trouble and money for my company.

Mr. Tynan: I do not agree with Mr. Lucas when he says that you do not have to drop the side sheet, etc.; I want to tell you that if you don't do it, you are going to have trouble. We cut our side sheets out, fit them to place, just as closely together as possible, drop the sheet one-eighth of an inch to the foot and hold that down with a turnbuckle, and as the operator goes along the helper lets the sheet come together, just where he is welding. You will find that the sheet will travel up just as fast as he welds and the closer you have the sheet fit, the quicker the operator goes through the sheet. You have got to remove the row of staybolts above the weld, the contraction in the iron will pull this top row of staybolts, and consequently the staybolts are loose in the sheet and will leak badly. If the staybolt holes get too large, we countersink the hole and weld them up, but as to cracks in the firebox, I don't believe they can be welded successfully and made a permanent job.

Mr. Walsh: I agree with Mr. Lucas, because we are practicing what he says every day—we are putting in complete side sheets, putting on the staybolts and driving in the mudring rivets before we even start to weld the seam. It is only just a matter of what way a man wants to do this work. He can leave the work loose or make it rigid, it simply depends on the operator; if you have a good operator, you are getting good results. In removing fireboxes, we burn the staybolts off, take out the fireboxes in sections. After the firebox is removed, the operator gets inside and burns out the staybolts; consequently, when our operator commences to get slack we take the engines waiting for shopping, place them on the outside; before the machinists ever go near the engine we get the work out and actually put it back before we put the engine in the shop.

Mr. Murphy: I would like to ask you gentlemen if you are welding flues with this process; everyone says it can't be done.

D. A. Lucas: I have done very little work along that line, we have welded about sixty-four flues on the top of our Mallet type engine; on the boiler top where the heat affects them the most they could not be kept tight with the old method, but welding them with the oxy-acetylene we have got good results.

Mr. Powers: I would say that on the Northwestern, we welded four or five sets of flues with the oxy-acetylene process, and I think it is about nine months that they have been in service and we find that we have got to cover up the welding; it takes a little longer, but we have had no failures.

WEDNESDAY AFTERNOON SESSION

Mr. Harthill: In welding side sheets or three-quarter door sheets, it costs $1.23 per foot, and we can weld 2 feet 4 inches per hour. I welded side sheets on a firebox, 9 feet 6 inches at $1.23 per foot. Now, in cutting, it costs you about $2.94 per hour, for cutting with a torch. A good operator can cut between two and three feet per minute. In cutting off staybolts, we figure a cent and 8 mills per bolt. For flexible bolts and fireboxes, the cost is reduced by using the air tools. We cut off the bolts but the thread is not disturbed at all, and we get 50 percent better results by burning them off than by cutting; of course, where we can use the nippers on the outside, you can cut for less, but where you cannot get the nippers in, it is much better to use the oxy-acetylene. The figures that I quoted, the one cent, eight mills, include everything, complete, both labor and material. In cutting out a firebox, our method used to be to remove the back head, pull the firebox out; we applied flexible staybolts, so we could pull the box out; but in using oxy-acetylene, we can cut the firebox to pieces, drill a hole in it, which saves removing of the gussets and braces. By this method we save $58 and some cents. In the old method, when we cut out the rivets on the firebox and across the boiler head, it costs us much more. With the method we now use, we figure that it costs us about $9.70 per firebox. This is what we have gained in the Collinwood shops, New York Central Lines West, by cutting out with the oxy-acetylene instead of the old method of cutting.

Mr. Madden: What wages do you pay your operator?

Mr. Harthill: We start a man in at 20 cents per hour, and if he shows any evidence of being a welder, we give him 25 cents, and the men who are doing firebox work, the principal work in our shop, receive 36 cents an hour. We figure that we save $2,000 a month on reclaiming work, from scrap. It is a little more expensive to weld in a side sheet than to rivet it, but if you follow it up for a couple of years, you will find a saving. It costs practically $7.63 more to weld than to rivet. At our Collinwood shops we find it cheaper to drive the rivets than to use the oxy-acetylene welding, but the latter will give you a better job.

Mr. Bennett: Do your welders work piece work?

Mr. Harthill: No, day work; we never hurry a man—he is never told to hurry on a sheet—so as to insure a good job. As I stated this morning we weld the two sheets together, before we start to put in the wire.

What Are the Advantages or Disadvantages of Using Electric Process for Boiler Maintenance and Repairs?

We find that the electric process has its advantages and disadvantages in boiler repairs and a careful study of the job should be made before using this method in making the repairs, as in many instances the job would be only temporary and a waste of time and money.

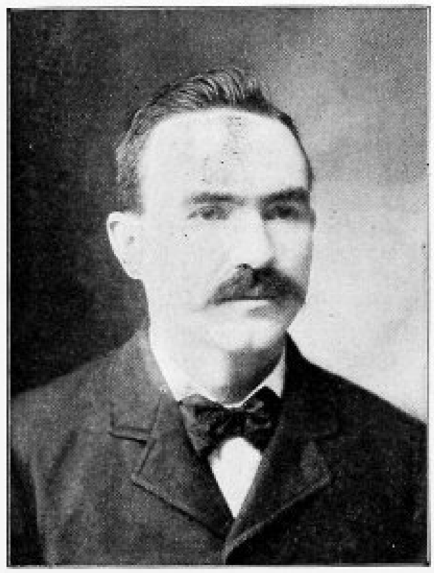
Welding is here to stay and no up-to-date shop should be without it, for its value in welding side sheets, half side sheets, three-quarter door sheets, mudring corner patches, cracked mudrings, filling up worn spots on sheets and washout plug holes on the outside of firebox, and welding up small cracks up to 6 inches long and welding of flues in fireboxes is indescribable to the company that uses this method of repairs.

It is the opinion of the committee and of many boiler maker foremen who have been consulted and who are using the electric method of welding that it is a disadvantage to weld cracks in fireboxes over 8 inches long, as it is only a temporary job and gives much trouble, having to be rewelded often and should not be practiced in back shop repairs. It is a positive fact that a horizontal crack can be more successfully welded than a vertical crack, as the expansion of the firebox is more even vertically than horizontally. This is true in welding cracks in top flange of the flue sheet, as horizontal cracks have been welded and known to give good results for engine house repairs, holding up for six or eight months when cracks from flue holes to rivet hole have to be rewelded often.

In getting sheets, patches and cracks ready for welding, the best results are obtained by beveling, both edges of sheets, or cracks 45 degrees and leaving an opening 3/16 inch, so as to get the weld through the sheets. In building up thin spots or reducing the size of holes, all scale and grease should be removed, as clean sheets insure good welding. All welds should be built up 1/16 to ⅛ inch.

The chairman of this committee has had unlimited success in welding flues at the firebox end, and at the time of this report the Erie division of the N. C. R. R. Co. has flues welded in passenger service that have been running two years and three months.

The welding of flues, if properly done, will reduce the flue troubles to a minimum. The writer has had many conversations with boiler makers who have had many failures in welding flues, and I find that it is due to improper methods. The flues should be applied the same as if no welding was being done, except that no oil should be used on the tools in working the flues, for electric welding is unsuccessful if oil is on the work. The proper way to prepare flues for welding is as follows: After copper fer-



Frank Gray, Treasurer

rules are applied and flues in place, a soft soap should be used as a lubricant instead of oil, on the flue prossers and rollers, after the flues are beaded; rough the sheet around the bead with a roughing tool one quarter of an inch wide. This will remove all the scale from the sheet and gives good metal for welding; then heat the sheet with a burner, which will burn up the soft soap, and this will leave the sheet free from grease and the flues are ready for welding. Any time the sheet gets wet, dry it or you will have leaky flues.

Care should be taken that the voltage is not too high. High voltage makes it easier for the operator, but it is not good for the flues, as the operator with high voltage keeps the metallic pencil half to five-eighths of an inch from the sheet and the metal only sticks and not welds. A voltage of 64 volts and 125 amperes makes the operator get within three-sixteenths inch of the sheet, and at this distance you can get a good weld.

You cannot get as good results welding flues that have been in service eight to ten months before welding as from welding flues at the time they are applied. Flues, if properly welded at the time they are applied, should give three years' service as far as the firebox end is concerned. It pays to weld flues if only one year of service is obtained, as it will eliminate the engine house flue trouble.

The general opinion of the committee is that it is an advantage to use electric welding for side sheet, patches on mudring corners, small cracks, building up thin spots on sheets and welding flues, but a disadvantage to weld long, vertical cracks in any sheet where there is expansion and contraction.

John Harthill, chairman.

Mr. Harthill: You will find that your success in welding flues depends on having the sheets clean, no oil should be used on the tools in working the flues, and using an arc so that the operator has to get within 3/16 inch, instead of ⅝ or ¾ inch, as some use it. If these methods are followed out, there is no reason why anyone cannot get success in welding flues. We use a soft soap for a lubricant instead of oil. After the flues are set, we apply a gasoline burner for about twenty-five minutes, removing all grease. If you rough the sheet around the bead about a quarter of an inch wide, you will remove the scale from the sheet and leave a bright new metal, which is ready for the weld. In welding side sheets, we have got good results with the electric welder, but find there are other methods that are cheaper. In welding small cracks, nine to ten inches, we cannot weld them according to the figures of the other method. We use a voltage of 64 volts and 125 amperes, and we find that horizontal cracks can be welded more successfully than vertical cracks.

Mr. Fitzsimmons: Our experience has demonstrated that the best way of welding cracks is to put in layer after layer of metal until the crack or seam is thicker than the plate. On the subject of cracking or breaking off of welds, we find that a great deal of that is brought about by improper wire. The electric welding properly done and with the proper materials, I believe is practically as strong as the solid plate.

With regard to voltage, up until a very short time ago we had used from 58 to 60 and 64 and 135 amperes; you will find that this will give excellent results, and if you can get a machine that will control the voltage and keep it uniform at the weld, you will get good results. A fluctuation in the voltage or the amperes, means a difference of temperature at the arc and weld, and you have a weld that is not uniform throughout.

In the discussion here it was proposed that we limit the welding of cracks to 8 or 9 inches; now if we can weld the end of the patch, 28 or 30 inches, I see no reason why we cannot weld cracks that long, if it is properly done.

Mr. Gray: We had several welds fail and this was explained by watching the welder. If the welder holds the wire too much in one position, it welds fast to one side and only sticks to the other; these are the conditions we found and we think they are the cause of the cracking. We have not welded any small flues, but we have welded all superheater flues, and we have only had two of the welds fail in the flue, out of about sixty engines that we have welded; otherwise, they have given us no trouble at all.

Mr. Goodwin: Mr. Griffin, I would like to ask if you have ever welded any flues that did not have a copper ferrule?

Mr. Griffin: We welded seven sets without a copper ferrule and the longest mileage was practically 9,000 miles before we had to renew them; we did not have success in welding flues without the copper ferrule.

Mr. Hempel: We have five electric welders on the Union Pacific Railroad, covering a pretty broad territory. We have welded practically all kinds of boiler work. I think that Mr. Fitzsimmons hit the nail on the head when he said that failures were possibly due to variations in the voltage and the amperes, and I hear that they are getting up an automatic control that will control the voltage at the operator's hand. There are many things in a shop, a large shop, that could be better welded with the acetylene. I think the proper thing to do in a large shop is to separate the work; that which you find is best welded with acetylene, continue with that process, and when you find that on another class of work you have better results with the electric welder, use that.

Mr. Harthill: Will you explain how you weld cast iron, castings of all kinds?

Mr. Hempel: Up to the present time we have not been as successful as we hope to be with welding cast iron. We can do better with the carbon process and the stick welding.

B. M. Hurst: We have about twenty-seven Mikado engines and have welded the small tube flues and the superheaters. We expect them to be in for the three-year limit. We set our flues exactly the same as we always did, fire the engine to burn off the oil and sand the flues and weld them. We also get good results welding oval patches. As far as vertical cracks are concerned, I have fireboxes with cracks fifty-five inches that have been welded and they have been in service eight months. I did not enter into the discussion this morning, although we have an acetylene outfit, but I, myself, favor the electric welding for boiler work.

Mr. Batchman: Practically 95 percent of our flues are welded. Outside of welding flues, we have not done much else with the machine, because we haven't got the capacity.

Mr. Talbot: We have been welding flues for the last three years; we welded some after beading and some without the copper ferrules, but we found that those welded after beading gave better results than any other way.

Mr. Sarver: We have done quite a good bit of electric welding at our plant, but we have not done much flue welding, except the large flues. We are making experiments at the present time in welding flues by different methods, that is by putting a ferrule in and by leaving the ferrule out, and preparing the sheet, and have tried almost every method known, but up to the present time I can't say that we are at all successful. We have been very successful, however, with the small flues. My notion in regard to welding the large flues is that all this preliminary business ought to be done away with; we should depend upon the weld alone. We have been reclaiming all kinds of steel castings. I think that if electric welding is gone into as it should be, there is an unlimited field for it in the future, and there will be an electric welding machine in every shop.

Mr. Powers: We have, at the present time, practically 450 sets of superheater flues welded by the electrical process. If the flues have expanded very much, it does not pay to weld them; the water conditions have a whole lot to do with the weld. We have also welded cracks in the side sheets with very good success.

The next speaker was Mr. Geo. L. Fowler, mechanical engineer, New York.

Abstract of Mr. Fowler's Remarks

I expected to discuss the question of staybolts, when it was suggested that I speak here this afternoon, because I have been making an investigation which I think will be of some interest to the members of this association.

Mr. Harthill, of the Lake Shore, built two fireboxes for me, about 8 feet 8 inches long and 5 feet wide at the sloping side. One firebox had a complete installation of rigid staybolts, one inch in diameter; the other firebox was identically the same with the exception that all the staybolts were flexible. The point that we were after was to determine the difference in the action of the sheet and the firebox under those two different ways of staying. I thought, and still think, that the machine which I use for this work was exceedingly delicate, and I made arrangements, in the first place, to measure down to about a fifteen-thousandth of an inch.

The method of doing the work was to have a fireman get up steam and at first hold the pressure for ten or fifteen minutes, then dump the fire and apply the safety valve, one pound to a minute. Afterwards we separated that a little and took the valves off of the engine so we could open the throttle, the same as on the road. We were running the engine with the injector on.

The first thing that impressed me was that before the fire had been lighted a minute the firebox sheets began to "crawl," and the curious thing was that the sheet always started to go in the wrong direction. Another thing about it was the very great variation in movement between the flexible stayed bolts and rigidly stayed bolts. The flexible stayed bolts moved almost twice as far as the rigid bolts. Still another startling thing was that the staybolts are always in motion; when you put a fire in your boiler the staybolts begin to deflect, and the deflection and bending backward and forward take place all the time the boiler is in operation, until the boiler is down to zero pressure. In all the hundreds of measurements made there were no two consecutive measurements alike, and that goes to support the theory that the staybolts are always bending backward and forward or one way and another in a very erratic manner.

We learned two or three things from our investigation; first, that the staybolts are always in motion, that the motion starts at the very instant that the fire is lighted and keeps it up until the boiler is cold, and I have my very serious doubts as to whether any boiler ever gets back to the original position in any particular after the fire has been built in it. We were also measuring the different temperatures on the water and fire sides of the sheets. Every time the fire door was opened it cooled the sheet off almost instantanously. We would have a temperature of 550 degrees on the fire side sheet and when the door was opened it would come down to 275 inside of 20 seconds and when the door was shut it would go right up again to the old position. This happened every time the door was opened and closed, and I think it is one of the very best arguments I ever heard for keeping the fire door shut as much of the time as possible.

Which Firebox Steel Gives the Best Results in Locomotive Service—the Basic or the Acid?

After considering this question, we have concluded that it is a very difficult one to solve, as we are unable to furnish any statistics or reliable data on the subject. As far as we have been able to learn from a chemical test, the acid steel is the best, but owing to the fact that it is getting to be a scarcity in the mining production, the cost of same is a good deal higher than that of basic steel and it is devoted mostly to high grade tools.

We therefore recommend that the subject be left open for discussion at our next annual convention.

JOHN HOLT, chairman.

THURSDAY MORNING SESSION

What Should Be the Standard Slope for a Crown Sheet in a Locomotive Firebox?—Its Advantages and Disadvantages

Your committee has been unable to find any standard slope for a crown sheet in a locomotive firebox, but in order to get the best results your committee would recommend that the sheet slope one-half inch to the foot, starting at the flue sheet and back to the door sheet, and across the top, starting at the highest point in the crown sheet. The camber should be three-quarters inch to the foot each way.

Sheets constructed in this manner are comparatively easy to keep clean and free from scales and sediment, and in our opinion will give the best results.

The advantages of a sloping crown sheet are:

First—In case of low water the highest point in the crown sheet will become over-heated first, and in all probability will let go quicker and do less damage than if it had no slope.

Second—With this slope the heat strikes the crown sheet more uniformly and is more evenly distributed, thereby causing less strain on the sheet and gives greater life to crown sheets and better results thereof.

Third—There is more combustion of heat units in the front end than in the rear end of the firebox, and more room is allowed for combustion to take place.

Fourth—A greater amount of heat surface can be used at the front than at the rear end.

Fifth—It gives more room for flue spacing in the back flue sheet.

Sixth—It also gives more room for cab, and cab mountings on the outside.

The only disadvantage of the sloping crown sheet, that we know of is that in the construction of the crown and side sheets in one piece there is more waste of material.

M. J. GUIRY, chairman.

What Benefits Are Being Derived from Treated Feed Water for Locomotive Boilers, Chemically or Otherwise?

So far as we can learn, a considerable number of the Western lines and a small number of the Eastern lines have gone into the matter of water treatment in roadside tanks quite extensively—that is, the installation of treating plants—and from the evidence obtained your committee conclude that in the matter of treatment of water through treating plants, where soda ash and lime are the principal reagents, this method of treatment for main lines, where large quantities of water are used, appears to be the most scientific method, because it removes from the feed water a large percentage of impurities which otherwise enters the boiler.

The cost of water treatment, which we understand includes chemicals and supervision only, and not interest on investment, upkeep and depreciation, is between three and four cents per 1,000 gallons of water treated. It is also the opinion of your committee that in order to insure the best results from the use of treated water, where the above method is employed, it is necessary to have water treating plants installed at all water stations which contain incrusting solids even as low as 10 grains per gallon. This is very liable to make the cost of roadside treatment considerably in excess of an efficient engine tender treatment, which would produce equally good results, so far as preventing scale formation and increasing miles between washouts and water changes.

Waters carrying only 8 or 10 grains of incrustants per gallon do not always mean a good boiler water, especially when it is located between two waters which have been treated. The fact is that this untreated water, although low in incrusting solids, may have a decided tendency to cause foaming when used in connection with treated water, and at the same time cause incrustations of injectors, line checks and boiler check valves.

Many railroad lines have had more or less experience with the use of soda ash, applied to locomotive tanks; and, according to the testimony received, in every case where soda ash treatment has been employed to prevent incrustation, there has been a positive tendency to an increased foaming condition, and it has been found necessary to use anti-foaming compounds to allay such foaming or resort to an excessive amount of blowing out of the boiler.

In this connection your committee would call attention to the fact that a 2-inch blow-off valve with modern boiler pressure will discharge approximately 2,000 pounds of water per minute, which represents a loss of heat equivalent to what 120 pounds of average coal will produce. It would seem, therefore, that there must be a point at which blowing out ceases to be profitable and other methods might be advantageously employed by which desired results could be obtained and loss in engine efficiency, due to foaming, could be eliminated.

It is a pretty difficult matter to give even approximate figures on the benefit of treated water for locomotive boilers. Claims are made that the life of flues and fireboxes is increased from 50 to 300 percent, which is no doubt substantially correct in many cases, and also the further claims that firebox and flue repairs have decreased proportionately. It also seems that on account of increased foaming due to water treatment there is some increased expense of machinery maintenance; but on the whole the saving to the boiler due to water treatment is largely in excess of increased cost of machinery repairs, and it is anticipated that further experience with water treatment will develop still greater improvement.

C. N. NAU, chairman.

Mr. Newgirg: In our locality the water is bad; we have a great deal of trouble with pitting and solid crustation in the boiler. In one locality we had to put new flues in a boiler after sixty to ninety days. The flues were pitted worse than any cases of smallpox a man ever saw. They have to be removed and the way we extend the life of the flues is to use the treating compound, and in some places we found that they would complain about not getting the proper results. In checking up, we found that they were not living up to the instructions issued by the people who make the chemical, and after following up the case and getting them started we found a great improvement. It has helped us in reducing the scale and eliminating pitting.

Mr. Madden: At the present time we have forty-five water softening plants on the Missouri Pacific Railway. We have twelve switch engines in our yards in Kansas City, where the water contains thirty-six grains of hardness. Where we used the raw water we got about ten months' service out of our flues, but after the softening plant was put in operation we are now getting twenty-one months' service out of them. Leaks in the fireboxes, staybolts, cracked side sheets, and such things as that, are things of the past.

On the Colorado division, out of nineteen water stations we have seven train plants; we have made big improvements in the life of flues on this division, although we are having serious trouble with pitting of plates in fireboxes and flues. After a set of flues have been in service about fifteen months, or perhaps a little more, small pit holes appear on the body of the flues; this necessitates the removal of the entire set. After the flues have passed through the cleaner or rattler, they are closely inspected and found that 75 percent of the scale has been taken off. The water acts on the crown sheets around the radial stays, along the nipple of the flanges.

I think if we had a complete system, if we had water softening plants throughout the entire division, we would eliminate pitting. I don't think it is good policy to treat water at certain points along the division, where you have trouble of this nature, and then take raw water at another station, etc.; good results cannot be obtained. On the Wichita Division, we have one water treating plant and nineteen water stations. We are using nine pounds of soda ash to the boiler. Before we started using soda ash we were averaging nine months per set of flues at this point, but at the present time we get fourteen months out of a set. We used to have all kinds of trouble trying to get engines over the division, due to leaky side sheets, staybolts and seams in the firebox; but since we have had this treating plant installed and are using the soda ash, we are getting good results.

I don't think that we can get proper results by using chemicals; in other words, using the boiler as the treating plant. This is especially true in bad water. It is my opinion that the water should be treated before it enters the boiler and the mud and other impurities taken from the water.

Mr. Borneman: What kind of flues do you use, steel or iron?

Mr. Madden: We are using almost every flue on the market; cold drawn, hot rolled steel and some charcoal hammered iron and they all look alike to the water.

Mr. Patrick: How often do you wash the boiler?

Mr. Madden: Four hundred miles to the washout.

Mr. Austin: Do you change the water in the boiler in between the washouts?

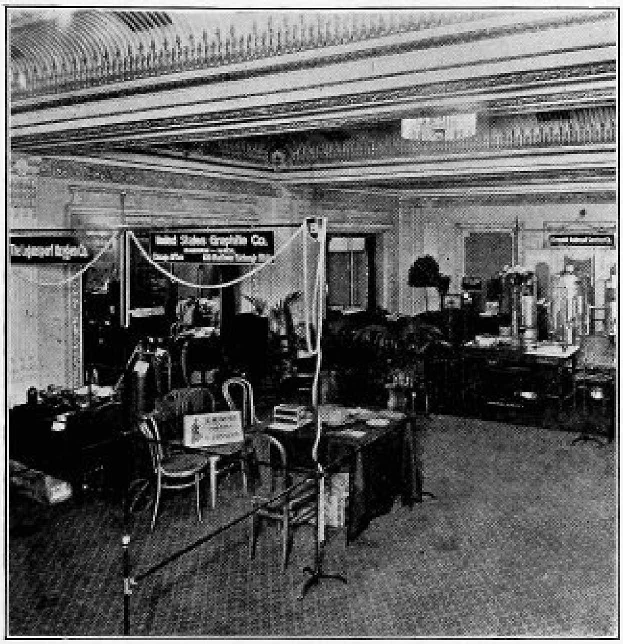
Mr. Madden: We frequently use the blow off cock; we perhaps change the water at the end of the division, but we try to make a round trip between washouts; it is optional with the engineer—if it is acting badly he will have the water changed.

Mr. Lowe: At the last convention I told you that we were using polarized mercury to treat our boilers in the bad water districts, and I wish to say that we still continue to do so. We have now used this material for over three years and we are in a position to speak of the advantages of it over what obtained with wayside treatment, or any other treatment that we ever used. We have been able to extend our periods between washouts, which is something that some of us do not seem to appreciate, the cost of that operation. We have been able to extend, and to reduce, our cost of washouts about 33 percent. In some places we obtain greater benefits than in others, but speaking of it on the average we can obtain on our freight power an average of 47 percent greater mileage, but on our passenger power we do better than that. In our superheated engines we have been able to obtain about 38 percent. We have no bad effects such as we did when we used soda ash, in our tender tanks, or by wayside treatment. Where you have wayside treatment the best chemists will tell you that when you get a sufficient hardness of water, they can't treat it without the use of chemicals that will cause foaming afterwards. Now there is a contrast, in this respect, between the use of polarized mercury and wayside treatment or soda ash, in so far that polarized mercury does not produce foaming. Polarized mercury does not create pitting, it does not create galvanic action next to the back tube sheet to which the copper is applied.

Mr. Nau: On our division we have two different chemical treatments and when we were using soda ash we were running engines from four to five hundred miles to a washout, and since we have started the chemical treatments we are making from eight to nine hundred miles on one division between washouts, and on another 1,200 to 1,400. We have reduced our force, and the men are working from forty-five to sixty engines in the twenty-four hours. From this you can see that the engines are not in very bad shape and we are not having much flue trouble.

D. A. Lucas: We have been treating water for ten or fifteen years, and we are still looking for something to give better results. We have increased the mileage on our flues and to-day we are getting a good mileage, but we hope to find something that will still increase our mileage. We are bothered more or less with pitting and corrosion of the sheets, we are using soda ash and we have used Dearborn and several other different methods for treating water, and I think one very vital point is the hot washout; if you have hot water to wash out, you are going to benefit your flues; we are contributing a lot of it to water treatment.

Mr. Austin: When I started road treatment of water in 1903 the locomotives were making 17,500 miles to a flue failure. Last year we had a very low mileage, only 14,750 miles to a flue failure, but last month the average was 262,000. Now I mention this to show that the improvement of the flue performance begins with the water treatment. I think, as a matter of fact, that incidental to the decrease in the number of failures on account of flues leaking, there is a big increase in failures on account of flues bursting. Now that might come in two ways, it might come on account of soda ash cleaning off the old scale or it might be that we are keeping the flues in longer so that the pitting action which started would get through before we would take the flues out, while before we took them out after such little mileage that we did not notice them. On the Santa Fe we have 116 water treating plants; on the Eastern line we have thirty-seven and the average foaming in this territory is 20.6 grains per gallon, and the water treatment increased the foaming. When the water treatment increases the foaming, you have got to use the roadside treatment, you have got to put in a foaming matter to take the hardness out of the water, and you cannot take the foaming matter out again; you can get the hardness out, but not the foaming matter. You have got to use soda ash to soften the water and anti-foaming compounds to stop the foaming. If you start to treat water on a division you usually start with the worst tanks you have got, the worst water you have got—and that water may be 20 or 30 grains hardness, we have water 70 or 80 grains hardness; now you start treating the worst tank and you may get to a condition where you will find it profitable to treat water at even 12 grains hardness. I believe it is profitable to do this.



A Corner of the Exhibition Hall

Mr. Austin: I would like to get from any member present, who is in a position to know, his experience as to whether or not the use of soda ash, as a water softener, has any effect in increasing or decreasing pitting of flues.

Mr. Bennett: I have had experience with a stationary boiler on the third story of a building, in which they were using soft water; about every six months they put in a set of new tubes, and they said "We have got poor water." I suggested that they put some lime in the water and that gave a coating of lime to the tube and protected them from the chemical action of the water; after that they did not have any trouble with the tubes pitting. When you apply soda ash to the boiler it removes the scale from the interior of the boiler and on the surface of the tubes and that allows the impurities in the water to act on the tubes and the interior of the boiler, and if the water is impure, why, naturally it will pit.

Mr. Madden: In reference to the water treating plants along the Great Northern, at Devil's Lake, Butte, Mont., they have had about 50 water treating plants in this locality. Previous to the time the plants were installed the life of a set of flues was about ten months, but since that time they have been running three years. They have also cut their forces down 50 percent and engine failures are now a thing of the past on that line. We used several so-called compounds for treating the water and have come to the conclusion that there is only one system—wayside tanks.

Mr. Doarnberger: The mire from the Ohio River makes my territory subject to very bad water conditions. We have used most everything in the line of paraffine chemicals, soda ash and so forth. Years ago we used nothing but soda ash and we got about ten months out of a set of flues, and we would have to remove them on account of scale and the collar being filled up. Since that time we have got what is known as a soft artesian water; it is practically clean and we have gotten away from the trouble of the boilers filling up, but we got into flue pitting that was more serious than the boiler filling up. We wash our engines every 206 miles, every trip, and use soda ash. We get from fifteen to eighteen months out of a set of flues.

Mr. Batchman: We have been using soda ash on the Lake Shore for the last six or eight years and we have increased the mileage from 30,000 to 80,000 and 90,000 and are continuously doing better, we have run up to as high as 160,000, and in that time everything has run to the three-year limit.

Mr. Edward J. Reardon, a district inspector of locomotive boilers of the Interstate Commerce Commission, was given the privilege of the floor at this point in the discussion, and read a paper on "Circulation," his remarks being based on the results of experiments made with a small model of a locomotive boiler which was exhibited at the convention.

Mr. Fowler: At the Omaha convention I spoke to you about the circulation of the water in a boiler, and I told you what should be done and you commissioned me to measure the circulation in a Jacobs-Shupert boiler and also a plain radial boiler. I did as you requested and I found that the circulation and the movement of the water in the locomotive boiler is very slow. There is a great deal of agitation in the water leg of a locomotive boiler, but a very slow current in the flow.

The morning session was concluded with an address by Professor Lawrence W. Wallace, M. E., associate professor, Railway and Industrial Management, Purdue University, Lafayette, Ind., who described a series of elaborate experiments on the line of the Chicago, Indianapolis

General View of the Exhibition Hall at the Boiler Makers' Convention

& Louisville Railway, to determine the zone of danger from fires set by locomotive sparks. These experiments led to the conclusion that fully 90 percent of all danger from this source lies within a distance of 100 feet on either side of the track, and that only in very rare instances is it possible for fires to start at a greater distance than this from passing trains.

Mr. M. O'Connor responded to Prof. Wallace's address.

THURSDAY AFTERNOON SESSION

What Can the Association Do to Get a Uniform Rule Regarding the Load on Staybolts and Boiler Braces?

The maximum load allowed on staybolts and boiler braces has been fixed by a committee representing the railroads and the department of boiler inspection of the Interstate Commerce Commission which we deem reasonable and fair. Therefore, in order to ascertain a reasonable minimum load, to provide flexibility, as well as ample holding strength allowed, your committee sent out questions to all members asking their expressions, based upon actual experience.

It is regretted that only about 10 percent of the members answered the committee. However, we believe that those who did reply voice the actual condition experienced of those that have the matter to consider. That is, small staybolts are more flexible and give greater life to fireboxes than large bolts, that the first firebox will last longer than the second; that the second will last longer than the

Elaborate Display of Boiler Makers' Tools and Appliances on Exhibition at the Convention third; that the reason of less life to the second and third firebox is because of the increase of the size of staybolts made necessary by repeated application of staybolts.

Therefore, we recommend 7/8-inch staybolts be applied as a minimum and that 1 inch be the maximum size; that all bodies of rigid bolts beyond 1 inch be turned down to 25/32 inch between the sheets.

Chas. P. Patrick, chairman.

This report was accepted without discussion.

What Are the Advantages of Cross Stays Above the Inside of Firebox?—Has Their Introduction Brought About Failures at Other Locations, and, If So, Where?

In the Belpaire firebox and some designs of crown bar fireboxes that have flat or nearly flat surfaces where sheets converge from the side of fireboxes to the roof, it is

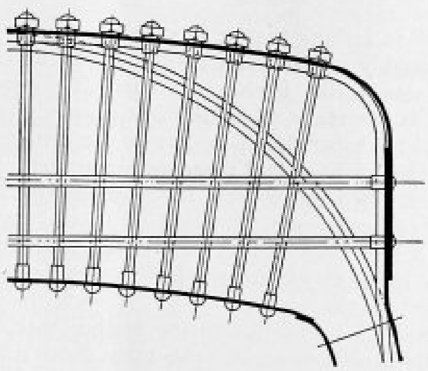


Fig. 1.—Section Through Extended Wagon Top Boiler with Belpaire Firebox

necessary that they be properly braced with cross stays. In this construction, however, there is a considerable distance between the connections of the firebox staybolts to the roof sheet, and the necessary slings, braces or stays in the crown sheet, which permits of a certain flexibility that will allow some adjustment to take care of the stresses which are the result of the greater expansion of the side sheets of the firebox under the high temperature of direct

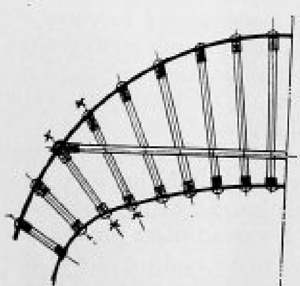


Fig. 2.—Section Through Radial Stay Boiler, Showing Cross Braces

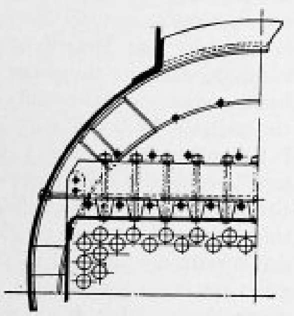


Fig. 3.—Section Through Crown Bar Boiler, Showing Cross Braces

contact with the fire as compared with the expansion of the side sheets of the roof sheet.

The radial stay boiler, however, should have a circular cross-section above the crown sheet, and it is our opinion that the use of cross stays in this type of boiler restricts the proper equalization of stresses, which result from the unequal expansion of the firebox as compared with the roof sheet, which, in the case of radial stay boilers, has practically a continuous connection through the staybolts and radial stays. We believe a rigid cross stay above the crown sheet in a radial stay boiler increases the bending stress in radial bolts at about the line where cross stays are applied, and as indicated by "X" in Fig. 2. We find that breakage of radial staybolts in the zone indicated has been experienced due to the presence of cross stays in this type of boiler, and that when their use was discontinued no further trouble from this cause was apparent. We do not consider cross stays in the radial stay boiler desirable or necessary, provided the boiler is properly designed with a circular cross section.

In conclusion, we wish to state that although the cross stays are necessary in the Belpaire and other fireboxes having flat surfaces, they necessitate the use of extreme care in washing the crown sheet, owing to the numerous interstices between the cross stays and crown bar or sling stays, in which mud and scale will inevitably collect and become difficult to dislodge.

J. J. Davey, chairman.

Best Method to Determine the Reduced Percentage of Strength in the Shell of a Boiler Occasioned by Pitting or Corrosion

When corrosion is present in a boiler it takes the form of pitting, grooving or wasting.

Pitting usually takes place in the bottom of the shell and sometimes in the firebox sheets.

Grooving generally takes place at the lower part of shell next to girth seams, in the neighborhood of frame support angles, at the root of flange in front flue sheet, along the top of mudring in firebox and casing sheets, at the ogee of throat sheet, at the root of flange in upper half of back-head, along the outer vertical row of staybolts in throat sheet and lower half of back-head and sometimes in wagon top and along longitudinal seams, especially if the seams are below the horizontal center line of boiler. In fact, grooving as a rule will take place wherever there is an unusual torsional, crushing or bending strain.

Wasting occurs in the lower part of shell, along the lower part of firebox, at the lower part of front flue sheet and wherever there is an occasional or continuous water or steam leak or where moisture is present. The most active corrosion and therefore the greatest amount takes place in the shell.

The reduced percentage of strength may be determined by giving the boiler, with especial reference to the shell, a visual examination, and where any suspected wastage of the plate is found the extent or area of the wasted parts should determine what further action should be taken.

Usually a slightly wasted surface, or one that is wasted more, but is confined to small areas, may be disregarded. This does not, however, apply to grooving at the seams, in which case an effort should be made to find the depth of the groove. We recommend that the corroded parts be thoroughly cleaned in order to determine their depth. This can usually be determined by a visual inspection.

If the shell is wasted over a considerable area and it is impossible to determine the thickness by sounding the plate with a hammer, drilling may be resorted to, drilling the plate at what is apparently the thinnest part and measuring the thickness.

The percentage of strength is, of course, found by dividing the average thickness of the wasted parts by the original thickness of the plate, and in no case should the boiler be allowed to pass without repairs if the percentage so found has approached closely to that of the joints, carrying the same strain.

H. J. Raps, chairman.

What Method of Driving Staybolts and Radial Stays Gives the Best Results and Service in Locomotive Boilers?

In going over the detailed reports of the different members of this committee, the chairman finds that their opinions differ very materially as to just how this work should be done. One member has had quite a good deal of experience in this particular line of work, and has made some extensive tests with hand-driven bolts with a hand hammer weighing 6 pounds, as compared with a pneumatic hammer. This test was made in a bad water district and was confined to the hardest point to keep tight, that is, the fire line of the firebox, and he claims the hand-driven bolts are far superior to the ones driven with a pneumatic air hammer. These bolts were all held on with a hand holding-on bar.

In good water districts they drive all their staybolts and radial stays with pneumatic hammers with good results, but did not say how these bolts were held on, but I presume with a hand holding-on bar. The objection and criticism to driving staybolts with pneumatic hammers and holding them on with a hand holding-on bar are that the vibration of the holding-on bar, when a pneumatic hammer is used, is such that a number of blows are struck by the hammer while the holding-on bar is rebounding; therefore the bolts are not properly upset in the holes, and naturally the method does not make a good, tight job.

Another member of this committee drives quite a number of bolts without the boilers being turned over on their sides. This work is done with a 4½-pound hand hammer, and is held on with a hand holding-on bar, but when it is possible to have the boiler turned over, he prefers driving these bolts with an air hammer, but so far as his general good results are concerned, he cannot see where there is any particular advantage in any one of these practices over the other, so far as quality is concerned, but for quantity he favors the air tool.

Another member of this committee does all this class of work—that is, tapping all holes, running in of all bolts, as well as driving of same by hand, and naturally he favors this method of doing this particular class of work.

It is my personal experience, as well as the practice in the shop of which I have charge, to drive all staybolts, as well as radial stays, with pneumatic air tools, which is being done with good results. To drive staybolts or radial stays successfully with air tools, it is absolutely necessary to hold them on by the same process—that is, with air tools, as it is impossible to hold these bolts on properly with a hammer or hand holding-on bar and keep on the bolts for every blow that the air hammer is going to strike, this being the case when bolts are driven with pneumatic tools and held on with hand holding-on bars.

In driving these bolts I use a set slightly higher in the center than on the edge, with a small radius on the outer edge of same, and a staybolt set made especially for this work. This set is used on the inside as well as the outside end of the bolts; this cuts off all the ragged particles that may be around the edge of the bolts, making a smooth job, which is less liable to gather any accumulations of foreign matter. This work is done with a No. 90 air hammer and held on with air holding-on tools made especially for this class of work. In some places a set is used with a center tit on same to drive the bolt on the outside. This is done where the telltale holes are put in staybolts before the bolts are applied.

It is the opinion of your committee that if the staybolt and radial stayholes are properly tapped, and the bolts have good first class threads, and are properly fitted to the holes, that three full threads will be sufficient to make a good serviceable head.

In summing this matter up, and taking as a basis the average shop where there is a goodly amount of this work being done and where they have proper facilities for turning and handling boilers, the proper way to do this work, in my opinion, is to use air tools, either a staybolt driving machine or a long stoke air hammer. When these air tools are used, air holding-on tools should also be used where it is at all possible to do so, as in our opinion it is just as necessary to hold on these bolts properly with air tools as it is to drive them with same.

If the holes are properly prepared, and the bolts properly applied and driven and held on with air tools, I can see no good reason why these bolts should give any trouble whatever, under ordinary conditions.

B. F. SARVER, chairman.

Mr. Griffin: I think that it is necessary to set the bolt back thoroughly in the sheet, in the center and make it tight. I would like to hear further discussion as to whether it is necessary to cut the bolt perfectly square or whether a little taper should be left on the end of the bolt.

Mr. Hodges: I have laid down very thorough, rigid instructions to swell the bolts in the hole, regardless of the telltale hole; swell it out, fill the sheet up and then knock down the edges. We redrill the telltale hole and that's all there is to it. If you follow these instructions you will have perfect results.

Mr. Sarver: I would like to say further that the committee, after careful thought, agreed that three full threads would be enough for a head. At the shop of which I have charge, we drill our staybolts after they are applied, just for the purpose of being able to drill a bolt the way it should be driven, but at some places I believe they set the tit into the telltale hole, and while I have never done any of that work myself, I have had engines come to me that had the bolts driven in that manner and they were in good condition.

Mr. Hempel: Mr. Griffin asked a question relative to cutting off the bolts, that is whether the bolt was to be perfectly square. For the past twenty-five years I don't believe that I have cut off a bolt other than perfectly square on the fire side. While I was boiler foreman at the Burlington shops, I carried out the same method that we now carry out on the Union Pacific. In applying fireboxes take the length of all the bolts, take them to a machine and get them cut off down to about 7/16 or 1/2 inch. Screw on the bolts from the firebox side, leaving the telltale hole driven. After the bolt is in, nick it a little and break it off. I did this instead of nipping it off and getting the bolts beveled. I wanted them square, for the reason that Mr. Griffin said, so he could strike in the middle, swell the bolt to the sheet and then turn the edges down with a few strokes of the hammer and put a further edge on it. Later on we got to using the air tools, and some shops drive from the outside and then the inside. We followed this for some time and found it very good. I would either drill or punch the hole in the outer end after the bolt has been broken off. Drill a hole a quarter of an inch deep on the fire side before driving, then take your air tool having a center tit on same, and put it on the little hole that is drilled for that purpose and the air tool will spread the bolt.

Mr. Green: In the modern shops the day of the old flogging hammer is gone; everybody knows that we put in staybolts any old way and drive them, thirty-five heads in forty minutes. We are not particular how you nip them and we get just as good results now as when we used the flogging hammer and, in my opinion, better. We still continue to cut in the old-fashioned way, and do not point them on the end.

The Chairman: I would like to be permitted to say a few words along this line myself. I have tried several different methods of driving the staybolts, and I found that if you drive them regardless of method, why, you get pretty good results, but we are still following the method of Mr. Hempel, by taking the bolts and cutting them with shears we have for this purpose. We cut them very nearly square, although we taper the bolt on the end for the first thread, which I think is a good thing. Then the bolt is taken to the staybolt machine and threaded and put in the lathe. Two and one-half to three threads are allowed for the head; the bolt is then nicked and screwed in with a staybolt chuck on the end. The bolt is set and one of the men takes a small light air hammer and nicks them and the other man follows along and breaks the head off. Then they start driving. Personally, I prefer the tip set; it does a very nice job and it is the only one that crowds the metal in the hole. I think that the question of threads is a very important one.

Mr. Gallagher: We probably drive over 100,000 staybolt heads a month. We use the pneumatic hammer inside or out of the telltale hole and burn it off with oxy-acetylene. We allow two threads and a half, and we don't experience any leaky staybolts.

Mr. Madden: The most important thing in my opinion is getting a good thread.

Mr. Lewis: I think, as this gentleman just said, that the first thing in the operation is to have a good fit on the bolts—not a steam tight fit, but it should be a good fit and should have a good thread both on the bolt and on the sheet. After the bolts have been applied, we burn them off with the oxy-acetylene. Although it costs a little more money to burn them off, I believe it does a better job and does not disturb the bolt after it is once applied. We use three threads, never below two threads and a half, but three threads is better. We drive our bolt with the air hammer and I have never seen better work in my life.

What is the Most Economical Method for Constructing New Locomotive Tanks, and What Advantages Have the New Designs Over the Old Style?

The first thing to be considered in economical construction of locomotive tanks is proper facilities for handling plates, punching, etc., which should consist of an overhead traveling crane of sufficient capacity for handling the plates through the shop to and from the machines and to the erecting floor, also for handling the finished tanks.

There should be suitable swing arm cranes over the punching and shearing machines to handle plates with the least labor possible, two men being sufficient to handle any plate in a tank. It is also necessary to have suitable machines for this class of work, consisting of a combined automatic spacing, punching and shearing machine. Also a suitable deep throat punch and shears as well as angle shears, plate straightening and plate bending rolls, short and deep throat yoke compression riveters suspended from light traveling cranes, either wall or overhead type, preferably the wall type with swinging arm, as it can be operated with more speed than the direct overhead type.

The proper facilities for bending angles is also necessary in order to keep the labor cost down to an economical basis. With the above equipment and a sufficient amount of air hammers and motors, you are ready to proceed to erect a locomotive tank of any type economically.

By way of preliminaries, the first thing to do is to see that the material is checked and separated, each size being piled so that the man marking the holes will not have to do any unnecessary handling. You are now ready for the layer out, who proceeds to lay out the templet sheets, after which they are punched, sheared, etc., the straight work being done on the automatic machine and the curved work on the single machine.

They are then used to mark off corresponding sheets for any number of tanks, always reserving the original or templet sheets for the last tank, thus reducing the variation in holes to a minimum. After sheets are punched and sheared, they are taken to the bending rolls and formed to shape. Side and back sheets should be run through the straightening rolls to take the waves out of them before forming them to the required shape, after which they are taken to the erecting floor, where the bottom is assembled, holes reamed and riveted, using tar paper between all seams and angles, which insures tight and economical work.

After the bottom is completed, the sides and end plates and top angle irons are assembled and riveted. Then the top sheets are applied and braces installed and riveted, after which the coal space sheets are assembled and riveted; steps, grab irons, ladders, lugs, valves, etc., are applied and the tank is ready for the testing floor, where it is filled with water and all leaks and defective rivets taken care of. It is now ready for the sand blast man. The boiler maker having completed his part, now checks up the cost, which for a modern 9,000-gallon, water-bottom, rectangular tank, we find amounts to about 27,000 pounds of plates and angles, 1500 pounds of rivets and $200 labor.

As the procedure for building the Vanderbilt type of tank is practically the same as any other tank, your committee, therefore, thinks it unnecessary to go into details. However, it might be interesting for some to know about the cost, as there is some difference, the Vanderbilt tank being about 5,000 pounds lighter than the rectangular type of the same capacity and the labor cost from $25 to $40 more.

As to the advantages of the new style over the old, it depends, somewhat, on what is considered old. Believing you are familiar with the standard water-bottom rectangular tank, we do not think it necessary to refer back further than this and will consider the Vanderbilt type the latest. The use of this tank is limited to only a few roads and we are unable to secure much definite data.

One member stated that he had had fourteen years' experience with this type and had had no trouble, but he did not give any comparisons, his only criticism being that they did not make as good an appearance as the rectangular style. Another member has had considerable experience with this type and has experienced considerable trouble from leaky rivets, caused by the draft gear arrangement jarring them loose.

However, it is his opinion that this could be overcome by the application of suitable draft gear, and should this trouble be eliminated, he would prefer this type of tank, as they do not obscure the vision of the engineman as the old style does. As none of your committee has had any personal experience with this type of tank, we are unable to give you anything further in the way of comparison.

W. H. LAUGHRIDGE, Chairman.

Mr. Lewis: Several years ago we had lots of trouble with rivets leaking on the bottom of the cisterns. We finally decided instead of using the angle iron bar, as had been our custom, to order larger sheets for the bottom of the cistern, and flange them upward, so that the rivets could be placed through horizontally. That removed every rivet out of the bottom of the cistern, and during the last three or four years we have constructed all of our tanks along those lines. We eliminated all the angle iron bars that were formerly used in the tanks, from the bottom and in other places, and now we never have any leaks in the bottom of the tank. The construction of these tanks, in comparison with the others, costs less because of having a horizontal press in our shop with which we flange the sheets at small expense.

FRIDAY MORNING SESSION

Which is the Most Economical Method of Removing and Replacing New Fireboxes in Wide Firebox Locomotives—Taking Out the Head, or Cutting Back End Off at the Connection, or Taking Boiler Off the Frames and Removing Old Box and Replacing New One Without Removing Back Head or Connection?

This subject was taken up with the different members of the committee and it seems better to give the substance of each of their reports instead of a composite report.

Regarding the method of removing fireboxes at the main shops of the Atchison, Topeka & Santa Fe, Figs 1 and 2 show the method of separating the back head from the shell for the purpose of applying a new firebox.

On the different classes of boilers on the Santa Fe, there is an extra back end suitable for interchange, so that when an engine enters the shop the back end can be cut off as shown in the illustrations, and the extra back end complete with new firebox applied, holding the engine not to exceed ten days. This method has a new back end in reserve for interchange, and has proved a paying proposition.

It is not necessary to remove the frames or break the connection at the smoke box on engines of the modern

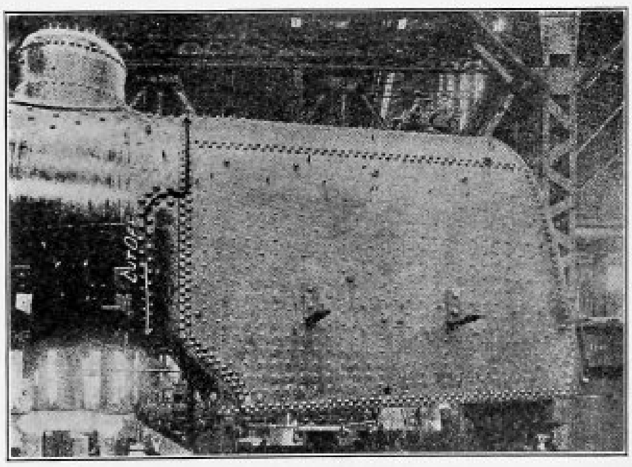


Fig. 1

type whose firebox is directly over the frames. Experience has also taught that it is a more expensive method to cut the back end and door sheet loose, in order to avoid cutting away at the connection.

In some cases where the ogee box passes through the frames it is customary practice to separate the boiler at the smoke arch and have the work done in the boiler shop, going over the machinery while the boiler is receiving a new firebox. Otherwise it is simply cut off and modern back ends replaced in the manner described.

It costs the Topeka shops from $650 to $900 to put in a firebox and back end in first-class shape, depending solely on the size of the boiler. Where the fireboxes are interchangeable it is not necessary to bring the boiler to the boiler shop, but simply put it in the rear of the file of engines to be turned out of the shop during the month.

J. B. Tate, of the Pennsylvania, states that the subject is one largely governed by the facilities of the shop at which the work is to be done—that is, where there are proper lifting appliances and the erecting shop space. It is more economical to lift the boiler from the frame and send it to the boiler department and the frame to a department for necessary repairs. This will give a track in the erecting department to repair another engine while the boiler and frame are undergoing repairs.

D. A. Lucas, of the St. Paul, advocates the removal of boiler from cylinders and frames, and furnishes the following comparative statement of such operation and re-

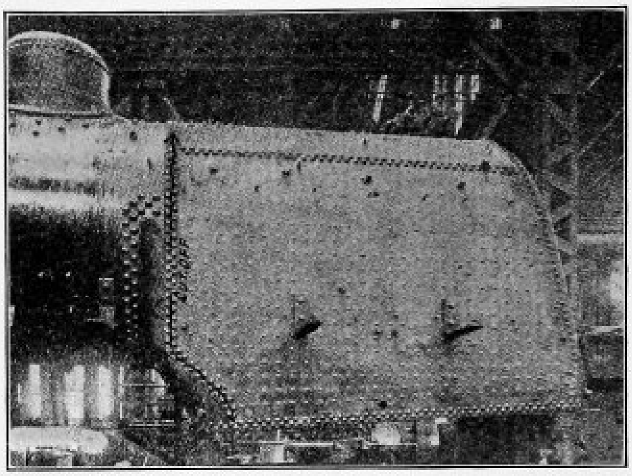


Fig. 2

moving backward, to apply new firebox and deliver to boiler shop, Class R-4.

Total cost of removing back head................	$29.35
Total cost of removing boiler....................	22.31
Amount saved by removing boiler instead of back head..	$ 7.04

This is figuring the cost of putting in firebox the same in both cases, but it would be slightly higher with boiler on frames.

W. F. Charlton, general boiler inspector of the San Pedro, Los Angeles & Salt Lake, gives the following labor costs for the complete job of renewing a firebox in boiler of consolidation locomotive, having 413 two-inch flues, 1,065 staybolts, 315 crown bar bolts, with tee bars, mud-ring, 66 x 108 inch inside.

To remove and replace firebox by cutting butt at connection, $700; by cutting boiler off at smoke arch and removing from frames, $650; by taking out the back head, $775.

When a boiler shop is cramped for room, Mr. Charlton advocates boilers being cut off at connection, as the cost of removing steam pipes to do this about equals the cost of the boiler job. He would remove the back head to renew a firebox, only when there are no crane facilities for handling the boiler or butt end.

Labor at Las Vegas is paid 48 cents per hour for boiler makers, and 27½ to 30 cents per hour for helpers. It is hard to maintain owing to the handicap of frequent changing of men.

ARCHIE M. BAIRD, Chairman.

Mr. Greene: We have used most every method with our fireboxes. We have put the wrapper sheet all in place and we don't remove the back head and staybolts and we put the rivets in and start two gangs and they apply the box and put the wrapper sheet up in place and the bolts in the door sheet and bolt the back head and then we start one gang on the back head and one on the door sheet and rivet around the mudring and then we are ready to apply the staybolts. That is one method. I don't care whether you leave the boiler on the frame or off; we take them any old way. I think that is a very good method where you can do it. We have the frame and everything for handling the work, and unless you have I don't think you could handle it that way.

Mr. Bennett: I have been in shops where the practice has been to cut off the boiler at the back end and take the back end over to the boiler shop and apply another back end, one of the extra back ends they had on hand. Now boiler makers know that it is a difficult proposition to put a back end on a boiler and have the holes come right. I have asked in those shops where they make that a practice how the holes came around on the wagon top and around the throat sheet and they tell me they come very good, but I asked the inspector in that district and he says that he found a number of back ends where some of the holes were almost blind. That shows that you can't, in all cases, even with the same class of engines, cut the back end off and apply them to the shelves of another boiler.

Mr. Harthill: I believe the most economical way is to remove the firebox from the frame. We remove the boiler from the frame and put the boiler in the boiler shop. By doing this you have got the use of the pit in the shop to put another engine in, to be repaired, and if you haven't a very large shop this will be of great advantage. Our method is as follows: The minute the boiler strikes the boiler shop we put the flexible drill on. He loosens up and cuts the firebox around the door of the flange sheet and flue sheet and through the center of the crown sheet. He drills the sheets and burns the rivets out, removing the mudring, burns the corner and also drills two holes in the sheet, drops the floor and lifts up the boiler and carries away the scrap. That is our method, and we think it is a great improvement over the method we use when we remove the back head. We save about sixty days over removing the boiler head. You will have one hundred rivets, all the gusset stays to remove and when you count the time and labor you will find that it takes about sixty days in putting the firebox in. Where we have an offset flue sheet, 7 to 12 inches, we leave the door sleeve out, those with extended sleeve, you can swing it in, we can swing the firebox in place and save a lot of extra work of applying the back head. Therefore, it is economical in time and economical in labor. It gives you an opportunity to use your pit while they are working on the boiler in the shop. We think it is better to take the boiler from the frame.

Mr. Hodges: The shop conditions should determine the method that we should employ in removing and applying wide fireboxes. In some instances it may be the most economical, if you have a back end, to just take the back end off and remove and put on another back end, and I have applied them in that manner. We remove the boiler from the frame and carry it to the boiler shop and then you have the use of the pit.

A. N. Lucas: Our method for the past few years has been to cut the firebox loose with oxy-acetylene and drop it out and in a narrow firebox we put it up piecemeal. We do not take out the back end, nor cut the boiler through the connection. If the mudring is good, we do not even take the mudring out. The difference in cost to driving the box up instead of cutting off comes by leaving the back head and mudring in place. On wide fireboxes we also drop our firebox out and cut through with acetylene, and in some cases put up piecemeal, putting a gang on the outside corners and another gang on the mudring so that they can move that work along pretty nicely. When we cut the boiler at the connection we cut the old rivets out, we start to crack the rivet holes in the shell and other times in the throat sheet; many times I have seen the throat sheet on the scrap pile; I think, as a rule, the throat sheet will wear a boiler out, especially in modern boilers. In the back head we remove same and the gussets, if they have started to crack. I believe the method at the present time with wide firebox, is to cut loose with oxy-acetylene and drop out, put in the door flange—you can weld in the door flange—flange the back head, cut it off if you want to and on the narrow firebox you can cut it off piecemeal and save time and money.

D. A. Lucas: In removing fireboxes with combustion chamber, we found it necessary to take the combustion chamber out, but if the combustion chamber is still in good condition when the firebox is worn out, it is not necessary to remove the combustion chamber when we remove the firebox.

Mr. Wintersteen: We have had combustion chamber boilers for about eighteen years and we have had them give out, especially in the bottom. We had much more trouble before we got to welding the combustion chamber. To-day our main trouble with the combustion chamber boiler is with the bottom and we tried to get away from that by using braces, changing the braces at first we cut the braces at the throat stays and rivet the braces inside of the throat and on the inside sheet and changed the one beyond the flue sheet and outer shell.

Mr. Harthill: Do you have any trouble with cracking of the combustion chamber flue sheets; have you had any trouble with riveting out the flange and causing leaks on the seams of the boiler?

Mr. Wintersteen: We have had no trouble at all as far as flue sheets are concerned, it can stay there for ten years. It may crack a little, and, in working, the flues crawl up a little and you may get a crack on the top flue but never a fire crack.

Mr. Strinsky: My method of removing the firebox is to cut it with the oxy-acetylene and put it up and drop it down in the pit, then we get the sheet up and bolt them in and rivet them up. We don't remove the back head; take off the sheet, we don't fit up the floor. We fit the door sheet on the crown sheet and lay up half a dozen bolts and then pull on the crown sheet and door sheet and bolt the whole thing right up and go right on and rivet them.

Mr. Laughridge: A number of years ago when the boiler became large we could not handle them and we began to cut the fireboxes out and leave them right on the frame—cut the fireboxes out and apply the sheets one at a time. While we were doing the work, the machinists were doing their part of it and we found that really was the most economical way of taking out the box and applying it.

Mr. Raps: We simply drill the bolts, the radials, drill in the shop, and use acetylene on the sheets, cut them, prosser the top and down the two ends, cut the crown sheet in two pieces with the acetylene burner, drill all bolts and burn them out. If we have an engine running in a very bad water district and the floor sheet is bad, we remove the sheet in the box.

Mr. Hempel: We remove all the fireboxes by cutting the back end off at the connection sheet. We then take this back end to the boiler shop and remove the firebox after the staybolts have been broken down with a battering out ram; we then apply the box in the mudring, put the mudring into the back end, put all bolts in, put all crown bar braces and we are ready for the staybolts—I am speaking of all classes of boilers, crown bars, etc.—and in six hours it is applied, finished, riveted, calked and all. By this method you save the removal of the saddle bolts, which is considerable, the lining up of the engine and the possibility of having bad corners, because they are all fitted right up on the floor, and I have been unable to find any shop that would apply the back ends cheaper, in dollars and cents, than we apply them.

Mr. Brown: I think that the different shapes of boilers control the matter of removing the fireboxes. I have always been very favorable to the separation of a boiler at the throat sheet and riveting the boiler in order that you might save the braces, if they are in good condition. It is just as Mr. Hempel said, my method is very similar to his. In applying the back end of the boiler proper on radial stay boilers, invariably, we remove the back head and apply it in that manner. We have not, I think, been cutting out the firebox with the oxy-acetylene, but I consider it a very good proposition and ultimately, I think, a great many of the larger shops, at least, will use it.

Election of Officers

The following officers were elected for the ensuing year: President, Andrew Greene, general foreman boiler maker, Big Four, Indianapolis, Ind.; first vice-president, D. A. Lucas, general foreman boiler maker, Chicago, Burlington & Quincy, Havelock, Neb.; second vice-president, J. B. Tate, foreman boiler maker, Pennsylvania Railroad, Altoona, Pa.; third vice-president, Charles P. Patrick, foreman boiler maker, Erie Railroad, Cleveland, Ohio; fourth vice-president, Thomas Lewis, general foreman boiler maker, Lehigh Valley Railroad, Sayre, Pa.; fifth vice-president, Thomas F. Madden, general boiler inspector, Missouri Pacific, St. Louis, Mo.; secretary, Harry D. Vought, 95 Liberty street, New York City; treasurer, Frank Gray, foreman boiler maker, Chicago & Alton, Bloomington, Ill.

OFFICERS OF THE SUPPLY MEN'S ASSOCIATION

The new officers of the Boiler Makers' Supply Men's Association are as follows:

President—D. J. Champion, Champion Rivet Company, Cleveland, Ohio.

Vice-President—B. A. Clements, Worth Bros., Coatesville Rolling Mill Company, Coatesville, Pa.

Secretary-Treasurer—Geo. Slate, THE BOILER MAKER, 17 Battery Place, New York.

Executive Committee—To serve three years: George Sevey, Otis Steel Company, Cleveland, Ohio; S. F. Sullivan, Ewald Iron Works, St. Louis, Mo.

Registration at the Convention

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A. M. Baird, Asst. Supt. of Shops, A. T. & S. F. R. R., Topeka, Kan.
John Berry, Boiler Inspector, Grand Trunk Railroad, Toronto, Ont., Can.
C. J. Baumann, F. B. M., N. Y., N. H. & H. R. R., New Haven, Conn.
G. W. Bennett, Dist. Insp., I. C. C., Albany, N. Y.
G. Bennett, Foreman Boiler Shop, Penn R. R., Verona, Pa.
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F. V. Blucher, R. H. Foreman, G. C. & Santa Fe.
L. Borneman, F. B. M., C., St. P., P. M. & O. R. R., St. Paul, Minn.
L. P. Bowen, F. B. M., Covington, Ky.
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John B. Brown, Dist. Insp. Loco. Boilers, I. C. C., Spokane.
G. J. Burnside, Gen. F. B. M., N. Y. C. & St. L. R. R., Conneaut, O.
C. F. Buell, Foreman, M. P. R. R., Falls City, Neb.
Elmer J. Barclay, F. B. M., G. & F. R. R., Douglas, Ga.
A. E. Brown, G. F. B. M., L. & N. R. R. Shops, New Albany, Ind.
John F. Beck, F. B. M., G. R. & I. R. R., Grand Rapids, Mich.
R. B. Bresette, B. M. F., C. & N. W. R. R.
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James E. Cooke, F. B. M., D. & L. E. R. R., Greenville, Pa.
R. W. Clark, F. B. M., N. C. & St. L. R. R., Nashville, Tenn.
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Daniel W. Phillips, G. F. B. M., R. D. Cole Mfg. Co.
Louis R. Porter, F. B. M., Soo Line.
C. D. Powell, Gen. Boiler Insp., T. & P. R. R., Fort Worth, Tex.
L. W. Poling, Boiler Foreman, B. & O., Grafton, W. Va.
Charles P. Patrick, G. F. B. M., Erie Railroad, Cleveland, O.
Phillip Peters, Boiler Insp., Pere Marquette R. R., Saginaw, Mich.
Thos. F. Powers, F. B. M., C. & N. W. R. R. Shops, Oak Park, Ill.
A. Parfitt, G. B. M. F., G., C. & St. F. Ry., Cleburne, Tex.
Robt. Russell, Boiler Insp., Grand Trunk, Battle Creek, Mich.
T. L. Reddy, F. B. M., C. & E. I. R. R., Danville, Ill.
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Edward J. Reardon, Dist. Insp. Loco. Boilers, I. C. C., Chicago.
G. M. Rearick, Gen. Boiler Insp., B. & S. R. R., Galeton, Pa.
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W. F. Stauch, G. B. Insp., B. & O. R. R., Newark, O.
Fred M. Smith, Princeton, Ind.
A. E. Shaule, B. M. F., D., M. & N. R. R., Proctor, Minn.
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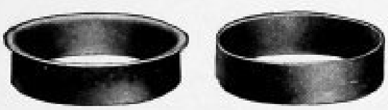

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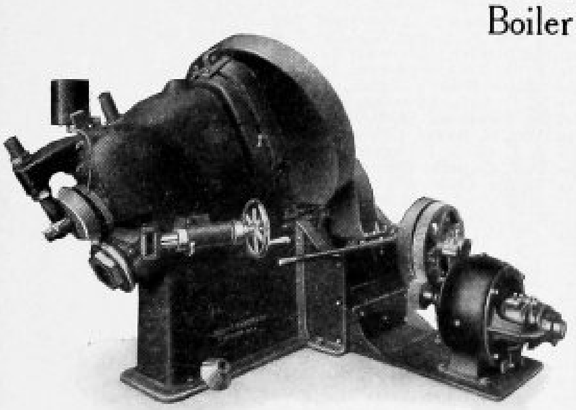

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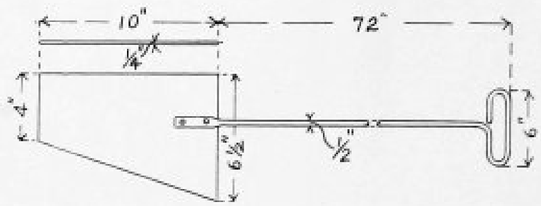
Tool for Cleaning the Exhaust Nozzle

It is usually the lot of the boiler maker, working on hot work, to clean the exhaust nozzle. When such a job is reported, this generally entails the opening of the front end and the removal of the square netting, which takes up much valuable time. To overcome this loss of time



Exhaust Nozzle Cleaner

and avoid all unnecessary trouble, the simple but very efficient tool illustrated was made, so that a man could drop it down the smokestack into the exhaust nozzle, work it around and break up and remove the accumulated matter in a very few minutes. The taper in the tool prevents it sticking, and, at the same time, it goes deep enough to make a clean job.

Pittsburg, Pa. G. H. HARRISON.

A Useful Kink

A small vest pocket mirror, with a short handle, will be found to be very useful for foreman boiler makers, boiler inspectors and boiler makers.

The mirror should be small enough to enter through any washout plug hole in a boiler. By placing an electric light or any other light in any of the other washout holes, so the light will be reflected from the mirror on to the inner sides of the sheets between the light and the mirror, it is surprising what defects will be disclosed. Mud banks, broken staybolts, broken brace pins and braces, staybolts nearly eaten in two close to the sheets, staybolts lodged on top of other staybolts, but not removed from the water space, and a lot of other defects like cracks and grooves in the sheets near the mudring can be found where it is impossible to see them in any other way without cutting holes in the boiler.

This may be an old kink to most of the foremen and inspectors, but I think it is new to some, as I have not seen anything published about it. I have found it very useful in my work as a boiler maker and inspector and foreman, and should be glad to have others know about it so that they may be benefited by using this method.

OSCAR RYDMAN,
Foreman Boiler Maker, C. & N. W. Railway.
Council Bluffs, Iowa.

Simple Rule for Laying Out Base of Stack

BY JOHN COOK

Fig. 1 shows the plan and elevation of the base of a stack for an upright boiler, or for any other purpose, where a frustum of a cone has to be used. First draw the line *A-C*, Fig. 2, and erect a vertical line *A-B*. With the trams set to half the diameter of the bottom of the base and with one point on the point *A* draw the quarter circle 6′ *C*; also the quarter circle of the top, as shown in Fig. 2. Divide the large and small quarter circles into equal spaces. In this case 6 divisions were used. Draw a line from point *A* to 1′. This line is not absolutely necessary, as it is only drawn to show that the points on the quarter circle are true. Now set the trams from the point *n* to *m* and with *A* as a center scribe an arc as at *a* on the line *A-C*. Again, using *n* as a center, set the trams to point 1′ as shown by the dotted line, which will give the point *b*. On the line *A-B* lay off the perpendicular height, as shown by the dotted line *R-X*, Fig. 1, and *A-B*, Fig. 2.

To lay out the pattern there will be needed two sets of trams, and two pairs of dividers in order to make quick work of it. Set one of the trams from *B* to *a* and the other from *B to b*. One pair of the dividers must be set to the spaces on the large quarter circle, and the other to the spaces on the small quarter circle.

Having the trams and dividers properly set, draw a line on the sheet for the lap and, with the trams set from *B-a*, locate the points *O-O′*, Fig. 3. Then with *O′* as a center and with the wide pair of dividers scribe an arc at 1′. With the trams set from *B* to *b*, using *O* as a center, cut this arc and locate the point 1′. Then with the trams set from point *B* to *a*, scribe an arc at 1 on the small end. Then take the small pair of dividers and scribe an arc from *O* cutting the arc just made, which will locate point 1 on the small end. In a similar manner locate the other points on both the large and small ends.

Everything should come out right in the pattern by using this method, if care is taken to avoid mistakes in using the dividers.

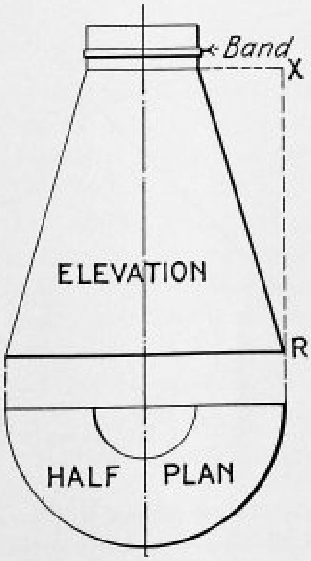


Fig. 1

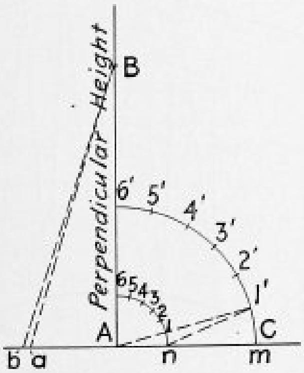


Fig. 2

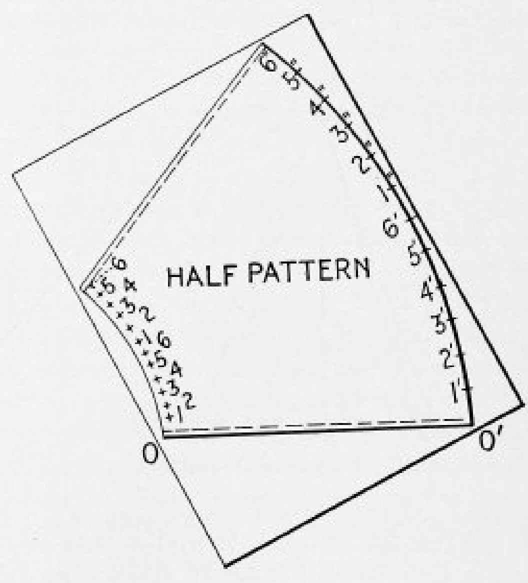


Fig. 3

Smoke Stack for Steam Shovel

BY J. L. WILSON

The plan and elevation of the top of a smoke stack for a steam shovel are shown in Fig. 1, which represents a shop drawing of the part to be developed by the layer out.

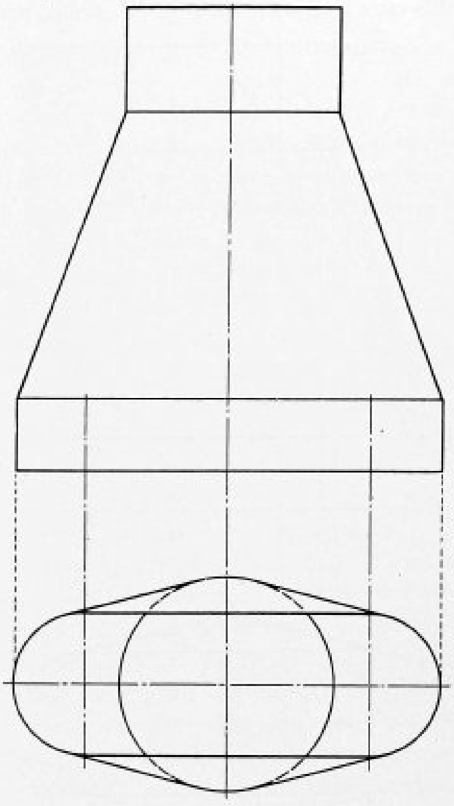


Fig. 1

The stack is made up in three parts, the rim at the top and neck at the bottom joined together by a transition or tapered piece.

For laying out the transition piece it is divided into two triangles and two conical surfaces, all of which may be cut from the same piece of metal. The triangle is a flat surface defined by points *g*, 7, *h*, Fig. 2.

Subdivision of Surface

The circular neck is divided into a number of equal parts, in this case twelve, by points 1, 2, 3, etc., and a corresponding division made for the two semi-circular ends of the top by points *a*, *b*, *c*, etc., Fig. 2. Corresponding points on top and bottom are then joined by straight lines such as lines *g*-7, *f*-6, *e*-5, etc., forming elements of the conical surface. Diagonal lines are also drawn connecting alternate points in top and bottom, such as *g*-6, *f*-5, *e*-4, etc., and although these are not straight lines they may be taken as such and will be for all practical purposes provided a sufficient number of divisions are made in the top and bottom.

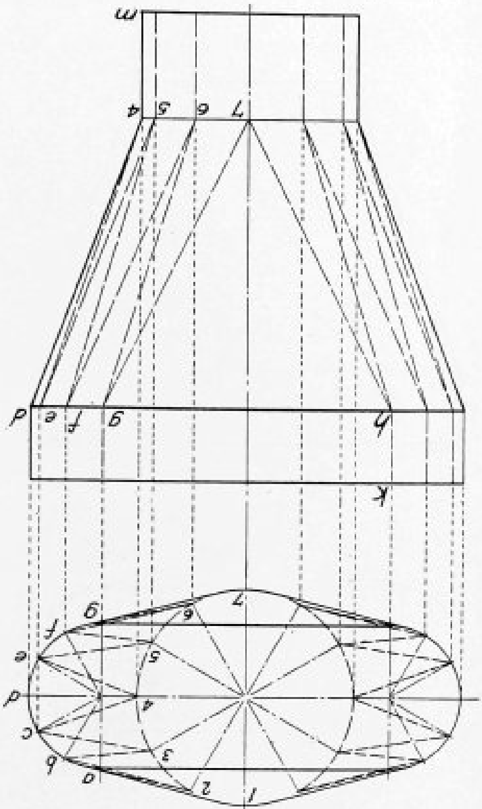


Fig. 2

This completes the subdivision of the surface to be developed and we now proceed as in triangulation to determine the true lengths of the lines. It is only necessary to lay out one quarter of the entire surface, as the other three are symmetrical or to the other hand.

Diagram of Triangles

In determining the true lengths of the various elements and diagonals shown by dashed lines in plan and elevation, Fig. 2, we construct a series of right triangles with bases equal to the lengths of these lines in plan and heights equal to their lengths in elevation, and the hypotenuse of the triangle in each case will be the true length of the lines. For instance, if, as in Fig. 3, we construct a line *O-P* at right angles to the horizontal line and from *O* lay off to the right on the horizontal *O*-7 equal to *g*-7 in the plan of Fig. 2, and lay off *O-g* along *O-P* equal to *g*-7 in the elevation, Fig. 2, we have *g*-7 in the diagram of triangles on the right of *O-P* equal to the true length of element *g*-7 on the surface. This process is continued for all the elements and diagonals, the elements being laid off on the right of *O-P* and the diagonals on the left.

To complete the necessary data for triangulation, the lengths of the arcs 7-6 and *g-f* must be determined and can easily be done by spanning them on Fig. 2.

Laying Out the Pattern

A center line, 4-*d*, is drawn as in Fig. 4 and the length of the element 4-*d* marked off on it. An arc is then swung about 4 as a center with radius equal to 4-*e* diagonal and intersecting this in point *e* another arc is swung about *d* as a center with arc *d-e*, Fig. 2, as radius. Point 5 is then determined by swinging an arc about *e* as a center with a radius equal to element *e*-5 and intersecting it at point 5 an arc about 4 with radius equal to arc 4-5, Fig. 2. This is continued until the element *g*-7 has been determined, which forms the bend line between the curved surface and the flat triangle.

Now with 7 as a center and 7-*g* as a radius, describe an arc and intersecting it in point *h* another arc about *g* as a center and with a radius equal to *g-h*, Fig. 2. Completing the triangle 7-*h-g* and the pattern of the curved surface by curved lines 7-6-5-4 and *g-f-e-d*, we have the necessary pattern by which the whole transition piece may be cut.

Laying Out Neck and Rim

The neck is a right cylinder and when laid out forms a rectangle with length equal to the circumference of the circle forming its base plus enough for lap. The height of this rectangle is equal to the side of the neck 4-*m*, Fig. 2.

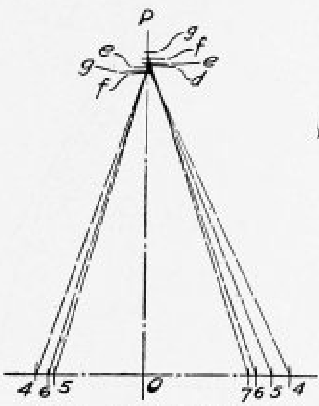


Fig. 3.—Diagram of Triangles

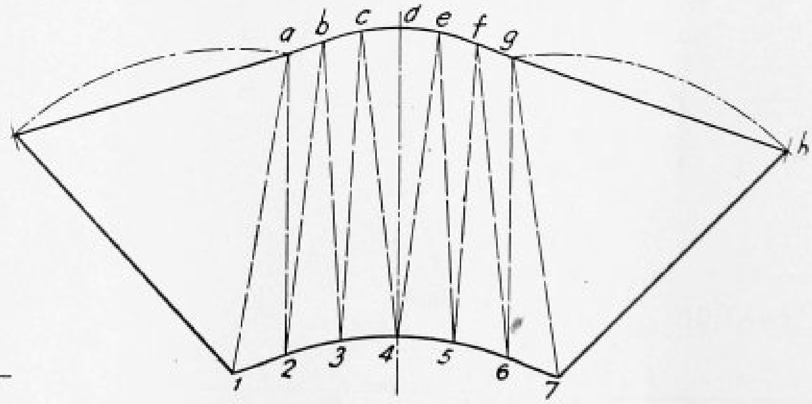


Fig. 4.—Pattern

The rim is also a rectangle when developed with height equal to *h-k*, Fig. 2, and length equal to twice *h-g* plus the circumference of a circle with diameter equal to *a-g*, Fig. 2, and allowance for lap.

The Boiler Maker

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5600 copies of this issue were printed.

NOTICE TO ADVERTISERS

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

It is a source of gratification to record in this issue that at the ninth annual convention of the Master Boiler Makers' Association, held in Chicago May 25-28, it was voted to endorse the new steam boiler code recently compiled by the American Society of Mechanical Engineers and endorsed by practically every other boiler makers' association of prominence in this country. This action means that the A. S. M. E. Boiler Code now has behind it the solid backing of the entire boiler making industry in the United States in so far as it can be expressed by the endorsement of its representative organizations.

In addition to this the States of Ohio, Wisconsin and Indiana, where boiler laws are now in force, have adopted the A. S. M. E. Code in its entirety. The State of Massachusetts, which was the pioneer in establishing State laws for the construction and inspection of steam boilers, and which blazed the way for the other States in this respect, has recently amended its boiler rules so that with a few minor exceptions the Massachusetts boiler rules now conform practically to the A. S. M. E. standard code, and it is believed that before long these two standards will be brought into absolute conformity. The State of Pennsylvania is favorably disposed towards the A. S. M. E. standard and it is probably only a question of time before the A. S. M. E. Code is adopted in this State. In Michigan a bill providing for the adoption of the A. S. M. E. Code passed the Senate during the last session of its legislature, but was defeated in the House. It is reported, however, that the opposition to the bill on the part of thresher engine builders is weakening and that at the next session of the legislature such a bill will become a law. Similar bills have also been prepared for Florida and California, and it is believed that they will become laws in the near future.

An added impetus to the universal adoption of the A. S. M. E. Code is found in the fact that it has been adopted by many of the prominent boiler inspection and insurance companies, among whom are the Hartford Steam Boiler Inspection and Insurance Company, the Fidelity and Casualty Company, the Maryland Casualty Company, the London Guarantee and Accident Company, Ltd., and the Travelers' Indemnity Company. It is also encouraging to note that the American Bureau of Standards has stated that while it cannot adopt the A. S. M. E. Boiler Code as a standard without very carefully investigating its formation and the discussion attending the drawing of the code, nevertheless if all this information is submitted to the Bureau for investigation it is quite probable that the result will be its ultimate adoption by this important authority.

Needless to say, THE BOILER MAKER heartily endorses the A. S. M. E. Boiler Code and all the steps that are being taken to secure its adoption as a standard in the laws of every State in the Union. This movement should receive the unqualified support of the boiler making, the boiler using and the boiler inspection interests, and an excellent opportunity to give this support is afforded at the forthcoming convention of boiler manufacturers at Erie, Pa., on the twenty-first of this month, where ways and means for promoting the adoption of uniform standard boiler specifications in State legislation will be discussed.

In referring in our last issue to the A. S. M. E. Boiler Code, we mentioned that the code, as stated in its title, applies only to stationary boilers. Our attention has been called to the fact that this statement is apt to be misleading, as the code applies not only to stationary boilers, but also to agricultural boilers, portable, semi-portable and traction boilers, as well as saw-mill boilers.

The point seems to be well taken and we understand that an attempt is being made by manufacturers of portable boilers to have the wording of the title changed so that it will read "steam boilers" instead of "stationary boilers." The indiscriminate use of the term "stationary" to all types of boilers except railway locomotive and marine boilers is common and well understood among boiler makers, but it is very true that persons unfamiliar with the distinctions between types of boilers might be misled by the application of the term to any other type of boiler than the strictly stationary, or wall-in, boiler, and for this reason misunderstandings might arise. In no case should any ambiguity exist in such a specific set of rules as a boiler code. Its intent and purpose should be clearly defined.

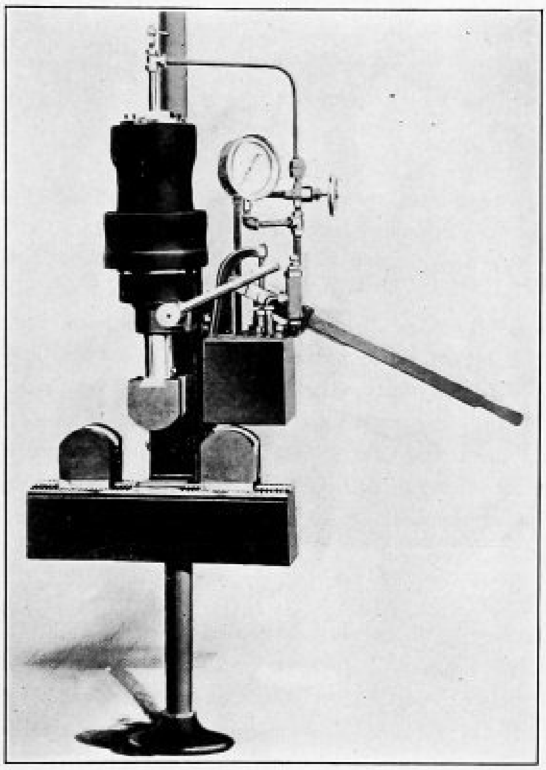
Engineering Specialties for Boiler Making

New Tools and Appliances for the Boiler Shop and Improved Fittings for Boilers

30-Ton Hydraulic Pipe Bender

Originally designed for bending pipe ot various sizes, the press shown in the illustration is also adaptable for miscellaneous bending work which comes up in machine shops, such as bending and straightening axles, small structural shapes, bars, shafts, etc. By the use of bending blocks, pipe up to 4 inches in diameter can be bent. Clamps are provided for attaching the press to a stanchion, which has a maximum diameter of 5 inches.

The construction of the press is of steel throughout. The "C" frame and bending bed are cast in one piece. The top of the "C" frame is provided with a ring into which the cylinder sets. When the cylinder is received into this ring and turned to its desired position it is keyed into place. An advantage is claimed in having the cylinder set in a ring in this manner, because it can be placed in any position desired, bringing the handle of the rack and pinion to any point which is most convenient to the operator. Another advantageous feature is the fact that the bending blocks are changed without the use of wrenches, screws, etc.



Hydraulic Bending Press

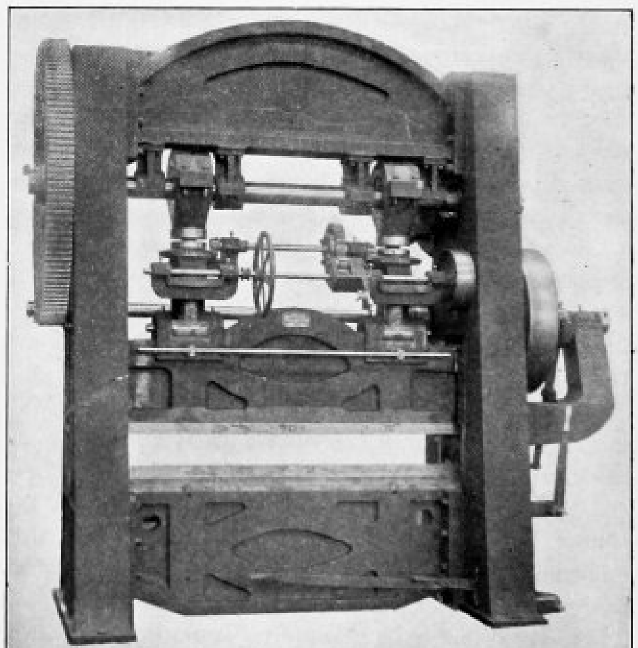
The ram of this press is forced downward by a hand-operated pump, which has a plunger diameter of ⅝ inch and a stroke of 3½ inches. The pump is equipped with a ½-inch safety valve and ½-inch tee wheel operating valve. The reservoir is a part of the pump. A hand-operated pump is more desirable on a hydraulic press of this kind, it is claimed, because there is no danger of over-bending the pipe or other material. By the use of hand power a rapid movement of the ram may be obtained at the start when it is most desirable and when the bend has almost reached the predetermined point any desired speed of the ram can be developed. In this way just the character of bend which is wanted can be produced. The rack and pinion is provided for the rapid movement of the ram to the work before the pump is operated. The downward movement of the ram fills the cylinder with fluid and the upward movement returns the fluid to the water box. In this manner there is no lost motion in the operation of the pump. A maximum pressure of 30 tons is developed on the press.

The ram has a diameter of 6 inches and a run of 9 inches. The pressing bed which receives the bending blocks is 27 inches long with a pressing width of 8 inches. When the ram is returned the distance from the top of the cylinder to the head of ram is 24½ inches. The distance between the ram head and the pressure bed is 14¼ inches. The height of the press overall is 3 feet 11 inches.

This press is a new design recently developed and added to the line of hydraulic machine tools manufactured by the Hydraulic Press Manufacturing Company, Mount Gilead, Ohio.

A New Power Press or Brake

A new power press or brake designed and built by Bertsch & Co., Cambridge City, Ind., is shown in the illustration. It has ample capacity for bending a ¼-inch plate.



Bertsch Power Press

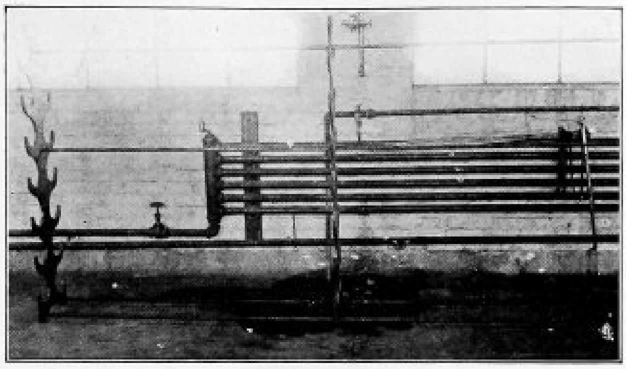
Each part was carefully figured for the correct stress and strain, with a liberal factor of safety. The bearings, shafts and gears have ample proportions. The main drive is so controlled through a friction clutch in connection with an automatic friction brake that the slide head can be stopped instantly at any point in the stroke. The head is adjusted by means of either hand or power, clearly shown in the illustration.

These machines are designed for a general class of work, a part of which includes fireproof construction for making steel doors, windows, partitions and trim, also all kinds of metal furniture, lockers and shelving, cornice and skylight work, track work for trolley systems, gang punching and other classes of bending operations.

They are built in all standard sizes from 6 feet to 12 feet for various capacities up to 100 tons in weight.

An Oxy-Acetylene Cutting Job

The illustration shows a 3-section steel rack, each section of which was cut out of ½-inch by 14-inch boiler plate in forty-five minutes with an exy-acetylene cutting

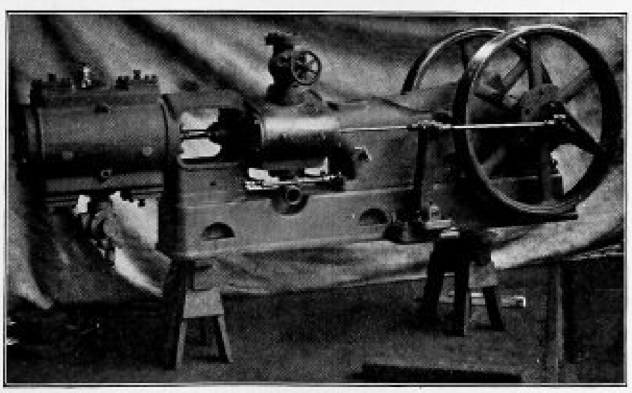


3-Section Steel Rack

torch supplied by the Dyer Apparatus Company, Cambridge, Mass. This job indicates the wide variety of possibilities for the use of such apparatus as applied to irregular cutting of steel plate with the oxy-acetylene flame.

A Highly Efficient Small Air Compressor

The constant demand for higher efficiency and greater economy, and the increasing tendency towards the use of higher steam pressures, have led to the development by the



New Ingersoll-Rand Air Compressor

Ingersoll-Rand Company, New York, of a small steam-driven high-speed air compressor. This machine is designed along the same lines as the company's former small steam-driven type, but embodies many improvements which, it is claimed, give it a higher efficiency in the air end and a considerably lower steam consumption.

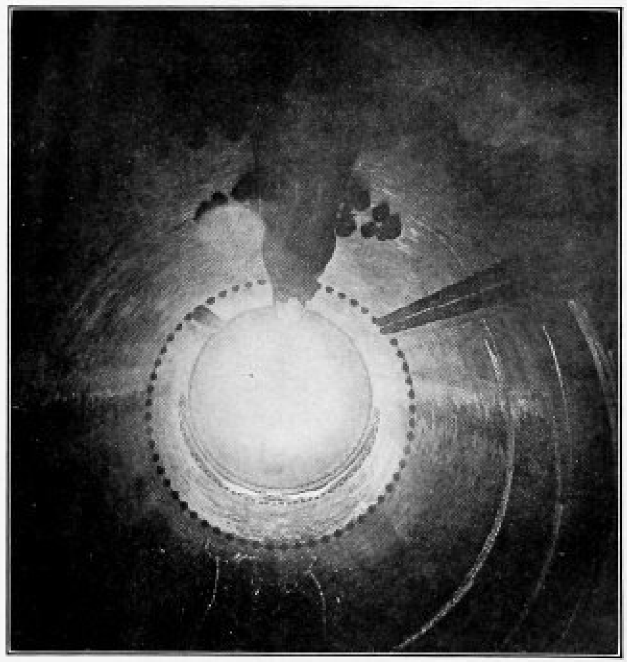
These improvements include "Ingersoll-Rogler" air valves, which are now standard on the company's extensive line of steam, power and electric driven compressors known as the "Ingersoll-Rogler" line. They allow of high speeds, give high compression efficiency, are almost silent in operation, and are independent of any operating mechanism.

Another improvement consists of balanced piston steam valves, which were adopted after extensive research. This type of valve, it is claimed, permits of higher speeds, high steam pressures, and the use of superheated steam, at the same time giving a higher efficiency under ordinary low-pressure steam conditions.

There is also an automatic cut-off control designed to give the highest possible steam economy under conditions of varying load or varying steam pressures.

Use of Silica-Graphite Paint

A practice that is fast gaining adoption in progressive power plants is the use of paint for the inner surface of steam boiler drums. The paint is said to afford protection against pitting. Silica-graphite paint is used for this pur-



Interior of Drum, Showing Absence of Scale

pose and for a number of years the manufacturers of this paint have coated the steam drums of five Babcock & Wilcox boilers installed in their plants which develop 1,800 horsepower, and as a result the drums have been kept in almost perfect condition.

In another instance, in a plant equipped with Babcock & Wilcox boilers developing 8,400 horsepower, the interiors of the drums were scalded, painted both above and below the waterline, and allowed forty-eight hours to thoroughly dry. This treatment was repeated every ten months, and not only stopped pitting, but where it had previously taken six men seven days to clean the drums of one boiler, two men now clean them in a day.

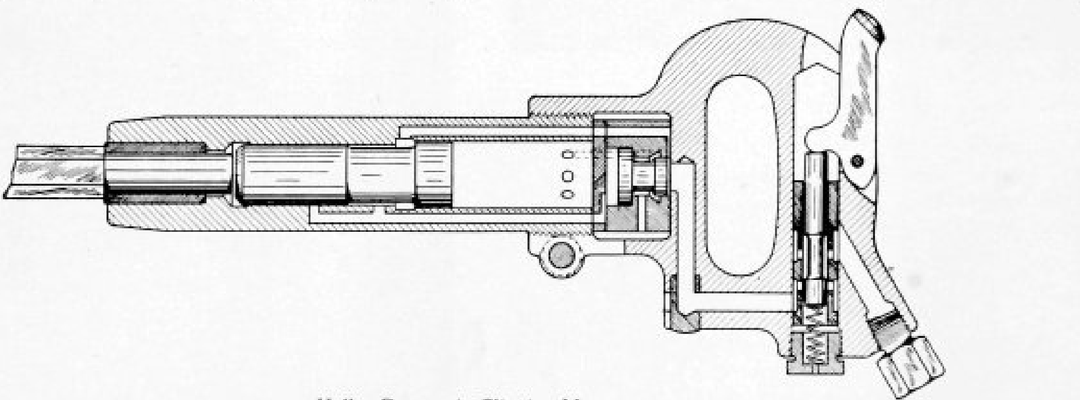
This latter experience is quoted from a letter of the chief engineer of the New York Life Insurance Company, in the April issue of *Graphite*.

The illustration shows the interior of the drum of a 500-horsepower Babcock & Wilcox boiler at the plant of the Joseph Dixon Crucible Company, Jersey City, N. J., showing the excellent condition of the drum after it had been in continuous operation for five months and nineteen days with no other care or treatment than that of feeding 1½ pints of Dixon's boiler graphite every ten hours and of painting the drum with Dixon's silica graphite paint every ten months. The photograph was taken a few hours after the drum was opened and before any attempt to clean it had been made. Only a light coating of dust was visible and no scale whatever was found.

The boiler was one of a battery of five boilers, two of 500-horsepower each, one of 300-horsepower and the remaining two of 250-horsepower each, making a total of 1,800-horsepower. The drum shown carries a steam pressure of 115 pounds per square inch. The feed water used in this case was 80 percent city water and 20 percent return from the heating system.

Keller Pneumatic Tools

The accompanying illustration shows a longitudinal section of a Keller pneumatic chipping hammer as manufactured and sold by the Keller Pneumatic Tool Company, Fond du Lac, Wis. It will be noted that the construction is simple. These hammers, like the Keller riveters, are made with all parts exposed to wear, such as cylinders, valve boxes, and throttle valve bushings, hardened and ground. It is claimed that the wear usually occasioned by the piston as it strikes the chisel or rivet set is eliminated entirely, and also that hardened cylinders will outwear soft ones several times over.



Keller Pneumatic Clipping Hammer

Another valuable feature in these tools is the fact that the air is used only intermittently. By a novel arrangement of the air ports the air that returns the piston is not exhausted, but is used further to reverse the valve. There is no live air blowing out of the front of the tool and a big saving is effected, it is claimed, in the air consumpton. Since the cost of compressing air is so very high a saving such as the manufacturers claim should be of great importance to pneumatic tool users.

Personal

N. J. Frenzer, formerly master boiler maker of the Santa Fe shops at Amarillo, Tex., has been appointed to a similar position on the same road at Clovis, N. M., succeeding C. G. Duffy.

W. B. Carnes, formerly in charge of the New York office of the Lima Locomotive Corporation, has been appointed Western representative, with headquarters in the McCormack building, Chicago, Ill. William T. Middleton succeeds Mr. Carnes in the New York office.

Clyde M. Carr, president of Joseph T. Ryerson & Son, Chicago, Ill., has returned to Chicago from Santa Barbara, Cal.

E. W. Swartwout, formerly of the Chicago office of the Nordberg Manufacturing Company, Milwaukee, Wis., became associated on June 1 with Mr. MacLaren in the New York office of this company. John E. Lord is now in charge of the Chicago office.

Joseph McNeil, formerly chairman of the Massachusetts Board of Boiler Rules, and recently in charge of the inspection department of the Boston office of the Hartford Stam Boiler Inspection and Insurance Company, is now stationed at the New York office of the company.

Obituary

Samuel Hunter Milliken, president of the Pioneer Iron Works, Brooklyn, N. Y., died recently at his home in Brooklyn, aged 73 years.

Charles Letteri, foreman boiler maker of the Columbus, Ohio, shops of the Pennsylvania Lines west of Pittsburg, died of Bright's disease in Columbus on May 20. He was born in Columbus in 1860. At the age of thirteen he entered the service of the Pennsylvania Railroad as a rivet heater and was in the employ of the company until 1877. He then entered the service of the George Wineman Boiler Works at Columbus, Ohio, and served as boiler makers' helper until this company was dissolved, going from there to the Hayden Rolling Mills as a boiler maker.

Some time later Mr. Letteri secured a position with the Huber Threshing Machine Company, Marion, Ohio, and remained with that firm until 1880, at which time he went to Muskegon, Mich. He returned to the Pennsylvania Railroad at Columbus, Ohio, in 1882 and was employed by this company as boiler maker, assistant foreman, and foreman boiler maker up to the time of his death. For the past twenty-three years he has been foreman boiler maker of the Columbus shops.

Mr. Letteri was an active member of the Master Boiler Makers' Association and always took an active interest in all work pertaining to boiler construction. He was a member of the Knights of Columbus, Foresters and other social orders, and was held in high esteem by all who knew him. He is survived by his widow, five daughters and two sons, besides a host of friends who mourn his death.

Letters from Practical Boiler Makers

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

Questions for Readers to Answer

I would like to have practical boiler makers who are readers of THE BOILER MAKER answer the following questions:

1. Why is the front end of the crown sheet of a locomotive firebox always higher than the back end?

2. Which is the simplest way to find the water level on a locomotive boiler? Please explain in detail.

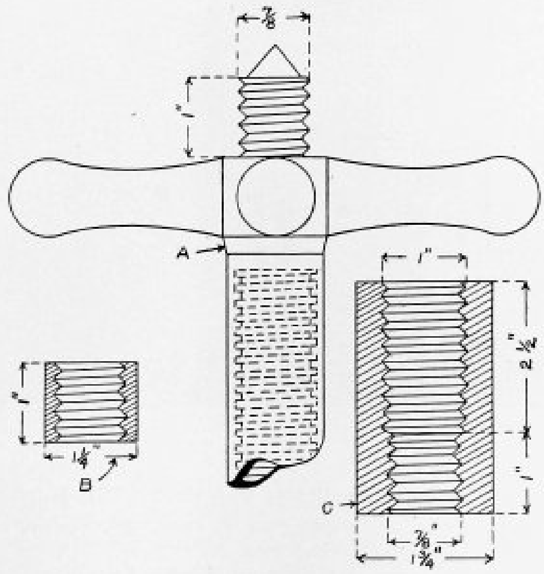
3. How far apart should gage cocks be, according to the rules of the Federal locomotive boiler inspection service?

A CONSTANT READER.

A Useful Shop Kink

The kink described in the following letter is something that perhaps other readers of THE BOILER MAKER are using, although I have never seen it described in previous issues of this journal. Those who have not seen it, or used it, will find it a very handy kink, and inexpensive to make.

Having had a girth seam to drill on a job after it was assembled in the field, I devised the following method:



Arrangement for Bracing Air Drill

The job was a 48-inch pipe and the girth seam was to be drilled on the inside, where it would have required a lot of time and work to use an "old man" or blocking in the pipe. To get around this, I used the following arrangement:

A is the feed screw on a drilling machine. The pointed part, above the handle, is about 1½ inches long over all, and about ⅞ inch in diameter. I had the toolmaker thread this for a ⅞-inch standard thread; I then had a sleeve made 1¾ inches diameter by 3½ inches long with a ⅞ standard thread 1 inch long on one end to fit the thread on the feed screw. The rest of the sleeve, 2½ inches long, was threaded for 1-inch standard. I then got a piece of common 1-inch round iron of the required length threaded for 2 inches on one end to fit the other end of the sleeve, *C*. I then pointed the other end of the 1-inch round bar slightly to hold it in place when drilling.

I found that this worked satisfactorily and it was unnecessary to use an "old man." The seam was drilled rapidly.

I have never seen this arrangement used in fireboxes, yet it would be just as useful for such work. All that would be needed would be some rods of common iron of different lengths. These rods would be of comparatively soft material and the pointed end would not put a lot of marks in the sheets. They would need regrinding on the point occasionally.

B is a sleeve 1 inch long and 1¼ inches diameter threaded ⅞-inch standard, which is screwed on to the feed screw to protect the threads when using the machine with an "old man."

The machine on which this kink was used was a Little Giant drill.

GEORGE A. JONES.

New Castle, Pa.

A Word of Appreciation

Being a constant reader of THE BOILER MAKER, and having followed with keen interest the articles contributed to this valuable journal by men of practical experience and knowledge, such as Mr. S. J. Jeter, Mr. Young, Mr. Near and many others (showing no partiality), I think it only just that these men of wide experience deserve, and be given, a word of praise and gratitude from men of less experience, such as myself and others, whom you might term "beginners." As I anticipate entering the boiler inspection field in the near future, such articles as "Boiler Inspection," contributed by Mr. S. F. Jeter in the May issue of THE BOILER MAKER, and other articles of interest contributed by men of experience, certainly prove instructive and of great benefit to the man who is striving to get ahead.

No doubt there are many others beside myself who would like to extend their gratitude to THE BOILER MAKER and its contributors, but who feel ashamed to write for fear they may not word their letter correctly, so I trust this letter will serve as an expression of gratitude for others as well as myself.

Port Richmond, N. Y. HENRY G. KLINE.

Rolling Boiler Flues

I have read all the letters on "Rolling Boiler Tubes" with intense interest, especially D. G. Young's, who takes several raps at me and my ideas because I want to know of a "simple way to explain boiler tube rolling"—a method that a novice could quickly master. Perhaps these arguments of mine, on the side of theory, will therefore be of interest:

Although nobody at the present time might expect a novice to successfully handle a flue expanding job, I maintain that if the method is thoroughly explained in THE BOILER MAKER, in a book, or verbally, and if the novice is a natural mechanic, he will be able to do that job very well indeed. Natural mechanics have very good mechanical judgment, of course, but I would not expect one to do as good a job as would a real boiler maker of Mr. Young's caliber. I might cite a case in photography, for instance. Up to a year ago I never took a picture in my life. I never did a bit of practical photographic work. But I understood the theory of picture taking and making pretty well. My employer, who owns a very good camera, asked me if I would take a trip to a town in New Jersey and photograph a structure for him. I told him what I have already told you, but he just said, "H-m-m-m-m. I will tell you how to do it." He told me. He gave me an exposure chart which I now know to be a very good chart and one that it took many years of experience to make. He gave me a booklet to read on the train. He told me that I wouldn't need any practice whatever. I merely had to follow directions. I set up the camera, got out my chart, consulted my watch, used my judgment as advised on the chart, set the camera in accordance with the chart, and "shot" the bloomin' structure. I didn't develop the plate. I have not advanced that far yet. I never have developed a plate or made a print, but I could do it, I know, with proper instruction. The above picture was good. The boss was and is proud of it. Now isn't photography about as complicated as is tube rolling, and as hard to explain? I admit, though, that a professional photographer can do better work than can a novice, but thorough, simple explanations will make a professional of a novice more quickly than will "learning by experience." Mr. Young will agree that the apprentice who understands the principles of flue expanding will "catch on" before the apprentice who does not understand. That is why I want the method that can be described in words.

Glenn Lacey gives two methods that sound very good to me. They are the very "earmarks" that a novice needs when he is being instructed. Mr. Lacey says: "I always notice that little scales will form on the tube sheet, and, when a tube is rolled tight enough to break these scales off, the flue is rolled hard enough." This, I presume, will hold for new work only, and not for a flue sheet already scaled. And Mr. Lacey's second kink is certainly the height of good mechanical logic. He says: "After watching this action on the first few flues rolled, and watching the expander pin, every flue in the boiler can be properly rolled by letting the pin go in just the same distance on each flue." Why not put a stop on the pin to hold it so it cannot go in any further? It won't have to be watched then. One man could then run a batch of rollers at once. Flue rolling would then become an almost automatic operation. Where holes in the flue sheets are all reamed to exactly the same size, where flues are all the same size, and where the mandrels in the rollers, the rollers themselves, etc., are all the same size, I can see no reason why the operation could not be made automatic, very nearly, in the making of boiler after boiler. In such case all that would be necessary would be an expert flue man to see that the first operation, by which all later ones would be gaged, was "just right."

There are plenty of parallel operations in mechanical engineering nowadays to show that my arguments are not pure theory. For instance, I might name the pressing of car wheels on to axles. The axles are made all the same size, as closely as they can be gaged. The wheels are bored all alike. And in the forcing process it is found that the hydraulic gage of the press registers about the same pressure every time a wheel is pressed home. The job has become almost purely automatic, and results are uniformly satisfactory.

In support of Mr. Young I might mention a job of flue setting which I once saw in one of our engineering colleges. At that school it was the duty of each engineering student to "tip and install one flue" in a boiler made expressly for educational purposes. The resulting boiler would scarcely be usable, for it looked more like a conglomerate mass after it was made than like a boiler. Each flue was inserted in an "original" way. Most of them were cracked. And there were more scratches on the flue sheet than in a typical henyard. Still, I hold that the blame does not lie with the students. They doubtless did the best they could. The principal blame lay with the instructor, who didn't know how to install flues himself, and if a man doesn't know how to do a job himself he can hardly be expected to teach others how to do it right.

I am therefore sure that these letters on "Rolling Boiler Flues" will do much good, both for embryo rollers and for men who have spent years at the game. We can never be too old to learn. I admit that the method I once used, and which I first suggested as a "good" one, is a back number as compared to Mr. Lacey's. Has anybody else had experience similar to Mr. Lacey?

New York. N. G. NEAR.

An Unexploded Boiler

Figs. 1 and 2 show very graphically to what extent a neglected boiler can be affected by corrosion both internally and externally. These photographs show a small Scotch marine boiler, 5 feet in diameter, 5 feet long, built

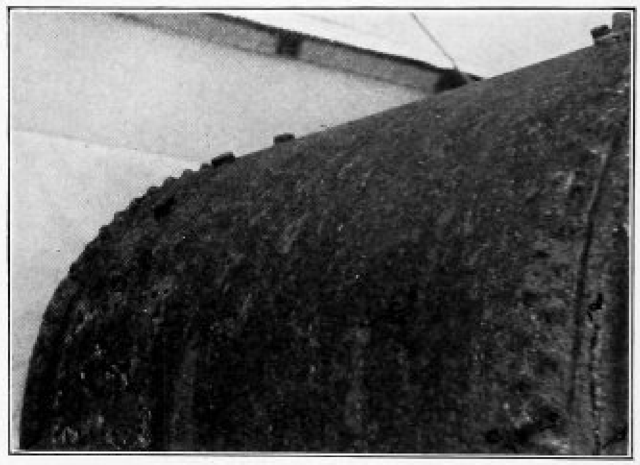


Fig. 1

with shell plates originally ½ inch thick. The boiler was built some fourteen years ago in Hongkong, China, and installed in a small harbor launch.

On the last annual inspection of this launch the Government inspector of boilers recommended her owner to have the boiler unshipped, so as to enable him to make a survey as complete as the size of the boiler would permit.

When landed ashore the external surface of the bottom of the shell and the lower parts of the front and rear head plates were found covered with a layer of rust nearly ¼ inch thick; a soft patch made of an iron sheet ¼-inch thick, and fitted with ½-inch bolts, was seen also in the place indicated on both photographs. This patch was removed, the rust chipped off, and two test holes drilled in the shell, all the order of the inspector, after which the following defects, all shown in the photographs, were discovered:

Several big irregular-shaped holes (*a*, Figs. 1 and 2) on the patched part of the shell; these holes, it may be presumed without fear of contradiction, did not exist at the time the patch was fitted, or, if they existed, they were not so large, otherwise a stronger patch would have been made than the one removed. Also the existence of these holes may be attributed mostly to internal corrosion caused by the accumulation of scale on the water leg under the combustion chamber.

The thickness of the shell plate found at the test holes was as marked on Fig. 1, showing a minimum reduction of 12 percent and a maximum of 62 percent in the original thickness of the plate. Most of this reduction could be

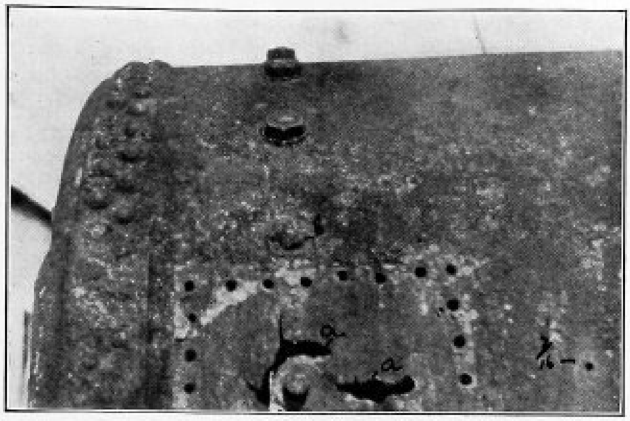


Fig. 2

caused only by external corrosion, which is shown also on the nearly wasted away staybolt nut above the patch (*b*, Fig. 1); on the front girth seam, where the thickness of the shell plate was in some places reduced to less than 1/16 of an inch (*c*, Fig. 1); and on several rivet heads, one of the rivets having been knocked out by a few slight strokes of the inspector's hammer.

Another serious defect discovered is plainly seen in Fig. 1 at *d*. It is a crack about 18 inches long on the front head under the furnace, where the plate is flanged to join with the shell.

Notwithstanding all the above-mentioned dangerous defects this boiler, according to the engineer in charge, showed scarcely any leakage, and the writer easily believes this on account of the large quantity of incrustation found inside the boiler. This was so great that in some places, like the water leg under the combustion chamber already mentioned, and under the furnace where the crack is seen, the scale formed a solid block between plate and plate.

Why this boiler never exploded is a cause for wonder, but the moral is that all boilers which are so placed on board ships that proper care can not be taken of them, and that an inspection of the shell can be made with extreme difficulty, if at all, should be lifted from their seats once in a while, at least once in every four years, to allow a good cleaning and inspection of the boiler, as well as that part of the hull which is directly underneath the boilers. This the British Board of Trade requires in its regulations for the survey of passenger steamships. AUG. SUZARA.

How to Compute and Construct an Ellipse

To draw a perfect ellipse is easy. Stick two tacks, *T T*, into the drawing board distant *A* apart. Tie string *S* loosely to the tacks as indicated, and then with pencil *P* inside of and pulling the string taut describe the curve. The pencil will slide along inside the string very easily and nicely and the curve will be very smooth if carefully done. The ellipse will be a "true ellipse" and not an approximate one, such as is usually drawn. True, an approximate ellipse is often "good enough" for most work, and if made up of portions of true circles, the approximate ellipse such as is found in manhole construction is often even more desirable than the true ellipse, which is machined with greater difficulty.

However, I am going to tell here how to draw any ellipse. Let us suppose that you want an ellipse 9 inches

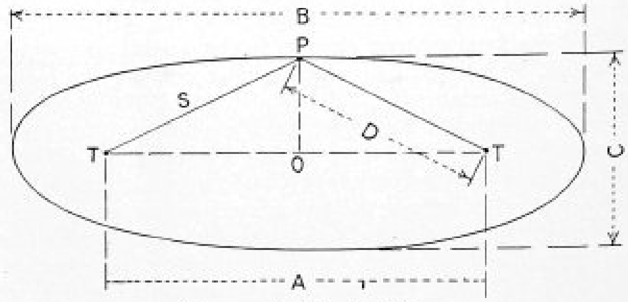


Diagram for Drawing Ellipse

long and 4 inches high. (a) What length of string will you use and (b) how far apart must the tacks be spaced?

The answer to (a) is simple. The length of the string is always equal to the length of the ellipse. In this case, therefore, a 9-inch string is needed.

As for (b), this is easily computed. Put the pencil, *P*, in the position indicated in the drawing, midway between the tacks *T T*. We want distance *A*, which is equal to $2 \times OT$.

Since triangle *PTO* is right-angled whence

$$OT^2 + PO^2 = PT^2$$
$$OT^2 = PT^2 - PO^2$$

and

$$OT = \sqrt{PT^2 - PO^2}$$

Therefore

$$A = 2 \times OT = 2\sqrt{PT^2 - PO^2} \text{ in } any \text{ case.}$$

In our problem, since $PO = \frac{1}{2} C = 2$ inches, we get

$$A = 2\sqrt{4.5^2 - 2^2} = 8.04 \text{ inches.}$$

New York. N. G. NEAR.

Old Locomotives

Old locomotives and what becomes of them is a question frequently put to me, and a question that will naturally start you thinking, if you stop to think of the large number of locomotives that are built every year. During some years' connection with a firm of locomotive builders doing a world-wide trade, I have had quite an experience with old engines of various kinds; some of them the discards of large railways, some of them worn out in trunk line service, and others the painted beauties fresh from the hands of the second hand dealers.

On a visit to an iron works, a customer of our firm, the master mechanic complained that their engine was too light to handle the large cars now in use, and they did not know what to do. Always being on the lookout for the firm's interest, I suggested a new engine, which we were then building on stock, as the solution of their trouble, and talked the matter up until I was almost sure of placing the new engine with them, and there let the matter stand.

Some short time afterwards I was called to the same works to examine a locomotive firebox, and to my surprise, on reaching the works, I found a large road engine, the discard of an Eastern railroad, which the firm had bought, taking the word of the railroad company that the engine was O K, but upon putting the engine into service their troubles began, hence the call for an examination. Upon examination I found the engine to be of the vintage of 1882, with a firebox beautifully patched. Some of the patches were masterpieces of the art of patching, but the work had been done so long ago, and was then in such bad state of decay, that nothing short of a new firebox could put the boiler in a serviceable condition.

The master mechanic, however, was not satisfied and called in a local contract shop to do the repair work, which they did by putting in a new crown sheet, but the boiler never gave satisfaction and was always a bill of expenses. This firm thought they were getting something for nothing, but in reality they got nothing for something. There is no doubt that the master mechanic was taken in by the nice coat of paint and the low price (that of scrap iron), but soon realized that he had made a mistake, for the cost of the old engine, repairs to firebox, hire of another engine while repairs were being made, amounted to the cost of the engine we wanted to place with them.

Again, I was called to a limestone quarry to look at an engine (recently purchased from a second hand dealer) and find out the cause of the side sheets bulging out about half-way up the side sheet. The engine looked spick and span with a new coat of paint. Upon examination I found that there were no broken staybolts to cause the bulging, nor was the sheet laminated. I questioned the superintendent as to the time the boiler was last washed out and was told that they had had the engine only a couple of weeks and that the water was of good quality and they did not think it necessary to wash it out so soon. After the washout plugs were removed, I found the water spaces were full of mud. Evidently the boiler had passed into the hands of the dealer and out of them again without a wash out or anything else being done, only the attractive coat of paint, and the superintendent had taken the dealer's word that everything was in good shape and had paid a price that came very little short of the cost of a new engine of the same class.

Another case was that of a mining company that by some means got possession of an engine that had lain idle for nine years. When fired up, this engine started to leak around the staybolts, washout plugs, etc. The superintendent of this company (an old railroad conductor) could not understand why an engine out of service so long should give trouble so soon. After the condition was explained to him, and a number of staybolts changed and three patches put on the firebox sheets, and a good stiff bill for repairs and expenses handed to him, he began to realize that there was nothing in second hand engines, and eventually we placed a new engine with him.

Recently I received a letter from my son, also interested in boiler making, saying that the road he was working for had several engines bought second hand. One of the engines leaked badly around the staybolts, and when a boiler maker was put to work calking he missed the staybolt and put his hammer through the side sheet. Here is a case of sheer neglect on the part of some one who should have known better than to take the word of any dealer or official of another road. Over-confidence in anyone's word is a bad thing where a boiler is concerned.

A friend of mine, who is chief boiler inspector for a large road, told me that some time ago his road was in need of more power and wanted it in a hurry. Another road had a large number of engines to dispose of. Thinking that they could get those engines cheap, and at the same time avoid a long wait should they order new ones, the superintendent of motive power and my friend went and looked over some twenty-three old engines. After a careful examination, it was found that seventeen of the engines would need new fireboxes before they could be put into service. This, of course, would mean an outlay of thousands of dollars outside the purchase price, so that they would cost almost the price of new machines.

In another case, close at home, a second hand engine had been bought (one of the four-wheeled side tank kind) to do shifting around a rolling mill yard. The crown sheet of this engine had been burned at some time and crown bolts calked until there was very little bolt left, so that it was impossible to make a tight job and at the same time a safe one, unless the entire set of crown bolts was renewed. This the firm said they could not do on account of having no more power, but due to the fact that they were compelled to cut down the working pressure they were finally compelled to get a new engine, which we placed with them. Had this firm been wise, they could have saved the cost of the old engine by getting the new one when they were first aware that they wanted an engine to do their work, but it was another case of getting something cheap that would fill the bill, only to awake to the fact that they had a white elephant on their hands.

In all of my experience, I have never known of but one case, and that of a second hand stationary boiler, that was a good and substantial bargain. A local firm had built a battery of six boilers for one of our large steel companies. The boilers were installed and put into service, but from the start did not come up to requirements in their steaming qualities. After a year's service they were removed from their settings and of no further use. One of the office force, being very close to the president of the steel company and interested in coal mining, spoke to the president about the price of one of the now useless boilers and was told that he could have one for $100. The boiler was finally installed at the coal mine and the brother of the purchaser, who had a mechanical turn of mind, changed the feed water arrangement so that the water entered the boiler as a spray near the back end, and he had a free steaming boiler to all intents and purposes new.

My experience, then, is this: that engines after their days of usefulness with the first purchaser are over, pass to small roads and eventually into the hands of the second hand dealer, who usually gets rid of them (regardless of their condition) as quickly as possible, to be put into service to menace the life and limbs of an unsuspecting public. Should disaster overtake them, they wonder why they are held accountable. If you are in need of an engine or boiler, go to a reliable firm, state your needs to them, and I am sure that they will give you something that in the end will give satisfaction. The reputation of most firms is such that they would never think of trading on your credulity.

FLEX IBLE.

Tensile strength is the force or power required to pull a piece of metal apart.

It costs money to fill a boiler with water, and a number of boiler builders overlook this cost in their estimates.

Staybolt taps wear out and therefore do bad work. Some foremen forget that these taps can be ground sharp.

Selected Boiler Patents

Compiled by

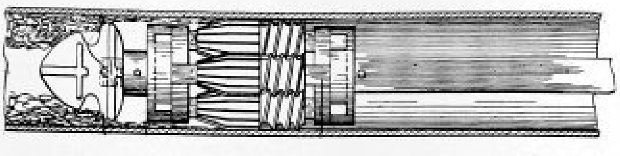
DELBERT H. DECKER, ESQ., Patent Attorney,

Millerton, N. Y.

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

1,133,262. ROTATIVE BOILER-TUBE CLEANER. JAMES OLIVER CASADAY, OF SOUTH BEND, IND.

Claim 1.—A shaft, cam disks thereon having cam slots in the inner face of each arranged along equal chords, rigidly connected radially slotted carrying disks rotatively secured on said shaft closely adjacent each of the cam disks, a shaft carried in each pair of slots in the carrying



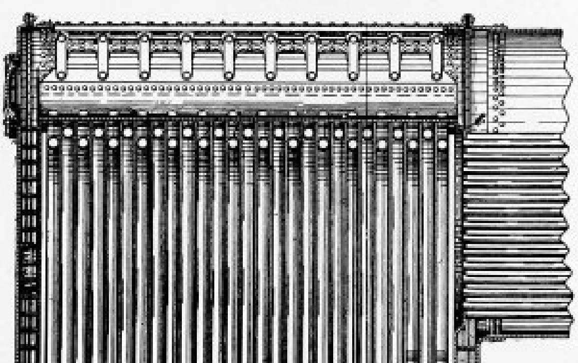
disks and engaging at its opposite ends in corresponding cam slots in the cam disks, rotative crushing and polishing members on each of said shafts, and an opening tool or point secured on the inner extremity of the driving shaft. Ten claims.

1,134,077. WATER-TUBE BOILER. DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—In a water-tube boiler, the combination of two units each comprising a bank of inclined water tubes, upper and lower headers into which said tubes are expanded, said units being so disposed that the upper headers converge toward each other downwardly and extend upwardly to the roof of the setting, whereby there is formed a centrally disposed A-shaped combustion chamber between the units, a steam and water drum for each unit, substantially horizontal separator tubes connecting the upper ends of the upper headers to the corresponding steam and water drum, down comers connecting said drums to the lower headers, and walls in front of said downcomers and extending from the steam and water drums to the banks of tubes. Seven claims.

1,135,114. FIREBOX FOR BOILERS. FRANK M. JACOBS, DECEASED, LATE OF ATCHISON, KAN., BY HENRY JACOBS, ADMINISTRATOR, OF ATCHISON, KAN.

Claim 1.—A firebox, provided with top and bottom fluid-containing headers or members, the top header or member being composed of a series of concavo-convex sheets constituting the lower wall thereof while



the outer shell of the firebox constitutes the upper wall of said header or member, and water tubes arranged intermediate of the top and bottom headers or members so as to constitute the inner side walls of the firebox and establish communication between said headers or members. Eighteen claims.

1,132,211. STEAM SUPERHEATER. JOHN PRIMROSE, OF DONGAN HILLS, NEW YORK, ASSIGNOR TO POWER SPECIALTY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 1.—A boiler provided with firetubes, in combination with a superheater, comprising transversely arranged inlet and outlet headers and superheating units, the latter projecting rearwardly into said fire tubes, the smoke box of said boiler provided with longitudinal slots extending to the front end of the shell for receiving the ends of the headers, and means for securing said headers in the said slots. Three claims.

1,137,465. BOILER FURNACE. JOHN DICK, OF MEADVILLE, PA., ASSIGNOR TO PHŒNIX IRON WORKS COMPANY, OF MEADVILLE, PA., A CORPORATION OF PENNSYLVANIA.

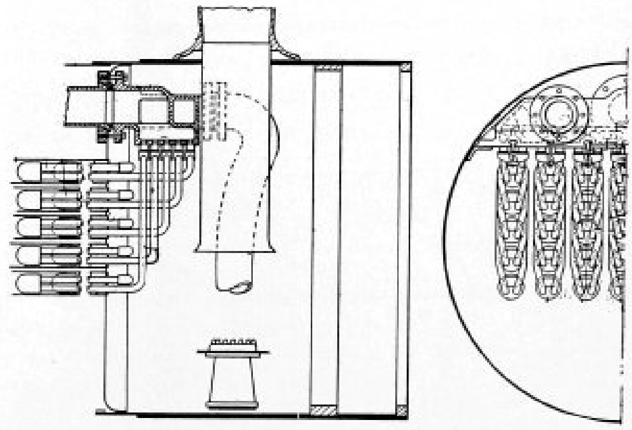
Claim 2.—In a boiler furnace, the combination with a boiler of a cylindrical furnace shell secured to the front of the boiler; a draft shell surrounding the furnace shell and adapted to convey air from the boiler end of the furnace to the front end of the furnace; a furnace head, having an inwardly extending cylindrical flange having draft openings therein; and a regulating ring arranged on the flange, the ring having openings adapted to be brought into and out of register with openings in the flange to regulate the draft. Two claims.

1,134,883. GRATE FOR BURNING FINE FUEL. WILLIAM McCLAVE, OF SCRANTON, PA., ASSIGNOR TO McCLAVE-BROOKS COMPANY, OF SCRANTON, PA., A CORPORATION OF PENNSYLVANIA.

Claim 1.—A grate comprising a plurality of tilting sections, each section embodying a rigid grid having parallel bars and a series of removable tops rigidly mounted on each bar, the removable tops on adjacent bars having their proximate ends overlapped below the general level of the fuel supporting surface and spaced to form air admission openings between them inclined to the general plane of the grate. Eleven claims.

1,135,422. SUPERHEATER. CHARLES D. YOUNG, OF ALTOONA, PA.

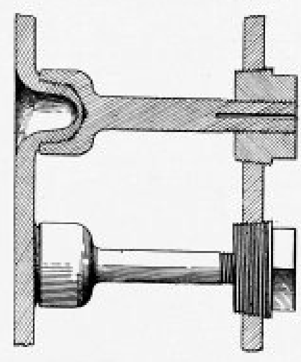
Claim 1.—The combination in a boiler having fire tubes, of a superheater having a pair of headers, a superheater tube having its ends connected to the headers and comprising four lengths of tube lying in a fire tube, and a band of strap metal encircling the two upper lengths of



tube and the lower lengths of tube with the exception of the inner sides thereto which are left free, and also engaging the wall of the fire tube on opposite sides of its vertical center line whereby the vertical space between the tubes and below the tubes is left unobstructed for the passage of a cleaning tool. Nine claims.

1,136,374. BOILER CONSTRUCTION. DEARELL D. SHIERK, OF ROCKFORD, ILL., ASSIGNOR OF ONE-THIRD TO WILLIAM J. STEWARD, OF ROCKFORD, ILL.

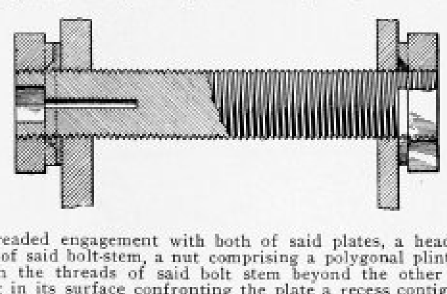
Claim 7.—A boiler construction comprising a fire-box sheet provided on its outer surface with a plurality of nipples, a boiler shell having



openings arranged in alinement with said nipples, stay-bolts having their inner ends threadedly engaged with the nipples, and bushings threadedly engaged with the outer ends of said stay-bolts and with the walls of said shell openings. Seven claims.

1,137,433. BOILER STAY-BOLT. GEORGE SWARTWOOD, OF CHICAGO, ILL., ASSIGNOR OF ONE-THIRD TO AUGUST KRUMM AND ONE THIRD TO LUDWIG J. KOEPPEN, BOTH OF CHICAGO, ILL.

Claim 1.—A stayed-plate boiler structure, comprising, in combination the parallel plates having alining threaded openings therein, a bolt-stem



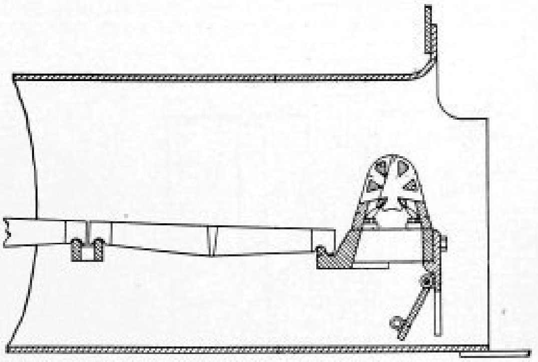
having threaded engagement with both of said plates, a head upon one extremity of said bolt-stem, a nut comprising a polygonal plinth threaded directly on the threads of said bolt stem beyond the other plate, said nut having in its surface confronting the plate a recess contiguous to the bolt hole in the nut, and a flat bearing surface surrounding said recess and within the periphery of the plinth. Seven claims.

1,128,895. STAYBOLT. DENNIS J. O'BRIEN, OF JEROME, ARIZONA, ASSIGNOR OF ONE-FOURTH TO JOHN P. HARRINGTON, ONE-FOURTH TO THOMAS J. NAGLE, AND ONE-FOURTH TO JOHN L. MURRAY, ALL OF JEROME, ARIZONA.

Claim 1.—The combination with a pair of boiler sheets of a partition between said sheets, screws connecting the partition to one of said sheets, and bolts connecting said partition to the other of said sheets. Three claims.

1,137,048. FIRE-BRIDGE FOR BOILER OR THE LIKE FURNACES. GEORGE HERBERT BUTTERWORTH AND ROWLAND CANLIN, OF GREAT CROSBY, NEAR LIVERPOOL, ENGLAND.

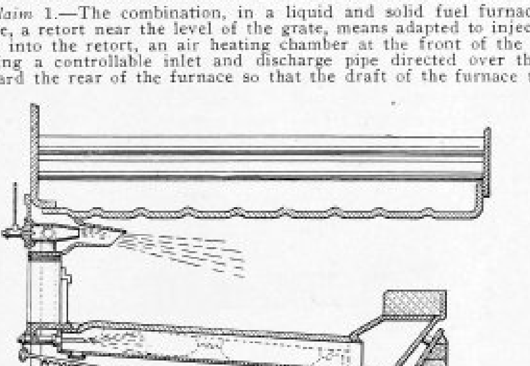
Claim 3.—In a fire bridge, in combination, a pair of rails extending across the furnace, supporting means therefor, an arch formed of a series of arch pieces each consisting of two sections, each of said arch pieces



comprising a web, which in transverse elevation is co-extensive with the arch piece as a whole, and a series of distance facings on each side of the web located so as to leave a margin of web outside the facings, said distance facings being adapted, when the arch pieces are assembled to form the arch to abut and form air-ways between the webs. Eleven claims.

1,137,310. LIQUID AND SOLID FUEL FURNACE. GEORGE ROBERT GREGORY, OF WESTMINSTER, LONDON, ENGLAND.

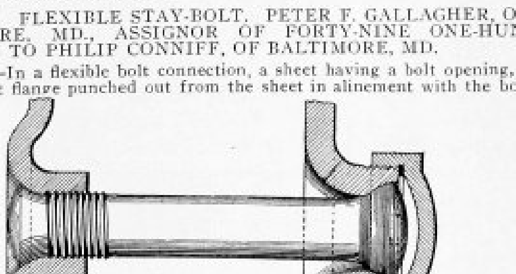
Claim 1.—The combination, in a liquid and solid fuel furnace, of a grate, a retort near the level of the grate, means adapted to inject liquid fuel into the retort, an air heating chamber at the front of the furnace having a controllable inlet and discharge pipe directed over the grate toward the rear of the furnace so that the draft of the furnace tends to



draw air from such chamber, an ejector located in said chamber and adapted to discharge into the discharge pipe of such chamber, means adapted to supply fluid pressure to the ejector and a connector placing the ejector in communication with the retort so that the fluid under pressure and gas are caused to issue in a well-mixed jet into the discharge pipe of the air heating chamber, the arrangement being such that the hot air introduced into the furnace is controlled in part by the draft of the furnace and in part by the mixed jet of gas and fluid supplied independently under pressure to the ejector. Four claims.

1,137,600. FLEXIBLE STAY-BOLT. PETER F. GALLAGHER, OF BALTIMORE, MD., ASSIGNOR OF FORTY-NINE ONE-HUNDREDTHS TO PHILIP CONNIFF, OF BALTIMORE, MD.

Clam 1.—In a flexible bolt connection, a sheet having a bolt opening, a tubular seat flange punched out from the sheet in alinement with the bolt



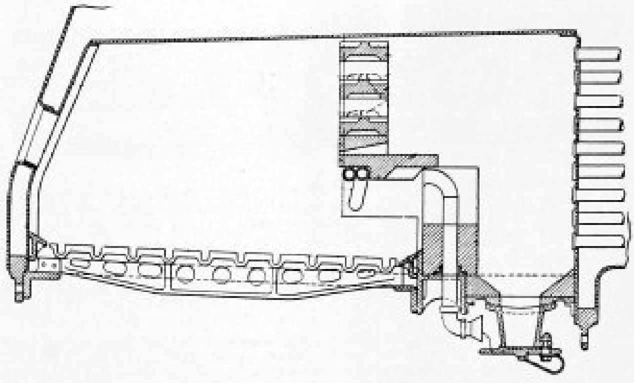
opening, a bolt extending through the opening and having a headed end engaging said seat flange, and a cap engaging and closing the outer end of said tubular seat flange. Twelve claims.

1,136,175. BOILER FURNACE. MINOTT W. SEWALL, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—Boiler furnace having a traveling grate, a bridge wall above the grate at the rear, a shield in proximity to the rear curvature of the grate, a pit for the ash and fuel refuse which is discharged between the grate and the bridge wall over said shield, and a series of water tubes forming a shield for said pit for the purpose described. Five claims.

1,138,058. LOCOMOTIVE BOILER FIREBOX. JOHN P. NEFF, OF EAST ORANGE, N. J., ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATIO OF DELAWARE.

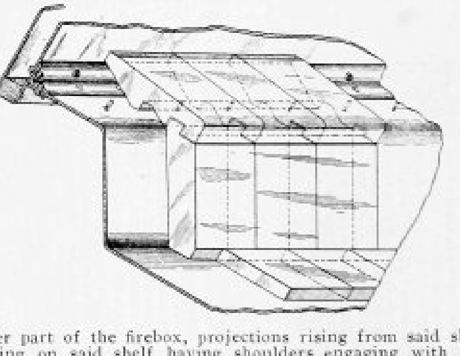
Claim 1.—In a locomotive boiler firebox, a refractory baffle extending from the grate to the crown sheet and from side to side in the firebox and spaced rearwardly from the flue sheet dividing the firebox into an auxiliary combustion chamber in the forward part, and a main combus-



tion chamber in the rear part, the lower part of the baffle preventing the direct flow of gases from the fuel bed to the flues and the upper part comprising checker-work permitting the gases to flow forwardly from the main combustion chamber to the auxiliary combustion chamber, and transverse water circulating tubes extending from side to side of the firebox supporting said checker-work in position. Nine claims.

1,138,063. OIL-BURNING LOCOMOTIVE. JOHN P. NEFF, OF EAST ORANGE, N. J., ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim 1.—In a locomotive boiler firebox, a metal structure closing the lower end thereof and having a depressed central portion forming a fuel oil combustion chamber, said depressed portion having a floor and upwardly extending side walls, a horizontal shelf joining the side walls



to the lower part of the firebox, projections rising from said shelf, firebricks resting on said shelf having shoulders engaging with said projections and being held on the shelf thereby, firebricks covering said side walls and having interlocked engagement with the shelf bricks whereby said bricks are held in position. Six claims.

1,132,225. STEAM-SUPERHEATER. ROBERT C. STEVENS, OF ERIE, PA., ASSIGNOR TO SKINNER ENGINE COMPANY, OF ERIE, PA., A CORPORATION OF PENNSYLVANIA.

Claim 2.—The combination of a plurality of header plates having tube receiving openings therethrough, return-bend tubes secured in said openings, hollow headers secured on said plates covering said openings, pipe connections on said headers for conveying steam to and from said headers and division walls within said headers having one edge thereof contacting with said header plates adapted to cause steam to flow successively through some of said tubes. Two claims.

1,138,031. LOCOMOTIVE-BOILER FURNACE. JOHN P. NEFF, OF EAST ORANGE, N. J., ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim 1.—A locomotive boiler and its contained firebox and flues, in combination with a substantially imperforate arch interposed between said flues and the bottom of the firebox, said arch comprising a plurality of upwardly and rearwardly inclined longitudinal water circulating tubes and refractory bricks supported thereby, the bottoms of said bricks together with said tubes forming a plurality of longitudinal channels that divide the products of combustion into longitudinal streams and the tops of said channels containing many distinct non-communicating cells or recesses which retard the products of combustion and break up said streams. Ten claims.

The Boiler Maker

JULY, 1915

Construction of Stirling Boiler Drums

Methods of Laying Out, Punching, Planing, Rolling, Bolting Up, Riveting, Calking and Finishing Drums of Large Watertube Boilers

BY W. S. JOHNSTON

The standard Stirling boiler consists of four drums, connected along their length by inclined tubes and circulators, the baffling being arranged on or among the tubes to guide the path of the gases of combustion, to give either a three or four pass boiler, and a brick setting. With a glance at Fig. 2 it will be seen that there are three upper drums carried on steel supports, the center drum being set on a saddle and higher than the other two. These are the steam and water drums, the right hand one being referred to as the front drum, the next as the center drum, from which the steam is taken in standard practice, and the left hand one the rear drum, which carries the boiler feed water connection. The fourth drum is known as the mud drum, to which is connected the blow-off pipes, this drum being suspended by the tubes from the upper drums.

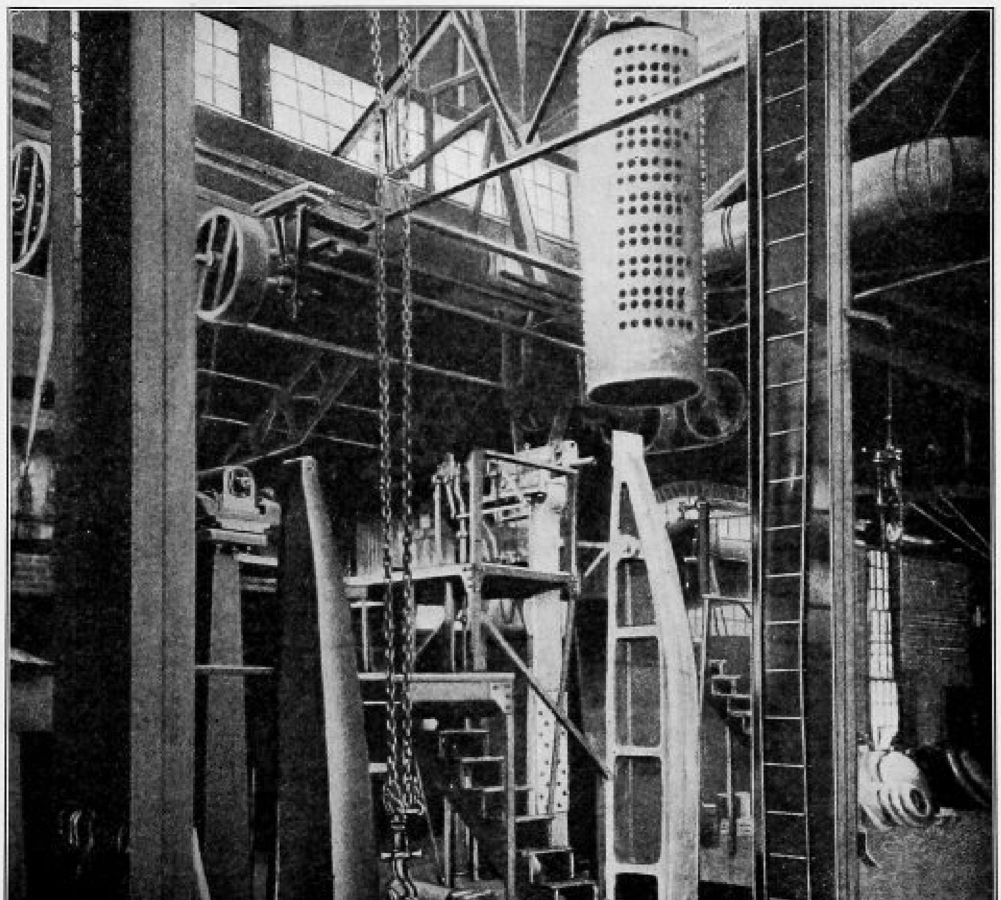


Fig. 1.—"Bull" Riveters in Drum Shop of the Stirling Works, Showing Suspended Drum

Each drum consists of two plates, except when light construction is used or the drums are of short length, when only one plate is used. The plate into which the tubes are rolled is known as the tube plate, the other the shell plate. Contrary to standard boiler practice, the tubes used in a Stirling boiler are 3¼-inch and not 4-inch.

This article is intended to cover the shop construction of these drums from the laying out of the plates to the completed drum, painted and properly marked for shipment to the point of erection. No attempt has been made to touch upon the thickness of the boiler plates or butt straps, or size or pitch of rivets to be used, as these vary

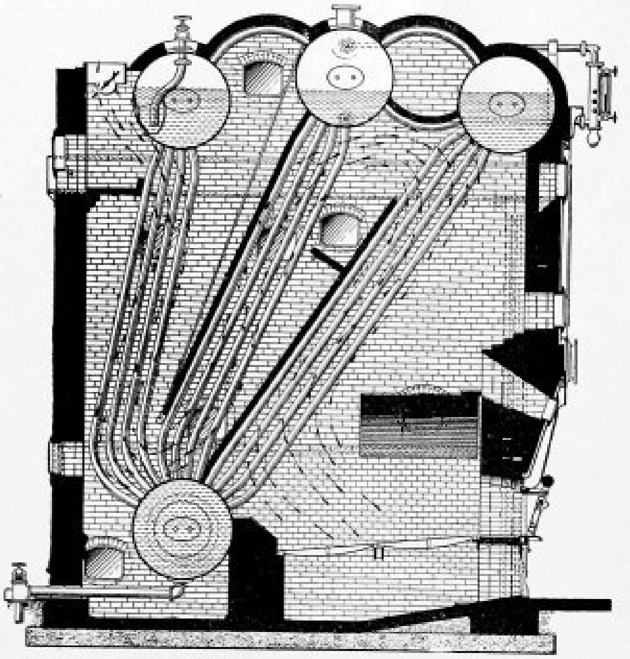


Fig. 2.—Sectional Side Elevation of 3-Pass Stirling Watertube Boiler

for every job that comes through the shops and depend for their value on the working steam pressure of the plant for which they are intended.

Laying Out

When the plate is placed in proper position for laying out it should be inspected for surface defects on the sides and edges, and ascertained to be of proper brand, size and thickness, according to specifications. In using templates for marking plates such templates should be closely clamped to the plate, and the marking punch used must fit the hole in the template and be held in a vertical position when struck. All marking by center punches must be clear and distinct, and easily visible to the punch hands.

The mill heat marks must always be visible on the outside of the plate when the drum is completed. Hence, in laying out a plate it is necessary to observe that for standard lap drums the tube plate is laid out with heat marks on the under side, shell plate with heat marks on top side. Buttstrap drum plates must have the heat marks on the under side. On jobs where holes must be drilled, or the plate pressed instead of rolled, the heat marks are on the upper side.

The proper observance of this one point is of great importance. To disregard it may necessitate cutting a drum apart when completed, if the job is inspected by insurance or state inspectors and all mill heat and brand marks are not in their proper place and visible.

For buttstrap construction all 36-inch drums are made of one plate, all 42-, 48- and 54-inch drums over 10 feet long are made of two plates. Mud drums are 6 inches longer than the furnace width. In special cases where two tubes per foot of furnace width are not used, the 5¼-inch dimension is the one changed and the 6¾-inch dimension is retained for 3¼-inch tubes. Circumferential spacing is 4¼ inches.

To lay out a Stirling boiler drum plate, Fig. 3, locate on the head seams, at the ends of the plate, the centerline of the plate, the centerline of the drum, and the end rivet holes of the head seams. Lay out along both end edges of the plate the location of the longitudinal seams, rows of tube holes, circulators, centerline of nozzles, flanges, pads, etc. Draw longitudinal lines between the points located as above.

The plate should now be squared, so the center of the plate on its length along one longitudinal seam is located. Then square plate to size by erecting a perpendicular bisector at this point and measuring on each side of the perpendicular to both ends of the plate the required distance to the centerline of the head seams. Draw these centerlines. Lay out from proper templates rivet holes on all seams. In laying out rivet holes the following points should be carefully observed. The top rivet of the head seams must come on the vertical centerline of the drum head. The minimum distance between tube holes and the seam of plate is 1½ inches. When marking rivet holes from a template it should not be forgotten to have the holes in the several rows of the seam complementary to each other, and on

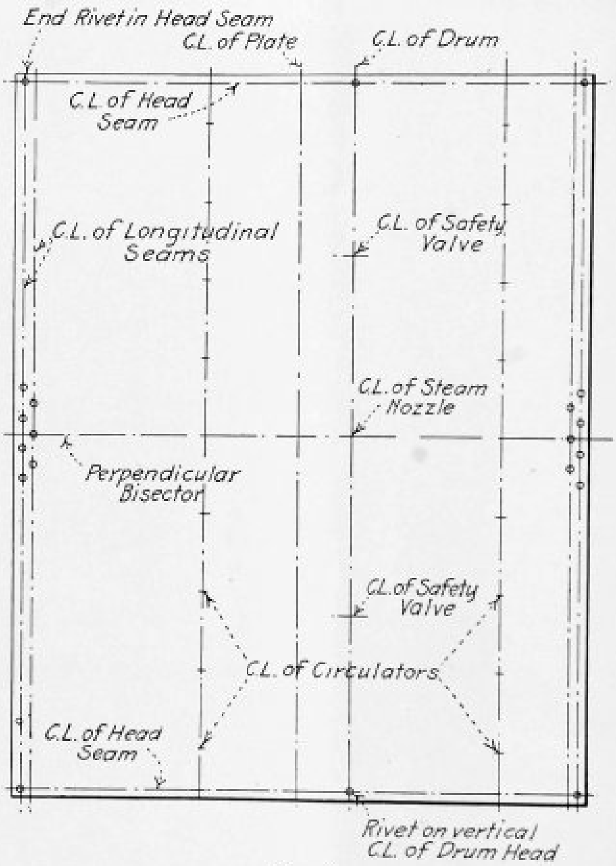


Fig. 3

lap construction omit the rivet holes coming where the shell plate is scarfed.

Returning to the longitudinal lines, the necessary tube holes, nozzle holes, etc., are now located on these lines. This completes the layout work on the plate.

To check the work thus far always lay out from the centerline and check on dimensions to the ends of the lines along which measurements are made. The plate should now be marked with a center punch, after which they are ready to have the holes punched.

Buttstraps are laid out as though a plate, a circumferential distance between rivet holes in the seam being measured off on each side of the centerline of the strap at the ends of the straps, the straps squared to size and rivet holes marked from templates. Heat marks must never be punched out; if a rivet hole is located on it transfer the heat mark before punching. Heat marks on straps are always on the top side of strap as punched, thus bringing the heat marks on the outside of the strap when in place on the drum, whether an outside or inside strap.

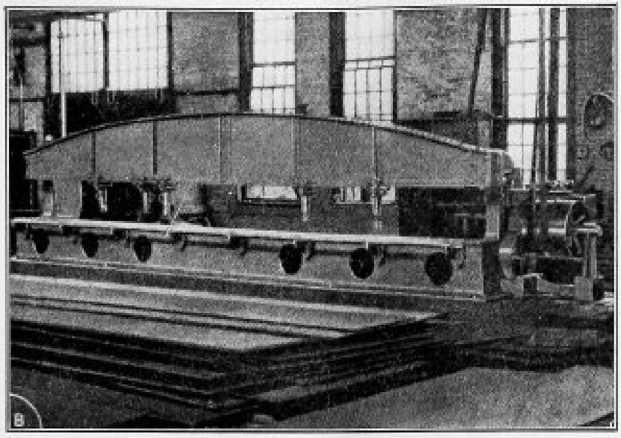


Fig. 4.—Plate Planer

Steam nozzles are always placed on the centerline of the furnace and on the middle drum, except when placed on the rear drum. When superheaters are used a 6-inch or 8-inch nozzle is supplied and located 4 feet 9½ inches from inside of furnace wall at the blank head end of the center drum. Safety valves are placed midway between the steam nozzle on the centerline of the furnace and the furnace walls, except below No. 12 boilers, when they are placed 18 inches on both sides of the nozzle. Feed nozzles and feed pipes are placed one on the centerline of the furnace and on the rear drum. Feed pans are supplied one per boiler in the rear drum. Eight-foot furnaces and above take an 8-foot pan, below 8-foot a 4-foot pan. Blow-offs are located one on the centerline of the furnace and on the bottom of the mud drum for furnaces below 13 feet wide, two located midway between the centerline of the furnace and the setting wall for 13 feet and above.

Fig. 5.—Plate with Edges Bent by Forming Blocks to Facilitate Entering the Rolls

Punching

All rivet holes on standard work are punched 5/32 inch smaller than rivets to be used, or nominally ⅛ inch. All holes must be concentric with the punch mark of the layer out. The standard punch diameter is ⅛ inch less than the size of the rivet; the die diameter 3/64 inch larger than punch diameter—i. e., for 1-inch rivets the punch diameter is ⅞ inch, the die diameter 59/64 inch.

On Ohio, Massachusetts and Detroit standard construction, punch only sufficient holes in which to get tack bolts to hold the drum together after rolling the plates when the drums are inspected at the shops. As a rule only ⅞-inch and 1-inch rivets are used, ¾-inch but rarely.

Tube holes are punched 3⅛ inches for standard work, 2⅝ inches for Ohio, Massachusetts and Detroit standard when no inspection is required. Where there will be an inspection tube holes are drilled out.

Planing

After a plate or strap has been punched it is planed. The bevel given the end edges of the plate is 21 degrees 30 minutes, and the stock from the centerline of the head seam to the edge of the plate must be 1½ times the diameter of the rivet plus the plate bevel. On Ohio, Massachusetts and Detroit standard jobs this dimension is increased by 1/16 inch. Hence for ⅞-inch rivets we have 1 5/16 inches and 1⅜ inches respectively, and for 1-inch rivets 1½ inches and 1 9/16 inches.

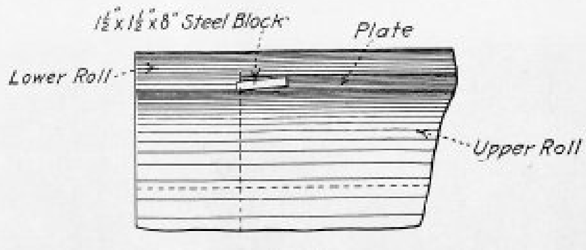


Fig. 6

The side edges of the plate are planed as above, but the bevel is only sufficient to facilitate calking.

Straps are planed only along the sides. Inside straps have the ends milled for about 2 inches or so back from the edge to allow the heads to fit inside the drum plate.

Rolling

The plates are now ready to be rolled. The longitudinal edges must first be bent to facilitate the plate entering the rolls by passing these edges through a bending machine, or bulldozer, Fig. 5. The plates are suspended on a crane jib and the plate drawn through a forming block.

When placing a plate in the rolls it must be set square so as to require no clamping to bring it in the proper position when setting up the drum. Plates up to 1 inch are rolled cold, 1 inch and over are heated in a furnace before rolling, and all rolling should be completed before the plate has cooled to a blue color.

During the rolling of a plate it should frequently be tried by using a template to see if the proper curvature has been obtained. Too much care cannot be taken in observing this rule and all plates before being removed from the rolls should be carefully inspected and ascertained if they are bent to the radius of the template and in a straight line.

If a plate is rolled too much it can be bent out by inserting a wooden block, 4 inches by 4 inches by 30 inches, between the plate and the upper roll and rolling slightly until the proper curvature is obtained as before. The corners, if bent, Fig. 6, may be straightened by inserting a steel block, 1½ inches by 1½ inches by 8 inches, as above set at a slight angle to the edge of the plate. If the plate lacks fullness at the center, due to insufficient pressure in rolling at that point, insert one or more plates of sheet metal, say No. 10, size 12 inches by 36 inches.

Buttstraps are bent to the form of an arc to the proper radius in a vertical hydraulic press. All straps must be bent in a straight line, and true to a template, and the template showing that the outer strap is over bent and the inner strap under bent, with a maximum clearance of 1/16 inch in the center in both cases.

Having now the plate and straps properly rolled and bent the drum can be set up. It is bolted with four tack bolts per strap inserted in the first holes of the two inner rows of rivets.

BOLTING UP

The drum is now bolted up preparatory to reaming the rivet holes. When a drum is set up no particular care is taken in drawing it up beyond getting in the necessary bolts to hold the plates together, and often the rivet holes in the plates and straps are considerably out of line, hence to properly ream these holes they must be brought into alinement. The drum is placed on rollers and a seam brought conveniently into position. A bolt is placed in a hole near the middle of the seam to hold the plates more closely together.

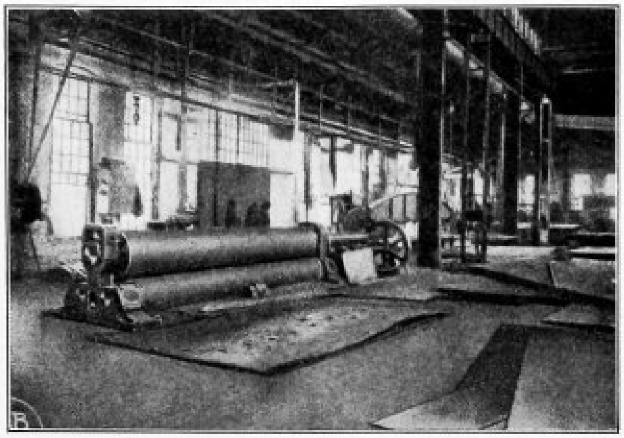


Fig. 7.—Plate Rolls

With sufficient pins the plates and straps are now drawn up by placing the pins in those holes most out of line and driving until all holes are in alinement. It is very necessary that this be carefully done, so that when reamed the holes will not be larger than required for the rivets. Beginning with one hole on lap and two on buttstrap construction at the end of the seam, holes in the inner row of rivet holes are marked and reamed to size to receive the tack bolts. The number of bolts to be used depends on the length of the drum and ranges from eight bolts for a 4-foot 6-inch drum to twenty-four for a 16-foot 6-inch drum, or approximately every six holes After reaming and cleaning the holes a bolt is placed in each one and brought up tightly so that the plates and straps lay up closely to the plate next them. The pins and bolts inserted when set up are taken out and the drum is ready to have rivet holes reamed.

REAMING RIVET HOLES

In reaming holes the drums are set on a drum turner under radial drill arms, Fig. 8. The seams are brought up under the reamers by revolving the drum, and each line of rivet holes is successively placed so the reamer may enter the holes vertically. Rivet holes are reamed 1/32 inch larger than the size of the rivet to be used in the seam—i. e., for ¾-inch rivets ream 25/32 inch, for ⅞-inch rivets 29/32 inch and for 1-inch rivets 1 1/32 inch.

CLEANING

Buttstrap seams are cleaned by removing the tack bolts and taking off the straps one by one—i. e., first an outer strap, the inner strap holding the plates together, then replacing the outer strap and removing the inner. All burrs are removed by reaming the edge of the rivet hole with a large drill, thus giving a very slight countersink. Cuttings, dirt, etc., should be brushed off both plate and strap before replacing the strap.

In reassembling a seam the tack bolts are replaced and dowel pins in parallel rows are driven in every 24 inches. The seam should now show that the rivet holes in both plates and straps come into line as before unbolting.

RIVETING

The drums are then taken to the "bulls" to be riveted.

The dies must conform to the standard rivet gages, concentric when both driving and holding dies are brought together under full rivet pressure with a piece of paper between the dies, and when the drums are being riveted they must hang true so that the dies will not be sprung out of a straight line with driving the rivets, and also to prevent marking the plate with rivet dies.

The rivets must be of full length to give full size to head, indicated by a slight even fin around the lower head of the rivet.

The exhaust valves must not be opened until the driving die has come to a final stop.

The rivets should be heated to more than cherry red, and the pressure gage in driving rivets should register the required line pressure, which is 1,500 pounds.

To commence riveting drive tack rivets at the bottom of the drum; then next tack rivets placed at the center of the drum and the third row at the top of the drum; then space another line of rivets between top and center row; then between center and bottom row, and finally rivet the drum complete.

FITTING HEADS

After a drum is riveted the heads are fitted. All heads must go in with a drive fit—i. e., with at least six heavy blows with a 200-pound ram.

Then lay up the inside plates at the scarfed corners to allow the head to enter, or lay up the edge of the inside buttstraps. Ream two rivet holes in head seam of tube plate, one near the seam and one near the center of the plate. Also ream two holes in the head to correspond with those in the drum. The head is set in the proper position, pinned up and two bolts inserted in the holes reamed above and bolted up.

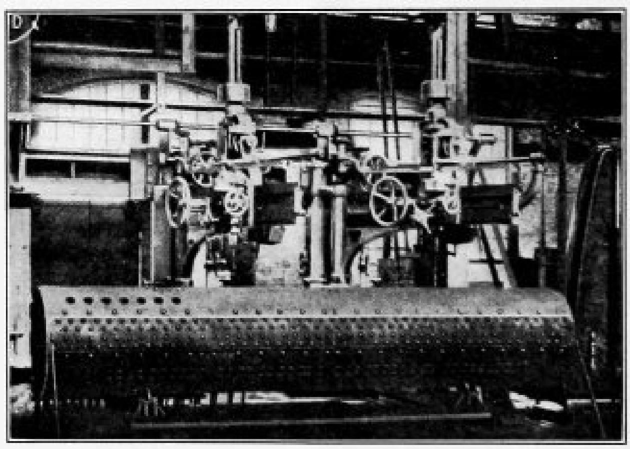


Fig. 8.—Double Arm Radial Drill Reaming Rivet and Tube Holes

Next drive in the head with the ram and pin up, getting rivet holes in drum and head in line. Three holes are reamed, one in the tube sheet near the seam and two in the shell plate, bolts inserted in these holes and the head is bolted up. Then lay up the plate at the seams on the outside by sledging and punch holes in the scarf by a gager. Examine to see if rivet holes come in line entirely around the head, and that the plates lay up to the head. If not, sledge up the plate and insert a bolt at that point.

When it is necessary to put in a blank head with respect to the vertical centerline of the drum and head, as when the head has a lug, or when putting in a manhead, special care must be taken to set it in the right position. In such cases use the lower hole in the vertical centerline of the drum for correctly setting the head.

Reaming Tube Holes

The setting of a drum in position to ream the tube holes is similar to that for reaming the rivet holes, except that in leveling the drum a spirit level is placed perpendicular to the longitudinal axis of the drum across a tube hole to insure true holes, Fig. 8.

Finished tube holes must be perfectly smooth, not showing any spiral grooves or cuts from reamers, and must also be free from burrs inside and out. Finished tube holes shall admit with a snug fit that end of the limit gage marked 3.281 inches, but shall not admit that end of the gage marked 3.297 inches, Fig. 9.

Bridges between finished tube holes lengthwise of the drum must be 3 15/32 inches for the wide bridges, 1 31/32 inches for the narrow bridges, Fig. 9. The operator should examine these bridges constantly with a gage provided and not allow the bridge to be more than 1/16 inch thinner than that indicated by the gage.

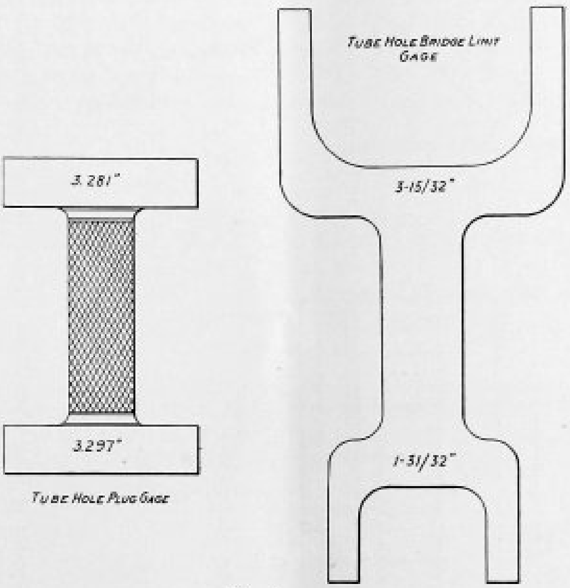


Fig. 9

Fittings

Having the drum on blocks, level it and plumb it from top and bottom centers as marked on the drum, Fig. 10. Place the nozzles or flanges in the position called for as per detailed drawing so that the centerline of the lower flange is in line with the top centerline of the drum. The upper flange of the nozzle should now show by spirit level that it is perpendicular to the longitudinal axis and horizontal centerline of the drum.

Then mark the centerline of the upper flange to locate the bolt holes in drilling same, and mark off the rivet holes in the lower flange from the rivet holes in the drum. After the above holes have been drilled in the nozzle thus marked, replace it in the drum, inserting calking strips with cast iron nozzles, bolt in position, and ream rivet holes. Check the nozzle for a true level when bolting down as when first fitted. Then have the nozzle or flange riveted.

Calking

The operator must examine the drum before any work is done to see that all the calking edges of the plates and buttstraps are down against the plate underneath. Then set down with butting tool or flatter, and finish with a round nose calking tool to a depth of not more than half a ⅛-inch wire.

Chipping should only be required to insure a true calking edge to a plate. The plate must not be grooved or marked with either a chisel, fuller or calking tool. To do so is absolutely criminal.

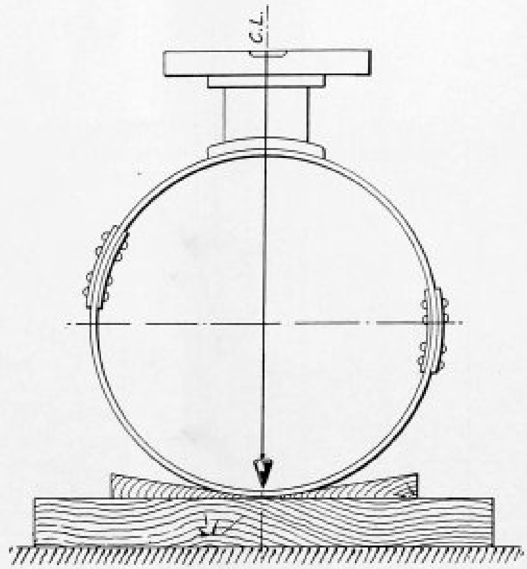


Fig. 10.—Leveling Nozzle on Drum

The edges of a plate or buttstrap must butt, metal to metal. If they do not fit, a wedge of the same depth as thickness of sheets should be placed in the opening between the plates and driven home. Cut the wedge 1/16 inch short of the edge of the plates, work plates from both sides over the wedge with a butting tool and finish by calking, Fig. 11.

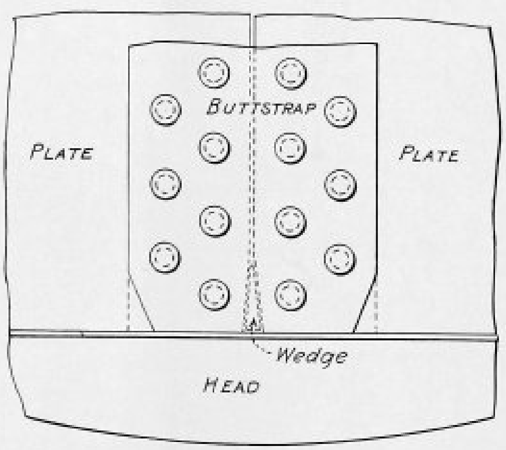


Fig. 11.—Enlarged Section, Showing End of Joint

Testing

Before leaving the shops the drums are tested by being pumped full of water and the pressure raised. All hydraulic tests are made at twice the working steam pressure. All leaks developing, whether at rivets or on seams, must be calked while under this pressure, and finished drum must show absolutely tight joints and rivets under this pressure for a period of ten minutes. Not more than 10 percent of the rivets should leak. If they do so, special

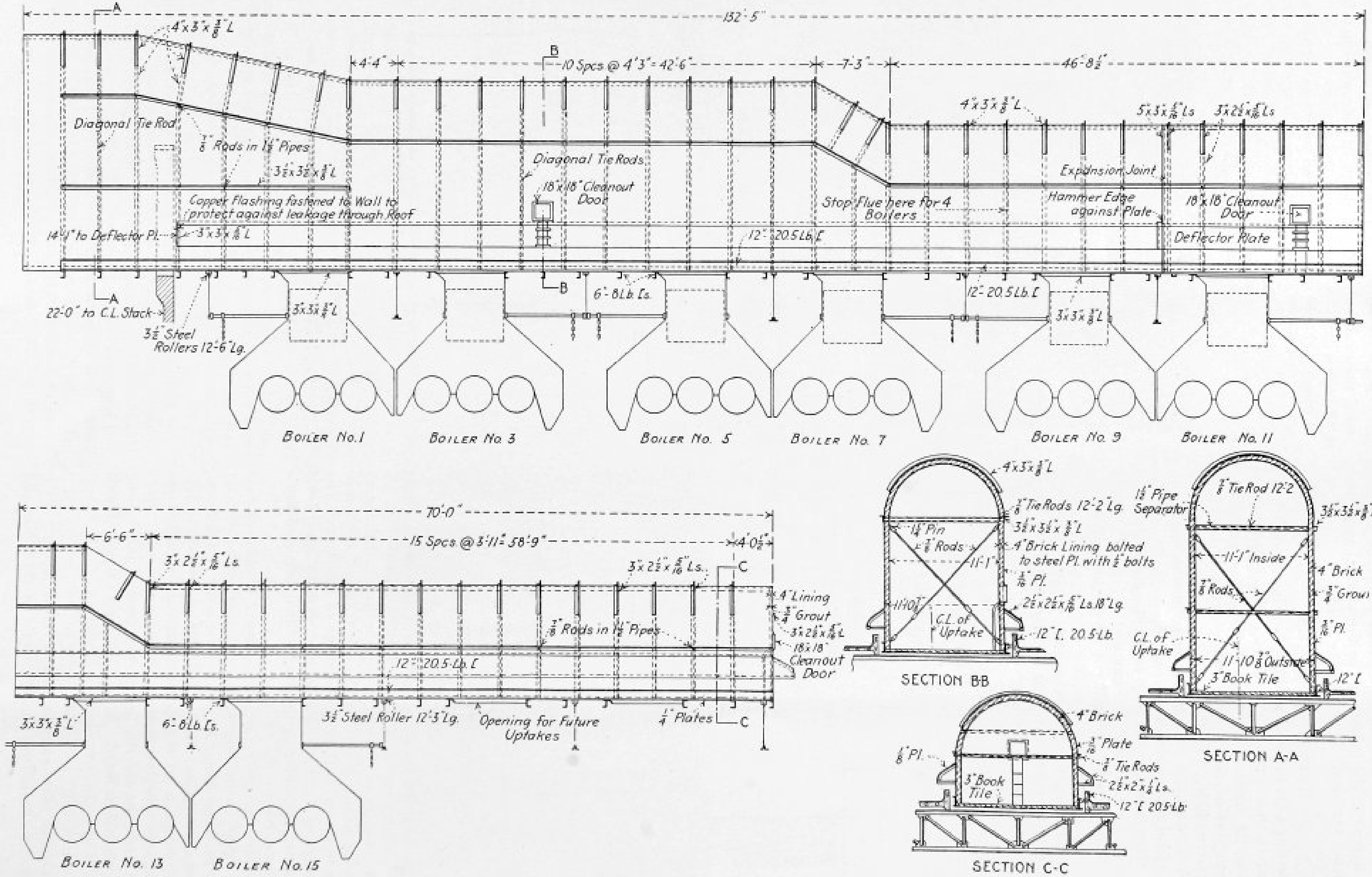


Fig. 1.—Elevation and Sections of Smoke Flue and Uptakes at East Waco Steam Power Plant of Texas Power and Light Company, Waco, Texas

attention should be paid to the riveting done at the "bulls."

Then give the drum thus finished, under test pressure as above described, a final hammer test—i. e., give each space on a horizontal seam within every two rivets a blow with a 2-pound copper hammer, the force of the blow to be equal to a drop of 24 inches. The seam under this test must show that it is absolutely tight.

Inspection

The inspector must check all drums externally and internally:

First, against any defect in material, viz., lamination, pits and scabby surfaces.

Second, workmanship, viz., riveting and calking, also that all the foregoing details of operation have been fully complied with in every particular.

Third, check against drawings, viz., that drum is of exact length and diameter as specified; number of tube holes and spacing of same as called for on drawings; also that tube holes come true in line and parallel to the longitudinal axis of the drum.

Check all fittings as to size and location as given on detailed drawings and that nozzles line up as described in paragraph on fittings.

Be sure that dry pipes are safely secured to drums, correctly placed, and all cotter pins opened up, and finally that the feed pipe is securely fastened to the feed pan; that lugs are lined up and chipped parallel to horizontal axis of drum and to a height from the center of the drum as specified on the drawing.

The inspector shall then finally take the heat mark and name of manufacturer from the plates, buttstraps and drum heads, and record same.

Cleaning Tube Holes

All burrs on both inside and outside edges of the tube holes must not only be removed, but the edges taken off to a radius equal to not less than 1/32 inch and not more than 1/16 inch.

Painting

The drums are first properly stenciled with letters not less than 9 inches high, showing the relative position of the drum in the boiler, covering unprotected surfaces of tube holes with a coat of vaseline, and then paint the drum inside and out without allowing the paint to run over the vaseline-coated surfaces of the tube holes.

The paint is well mixed before applying, and all surfaces are well coated with the exception of the space indicating heat marks and manufacturer's stencil marks, which space must be covered with oil.

Large Breeching and Uptake for Texas Plant

Steel Uptake for Conveying Flue Gases from Eight 600-Horsepower Boilers into 265-Foot Stack

The breeching shown on this and the opposite page was designed by Sargent & Lundy, engineers, of Chicago, and built by the Southwestern Mechanical Company, Fort Worth, Texas, for the Texas Power & Light Company's large generating station at Waco, Texas. The Texas Power & Light Company is a large corporation which maintains and operates generating stations in various Texas cities, furnishing power for the many interurban and street railway systems, and also for manufacturing establishments. This breeching is to convey the flue gases from eight 600-horsepower boilers into a gigantic concrete smokestack. The internal diameter of the stack is 16 feet and the height 265 feet.

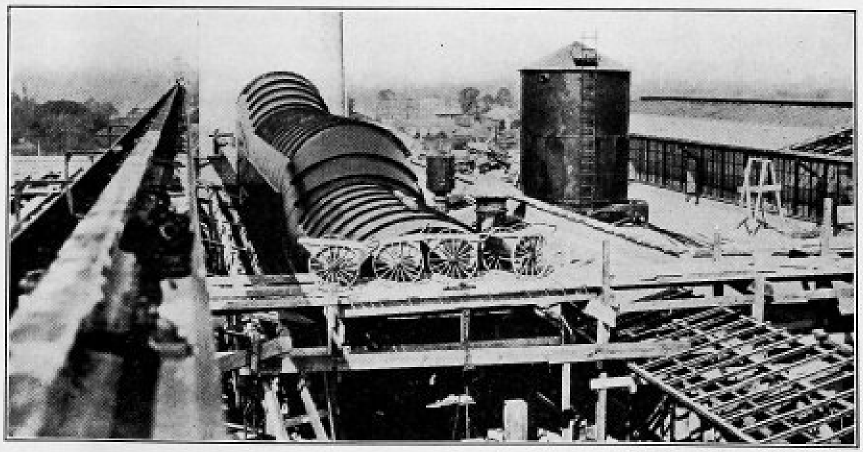


Fig. 2.—View of the Smoke Flue Under Construction

To give an idea of the size and magnitude of the breeching, the following figures have been compiled: Total length, 208 feet 5 inches; width, 12 feet; height where it enters stack, 23 feet 9⅜ inches; height at rear end, 10 feet 3½ inches.

It required 70 tons of 3/16-inch steel plate, 20 tons of rolled shapes for stiffening and holding to shape, and 8½ tons of ⅜-inch rivets. It required six weeks to fabricate in shop, on account of its shape, and eight weeks to erect.

Before assembling, every piece of angle, plate and channel was laid out or marked off by Mr. Harry Surtees from the drawing which is shown in Fig. 1. Mr. Surtees has worked for the Southwestern Mechanical Company for three years, laying out all kinds of sheet iron work. The erection was done by Mr. Tom Dewberry, and members of the trade will appreciate that it was no easy job to erect on account of the fact that there is an angle iron stiffener on every lap, and also on account of the height from the ground and the shape of the top sheets, which were 48 inches wide and 227 inches long.

The breeching is supported 50 feet 6 inches from the ground on steel trusses spaced 20 feet between centers. On top of each truss is a 3½-inch solid steel roller. This is to provide for expansion. There is one expansion joint to keep the entire breeching from moving in case one section becomes hotter than the other.

The job was fabricated and erected by the Southwestern Mechanical Company, a contract shop of Fort Worth,

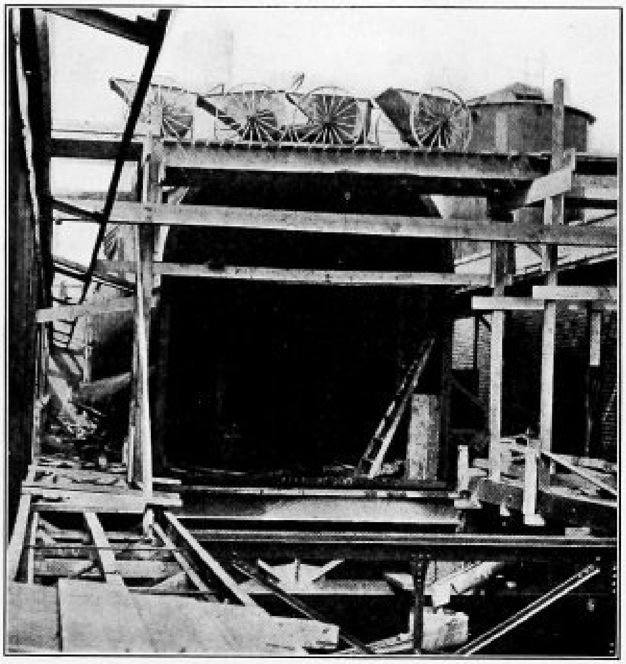


Fig. 3.—View Looking Into the Smoke Flue

Texas, which makes a specialty of building tanks of all descriptions, breechings, boiler repair work, or, in fact, anything in sheet iron. In connection with the boiler shop this company operates a 400-ton per month structural steel fabricating shop, a large blacksmith shop and a modern machine shop. Each department is under separate foremanship. Mr. John Tancred is general foreman of the above-mentioned departments and Mr. Chris Helmcamp is boiler shop foreman.

This company is at present erecting a 55,000-barrel oil storage tank in West Texas for a newly developed oil field.

Hartford Boiler Inspection Company's Annual Report

The work of the inspection department of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., for the year 1914 is tabulated below, the data being taken from the company's publication, *The Locomotive*.

It will be seen that by far the greater portion of the defects discovered were due to impure feed water. The large number of cases of scale, sediment and corrosion bear out this statement. The next item in importance, and a growing one, is the item of tube failures and defects. The importance of this type of defect will perhaps be more apparent, if note is taken of the large percentage of defective tubes which were dangerous, it will be found that the ratio is relatively very high.

SUMMARY OF INSPECTORS' WORK FOR 1914

Number of visits of inspection made	198,431
Total number of boilers examined	368,788
Number inspected internally	145,871
Number tested by hydrostatic pressure	8,239
Number of boilers found to be uninsurable	756
Number of shop boilers inspected	8,429
Number of fly wheels inspected	15,786
Number of premises where pipe lines were inspected	4,999

SUMMARY OF DEFECTS DISCOVERED

Nature of Defects	Whole Number	Dangerous
Cases of sediment or loose scale	29,008	1,920
Cases of adhering scale	44,554	1,739
Cases of grooving	2,806	382
Cases of internal corrosion	18,320	855
Cases of external corrosion	11,597	949
Cases of defective bracing	935	245
Cases of defective staybolting	2,336	453
Settings defective	9,241	949
Fractured plates and heads	3,340	523
Burned plates	5,793	511
Laminated plates	431	31
Cases of defective riveting	1,616	264
Cases of leakage around tubes	12,222	1,549
Cases of defective tubes or flues	16,592	6,860
Cases of leakage at seams	5,742	578
Water gages defective	4,067	927
Blow-offs defective	6,523	1,983
Cases of low water	440	116
Safety-valves overloaded	1,488	426
Safety-valves defective	1,883	426
Pressure gages defective	8,030	866
Boilers without pressure gages	71	71
Miscellaneous defects	3,847	549
Total	190,882	23,012

Results of Locomotive Boiler Inspection Law

In speaking at the Master Boiler Makers' Convention in Chicago in May, Mr. Frank McManamy, chief inspector of the Locomotive Boiler Inspection Department of the Interstate Commerce Commission, Washington, D. C., gave a comparative statement of the work performed, the conditions found and the results accomplished by the Federal locomotive boiler inspectors during the first nine months of each of the four fiscal years since the Federal locomotive boiler inspection law has been in force. The figures are tabulated below:

	1912	1913	1914	1915
Number of locomotives inspected	48,023	64,596	70,850	58,427
Number found defective	32,071	40,476	39,312	26,986
Percentage found defective	66.7	62.7	55.5	46.1
Number ordered held for repairs	2,222	3,790	2,992	1,739

The criticism has been made that many of the defects reported were not in reality violations of the law. On the other hand, however, the results achieved in the prevention of accidents due to defects make it extremely difficult to convince the locomotive boiler inspection department that its present policy should be changed.

The number of accidents to locomotive boilers that took place during the first nine months in each fiscal year since the law went into effect and the number of killed and injured are given in the following table:

	1912	1913	1914	1915
Number of accidents	656	643	463	312
Number killed	77	32	18	10
Number injured	792	720	517	343

From these figures it is seen that the decrease of accidents over the previous year was 2 percent in 1913, 28 percent in 1914 and 33 percent in 1915. The decrease in the number killed over the previous year was 58 percent in 1913, 44 percent in 1914 and 44 percent in 1915. The decrease in the number of injured over those in the previous year was 9 percent in 1913, 29 percent in 1914 and 33 percent in 1915. The total decrease since the law was put in force is 52 percent in the number of accidents, 87 percent in the number killed and 57 percent in the number injured.

Credit for these excellent results, Mr. McManamy pointed out, is not wholly due to the work of the Government inspectors, for it is only by the co-operation of those in charge of the maintenance of the boilers, such as the master boiler makers, that such satisfactory results are obtained, and by co-operation he meant the quality of being ever diligent in the effort to discover defects and to require prompt repairs.

Certain causes of accidents are not being overcome satisfactorily, however, chiefly because they are not receiving sufficient attention. One of these is arch tube failures, although the unsatisfactory showing in this respect is due partly, of course, to the increased number of arch tubes being used. Three out of four arch tube failures are due to improper application or to failure to keep the tubes clean. The remedy for this lies in the hands of the foremen boiler makers.

Accidents due to flue failures indicate that quantity rather than quality is the controlling factor in passing on the qualifications of flue welders. Progress in the elimination of accidents due to failures of injector steam pipes is also unsatisfactory, but this is not under the control of the master boiler makers.

Autogenous welding is a comparatively new feature in boiler construction and maintenance, but as the number of uses of this process has indicated its value the Government inspection department has hesitated to restrict in any way its usefulness to the fullest extent consistent with proper conditions of equipment. It is not a cure for all boiler ills and its over-enthusiastic friends are likely to retard its progress. Welding over staybolt heads so they cannot be tested, and renewing in the same way button heads, which on account of leakage have been heavily calked and cannot be kept tight, are practices to which the Federal locomotive boiler inspection department objects. Also the department believes that this process should not be used to repair any part of a boiler that is wholly in tension under working conditions. There is no objection to its proper use on stayed surfaces.

Referring to the new law that becomes effective on September 4, 1915, extending the authority of the Locomotive Boiler Inspection Department of the Interstate Commerce Commission over the entire locomotive, Mr. McManamy stated that this will not interfere with or change the present requirements governing the conditions of boilers, nor will it materially reduce the supervision now exercised over these conditions. No modifications are to be expected on that account.

Men and their bosses are in partnership, but it is hard to get most men to understand this fact.

The tangue of a file is a poor substitute for a nice, round feed pin when using a ratchet. It spoils the holes in the feed screw head and its use is slovenly.

It pays to get a tap wrench and not try to use a monkey wrench on a tap. The tap wrench will tap a straight hole and put an even strain on the tap and save time.

Some Principles of Boiler Design—IV

BY GEORGE SHERWOOD HODGINS *

The staying of flat surfaces in boiler work is exceedingly important, and to meet practical requirements it is necessary to have the stays of good material, properly made, and correctly placed. It is also necessary that the staying be intelligently done and in accordance with the rules established by good practice; but it is further necessary to allow a liberal factor of safety.

In the matter of staybolts in a firebox, the factor of safety is necessarily large because of the liability of stays to break and the difficulty of ascertaining the fact. There is also the ever-present human tendency to take chances, and though in properly supervised establishments and on railways, although this tendency may be reduced to its lowest terms, it necessarily always exists.

Staying of Flat Surfaces

The rule of the United Supervising Inspectors provides that braces or stays used in boiler construction shall not have more than 6,000 pounds tensile strain per square inch of section. The minimum factor of safety for stays, staybolts and braces is therefore 8, and it may be said that 10 is not too much, as this is a case where the motto "Safety First" is written large in the practice of the conscientious boiler maker or designer.

It may be said that the flat plate itself has a certain amount of strength, and is able, up to a certain point, to resist pressure evenly spread over the surface and applied on one side. This is quite true, and a formula given by Mr. Nichols, after some experiments made by him, and published in *The Locomotive* of February, 1890, is: "Multiply the thickness of the plate in inches by ten times the tensile strength of the material used, and divide the product by the area of the head (or sheet), in inches."

To take an example and apply this rule, let us suppose we have an unstayed sheet half an inch thick and measuring 6 feet long by 50 inches high. The equation for this would be:

$$R = \frac{T \times 10 \times Ts}{L \times B}$$

$$R = \frac{\frac{1}{2} \times 10 \times 50{,}000}{72 \times 50}$$

$$R = \frac{250{,}000}{3{,}600}$$

$$R = 69$$

where R is the resistance,
T is the thickness of the plate,
Ts is the tensile strength of the sheet,
L is the length,
B is the breadth.

A further investigation of this matter shows that if the plate is made twice as thick—i. e., 1 inch instead of ½ inch—the resistance will be double. It also appears that if the area be reduced to half what it was, or 36 × 50 inches instead of 72 × 50 inches, the resistance rises to double what it was, or 138. This is the number of pounds per square inch that the unstayed surface begins to bulge under. With a factor of safety of 10, the sheet ought not to carry more than 6.9 pounds per square inch, and where thicker plate is used or where the area is reduced one-half, a pressure of only 13.8 pounds should be permitted.

Whatever stiffness or strength this represents, it is not taken into account in the calculations for stays or staybolts in flat surfaces. It simply adds its quota to the factor of

* Member of American Society of Mechanical Engineers and formerly Consulting Mechanical Engineer of National Transcontinental Railway.

safety. That it exists and is an "asset" for the boiler is taken for granted, but it is not relied upon as part of the "strength of the structure." It is the "sleeping partner" of the factor of safety, that is all.

When we come to the calculation for stays and staybolts, we have to consider that we can only hold or tie the flat surface by means of bolts or stays separated from each other by regular distances and that the form of the plate—i.e., the flat surface—offers no resistance of itself as the form of a circular or even globular boiler would. We are, as it were, compelled to hold an area at a point. To clearly grasp the significance of this, we will suppose that we have a row of staybolts 4½ inches apart, center to center. It is manifest that each staybolt will be compelled to support the pressure on a space 2¼ inches on each side. In order to maintain the same proportion, a second row of staybolts will have to be placed 4½ inches from the first row, and so on until the entire surface is stayed.

It is evident that under these circumstances that each staybolt will support the pressure applied to one side of an area of 4½ by 4½ inches, or 20¼ square inches. If the internal boiler pressure is 150 pounds, the total pressure on 20¼ square inches, or the area supported by one staybolt, is 3,037.5 pounds, and the problem becomes one of deciding on the size of bolt to meet the conditions. If the factor of safety is 10, and the tensile strength of the staybolt iron is 50,000 pounds per square inch, it follows that the tensile strength allowable in the calculation will sink to 5,000 pounds. The area of a ⅞-inch staybolt is .60132, therefore this area when multiplied by 5,000 is equal to 3,006.6, which is slightly too small; a 1-inch staybolt with an area of .7854 would support 3,927 pounds on the area in question. This is slightly more than is needed, and the choice falls between ⅞ and 1 inch. As a matter of fact, a staybolt 29/32 inch in diameter is about what is wanted. This is 1/32 inch more than ⅞.

In dealing with stayed flat surfaces it is usual to assume that where the plate is riveted to another, as where the outside or casing sheets of a firebox are riveted to the back head and to the throat sheet, and to the mudring, etc., an area 2 inches wide measured from the back head, throat sheet or mudring, will be strong enough without requiring any staybolts, and this holds good for the top row of tubes.

One of the greatest menaces to the safety of flat stayed surfaces of boilers, such as that of firebox side sheets, is the fact that the heating and cooling of the firebox produce a slight up and down shifting of the outer and inner plates with reference to one another. This, of course, is very slight, but it is constantly at work, and as the firebox staybolts lie horizontally between them and are rigidly screwed into each, the staybolts experience a slight bending movement something like the way a man breaks a piece of wire in his hands, without cutting it. If the wire is bent back and forth in the same place often enough it breaks.

The staybolts in a firebox break for a similar reason, though very slowly; beginning with a small, superficial crack and going through all the stages of the "fracture in detail," until the effective area has become so far reduced as to give way under the internal pressure of the steam.

It is almost a daily occurrence in any busy railroad round house to see engines in for repairs to broken staybolts, and here, as in so many other departments of railway work, "eternal vigilance is the price of safety." It is more than probable that the area held by a staybolt in any well-designed and carefully built firebox, the theoretical areas (here taken at 20¼ square inches) really overlap the next, for we frequently find several adjacent rivets or rivets in adjacent rows broken, and yet without failure of the plates or apparent bulging of the sheets. Were it not for the large factor of safety and its "silent partner," it is probable that the effects of this slow but steadily advancing deterioration of the firebox sheets would be more readily apparent. The fact that no immediate disaster takes place is no guarantee of safety. Not only must the calculations be correctly made and the best material used, but the highest grade of conscientious workmanship must be employed, and over and above all this, the most unremitting and efficient inspection must be applied in order to secure that amount of working safety to which those concerned in working with or about locomotives are entitled.

One of the most effective stories written by Kipling, and entitled "Bread Upon the Waters," deals with the failure of a steamer shaft, first beginning with a minute superficial flaw or crack, and gradually growing as the fracture in detail slowly but relentlessly worked its way through the metal, until the final snap rendered the great ship helpless on the wide ocean. The story is entertaining, but it "points a moral and adorns a tale."

Layout of a Compound Elbow

BY J. MELDRUM

Draw the plan and space off on the arcs any number of equal spaces, in this case eight. Then in the elevation locate the pitch of the elbow, which is the distance from *A* to 1 for the bottom and *M'* to *U'* for the top. Divide these pitches *A*-1 and *M' U'* into the same number of spaces as we have in the plan, which is eight. From the plan project lines up from points 1, 2, 3, 4, etc., for the small radius, and 1', 2', 3', 4', etc., for the large radius. From *A, B, C, D,* etc., project horizontal lines intersecting the ones previously drawn from the plan. Through these points of intersection draw curved lines which will give the direction the elbow turns, and leads downward.

The top is produced in the same manner, except that the pitch *M' U'* is used for this, projecting the lines across. Then the elevation is the drawing used to work from for laying out the side plates.

Layout of Side Plates

Assuming the neutral diameter to be 36 inches, the corresponding length is 113.097 ÷ 4 = 28¼ inches. Draw a line of this length on the plate and divide it into eight equal parts, projecting up lines of indefinite length. Then get a piece of thin steel and mark off all the different lengths from the elevation, as 1-1', 2-2, 3-3, 4-4, etc., working from the base line. Place these lengths on pattern No. 1 as shown, which will give the true development for the small side.

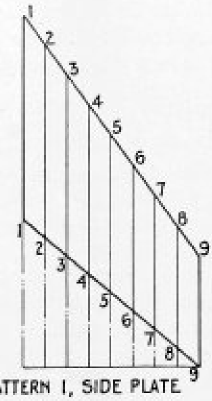
Pattern No. 2 (side plate) is laid out in exactly the same manner, only different lengths are used, as from 1 to 1', 2'-2', 3'-3', etc., on the large radius.

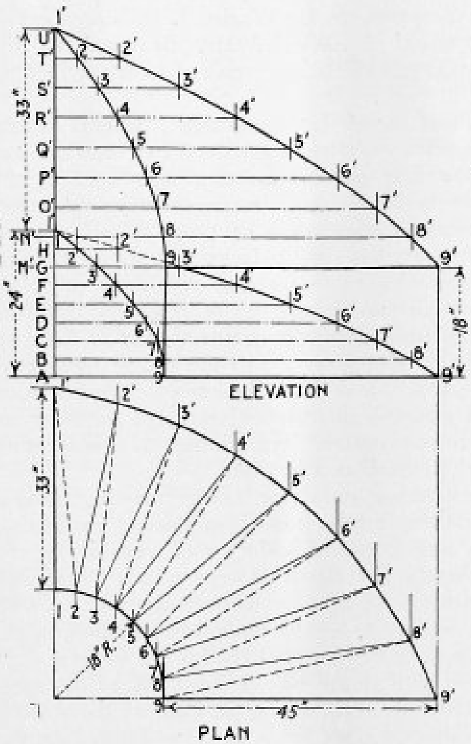
Layout of Bottom Plate

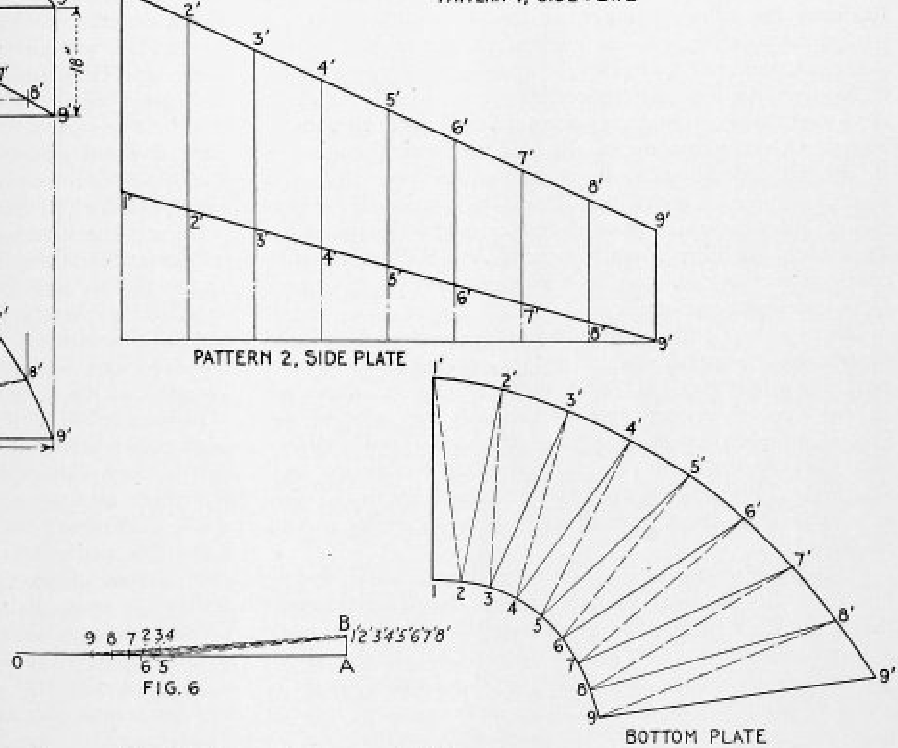
Going back to the plan, connect all points with solid and dotted lines, as shown. It should be remembered that the solid lines are the true lengths, while the dotted lines are not the true lengths.

To get the true lengths of the dotted lines, construct a right angle as at Fig. 6, and lay off the distance *A-B*, which is the drop the dotted line takes. Now, using these lines as bases, and marking them off on the line *A-O*, then the distances from the points *B*, 1', 2', 3', 4', etc., to points located on the base line, as 2, 3, 4, 5, etc., will be the true lengths to work from.

Erect a perpendicular equal to 1-1′, and with trams set to 1′-2, Fig. 6, with 1′ as a center draw an arc. With dividers set to the points 1-2 on the bottom (Pattern No. 1), draw an arc cutting the previous arc at 2. Then with the trams set to the solid line 2-2′ in the plan, and with 2 as a center draw an arc; then with the dividers set to points 1′-2′ on the bottom (Pattern No. 2) draw an arc cutting the solid line at 2′. Continue laying off in this manner, taking each line in rotation until the complete stretchout is drawn in.







Diagrams, Showing Layout of Compound Elbow

Our readers will notice that there is no camber on the side plates,, due to the fact that the drawing is on such a small scale. On laying it out to actual size, however, there will be a fairly large camber on the top and bottom of the sides. It is best to make the top and bottom of the elbow of four or more pieces on account of the irregular surface, and, when erecting the elbow, give the outside curve a few blows with a sledge hammer, which will cause the plate to buckle, so that it will give less trouble when putting it together.

It is a poor foreman who tells the boss that there are no more good boiler makers.

A man can learn a lot from books, and a magazine like THE BOILER MAKER, but skill cannot be acquired except by actual practice. No man ever learned from a book how to calk a seam.

Boiler Compound Does Not Cause Leaks

Some men are of the belief that boiler compounds cause leaks. They come to this conclusion, usually, through the fact that very often leaks occur soon after compounds are fed into the boiler. "Hence," they say, "compounds cause leaks."

However, this is not true, strictly speaking. The compound is an indirect cause, because its action is to dissolve scale from the interstices which should not exist. Scale should not be used as a "packing." There should be no scale whatever. So, when a compound is injected it actually does good when it uncovers a defect in tube rolling or calking.

Boilers should be kept clean always. That is an old and well established principle for maintenance of highest boiler efficiency. Compound pumped into a new or clean boiler that does not leak will not "cause" leaks.

New York. N. G. NEAR.

Boiler Manufacturers' Meeting at Erie, Pa.

Uniform Boiler Laws and Uniform Cost-Keeping Systems Discussed at Twenty-Seventh Annual A. B. M. A. Convention

The twenty-seventh annual convention of the American Boiler Manufacturers' Association of the United States and Canada was held at the Hotel Lawrence, Erie, Pa., June 21 and 22. President W. C. Connelly presided at all sessions, Mr. J. D. Farasey officiating as secretary.

Report of Committee on Uniform Boiler Laws

The activity of this committee during the past year, or since the report submitted by us at the 1914 New York convention, has been confined principally to getting a uniform draft of a boiler code through for adoption by the American Society of Mechanical Engineers.

Messrs. Broderick and Connelly of this committee met in Pittsburgh on September 14 with Messrs. Schaaf and Rees, also members of this committee, and went over the proposed rules of the American Society. The committee on the evening of the 14th left for New York, met Mr. Barnum, the other member of this committee, and attended the meeting in New York of the American Society at their rooms, and spent two days and part of one evening in debate with the boiler committee from the A. S. M. E. A vast amount of good was accomplished from this meeting, at which were some of the best mechanical engineers in the United States, also a committee from the steel manufacturers, a committee from the National Tubular Boiler Manufacturers' Association, a committee from the Threshing Machine Manufacturers' Association, committees representing the railroad interests and a committee from this organization.

The two days and one evening of sessions were devoted to debating the principal points upon which these different people in attendance had different views, and we might say at the time of adjournment of this meeting most of the important questions had been pretty well ironed out, so that every one of the different interests was pretty well satisfied. This meeting adjourned to meet for final action at a later date, the different interests again being invited to attend.

On September 29, 1914, a joint meeting of the Thresher interests, the National Tubular Boiler Manufacturers and the A. B. M. A. was called at Pittsburgh. At this meeting a joint committee of three, one from each of the above interests, was appointed to further take up this question, and a subscription of ten dollars per month was voluntarily made by those in attendance to pay for the expense necessary for this new committee to continue this work.

Since that date this committee's activities have ceased.

L. E. Connelly, Chairman.
M. H. Broderick.
A. J. Schaaf.
Thomas M. Rees.
G. S. Barnum.

Report of Committee on Uniform Standard Specifications

Five years ago the National Tubular Boiler Manufacturers' Association saw the absolute necessity in their business of having a standard uniform specification. The facts that led up to this are so apparent that it is scarcely necessary to mention them. The absence of this specification made it extremely difficult to conduct a large interstate business due to various States having regulations concerning boilers.

Prior to this time, your chairman had repeatedly written out letters to various boiler makers agitating the subject, but the first concentrated action with the tubular boiler people was about five years ago.

They appointed a committee to draw up the standard specifications. The committee consisted of Mr. W. M. Taylor, chairman, T. E. Durban, vice chairman, M. F. Moore of the Kewanee Boiler Works, J. B. Stanwood of Houston, Stanwood & Gamble, Mr. Brownell of the Brownell Company, and Mr. Stemmel of Casey & Hedges Company.

At the first meeting of this committee a general outline of the requirements covering a standard specification was discussed. Our first general meeting was held at the Hotel Schenley in Pittsburgh, concurrent with the meeting of the American Association of Steel Manufacturers. We had with us at that time a large number of tubular boiler concerns and a representative of all the principal insurance companies and inspectors representing different States and cities throughout the country, even as far west as Seattle, Wash. Every section of the country was covered by a unanimous resolution. Seventeen different items were covered and the committee instructed to draw up specifications in conformity. The minutes of this meeting were published in detail and sent out.

During the meeting and prior to the meeting several telegrams were sent by the American Society requesting us to take no action, as the society was working on the code. Subsequently, two meetings were held at Pittsburgh and the committee reappointed to work in conjunction with the American Society and to promulgate and advocate the adoption of the code when completed by the society.

In connection with this work the members of the committee have attended a meeting in St. Paul of the American Society and many meetings in New York. At the December meeting of the A. S. M. E., where it was generally understood the specifications would be adopted, no conclusive action was taken, much to the chagrin and disappointment of your committee. Your committee immediately got busy, visited New York and Boston, and consulted prominent members of the society and began vigorously a campaign to overcome the objections of the society to proceed with the work, in which the greatest possible assistance was given by the chairman of the A. S. M. E. committee, Mr. John A. Stevens, and also by his associates.

After visiting a large number of the council of the society certain decisions were reached that the society's committee should go on with the work and complete it under certain conditions, which was done, and the final code was adopted by the society on February 13, 1915. This delay in adopting the code very largely handicapped your committee in promulgating same.

Progress in the adoption of the A. S. M. E. boiler code is shown by its acceptance by the State of Pennsylvania, by the city of Chicago (which probably means that it will ultimately be adopted by the State of Illinois), by its endorsement by the Master Boiler Makers' Association, and by the favorable attitude taken by the Superintendent of Safety of California and by the Inspector of Boilers of the city of St. Louis.

The following legislatures convene next spring, all of whom we are in communication with: Kentucky, Louisiana, Maryland, Mississippi and Virginia. All of the rest of the legislatures in the country will not convene until **1917.**

Due to the slowness with which the boiler code came through the A. S. M. E., as mentioned before, your committee was enormously handicapped, and your committee expresses itself without reserve that had this code been in its hands six months sooner, as was originally anticipated, many more States would now have it written on the statute books.

We have a report that the State of Tennessee has appointed a committee to draw up a code and we are in touch with them.

The report also contains a statement of the financial condition of the committee and a list of contributors to this work.

In conclusion it is the unanimous opinion of the committee that this code can be made to prevail throughout the United States, and that they have a firm hope that it can be brought about to have the Canadian provinces adopt the same specifications, but it is absolutely essential that an unceasing effort must be behind the movement; that if this effort is not put forth with the utmost vigor we cannot hope to have the code by its own momentum predominate throughout the country.

There never before has existed in the country an opportunity to promote a standard specification that now exists, and probably the same opportunity will never again exist. The "Safety-First" movement and the desire to standardize laws is at its best now, and in the future some other great questions will no doubt come up that will occupy the attention of the public at large, and our opportunity will have been lost unless we pursue the subject now with the utmost vigor.

I cannot impress upon you too strongly the fact that the committee must have the unlimited support of the people that want this code to go through. I can't impress upon you too strongly that the committee has got the publicity necessary to put the code through, and, to repeat myself, great things are only accomplished by publicity. Publicity will cure all evils from which we suffer, and will promote all good things we desire to obtain.

Thomas E. Durban, Chairman.

Mr. H. A. Baumhart, of the Ohio Board of Boiler Rules, was then called upon.

Abstract of Mr. Baumhart's Remarks

The Ohio Board of Boiler Rules was organized in August, 1911, and the law, or rules, became operative on January 1, 1912. Quite naturally, there was considerable opposition to the rules. Some of the boiler manufacturers had an idea that it would put them out of business and that they could not manufacture boilers according to the rules. Some of the steam users had an idea that it was going to condemn their boilers and confiscate their property. The rules have been in force now for three and a half years. Last year in Ohio there were about 24,000 inspection certificates issued covering boilers in use in the State of Ohio. So far as I am able to learn, there has been no boiler shop put out of business because of the rules, and I believe that there has been no prosecution because of violation of those rules.

There is one condition, however, in Ohio that has annoyed the Board considerably, and that was the fact that boilers constructed to meet the Ohio rules could not be lawfully installed in some other States, and boilers constructed to meet the laws of some other States could not be installed in Ohio. The Ohio Board of Boiler Rules realized the situation and we did co-operate, and we are now co-operating, with this Uniform Specification Committee to remedy that evil. To show that we were sincere in the matter, just as soon as we received an approved and verified copy of the A. S. M. E. Code we called a special session of the Board, and amended the Ohio rules to include it.

Chairman Neff requests me to state to this convention that the Ohio Department will continue to co-operate with that committee and to do everything in its power to extend it to cover other States, provided, of course, that we do not lose sight of the motto "Safety First."

Practical Application of the A. S. M. E. Code

The next speaker was Mr. John A. Stevens, chairman of the boiler code committee of the American Society of Mechanical Engineers, who said in part:

Broadly speaking, the American Society of Mechanical Engineers' boiler code is simply a carrying further into the future the Massachusetts standard with the assistance of some of the best boiler engineers in this country, and we were especially assisted by your association and the great effort put forward by your members in this work. If the American Society of Mechanical Engineers' code is complete and what it should be, the men chosen to formulate rules on boilers would naturally take this work and make use of it, and of course the sooner the better, for to my knowledge the boiler making industry in the past twenty-five years has been a greatly harassed industry, since, with so many opinions as to what is right, the poor boiler maker does as he is told, irrespective of what he knows about the business which he has developed.

If you decide among yourselves that the A. S. M. E. is the best, the more missionary work is done the sooner it will be brought into general use. Two or three standards later on might multiply to twenty-five different standards out of a possible forty-eight. In America we should have one standard, and if not the American Society of Mechanical Engineers', choose the one you will have and we will all turn about and work for you to make it universal. I, for one, am thoroughly convinced that there should be but one standard of boiler construction in this country.

Personally, I am very glad to be relieved of the boiler engineering of power plant work, for that is about the only part of the plant which may destroy life and property if it goes wrong, and as long as I can find a reputable standard to tie to I, for one, am glad and willing to sacrifice my own individuality and ideas that may be good or bad for the sake of this protection.

For the first time in the poor boiler makers' history—and I say poor, for generally speaking boiler makers do not make their money very readily or easily—they are legally in a position to charge more for their product, for unquestionably and beyond any doubt boilers built to the American Society of Mechanical Engineers' standard will cost from ten to twenty percent more, according to the type of boiler, and in this world you cannot expect people to furnish or do anything without compensation.

President Connelly next called upon Mr. C. H. Wirmel, who represented the National Association of Stationary Engineers.

Abstract of Mr. Wirmel's Address

As practical men we fully appreciate the work and the effort on the part of the code committee in perfecting a system whereby we can avoid the confliction under present conditions in boiler construction, which is a matter of vital interest to all steam users, insurance men, and the inspection departments of our various States and cities. Now, it appears that this code has been uniformly adopted by those various interests that I have just enumerated.

I can assure you that in so far as our organization is concerned all the leading engineers are in accord with your views and in accord with this code; and we feel that the next step in promulgating the uniform code is to advertise it, as Mr. Durban says, and urge upon all the States the adoption of it. I believe the State ought to be used as a unit in the adoption of this code wherever it is possible to do without conflicting with the local authorities in such communities where they have local ordinances and laws regulating the use and construction of steam boilers.

We have in our organization upwards of twenty thousand members from every State in the Union. We intend to recommend to our coming convention, which will be held on the second Tuesday in September, Columbus, Ohio, the adoption of the code, and also urge upon our educational committee to carry on the work by means of literature and written instructions to the various organizations throughout the country, and thereby bring the code itself directly home to the man who operates the boiler.

The next speaker was Mr. John C. McCabe, chief boiler inspector of the city of Detroit.

Abstract of Mr. McCabe's Remarks

Detroit adopted the first regulations governing the use of boilers on September 20, 1881. The regulation was very reasonable because it did not specify anything. Any person might send a boiler to Detroit, and the only question at issue was what the opinion of the inspector would be as to how much pressure that might carry. Incidentally, there is reason to believe that more or less guesswork was done. In 1908 the matter of adopting something specific in the way of a regulation relating to boilers was brought up. There was some opposition that was not well founded against such a regulation. The regulation was the Massachusetts Code in its entirety. That was adopted on June 1, 1910, becoming effective January 1, 1911. Under the general powers we have always accepted the branding of the Massachusetts stamp and also the Ohio.

While the question has arisen as to accepting the A. S. M. E. branding, I see no reason why it cannot be done, even under the present law, for the reason that the corporation counsel of the city has told me that the only question for me to decide is whether a boiler is reasonably safe or not, and that the mere details of construction would not stand.

In regard to the attempt to pass a boiler law in Michigan last winter, I wish to say that the major part of the credit for the effort should be given to the National Association. The bill passed the Senate without a dissenting vote, but was held up in a committee in the House for the reason that the copper interests were apprehensive that the code would work a hardship on them. In order to interest the farmers the bill provided for the appointment of the head of the new agricultural college at Lansing as a member of the board. I am quite certain that if the publicity, as suggested by Mr. Durban, is carried out throughout the State, to the extent of advertising in agricultural papers, it will result in the adoption of the code two years from now with practically no opposition.

Not a little of the opposition is probably due to the efforts made by the unions to pass a boiler inspection law. I would advise that the boiler inspection code or bill be kept entirely apart from any license regulation. The trouble with most of the licensing regulations is that there is a tendency to get local politics and State politics mixed in it, and if the effort is made jointly it is going to retard the adoption of the uniform code.

Further Discussion

Mr. H. P. Goodling (A. B. Farquhar Company, York, Pa.): There is one point that comes to my mind, and that is the question of how you mean to put it in operation. Now, in the threshing industry, which I represent, the inspection offers quite a difficult proposition. On a large tubular boiler running into thousands of dollars the matter of inspections does not amount to so much, but on a small boiler of 100 and 150 feet of heating surface, it means something, and what I would like to see at this meeting is some definite step taken towards putting this code into operation. Our interests are thoroughly satisfied with the code, and we want to see it adopted in the various States, and with it a proper inspection law. I don't think that there is any question but that the code itself should be separate and apart from any licensing provisions. We have got to devise some practical means whereby the code can be put into effect in the various States and the inspection and operation taken care of at the same time.

Mr. Michael Fogarty (President, Michael Fogarty, Inc., New York City): You can't get a code made into a law to govern boilers when there isn't a law to govern boilers. You must first establish the law by legislature. The legislature appoints certain committees, and the members of these committees will get together to fix up the rules and regulations. That's the time to get your boiler code. Before that you can't do anything.

New York City is governed by the police department so far as boilers are concerned, and they work under the United States laws governing steam vessels. There are 38,000 boilers in New York City inspected by the police department, not taking into consideration those in the public schools and public buildings. The public schools have got about 1,600 boilers. Also, we must not forget the number of boilers in apartment houses which are not examined at all, as they carry but ten pounds of steam or less.

I have tried, with other men like myself interested in boilers, to get a law passed in the State of New York. About two years ago we introduced a bill, or rather we tried to, but it was like trying to pry open a door with a jimmy. The committee that had the matter in charge was composed of nine lawyers, two real estate men, a saloon keeper and a labor agitator. They took no action regarding the bill.

With the opening this year, however, of the New York Constitutional Convention, to which I am a delegate, I have proposed the following constitutional amendment:

"State of New York, No. 500. Proposed Constitutional Amendment. To amend article five of the Constitution by inserting a section, in relation to loss and damage by explosion of pressure carrying vessels and known as the Steam Boiler Inspection Service.

"The delegates of the people of the State of New York, in convention assembled, do propose as follows:

"Article five of the Constitution is hereby amended by inserting therein a new section, to be properly numbered, reading as follows:

"The execution of all laws in regard to the safety of vessels subject to pressure of steam, water, air or gas shall be vested in a department or bureau, the head of which shall be appointed by the governor by and with the advice and consent of the Senate, and who shall hold office for six years, and who shall be qualified according to standards to be prescribed by the civil service commission."

When the proper time comes I hope you will pass a resolution in favor of this proposed amendment.

Mr. F. W. Herendeen (Secretary of the National Boiler and Radiator Manufacturers' Association): The Boiler Code interests the manufacturers of cast iron boilers, and they, like yourselves, are giving it publicity the best they know how. The work of our association and the work of your association do not touch at very many points, but do touch along the lines of a proper inspection law, and therefore I am here more in the capacity of an emissary bringing to you the thought that our association will be very glad to work in harmony with you on proper inspection laws, which, after all, I think is the real root of the matter. I think if we could get good inspection laws that the States will adopt the Boiler Code.

Mr. Barnum, of the Bigelow Company, of New Haven, Conn.: Last week six boiler manufacturers from the New England States, four of them from Massachusetts, one from Maine and myself from Connecticut, held a meeting. Mr. George A. Luck was one of the four Massachusetts members, and he is a member of the Board of Boiler Rules. After talking over this matter of the Society Code, they came to the opinion that it was their wish and desire that they might retain the Massachusetts Code, but still that the Board have the power to make such regulations that a purchaser could order a boiler made from the Engineers' Code, and it would be admitted into the State of Massachusetts. If the Board has not now the power, doubtless special legislation will be passed.

MONDAY AFTERNOON SESSION

Annual Address by the President of the A. B. M. A.

At the twenty-sixth annual convention of this association, held in New York City in September, 1914, you conferred upon me the honor of the presidency of your association. I am sure there were other members better equipped than I to succeed our honored president, Col. E. D. Meier, who at that time was in very bad health, and has since departed this life. However, inasmuch as you did select me from your membership for the position of president, I accepted the place, realizing the responsibility, and promising to give you my best efforts for the good of the industry in which we are engaged.

While I may not have performed the duties incumbent upon the position to the full satisfaction of the entire membership, I trust you will believe me when I say that what mistakes I may have made were those of the head and not of the heart, for I assure you that at all times it has been my earnest endeavor and wish to serve you all faithfully, and to bring about the greatest good for our association.

When we were assembled in the Waldorf-Astoria hotel at New York last September war had just been declared by some of the European nations, and none of us could predict what result it would have upon business conditions in this country. Since then we have all passed through a time of business depression which has been as serious as any which has occurred within the past twenty years, and perhaps some of you older men who have been boiler manufacturers for twice the period I name cannot recall a time when general business suffered as it has during the past nine or ten months. Present indications are toward an improvement and let us all hope that this improvement may steadily continue until conditions are again normal.

I take it that the vital question which everyone here present is asking of himself, is "What can we do that will tend to put the boiler manufacturing industry back where it was prior to the panic of 1907?"

During the past few years many changes have occurred in our line of endeavor. Massachusetts and Ohio were the first States to pass legislation regulating the construction of high-pressure steam boilers, and as you have already heard a report on the activities of other States, as well as the action of boiler manufacturers relative to a uniform boiler code, I will not take up any time in discussing the details of that work, but wish to emphasize the fact that this new regulation of boiler manufacturing, while being welcome to us all, has certainly curtailed the production of all shops, and this has advanced the manufacturing expense in a considerable percentage.

Another thing that has tended to increase the cost of manufacture has been legislation regarding "Workmen's Compensation." As I understand it, about thirty States have already passed a law on this subject, and no two are identical. The cost of carrying liability insurance has greatly increased. In 1910 the rate paid by our firm was 40 cents, while to-day, under the Workmen's Compensation Act, we are paying a rate of $1.76, which you will see is more than 400 percent as much as we paid five years ago.

Again, the expense of conforming to the "boiler code" of various States has certainly increased the expense in the matter of office records, making out data sheets, etc. On one lot of fifty boilers, made to conform to Massachusetts, Ohio, Detroit and Chicago laws, we made out six data forms for each boiler, which meant a total of three hundred data reports. The time of properly recording the requirements of these reports and making out same was considerable.

In fact, the cost of manufacturing boilers has been climbing steadily, while I believe that the selling price of boilers has been either stationary or declining, and certainly it has been the latter during the past year.

It has been my opinion for several years that many boiler manufacturers do not go into the subject of "costs" as they should, and I had the honor of presenting to you at the twenty-fifth annual convention at Cleveland in 1913 a paper giving my views on this subject. We have a committee at work now on this subject, and I feel sure that what they will have to present to you at the morning session to-morrow will be of great value to us all. The methods of computing the cost of a job and the percentage for "overhead" as in vogue ten years ago, will certainly not prove efficient nowadays, with the added cost of manufacture, curtailment of production and increased selling expense. The cost of obtaining business has greatly increased, owing to excessive competition. Each manufacturer has been adding to his sales organization trying to get a larger proportion of the business that is going. This, too, has led to destructive prices, and I would here call attention to the fact, as being my opinion, that ruinous prices do not increase the volume of business to be had, and whoever does get the business usually does so at a price that means no profit and frequently a loss. It has been said by many boiler manufacturers that the year 1913 was the best they ever had, in so far as volume goes, yet I am sure that very few if any of us feel that we earned a just return during that year. It has also been my observation that an unusually large number of boiler manufacturing concerns failed during 1913.

Another matter that has occurred to your president as worthy of your consideration has been the subject of a "uniform guarantee" clause pertaining to materials and workmanship, also uniformity as to terms of payment. For that reason a committee has been appointed and we will have a report on same by Mr. E. R. Fish, vice-president of the Heine Safety Boiler Company, who has acted as chairman. It seems to me that this is a most important matter, and one of our difficulties that can be most easily rectified.

Another matter that should have your earnest consideration is the proper method to pursue in order to have the boiler code of the A. S. M. E. adopted by the various States now without such legislation, and also the matter of financing this work. Your president has given some thought to the subject, and it is my opinion that the proper way of financing this would be:

By increasing the membership dues of this association to create a fund large enough to defray the expense of the work, fixing a minimum of, say, $20 per year, as is now the dues, and a maximum of, say, $100 per year, and have each member pay in proportion to the benefits received.

Those firms who build boilers in less than, say, 2,500 horsepower per year, or do not build anything but tank work, should pay the minimum of $20. Those firms building over 2,500 and less than 10,000 horsepower per year to pay $40 per year. Those firms building over 10,000 and less than 20,000 horsepower per year to pay $60 per year. Those building over 20,000 and less than 100,000 horsepower to pay $80 per year. Those building over 100,000 to pay the maximum of $100 per year. If any member feels inclined to pay more dues than is his just proportion according to the method which this association adopts, I am sure the additional income will be welcome.

Or, the dues could be graded in much the same manner in a proportion to the actual capital invested by each firm; or again, the dues could be graded in proportion to the total volume of business by each firm. However, it is your president's opinion that the first method is the most just, for the reason that the benefit derived by the boiler code is in direct ratio to the amount of boiler horsepower sold.

I would suggest the action of appointing a committee later in the day to carefully review this matter and report before the close of our convention.

The next question that arises after providing funds to carry on the expense of establishing the new code in the various States, is what method is to be pursued in order to accomplish this purpose. As most of you know from the report of the chairman of the committee appointed at Pittsburgh on September 29 last, that committee was appointed to assist the "boiler code committee" of the A. S. M. E. in preparing a final draft of their code. This work, as you know, was accomplished, and the State of Ohio at the next session of their "Board of Boiler Rules" passed a resolution making any boiler built in accordance with the A. S. M. E. Code as acceptable.

This committee has completed its work and made you a full report as to its activities. Ways and means must now be devised to install this code into the other States. This is a work that will take considerable time as well as a fairly large amount of money. I have already suggested my idea of the proper method of securing funds, and for doing the other work I am of the opinion that same should be done under the direction of the executive committee of this association, the president appointing a local committee of three or four members in each State. On the local committee should be boiler manufacturers of that State, and I would also make eligible to such committee representatives of boiler inspection companies, manufacturers of threshing machines operated by steam, also makers of "boiler steel," if there should happen to be such a plant in that State. The actual expenses of these committees should be paid from the funds of this association. Perhaps it might be advisable (if the expense could be met) to have a paid secretary devoting his entire time to and working under the instructions of your *president* and *executive committee,* who could assist the "local committee" in each State when the legislative body was in session. It seems to me that to ask any committee of members to act for more than their own state is asking entirely too much of them, and perhaps it might result in neglect of the work. However, these are only suggestions, and the operating plan is to be decided by you gentlemen.

There is another matter that seems to me as being worthy of your consideration: We have with us two men who were former presidents of this association, and I am sure you will all agree with me when I say that they have each done as much for this association as any single individual. Both of these gentlemen have practically retired from boiler manufacturing, but I am sure you view the matter as I do, that we shall always welcome them to our conventions. I therefore suggest a change in the by-laws if necessary, in order to create the place of "honorary members" to which all presidents of this association may be eligible upon their retirement from active boiler manufacturing, and that no dues are to be paid by any one so elected. As I hope to be a manufacturer for a great many years more, I trust you will see that I have no selfish motives in making this suggestion. The two former presidents that I have in mind are Mr. Henry J. Hartley, of Philadelphia, and Mr. Richard Hammond, of Buffalo.

Another matter that occurs to me as being worthy of mention is for this convention to discuss the advisability of appointing a committee who would work with the engine manufacturers, or at least a committee of engine manufacturers, and do some careful figuring in order to show that an ordinary size factory or building can purchase power equipment and make their own power at a cost less than the price of the same amount of power from a central power station. It is my opinion that tables can be worked out showing this to be a fact, and if so it would result in an increased sale of boilers, engines, pumps, etc.

I would also suggest a change in the manner of the election of officers, and instead of doing so by a nominating committee, would suggest that the election of officers be made either in open meeting at the convention or by the method given in the original by-laws of this association.

It has been your president's idea that no person should be elected as president of this association for more than one year, but in talking the matter over with some of the other members I have been unable to get anyone to agree that they feel the term should be limited to the time I mention. However, they did feel that it might be advisable to change the by-laws so that no member would hold the office of presidency for more than two successive years.

Another matter that I also wish to bring to the attention of this meeting is that a method be worked out by which a boiler made in any State and accepted by the authorities in that State be acceptable to the authorities of all other States. In a measure this can be taken care of when all of the States have adopted or accepted the A. S. M. E. code as their standard, in which case, instead of stamping on the boilers the names of several States or cities, it would then be stamped with the name of the State in which it was built, as well as its registration number for that State. The only additional stamping that would then be needed would be "A. S. M. E. Standard."

Your president would also suggest as a matter for your consideration, as to whether it is or is not a fact that when the boiler manufacturers sell watertube boilers and guarantee them to carry a large overload capacity (some 50 or 100 percent overload), do we not thereby decrease the volume of the boiler business by the same percentage as the overload capacity guaranteed?

If it were within my power to do one thing for this association, and I had a choice in selecting the one thing to be done, it would be to instill into each and every member the "spirit of co-operation," for in my opinion that would be the greatest and most lasting of all beneficial things I know of. With kindly feeling existing and a

spirit of helpfulness instead of hostility, I am sure we could go forward much further and much faster, and as a result have something tangible to show for our efforts. In cities where there are several boiler manufacturers there should exist a feeling of "good fellowship," and they should meet occasionally and "iron out" any misunderstanding or difficulties existing between them. If necessary, this association should act as a mediator.

I wish to commend those men who have labored in the past as members for the things this association has sought to do. Very few remain of the original fifty who assembled at Pittsburgh twenty-seven years ago to found this association. To those who have been members for a long period of years I feel there is due our sincere thanks. Some of us may have perhaps criticised what this association has or has not accomplished, and in answer I say that those who have been boiler manufacturers during these past twenty-seven years and failed to become members of this association, or perhaps did become members but failed to support its work by attending the conventions and lending their assistance, should not speak harshly of the association for not having accomplished all that might have been done.

I am of the opinion that the proceedings of past meetings will show that pretty much the same members met year after year and did the actual work that was done, and in justice to those men it must be said that they did do some valuable work. The boiler rules prepared by a committee of this association in 1899 shows the activities of those men, and had the time been opportune and the spirit of co-operation pervaded the atmosphere of boiler manufacturers at that time, we should have had a uniform boiler code many years ago. Perhaps it may be said that I belong to the younger generation of boiler manufacturers, and as one I tender deepest respect to those who have preceded us, many of whom have been called to their final resting place.

Again I remind you that without "co-operation" we cannot accomplish the work before us. Furthermore, no organization can thrive where factions exist, and I would therefore caution against anything tending toward that. I would also take this opportunity of thanking all members of the various committees for the time and effort spent on their work, and, in fact, I thank the entire membership of the association for their loyal support.

I would also bring to your attention the work of your secretary, who has served this association for so many years. During the past year I have been in close contact with him in the work of the association, and he has always been willing to give freely of his time to the work of this organization. Furthermore, I know that he has personally paid traveling and other legitimate expenses in looking after his duties that should rightly have been paid by the association. He has served you during the past year without any compensation whatever, and I think for some years prior under the same conditions.

I would also commend the boiler manufacturing firm of Wickes Bros. for the work they did during the recent meeting of the Michigan Legislature in behalf of the A. S. M. E. code. I would also at this time make mention of the valuable services rendered for the same cause and at the same time and place by John C. McCabe, chief boiler inspector at Detroit.

As a summary of what I have offered for your deliberations:

1. Adoption of a uniform cost-keeping system.

2. Adoption of a uniform guarantee clause pertaining to materials and workmanship.

3. Adoption of a uniform clause relative to terms of payment for our products.

4. Proper action relative to method of procedure for adoption in all the States of the A. S. M. E. code.

5. Consideration as to change of annual dues in order to obtain funds necessary to carry forward the work of adoption in all States of the A. S. M. E. code.

6. Consideration of change in by-laws for creating post of "honorary members," making eligible former presidents no longer actively engaged in the boiler industry.

7. Consideration of an amendment to by-laws relative to election of officers, either by method given in original by-laws or by election in open meeting.

8. Consideration of subject relative to having a committee work out tables or data pertaining to cost of manufacturing power as against central power station prices.

9. Consideration of a method whereby a boiler may be registered only in the State where manufactured, provided same has been built according to the A. S. M. E. boiler code.

10. Consideration of an amendment as to the president holding office for not more than two consecutive years.

My final word to you is: Let us stand together for all that may be beneficial to our industry, to advance slowly, steadily and to support in a proper manner those whom we select for our leaders.

Whatever may be your opinion of the service I have rendered you, I am sure you have done much for me. As president of your association you have given me a vision of what this association can be, and I hope and trust to see that vision realized. The experience of having served you during the past year shall always remain a precious memory, and I tender you my deepest gratitude. I bespeak for my successor your earnest and undivided co-operation.

W. C. CONNELLY, President.

Capt. T. M. Rees, vice-president and general manager of James Rees & Sons Company, Pittsburg, Pa., objected to provision of the A. S. M. E. code favoring buttstrapped joints as against lap joints for boiler shells and spring-loaded safety valves as against the lever safety valve. He maintained that in the fifty or more years that he had been engaged in the construction of steam boilers of all types, and especially of the Western river steamboat boiler, he had failed to find an instance where any trouble was experienced with the lap seam construction when properly made. To support his contention he read reports from the principal district offices of the United States Steamboat Inspection Department showing that there were practically no records of failure or any troubles experienced with the lap seam construction of marine boilers under the supervision of the United States Steamboat Inspection Service.

Mr. Wynne: For the benefit of those who are doing a Canadian business, all of the provinces except one have agreed on a set of rules. They have not formally done so, but it is generally understood they will. Each province will adopt the code of rules formulated by a committee of chief inspectors which got together last year. Alberta has refused to come into the meeting and is still holding out. We hope to get them in line too.

Report of Committee on Clause for Uniform Guarantee Pertaining to Material, Workmanship and Terms of Payment

The letter of inquiry sent out asking for information as to the present practice of the several manufacturers of boilers met with very satisfactory response, and indicated, as was to have been expected, a very diverse practice. The forms used by some are very full and in considerable detail, while others include but very little. In submitting the suggestions which follow, the committee enlarged somewhat on the scope indicated by its title.

The first suggestion is that all matter relating to the design, construction, advantages, etc., of each particular type of boiler be separated entirely from the form of contract, making the former, however, a part of the latter by specific reference. In this way the general customs of the trade as to guarantee of materials and workmanship, replacing of defective parts, responsibility for damages, retainer of title, terms of payment, etc., may be widely and uniformly disseminated by having them concisely stated on a separate sheet which would contain the several signatures necessary to the consummation of the contract. What is herein suggested are intended as minimum requirements to which may be added such other clauses as individual preferences may dictate. It is quite possible that one form may not be applicable to all kinds of trade, although the general plan should not differ very greatly.

Retainer of title clauses are, as a matter of fact, not very much good because the laws of different States vary considerably and different procedure is therefore necessary in different localities. Making it incumbent upon the purchaser to take the necessary legal steps may help some. Retainer of title clauses are now in quite general use.

As every manufacturer is keenly aware, sales f. o. b. shop or destination are preferable to any other kind and the form is written on that basis. Of course it not infrequently happens that contracts have to be taken with very different provisions.

Another difficult point and one with which every manufacturer inevitably comes in contact to a greater or less degree is as to the determination of what constitutes defective workmanship and material and how responsibility for such shall be determined. Some forms make the seller the sole judge. More often than not the politic manufacturer assumes the responsibility because the customer says it is his fault rather than to have any controversy. This is somewhat on the theory that the large department stores follow in assuming that a complaint that a customer makes is justified just because the customer says so, figuring that the satisfied customer and his continued patronage is better than saving a small immediate pecuniary loss, even though it may not be a just claim.

One form which was received was in the nature of a lease for goods furnished, the title to the property to pass only after full stipulated payment has been made, at which time a legal bill of sale for the property is delivered. Failure to make any payments gives the seller right to enter the premises and remove his property, all payments that have been made being considered as rental. This form would avoid any retainer of title procedure, but I doubt whether it could be generally used. In the pages supplementary to these general clauses will be included the detail specifications of the manufacturers' product, both as regards material, design and workmanship, together with such lists of fittings and trimmings to be supplied, personal services to be furnished, and additional work to be performed as circumstances require.

One form of proposal made shipment contingent upon shop conditions, it being stated that the shop conditions at the time the proposal was made were such that it could be reasonably expected that the date of delivery could be met. Delivery should be contingent to some extent upon furnishing such full details as the purchaser must supply.

Verbose phraseology is to be avoided, for it tends to add to the salesman's burdens. Most of the forms submitted show that manufacturers in general try to make the clauses of their contracts as brief as possible. The great majority of sales are with honest and financially responsible purchasers, with whom it is entirely satisfactory to do business from every standpoint. It is only for the occasional exception that it is necessary to provide, and special provision may be made in such cases, if known beforehand, as many of them may be.

Doubtless most of you have had exasperating experiences with steam heating contractors. Generally speaking, they are a comparatively irresponsible lot, doing business on a limited capital and depending on those from whom they buy to carry them along. If for any reason their payments are held up, those who furnish them materials are held up also. It would be most acceptable to us as boiler manufacturers who often furnish a large item of their equipment, if some positive stand could be taken and prompt payments as per contract be insisted upon. This is more a matter of education in teaching such purchasers of boilers what to expect.

All of the above remarks and the suggested forms and clauses are the opinions of only a few and are presented with the idea that this is merely a foundation for discussion on which to build a general consensus of opinion and develop a plan that will be generally acceptable.

E. R. FISH, Chairman.

President Connelly: Before we close the afternoon session, I want to have the association hear a word from C. V. Kellogg, president of the National Tubular Boiler Manufacturing Association, a man who has been doing a great work for the tubular boiler people.

ABSTRACT OF MR. KELLOGG'S REMARKS

The National Tubular Boiler Association was organized in 1906 to better conditions, and to better conditions not only as to the manufacturer, but also to discuss the question of costs and that which we are all after, the item of profit. The first movement we undertook was the formation and adoption of a uniform price list. When we got to using that uniform price list and attempting to make quotations from it, we ran up against the other problem, the question of specification. We saw that it was necessary in this age to have a uniform basis, or uniform standard. We also found that no one manufacturer in those days, or even at the present time, could better his condition alone, and that it needed co-operation. Hence, a committee was appointed which was to adopt, or try to form, a uniform standard of boilers. That committee did adopt seventeen different propositions which pertained to the uniform standards of boilers. That was printed and sent out over the signatures of thirty-two or thirty-four different manufacturers. That was really the movement that started and led up to the question of the uniform code. The National Tubular Association, through your president, has been asked to join with your body either as a body or individually, which matter is now under consideration.

I want to say to you in behalf of our members of the National Association that we are in hearty accord with the movement to better conditions and to further the adoption of the uniform code, for that is a matter of great importance to us.

Now, what we are all after in this industry are profits. There is no line of industry to-day that, in my notion, is so badly off from a financial standpoint as the manufacture of tubular goods. Why? Because you are at the mercy of the buyer; because you are at the mercy of different specifications, and you are at the mercy of any change. Now, once having adopted a uniform standard, you come to the next problem, which is the all-important problem, and that is how you can get more money for that which you are producing. The time has arrived when the buyer is anxious to pay more for his goods because he knows that he can get a better article. Now if you will only feel free to get up and tell what you are doing, and to put your heads together and say that you will get more money for your product, you will be able to do so through co-operation.

There is one other thing I want to speak of, and that is as to the mode of putting this code into effect. I listened with a great deal of pleasure to the report of your president, which was an able one. I have to differ with him, however, upon one proposition, and one only. In endeavoring in our association to put into effect a standardization of boilers, which we did attempt, we too fell into the same error of appointing a single committee and also committees from the different States. We found that what was everybody's business was no one's. We found we did not accomplish anything at all through the local committees which were appointed in the different States, and that our only success was in appointing a committee whose duty it was to work for and to establish a uniform specification. We did so only through that committee, a member of which would give up his time and feel it was his duty to do so. I think if you will adopt that course rather than the course of distributing the work to several committees, you will accomplish a great deal more.

Report of Committee on Proper Method of Financing Uniform Code

Your committee finds itself in a position where it is absolutely impossible to make recommendation for raising money under the existing conditions, and therefore recommends the following:

That the interests enumerated below join the A. B. M. A. and further recommend the election of an administrative council to consist of one member of each of the following interests: American Boiler Manufacturers' Association, National Tubular Boiler Manufacturers' Association, insurance interests, watertube boiler manufacturers, National Tubular Boiler and Radiator Association, traction engine manufacturers, material manufacturers, using interests. This administrative council to meet and divide the aforesaid membership into classes, making such an assessment that the net revenue shall be not less than $12,000 per annum, to be used in promulgating the A. S. M. E. boiler code. MR. ASHLEY, Chairman.

MONDAY EVENING SESSION

Form of Proposal

(Name of the Company)
(Appropriate heading)

To (Name of prospective purchaser
and address)

Gentlemen:

We propose to furnish you
(No. and size of boiler units)
all as described in the specifications and data sheets hereto attached and made part hereof for the sum of..........

Shipment to be made within .... days after receipt by us of information needed to execute all details of the work herein contemplated.

Delivery contemplated is (Give location in detail)

Terms of payment, 50 percent cash on delivery f. o. b. cars our works, as evidenced by bill of lading.

All payments to be made in New York or other exchange, free of expense to us for collection charges. Payments to apply pro rata on material as shipped. If shipment is delayed by purchaser, then payments shall be due as though shipment had been made, dating from the time when the material was ready to be shipped.

Title to all material herein contemplated shall remain with us until full payment shall have been made in cash, notwithstanding the manner of its annexation to realty, you to take such steps to perfect the necessary legal processes as are required to retain our title. In case any installment of the price shall not be paid promptly as and when the same shall have become due and payable, according to the provisions hereof, all payments that have been made may be retained by us, and we shall be free to enter the premises and recover and remove all material furnished on this proposal.

Purchaser shall provide and maintain adequate fire and other insurance covering all material furnished under this proposal and shall assume all loss from fire or other causes in case of failure to effect such insurance. All such insurance shall be taken out in our joint names payable as our interests shall appear. No allowance will be made for material, labor, repairs or alterations furnished or paid for by the purchaser for our account unless specifically authorized in writing by us. All material and workmanship contemplated hereby is guaranteed against defects for the period of one year after delivery herein contemplated is completed, but our liability for any such defects shall be limited to the furnishing of such parts. This contract is contingent upon the non-occurrence of strikes, fires, floods, accidents, interference by civil or military authority, insurrection, or any other conditions beyond our control. The acceptance of this material when delivered shall constitute a waiver of all claims for damages of any sort whatsoever caused by any delay.

It is agreed that the purchaser is to provide proper openings in any building or other obstruction that may be necessary for the admission of the boilers to their final location, and that he is to provide the necessary space and furnish such light and heat as may be required to make possible and facilitate the performance of the work herein contemplated.

We will not be responsible for any damage caused to any of this material or equipment from improper management or the introduction or application of improper substances. All parts and attachments to be furnished by us are herein specified and nothing additional will be furnished except on written order from you. Any changes in terms of payment, additional or less work to be performed, shall be in writing and shall not change or invalidate this contract except in so far as it changes the provisions thereof. This proposal supersedes all previous agreements or understandings and it is agreed that it covers our respective obligations as herein set forth. When accepted by you and approved by an executive officer of this company, this proposal shall constitute a contract between us, as of the date of approval by us.

Administrative Council

The committee to raise funds for the promulgation of the code was finally provided for by an amendment to the original motion providing in part as follows:

The administrative council who will have to do with the raising and spending of the funds will consist of a member of the American Boiler Makers' Association, a member of the National Tubular Boiler Manufacturers' Association, a member of the insurance interests, a member of the watertube boiler manufacturers, a member of the National Boiler and Radiator Manufacturers' Association, a member of the Traction Engine Manufacturers' Association, material manufacturers, using interests, steam shovel manufacturers, locomotive manufacturers, wrecking and crane manufacturers. Also manufacturers of boilers for hoisting engines.

The Monday evening session adjourned to meet Tuesday noon, the delegates visiting the Erie City Iron Works, the Union Iron Works and the Burke Electric Company, Tuesday morning.

TUESDAY AFTERNOON SESSION

The nominating committee brought in the following nominations for officers of the American Boiler Manufacturers' Association to serve for the ensuing year, and they were unanimously elected:

President, W. C. Connelly, D. Connelly Boiler Company, Cleveland (re-elected).

First vice-president, C. V. Kellogg, Kewanee Boiler Company, Kewanee, Ill.

Second vice-president, G. S. Barnum, Bigelow Company, New Haven, Conn.

Third vice-president, E. C. Fisher, Wickes Boiler Company, Saginaw, Mich.

Fourth vice-president, Isaac Harter Jr., Babcock & Wilcox Company, New York.

Fifth vice-president, Charles S. Hooker, Union Iron Works, Erie, Pa.

Secretary, J. D. Farasey, H. E. Teachout Boiler Company, Cleveland (re-elected).

Treasurer, H. N. Covell, Gorton & Lidgerwood Company, New York.

Member of Administrative Council, E. R. Fish, Heine Safety Boiler Company, St. Louis.

Uniform Cost System in the Boiler Shop*

Direct Labor Percentage Plan Advocated—Other Methods Considered Deceptive and Unsafe

BY H. D. MAC KINNON †

The committee deemed it expedient and proper, in order to gather together all available knowledge, to address five hundred and thirty-one concerns engaged in boiler manufacture and kindred lines, requesting from them information as to how they computed costs, and to forward us the forms they used in connection with, and the recording of, costs. We were much gratified in receiving seventy-six responses, or about fifteen percent of the inquiries.

Nine firms, presumably with some sort of a cost system, declined to give any information. They are the kind that are sufficient unto themselves and do not believe in co-operation. Four had no system, or from the fact that they were revising, or were installing a system at this time, were not able to give information. Six in replying stated that either they were not boiler manufacturers or had discontinued that branch of their business.

Fifty-seven, however, answered in all or in part the questions asked, many forwarding their forms used and entering exhaustively into the subject, and showing conclusively how important they deemed the work this committee was attempting to do. All honor to these firms and individuals that gave of their time and knowledge to assist their fellow manufacturers. It was evident that they regarded the questions from a broad and generous viewpoint, and that they were not alarmed that a possible competitor might profit from knowledge imparted by them, recognizing that more universal knowledge on the subject of true costs was for the benefit of all.

Obviously it would not be practicable to submit in connection with this paper, only in a general way, the vast mass of papers and information therein, gathered together in this correspondence received. Cost systems and forms used in connection therewith may be, and of necessity should be, of a comparatively simple nature, for the works of the small or medium size concern, and in turn may be elaborated upon to any degree deemed desirable or found necessary for the proper recording of transactions of a large concern. We present copy of a chart which was furnished by one of the large shops which segregates to a marked degree their accounts as applying to what enters into their costs. This chart can be adapted to the needs of any concern by combination of items, not deemed necessary to keep separately.

We believe and recommend that it is imperative to keep the following accounts and to consider them in their aggregate, as making up the all-important item of overhead expense or fixed charges of a manufacturing business, namely:

Depreciation of buildings.
Depreciation of machinery and other equipment.
Taxes and insurance.
Power, heat and light.
General expense.
Barn or cartage and teaming.
Advertising.
Workmen's compensation insurance.
Drafting and estimating.
Repairs and maintenance of buildings.
Repairs and maintenance of tools and equipment.
Traveling and salesmen's expense.
Discount, interest and exchange.
Salaries of executives and clerical labor.
Non-productive labor.

Even a portion of these may be combined if deemed desirable. The main consideration is that every item of expenditure which enters into the conducting of your business, outside of materials purchased and for payrolls of direct labor entering into your product, be recorded in such a manner that they may be considered as a whole, in making up your true total overhead expense.

The element of overhead expense cannot be evaded. It is a tangible, ever-presnt ingredient in the operation of any business, large or small, and it is as inflexible as the law of the Medes and Persians. The concern that does not recognize this fact fully, and give it the consideration it is entitled to, travels a dangerous road. Manufacturing profits, however, do not begin until the item of interest on investment is provided for, and this item must be and becomes a part of your overhead expenses.

Total cost of product is made up of three elements, namely: materials purchased, direct labor and overhead expense or burden, as listed above. In recording costs we believe it essential:

First. That a proper form be provided for the making up of an estimate of cost, and a total of the amount to be submitted as a proposal. A splendid feature of such a

* From a report presented before the twenty-seventh annual convention of the American Boiler Manufacturers' Association, at Erie, Pa., June 22.

† Of the MacKinnon Boiler & Machine Company, Bay City, Mich., chairman of A. B. M. A. committee on Uniform "Cost-Keeping" System.

form would provide for special arrangement or ruling so that the actual weights of material, extensions of cost of material, and direct labor might be made, if the contract were secured, so as to make a comparison and check against the *estimated* weights and costs, and detect errors, if any exist. In the case of estimating on what is considered and termed standard work, such as fire tubular or watertube boilers or any apparatus, wherein this form can be printed with a list of the various materials entering into the construction of such, a printed form should be used in order to provide against the possibility of leaving out one or more items and to save clerical labor.

Second. That a form or forms be provided so that a written or typewritten order may be issued to the shop, or to the various departments that will be called upon to provide for a completed piece of work, and that no work be performed, no matter how small or unimportant, without such a written order.

Third. That a form be provided wherein the superintendent or the various foremen may call for the delivery of materials from the stock, and that no materials from stock be permitted to be used without the issuance of such written requisition.

Fourth. That workmen's time cards be provided, wherein a correct report and record of time be given on all jobs, and the cost of same be computed for the cost record. These cards should show the amount of time consumed in each operation or divisions of the work, and from them be assembled on to a labor distribution sheet. We believe that from the time the first manufacturing establishment started that the question of correct time reporting has been a problem to the management. If the number of men employed justifies it, we consider the best method is to have a time clerk in the works whose duty it shall be to record each workman's time, giving the starting time and the stopping time on each job, this work preferably to be performed with some type of a mechanical time recording device, thereby eliminating the human factor to every possible degree and its proneness to errors. If a time clerk is not deemed practicable, then the time must be necessarily reported by the individual workman, but the cards should be carefully checked by the department foremen or some one in authority so as to insure correctness as far as possible.

Fifth. A form to be provided for the final assembling of cost of materials, costs of direct labor and the overhead expense, giving the total cost of such job and the difference between this total and the contract price, constituting the net profit or loss, as the case may be.

These five forms, which may be termed the essentials or foundation of a cost recording system, may be supplemented by any other forms found to be necessary, and which do not add unduly to the expense of the cost recording and accounting department of your business.

Next comes the most vital proposition, with the exception of the efficiency of the working of your shops, and that is the proper method of distributing the overhead expense to the work performed. Many methods are found to be used, some advocate a percentage on the cost of materials and direct labor, some on the total annual sales, some use an arbitrary addition to the direct labor cost, termed a "Machine Rate," but a predominating number advocate the "percentage to the direct labor" plan, and we are forced to the conclusion that this is the correct method.

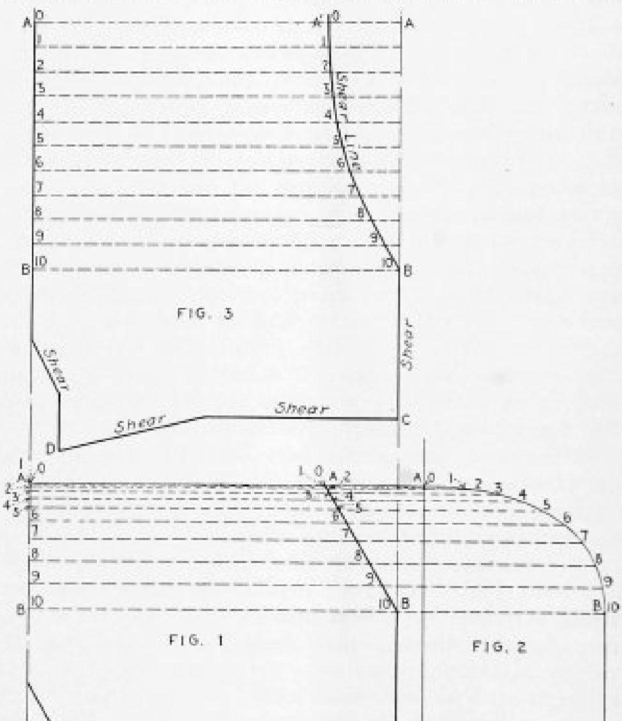
Some of the other methods under certain conditions may bring you to correct conclusions, but they are so susceptible to wrong conclusions, owing to the variations of proportions direct labor to cost of material, or volume of sales, that to the minds of the advocates of the "direct labor percentage" plan, or any other plan, is deceiving and unsafe.

If the stress of the times, or the pressing necessity of your shops, or competitive conditions, in your judgment demand that you make a proposal at cost, or below cost, it can be done under this plan of computing total costs as easily as under any other plan of computation, but it possesses the virtue of telling you exactly the probable loss you will sustain. You will then enter into the transaction with your eyes wide open, and you will not be deceiving yourselves with the idea that a profit exists when it cannot and does not exist. You will not then at the annual closing of your books, after having done a large or moderate volume of business, wonder why you face a deficit or have made no profit.

Layout of Irregular-Shaped Firebox

In reply to the inquiry in the May issue, the following is submitted as a rapid and accurate method for laying out an irregular shaped firebox.

First draw the side view, Fig. 1, and the half end view, Fig. 2, in accordance with the blueprints or shop drawings. Then divide the curved top of the firebox as shown from



A to *B*, Fig. 2, into equal spaces, and project these division points over to the lines *A-B*, Fig. 1.

To lay out the plate, first take the straight work or the bottom half of the side sheet as shown by *B-B-D-C* in Figs. 1 and 3. Then get the length from *B* to *A* in Fig. 2 and lay it out from *B* to *A* in Fig. 3. Divide the lines *B-A*, Fig. 3, into the same number of equal spaces as the curved line *B-A*, Fig. 2, then with the trams lay off the points 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 from Fig. 1 on to the corresponding lines in Fig. 3. A line drawn through these points as *A'-B*, Fig. 3, will be the shear line and will complete the layout for one-half the wrapper sheet.

Proceed in the same manner for the other half, which will be a duplicate of the half already laid out. *A-A*, *B-B* and *D-C* in Fig. 3 are squared up from Fig. 1.

Albuquerque, N. M. JOHN A. TROSSELTO.

The Boiler Maker

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Our subscription books are always open for inspection.

5400 copies of this issue were printed.

Two important meetings were held during the past month at which action was taken regarding the A. S. M. E. boiler code.

The first of these was the spring meeting of the American Society of Mechanical Engineers in Buffalo, at which the Council of the society authorized the official symbol or stamp of the society to be used to indicate that the American Society of Mechanical Engineers' rules have been complied with in the construction of a boiler, the stamp to be affixed by the manufacturer and certification to be governed by law or contract. The A. S. M. E. stamp as prescribed in the boiler code will thus be open to general use for this purpose.

The A. S. M. E. boiler code committee was also empowered at this meeting to make rulings where inquiries are made respecting constructions not covered by the code, and to interpret any parts of the code. In accordance with this action the boiler code committee devoted one of its sessions at the meeting to the consideration of ten such inquiries, and interpretations were formulated. It was arranged that each case ruled upon shall be given an index number, and the ruling thus made shall stand as a permanent interpretation of the particular portion of the code involved. The importance of this phase of the committee's work was duly recognized, and it is hoped that by this plan the application of the code to conditions in any community may be facilitated and its usefulness in general extended.

Further work of the boiler code committee was also authorized by the Council of the society in that the committee was empowered to take up the subjects of (1) economizers, (2) pressure vessels, (3) rules for operation and care of steam boilers and pressure vessels, and (4) recommendations. An index arranged in two parts, one a complete alphabetical index of the entire code, and the other a divisional index divided into three parts, one corresponding to each of the three principal parts of the code, were ordered printed, and this will be incorporated in the next edition of the code to be printed early in the fall.

The second meeting was the annual convention of the Boiler Manufacturers' Association held at Erie, Pa., on June 21 and 22, where much enthusiasm was displayed over the progress that has already been made in securing the adoption of the A. S. M. E. code by State and municipal authorities, by insurance companies and by boiler manufacturers.

The question of promulgating this code throughout the United States and Canada was vigorously taken up, with the result that an administrative council was formed to consist of one member from each of the following interests: American Boiler Manufacturers' Association, National Tubular Boiler Manufacturers' Association, insurance interests, watertube boiler manufacturers, National Boiler and Radiator Manufacturers' Association, Traction Engine Manufacturers' Association, material manufacturers, boiler using interests, steam shovel manufacturers, locomotive manufacturers, wrecking and crane manufacturers and manufacturers of boilers for hoisting engines. This administrative council is to meet and make such an assessment pro rata that the net revenue shall not be less than $12,000 a year, to be expended for promoting the adoption of the A. S. M. E. boiler code throughout the country.

The earnestness evidenced by the boiler manufacturers in taking such a step shows how greatly the need is felt by the boiler making industry of securing uniform boiler laws throughout the entire country. That all interests concerned, including the manufacturer, supply man, buyer, seller and the general public, are to be benefited by the universal adoption of the code is not to be doubted, as representatives of all of these interests were present at the convention and did not hesitate to express their approval of the work that is being done in this direction. As stated by a consulting engineer, the general acceptance of a uniform code compiled by the best authorities in accordance with the most up-to-date and safest boiler practice will lift a load of responsibility from the shoulders of the individual designer and engineer as regards the one item of power plant equipment that involves the greatest danger to life and property, and where an error in design or judgment may result in irreparable disaster.

Engineering Specialties for Boiler Making

New Tools and Appliances for the Boiler Shop and Improved Fittings for Boilers

Hanna Suction Oiler

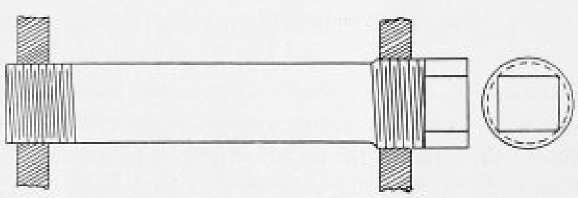
The Hanna Engineering Works, 2059 Elston avenue, Chicago, has recently developed a vertical type suction oiler embodying the same principles as the Universal type described in these columns some time ago. The operation of the Hanna suction oiler is entirely automatic, because suction action takes place the instant the

Vertical Suction Oiler

air moves and ceases the instant the air is shut off. A chamber containing an absorbent is kept saturated from another large oil storage chamber surrounding it. Air passing through the lubricator becomes sufficiently charged with oil, it is claimed, to properly lubricate all surfaces with which it subsequently comes in contact. The vertical suction oiler can be used only in the position shown in the illustration. It is made with ¾, 1 and 1½-inch pipe connections.

Betterman's "Hurry Up" Staybolt

In our May issue a description was published of an improved staybolt tap devised by Reinhold Betterman of Johnstown, Pa., for tapping the holes for staybolts in the firebox and outside wrapper sheets of locomotive boilers. This device is suitable for tapping holes of different diameters for either the short staybolts in the side sheets or for the long radial stays in the crown sheet. The inventor



Staybolt with Ends of Different Diameters

of this tapping device has also developed the staybolt shown in the accompanying illustration, which is made with the ends of two different diameters, say ⅞ inch at one end and 1 inch at the other end for rapid installation of the bolts. Instead of the slow operation of running a staybolt threaded throughout its entire length through both sheets, it is only necessary with this bolt to slip it through the larger hole and then with a few turns the bolt is run in sufficiently to support both sheets. The threads extend for about 1 inch on each end of the bolt and, of course, the bolt must be made of the proper length for each installation made. It is claimed by the inventor that with the improved staybolt tap described in our May issue, and this improved form of staybolt, the operation of installing staybolts in a locomotive boiler can be accomplished more rapidly than heretofore, hence the name "hurry-up" staybolt.

Gravity Fire Door

A foot-operated locomotive fire door, the two halves of which are so arranged as to counterbalance each other, thus making unnecessary the employment of a power cylinder, has been developed and patented by P. C. Withrow, mechanical engineer of the Denver & Rio Grande Railroad.

As shown by the illustrations, the upper part of the door is pivoted at the left and the lower part at the right. A foot lever, located at the left, operates the door-opening cam, which has a specially formed shoe at its upper end

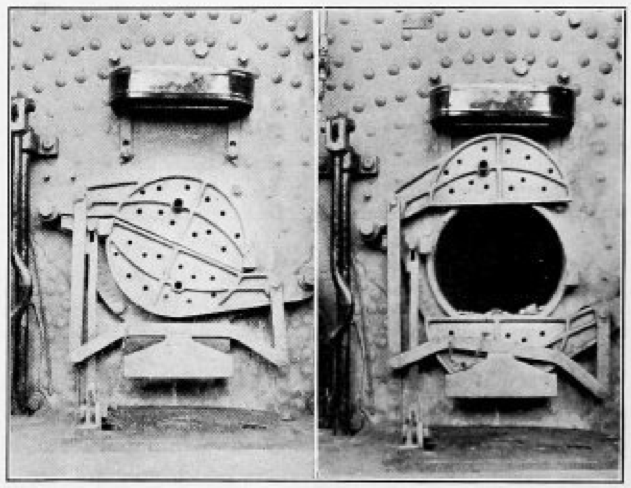


Fig. 1.—Closed Fig. 2.—Open

Gravity Fire Door on Locomotive Boiler

bearing against the under side of the upper door. As the pressure on the foot lever opens the door the point of contact between the cam and the door shifts, thus decreasing the leverage as the movement progresses. This arrangement gives a comparatively large leverage to start the door without unnecessary effort and keeps the travel of the foot pedal within reasonable limits.

The two sections of the door are connected by means of rods and an equalizing bar so proportioned and hinged that the leverage of the upper door, the weight of which causes the closing movement, is increased. On the other hand, the increase in leverage of the lower door in the open position is less than that of the upper door. A further increase in leverage of the upper section is effected by the rolling contact between the equalizer and the door frame at the right of the equalizer fulcrum pin. This causes the fulcrum to travel gradually to the right as the door is opened. The upper door thus has sufficient overbalance to insure prompt closing on the release of the pressure from the foot lever. As the closing movement proceeds the various parts return to a normal position, thus destroying the overbalance and the closing is accomplished without slamming.

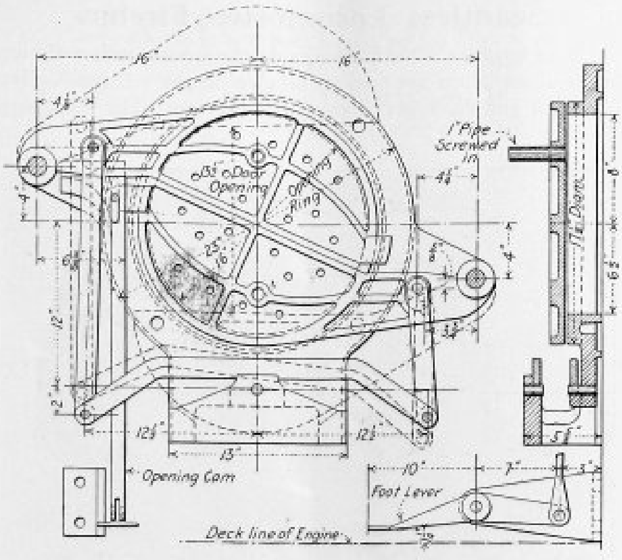


Fig. 3.—Details of Gravity Fire Door

This device has been used experimentally on the Denver & Rio Grande for about two years, where it has been meeting with considerable favor. It is claimed that prompt opening of the door is effected without extraordinary effort, as sufficient force is brought to bear upon the pedal by the natural swinging of the weight of the left foot as the fireman swings the shovel toward the fire door.

Welding Large Castings with Oxy-Acetylene Apparatus

Fig. 1 shows a casting of complicated pattern, weighing about 7,600 pounds, used as a portion of a connection between the exhaust outlet on a steam turbine and the inlet of a condenser. Owing to the conditions in the plant in which this connection was to be used, it was found necessary to shorten the casting 18 inches. This was accomplished by taking the casting to the Oxweld shop in Chicago, where a section of the casting 18 inches in width was removed and the flange moved back and welded in place, making the final casting 18 inches shorter than its original size.

Fig. 1 shows the section partly drilled out. This was done with an electric hand drill, as it was impossible to cut the cast iron with the oxy-acetylene cutting flame.

Fig. 2 shows the casting with the section removed and the flange moved back into place before welding. A temporary brick pre-heating furnace is shown partially constructed around the casting. This temporary furnace is shown complete in Fig. 3. The fire was burning during

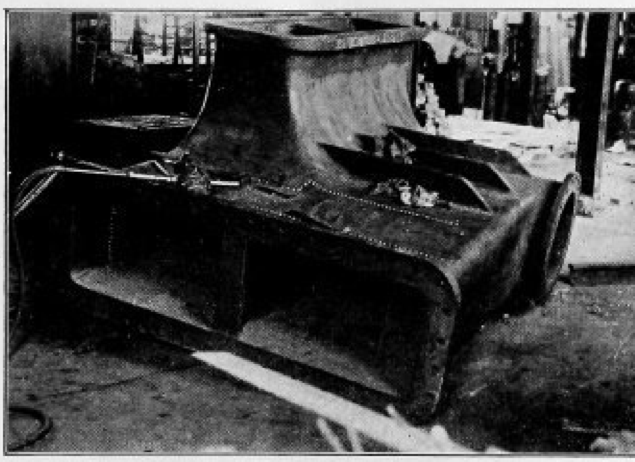


Fig. 1.—Exhaust Outlet Casting

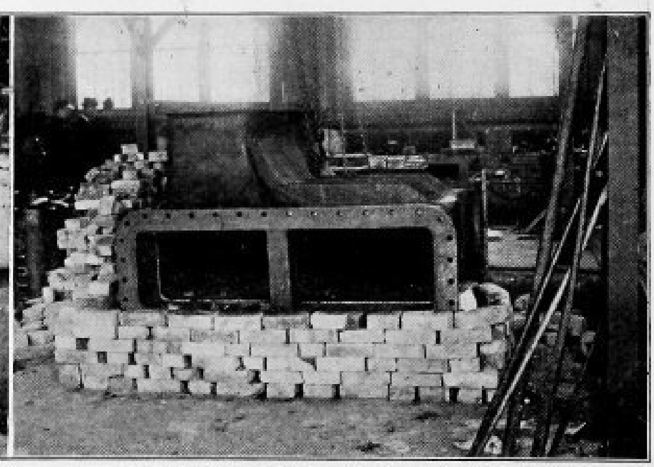


Fig. 2.—Casting Prepared for Welding

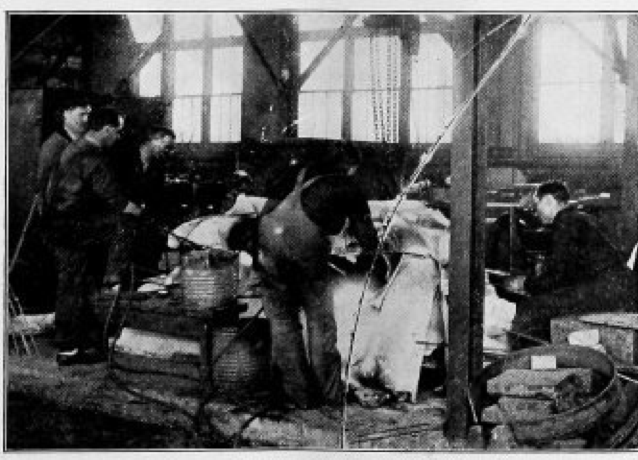


Fig. 3.—Welding Casting in Temporary Furnace

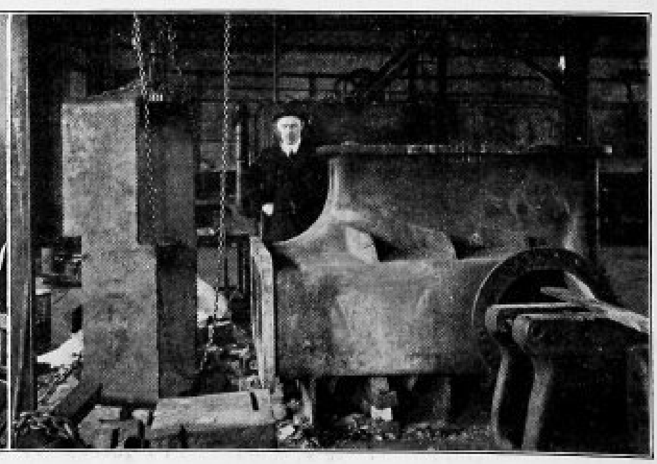


Fig. 4.—Welded Casting, Showing Section Removed

the entire welding operation, and four men worked continuously on the job for about thirty-six hours to complete it. The entire furnace was covered with an asbestos sheet, parts of which were removed to expose the portion actually being welded.

Fig. 4 shows the finished job with the 18-inch section of the casting removed standing beside it. The time required to cut the casting out was three days; for welding, one and one-half days, and for transportation about one week, making a total of about twelve days, or less than one-half the time it would have taken to secure a new casting, which would have cost about $300. To those familiar with large, gray iron castings the problem which was successfully solved in this case can be readily appreciated when

Fig. 5.—Broken Casting Subsequently Reclaimed by Oxy-Acetylene Welding

it is considered that a distortion of only a fraction of an inch in the casting itself, or in the alinement of the flange would have made the entire casting useless.

Fig. 5 shows another casting, the reclaiming of which by oxy-acetylene welding constituted probably one of the largest oxy-acetylene jobs ever successfully accomplished. This was a 30-ton cast iron spider for a gyratory stone crusher. A new casting would have cost about $2,300, but the fractured spider was brought to the Oxweld shop in Chicago and, after the crack and break were chipped out about one-half a ton of new material was welded in, making the casting as good as new.

The welding was done continuously in shifts of two men each for sixty hours, and all the welding was done while the hub was buried in a charcoal fire to take care of expansion and contraction.

Personal

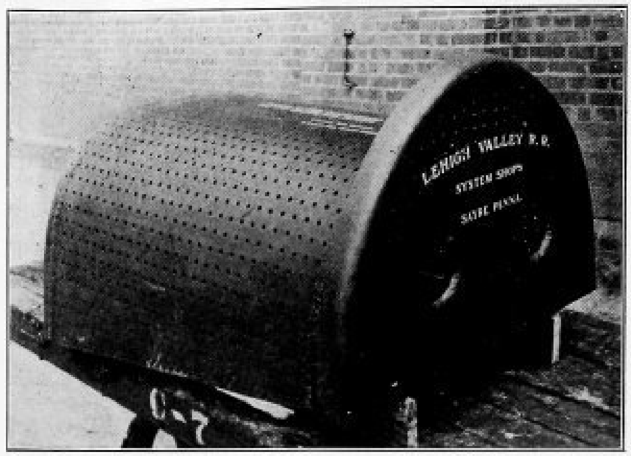
E. Stuart Brown, formerly with the Los Angeles shops of the Western Pipe and Steel Company, has been promoted to be foreman in the heavy plate and boiler department of the company at Richmond, Cal.

W. S. Greenawalt, assistant superintendent of the open-hearth department of the Pennsylvania Steel Company, has been appointed superintendent of the open-hearth plant of the American Iron & Steel Mfg. Company, Lebanon, Pa.

Arthur S. Burden has been elected president of the Burden Iron Company, Troy, N. Y. Other officers elected at the annual meeting are as follows: William P. Burden, vice-president; Daniel W. Tallcot, manager; Robert Forrest, secretary and treasurer; William Millhouse, assistant manager, and James D. Keith, manager of horseshoe sales department.

Seamless Locomotive Firebox

Three engines with fireboxes of the construction shown in the illustration are now in service on the Lehigh Valley Railroad and have given excellent service. The steaming



Seamless Firebox Used on the Lehigh Valley Railroad

qualities of the boiler have been good, showing a less consumption of fuel when compared with the same class of engines having riveted seams. Also the leakage commonly

Thomas Lewis, General Foreman Boiler Maker, Lehigh Valley Railroad, and Fourth Vice-President, Master Boiler Makers' Association

experienced with riveted seams in locomotive fireboxes has been eliminated.

The firebox illustrated was exhibited at the recent convention of the Master Boiler Makers' Association in Chicago by Mr. Thomas Lewis, general foreman boiler maker of the Lehigh Valley Railroad, where it aroused much interest and favorable comment. During the past year Mr. Lewis served as fifth vice-president of the Master Boiler Makers' Association and at the recent convention was elected fourth vice-president of the association.

Letters from Practical Boiler Makers

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

How to Draw an Ellipse

I have been reading with interest the articles by N. G. Near in The Boiler Maker. I must confess that at tube rolling, etc., I cannot add any information, but I believe I can about drawing an ellipse.

It is rather a hard matter at any time to draw perfectly an ellipse that is of any size. About a year ago I was called into another department of the shop to draw an ellipse. It was to be rather large. I think the major axis was about 4 feet. It had to be drawn on a steel plate and it had to be accurate. They had been trying to draw this ellipse by the method described by Mr. Near in the June issue of The Boiler Maker, but it seemed that they ran up against a snag. Of course they couldn't drive a tack in the plate, so, as they did not want to drill it, they tried to develop a template. It seemed that an ordinary string stretched too much and even a piano wire would not give accurate results.

Now I drew this by a method you probably know better than I, but it is the simplest and most accurate I have seen.

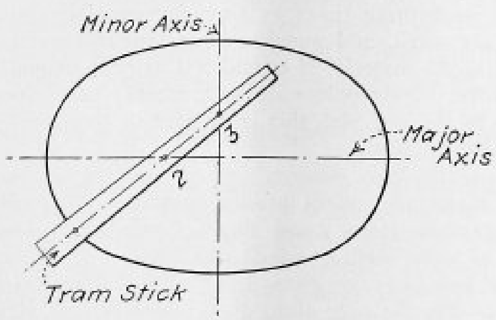
To start with, you lay off your major and minor axes, of course taking care to get them perpendicular to each other. You extend the line through the minor axis indefinitely. Taking a tram stick with three trammel points on it, you set the first and second to the radius of the minor axis and the first and third to the radius of the major axis. With the third trammel point on the center and the second on the line through the major axis, move the third along the minor axis and the second along the major axis; the first will describe an ellipse.

It has been quite a while since I used this method or or laid out an ellipse, and if I have made a mistake in the explanation I will be corrected.

I think this is better than the string method and would like to hear from others regarding it.

Chattanooga, Tenn. D. C. Sherman.

There is no question but that Mr. Sherman's method is O. K. The method is not a new one, nor is the one I gave. My idea in writing my method was merely to tell



how the ellipse is computed—how long a string to use and where to place the tacks.

Mr. Sherman's method, which I show in the sketch herewith, has been worked down to a mechanical nicety, so that ellipses have been cut out by automatic machinery by its use, but for my own personal use I have always thought it a little cumbersome, because it really involves the laying off of a great many points and the drawing of a smooth curve through those points. The only other way, so far as I know, would necessitate the making of a rather intricate jig.

As for the string method for laying out the large ellipse to which Mr. Sherman refers, I am sure this could have been done with extreme accuracy by using a very fine wire and as small a scriber as could be made, so as to make correction for the diameter of the scriber and the error due to the slight bend in the wire. Piano wire, to be sure, would be too heavy for accuracy because it does not bend easily.

It is not necessary to fasten the focal points directly on to the metal plate by drilling or other means. A thin metal sheet may be used for that purpose, or even wood will suffice, and it may be held in place by means of weights.

Where a great many ellipses are to be made I would therefore make a good jig in accordance with Mr. Sherman's method, and results would be quick and accurate. But where an ellipse is to be scribed only once in a while —no matter what the size, the string method will give very good results.

There is no question but that the tram method is easiest to compute, and it is very simple in every way. Which method is best, therefore, I cannot say. It all depends upon circumstances.

New York. N. G. Near.

Rolling Boiler Flues

I see by the correspondence columns of the June issue of The Boiler Maker that the topic "Rolling Boiler Flues" still holds sway.

Mr. "Engineer" (I mean N. G. Near) persists in getting at the bottom of the matter and hearing what the other fellows have to say about that art. Every person who has written about the subject so far differs slightly from the others, for each one has his own ideas and viewpoints. It is these different ideas that we want to hear about, and I, too, think that we cannot get too old to learn, so let some more boiler makers tell of their experiences in rolling both new and old tubes in different types of boilers.

How about expanding the nipples in the mud drums of boilers of the Babcock & Wilcox type? If anything, that job requires a little more care and attention than expanding the tube ends. Perhaps some readers may be induced to give their experiences along that line.

In the last analysis, it seems to me that while technical knowledge and the reading of books and papers are excellent and indispensable, a person who desires to learn any particular art must "get right into it," so to speak, and learn it by the sense of touch and by actual association with it. The best way to teach a novice how much stress to put on a bolt when tightening it up is to allow him to actually break one, and then he will know just how much to pull on the next and where to stop, in order not to reach the breaking point nor the straining point. Such a practical demonstration and personal experience will convey more to a learner in a shorter time than a lecture on the subject could do.

A lecture on the subject has its place, and undoubtedly would be helpful in preparing the learner as to what he may expect, but as a final guide to it all he must experience the sense of touch and the inner feeling that a thing is right, which no word of mouth can quite convey, no matter how cleverly or skilfully spoken.

A man skilled in rolling boiler tubes can do so with his eyes shut and without having to feel the tube after the expander has been withdrawn. He has acquired confidence in his ability to do a good job by actual experience. He has long since passed the awkward stage of the game which marks the beginner. Such a person can tell us his experiences and relate interesting incidents in his career to the profit of those who still desire to learn. The more we learn from books, papers, letters, lectures, etc., the better will we be prepared for our own personal experience, which must cap the climax, and which, like death, we must experience alone.

In conclusion, permit me to say that in papers such as The Boiler Maker and International Marine Engineering the three most interesting departments are "Practical Letters," "Questions and Answers" and, last but not least, the "Editorials." If a man keeps posted in these three things he cannot fall very far behind in up-to-dateness.

Scranton, Pa. Charles J. Mason.

Punching versus Drilling

It is always unsafe to dogmatize unless the facts correspond, and while there may be two points of view to many questions, there are others where stubborn facts eliminate any difference of opinion.

All theories, however conclusive or reasonable, are of no value unless they can be demonstrated, and a single perverse fact not covered by the theory is sufficient to upset received opinion and lead to new paths of thought.

For an example of this, it was once held that heat was a principle or substance residing in the hot body. The learned professors of the time gave it a name, "caloric," and discussed its nature in high-sounding phrases. Along came a sceptic in the person of one Count Rumbold, who by the use of a blunt boring bar in a mass of metal surrounded by water caused the latter to boil. Only units of work were put into the apparatus and units of heat produced, as evidenced by the water boiling. This upset all preconceived notions on the subject and led to the discovery of the new theory that heat was a mode of motion, not a substance, and a manifestation of energy, not a tangible and material caloric.

In the more modern discussion as to the best shape for a lathe bed in order to obtain maximum stiffness, a very simple experiment demonstrated a much disputed fact. If a cigar box be taken without its lid and both hands grasp either end, the box is easily twisted out of shape. If, now, the lid be shut down and nailed, it resists the twisting effort to a remarkable degree. This simple and easily demonstrated fact closed the case in favor of what is usually termed the box section lathe bed.

The two instances quoted serve to show the benefit of simple fact over elaborate theory. In the box instance quite a pile of higher mathematics, in the maze of which the common sense, practical man gets lost, was necessary to elucidate the same result. As a matter of fact, the mathematicians differed in results, for a solution is only as accurate, anyhow, as its assumption at the start.

Another remarkable demonstration, for the authenticity of which I have the word of an eye-witness, concerns the question of safety-valve areas. There is little but abstruse mathematics on the subject of steam flow from an orifice.

The investigation in question was undertaken by a boiler insurance company. A Lancashire boiler 30 feet long by 8 feet diameter, constructed for 100 pounds pressure, was chosen. A rivet hole 7/8 inch in diameter was purposely left unfilled by its rivet and arranged to be opened or closed as needed.

No amount of firing could keep the pressure going at 100 pounds with this opening in boiler shell discharging into the atmosphere. I have little reason to doubt the matter, having recently tested an air compressor with air cylinder 10 inches by 10 inches running 150 revolutions per minute. With a discharge orifice open to atmosphere 5/16 inch in diameter only 55 pounds per square inch could be maintained in the receiver. The compressor was new, in first-class condition, and by a good maker.

One of the most disputed points in boiler practice from a shop point of view is the relative value of drilled and punched holes.

Probably the history of the trade and precedent have influence upon the subject as to the opinions held. It must be remembered that originally iron plates only were used and the holes in these were invariably punched. To-day mild steel is universally employed, but the materials differ so much in working and nature that "good practice" has altered many things.

It is, of course, obvious that when punched holes are employed only one plate can be dealt with at a time. When plates are drilled this is done with both plates together. This alone should prove conclusions as to the merits of the drilled over the punched holes. With low steam pressures, punched holes and iron plates, it might be that a reasonable degree of workmanship was sufficient, refinement not necessary and the drifting of half blind holes permissible. With mild steel plates and high-pressures drilled holes are an absolute necessity to insure safety, leaving leakage out of the question.

With the advent of the multiple drilling machine, high speed drills and modern methods, there is no excuse whatever for a punched hole, even in jobs for low-pressures and of little consequence. Even in structural steel yards the punched hole has been in many instances, to the writer's knowledge, discarded. It has proved cheaper and more expeditious to drill than to punch.

To return to the question of material, some simple experience open to everyone in the trade is worth citing. When iron was in vogue shear blades lasted without grinding at least three times as long for equal quantities of work per week, and punches gave longer service. The effect on the material if considered as proportional to its resistance, surely points its own moral: that, premising injury to the material, this is greater in the case of mild steel than in iron.

The plate edge planing, looked askance at by many boiler shops, also enters into the question. All good boiler specifications insist upon this. From a workmanship point of view such an edge calks better. In the case of a seam leak in repair work, the first operation has always been to chip the edge along to produce better calking.

However, if the above evidence is not sufficient to convince, the following simple experiments can be made by anyone in the trade.

Take two pieces of boiler plate, say 12 inches by 2 inches; these should be of, say, 5/8 or 3/4 inch in thickness for the purpose. Shear these both from a plate of known good quality, the best brand or maker available.

Take the first of these exactly as sheared and bend carefully double until the space left between the two portions is rather more than the thickness of the plate itself. It will be found at the bend, the point of greatest stress, that cracks have developed at intervals along the sheared edges and one or two of these may extend from ¼ to ½ inch in length.

Taking the second piece, have the edges planed away, say reduce the width to 1¾ or 1½ inches, and just take the rough edge off with a file. Treat this in the same manner as the first piece. It will be found that the cracks are absent, and although the outer surface is visibly stretched no incipient cracks even exist.

If the second piece is sawn or planed right out, parted away by machining, the same result is obtained.

If the first piece is merely dressed with the file and the corners rounded well away, the result is certainly better, but in all probability some small cracks may develop unless the actual portion of metal affected by shearing is entirely removed.

A demonstration of the alteration to the metal in punching can be done in a similar manner. Punch two holes at 2-inch centers in a similar piece of plate, part the plate on the center line of holes so that the test piece has two half holes in the sides. Double over with the half holes at the bend and the cracks will start as in the former instance.

A further test rather more severe may be made on a sheared test piece and one machined. Heat both to a low red in the fire and quench in water at hand temperature. Treat these as before and the result of the sheared plate will be possibly worse, while the machined test, if of good quality (Siemens'-Martin acid hearth steel), will stand the test without injury. It is pretty obvious that the machined test is in no need of annealing, while to render the sheared test sufficiently ductile it must be heated to redness and then cool slowly, to remove the strain set up in the brutal crushing and tearing of the shear blades.

These facts are perfectly well known to steel makers and others, but somehow have not penetrated sufficiently into the average boiler shop.

When it is remembered that an incipient crack in a steel plate may with certainty be expected to develop, the obvious danger of sheared or punched plates in a boiler becomes apparent. When such a crack is found a hole is drilled at the extreme point and filled with a rivet: only by cutting can the crack be limited from extending.

The tests cited have a distinctly educational value; even if the reader is already convinced on the matter it is worth his while to actually make the tests. No boiler maker having made them can possibly plead ignorance as to the relative values of machining versus punching and shearing.

There is only one virtue acknowledged for a punched hole; that is, if the sheets are both punched from the inside of the seam the stem of the rivet when closed is larger at the ends than at the middle, the plea being that should a rivet head drop off the shape of the stem would hold the plates together. When, however, it is remembered that punching gives a clear depression on the punch side and a corresponding elevation on the bolster side, with a distinct sharp protruding edge towards the bolster, the advantage is considerably minimized. When also the two sheets possibly come bolster to punch side or bolster to bolster (not such unusual cases as might be imagined), they sacrifice the only possible defense in their behalf.

Again, it is impossible to punch a curved sheet, while drilling is, in good work, done after the sheets are rolled; a further advantage in favor of drilling is evident. It needs no mathematics to demonstrate that a hole round in shape punched in a flat plate is certainly not round when the sheet is subsequently curved.

There might in some former epoch have been a possibility of a rivet head dropping off, but with modern oil-fired furnaces and hydraulic closing of rivets such a possibility may be dismissed.

One word about drilled holes. After drilling *in situ*, the sheets must be taken apart and the sharp edge of holes on either side removed. The writer is of the opinion that a rose bit used by hand in a carpenter's type brace is the most desirable method of effecting this. The necessity for removal of sharp edges is apparent from the tests described above.

The question of cost is to-day, all things considered, in favor of drilling. This in the case of a progressive concern who is alert to install modern equipment. It is poor economy to turn out an inferior job with antiquated plant and methods, when a first-class product may be obtained at equal or less cost with modern equipment and organization.

It is probable that the trade of boiler making has more antique tools at work to-day than any other section of the metal-working industry, and while these may possess historical interest they may also cause actual loss through a misguided economy. A. L. HAAS.

London, England.

A Deserved Promotion

Mr. George Bliss was recently appointed foreman boiler maker at the New Durham Round House, New Durham, N. J., in place of Mr. John M. Church, resigned.

Mr. Bliss is a "boy" of the old school, having served his time in the Susquehanna, Pa., shops, some twenty-four or twenty-five years ago. The boys along the New York Central lines, and in fact all boiler makers who have come in contact with Mr. Bliss, and this includes a host of friends, most heartily congratulate him upon his appointment.

The writer has known him personally for the past eighteen years and has known him to be a man in every sense of the word and, last but not least, he has known him to be a boiler maker.

Union Hill, N. J. MICHAEL J. DOYLE.

Layout of an Irregular-Shaped Firebox

In reply to the inquiry of "Subscriber," on page 150 of the May issue, for the layout of an irregular-shaped firebox, the writer would call attention to the article on page 174 of the June issue, in which an explanation is given of the layout of a firebox wrapper sheet with a break in the flue sheet and with a sloping door sheet. The method used in this problem can be applied to develop the firebox shown in the May issue.

Rutland, Vt. C. F. AXELSON.

STAYBOLT INSPECTOR RETIRED ON PENSION.—Among the employees of the Pennsylvania Railroad retired on pension May 1 last was William Watson, staybolt inspector in the shops at Altoona, who had been in the service of the company thirty-four years and for over twenty years was inspector of flues in locomotives. A portrait of Mr. Watson is given in the bulletin issued by the company, and it is calculated that during his twenty years of service in this occupation he had crawled through the fire doors of 20,000 locomotives, and had inspected 6,440,000 flues.

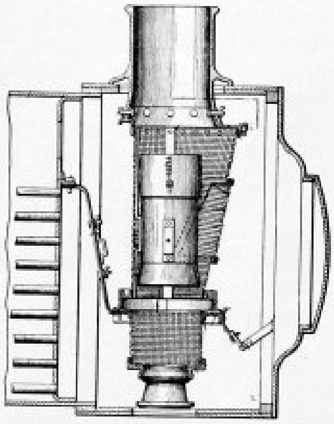
Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
Millerton, N. Y.

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

1,138,890. SPARK ARRESTER. PHILIP L. RAYMOND, OF READING, PA.

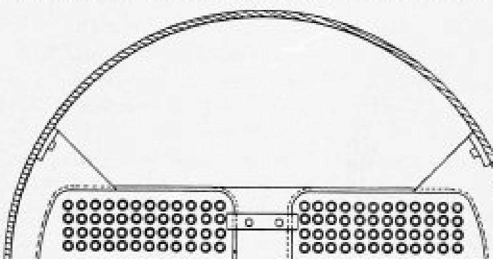
Claim 1.—In a spark arrester, the combination with a smoke box having a stack at its upper end, and an exhaust nozzle at its lower end in line with the stack, of a support in the smoke box having an opening therein in line with the nozzle and the stack, a screen, a coupling ring



secured on the upper end of the screen and having an upwardly projecting portion fitting within and secured to the stack, a sleeve adjustable vertically in the lower end of the screen and bearing directly upon the support, and a screen connecting the top of the nozzle with the support. Fifteen claims.

1,139,334. WATER-CIRCULATOR FOR STEAM BOILERS. EDWARD W. BRAY, OF NORFOLK, VA.

Claim 3.—In a circulator for steam boilers, the combination with a surface and combustion chamber, of a baffle plate radiating from the



combustion chamber to the shell of the boiler, and means in said baffle plate through which the water circulates from under the furnace and combustion chamber, up around the sides and back thereof to the water line. Three claims.

1,139,518. GAGE-GLASS. WILLIAM J. HANLON, OF FITCHBURG, AND JOHN H. HANLON, OF SOMERVILLE, MASS.

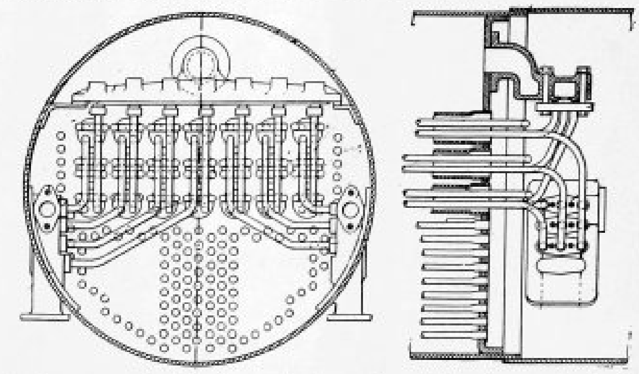
Claim 1.—The improved gage-glass comprising a body having an opaque back inclosing a water space, a series of bulls-eyes having vertically arranged prismatic ribs on their rear surface, and a blow of tube extending from the top mounting to a point somewhat above the lower orifice in the bottom mounting. Three claims.

1,139,527. BOILER-CASING. IRA MARTIN HOPE, OF CHICAGO, ILL.

Claim.—A boiler casing comprising a plurality of sections arranged at the opposite sides of the boiler and disposed in edge to edge contact, each section comprising a pair of plates spaced apart in parallelism, and a filler of heat insulating material interposed between said plates, each section having an open edge and a closed edge, the closed edge of each section abutting the open edge of the adjacent section, flanges upstanding from the confronting top edges of the sections at the opposite sides of the boiler whereby said sections may be secured together, and a flange on the closed edge of each section and extending outwardly therefrom and underlying the open edge of the adjacent section whereby an air tight joint between the sections is effected. One claim.

1,139,601. SUPERHEATER. PETER THOMSEN, OF CASSEL-WILHELMSHÖHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT M. B. H., OF CASSEL-WILHELMSHÖHE, GERMANY, A CORPORATION OF GERMANY.

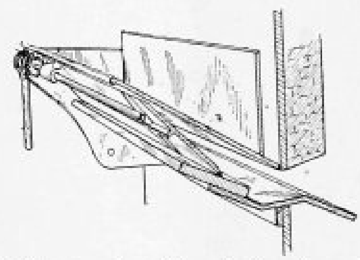
Claim 3.—A steam superheater for fire tube boilers in combination with the usual tube sheet, consisting of a saturated steam header located above the fire tubes and extending across said tube sheet, of superheated steam headers arranged on both ends of the saturated steam



header, perpendicularly thereto, but spaced apart therefrom, each of said superheated steam headers provided with a face perpendicular to the tube sheet and of superheater elements in the upper horizontal fire tube rows arranged in vertical rows, the elements of each vertical row terminating in said faces in such a way that the ends of the elements of the row nearest to the superheated steam header open into them at the same level with the lowest fire tube row containing superheating elements while the rows of elements more remote open at lower levels. Eight claims.

1,140,761. MECHANICAL STOKER. JOHN EDWARD MURPHY, OF WINNIPEG, MANITOBA, CANADA.

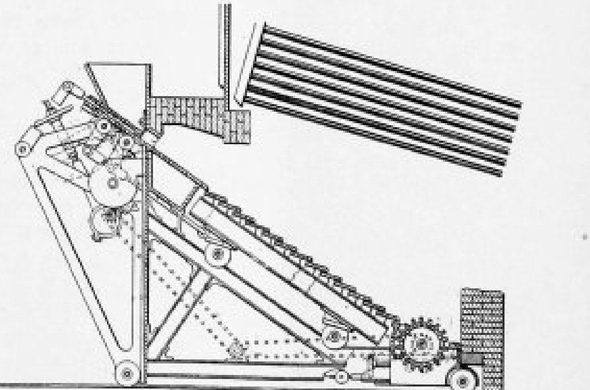
Claim 1.—In a mechanical stoker, a furnace wall having a feed opening therethrough, a hopper having side walls extending outwardly from said furnace wall, an inner wall secured to said side walls a short dis-



tance from said furnace walls and terminating above said feed opening and a chute bottom formed of a rigid plate and a pivoted plate, a cut-off plate extending across said hopper and beneath said inner wall to said furnace wall above the feed opening and slidably supported, and means for operating said cut-off plate. Three claims.

1,140,674. STEAM BOILER FURNACE. CHARLES E. GOOGINS, OF BROOKLYN, N. Y.

Claim 1.—In a furnace, the combination with the front wall, of parallel transverse shafts rotatively supported on the outside of the front wall, arms attached to the said shafts, a grate having portions each



movable back and forth, rods connecting the said arms and the movable portions of the grate, gears connecting the said shafts, a second arm attached to one of the said shafts, a transverse driving shaft arranged upon the front wall below said parallel shafts, an upwardly extending arm having its upper portion pivotally connected with the said second arm, and means connected with the driving shaft and constructed to move the said upwardly extending arm up and down in the direction of its length. Three claims.

THE BOILER MAKER

AUGUST, 1915

Grain Shelters or Bins

Details of Construction and Layout of Conical Roof

BY C. B. LINSTROM

The demand for metal grain bins is increasing, due to the fact that they can be made weather tight, fire and rat proof. Metal bins should be made strong and neat so as to insure lengthy service and appearance. They are usually made of galvanized iron sheets, No. 8, 10 or

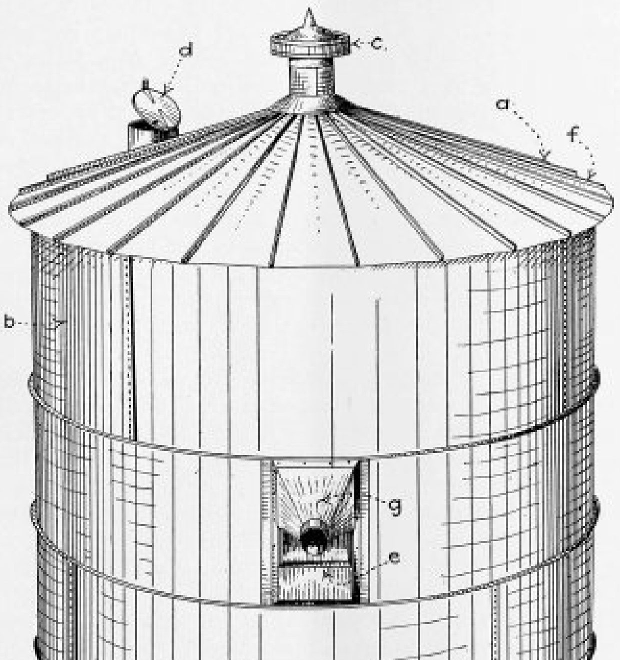


Fig. 1

12 gage. The roof can be made of sheets as light as No. 24 gage.

In Fig. 1 is illustrated one of the representative types manufactured in this country; the top, *a*, is conical in shape and made with standing lock seams as at *f*. Such seams insure a weather-tight roof and, as well, strengthen it. Roof *a* may be attached to the body *b* by the use of the angle iron *c*, as shown in Fig. 2 (*a*). The body, *b*, is made up of sheets bent to cylindrical form which are usually riveted to T-irons, as shown in Fig. 2 (*b*). The sheets *a* and *b* of this view are placed outside the leg *c* of the T. The T-irons also serve to strengthen the cylinder. The bottom is shown in section at view (*c*). Sheet *a* is riveted to angle iron *b*; the bottom sheets are also attached to bottom leg of the angle iron *b*.

A bin constructed in the manner just described is a strong one and will give good service. In Fig. 1 is also

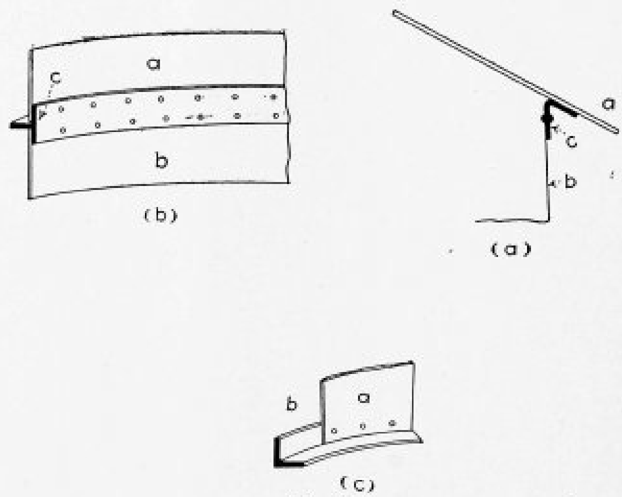


Fig. 2

shown the position of a ventilator, *c*, and loading funnel, *d*, with a cover and hasp for locking it. The door, *e*, is fitted so as to slide open on a track to allow a person to enter. The spout, *g*, is employed for removing the grain from the bin; this is readily done by gravity when the grain is above the level of the spout. There are various ways of constructing the door, but before figuring on manufacturing any be sure not to use a patented grain door, so as to insure against infringement.

The following table gives the capacity in bushels for bins of different diameters and heights:

Height in feet	Diameter in feet	Capacity in bushels
8	10	500
10	10	650
10	12½	1,000
12	12½	1,200

Development of Conical Roof

In Fig. 3 is represented the arrangement of the plan and elevation for a roof of the following dimensions. Height equals 48 inches and base 234½ inches in diameter. Its development is readily obtained by the radial method as follows:

Draw the vertical axis *a-a* indefinite in length. Lay off through *a'* the horizontal axis *b'-b'* at right angles to *a-a*. With *a'* as a center and with the trammels set to a radius *a' b'*, which is equal to half of 234½ inches, describe a circle. Next locate the line *b-b* in the elevation and make it 234½ inches in length. Draw the lines *ab, ab* to have a rise of 48 inches in the center. Owing to the size of the roof it is advisable to lay it off in segments. This will permit the use very often of some scrap material. To determine the size of the segments divide the plan into the number of desired parts, in this case 12, shown from 1 to 12 inclusive.

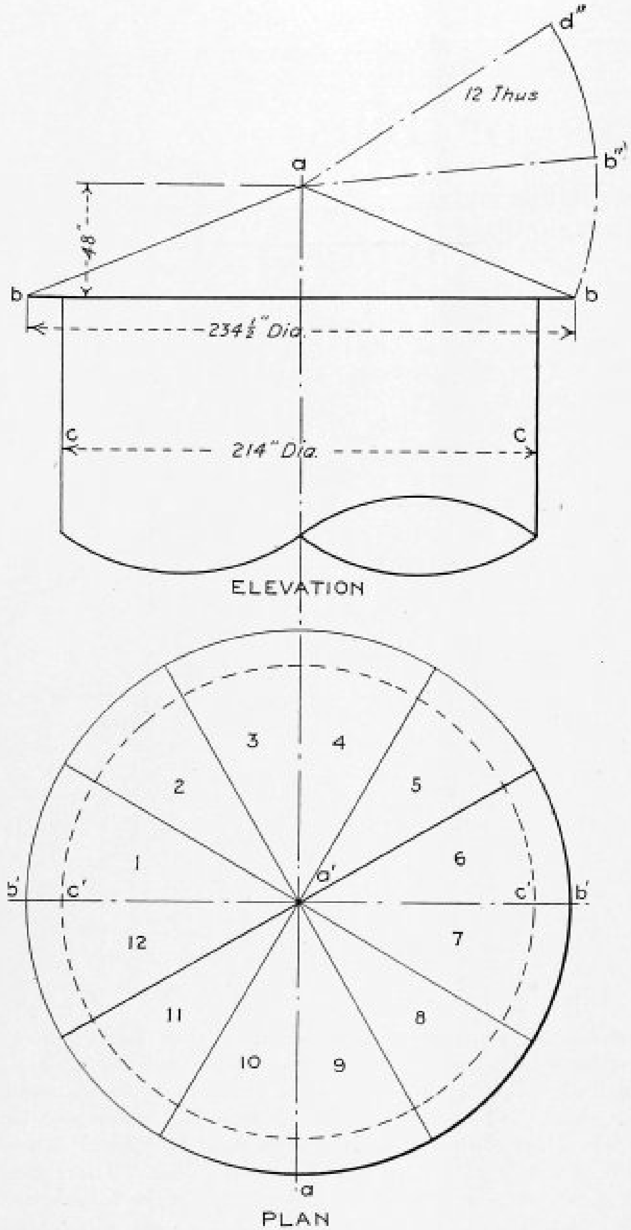


Fig. 3

LAYOUT OF PATTERN

As the roof tapers and is a cone in shape, the edge line as *a'b'* in the plan is foreshortened in length. A plane through *b'a'b'* of the plan is represented in the elevation in *bab*, hence as the section *bab* is shown in its true size, the line *ab* can be used for drawing the stretchout for the patterns of the segments 1, 2, 3, 4, etc. Then with *a* in the elevation as a center and *ab* as a radius describe the arc *b''-d''* for the stretchout of one segment. The length of this arc should equal 1/12 of the circumference around the base of the cone. This length is equal to

$$\frac{3.1416 \times 234\frac{1}{2}}{12} = 61\frac{3}{8} \text{ inches}$$

approximately. After the stretchout arc has been drawn, its length can be laid off with the traveling wheel.

Connect points *b''-d''* with *a*, thus locating the size of one segment. Allowances, however, must be made for the seams; if they are riveted flat seams allow about ⅜ inch for No. 16 gage metal. The allowance for the lap in light sheet iron work is usually made equal to 1½ times the diameter of rivet used; for example, if a ¼-inch rivet is used, we have $1\frac{1}{2} \times \frac{1}{4} = \frac{3}{8}$ inch, width of lap.

If standing lock seams are used the amount of metal required depends upon whether the seams are single or double lock, and the height of the standing seam.

The Use of Corrugated Furnaces for Vertical Fire Tube Boilers*

BY F. W. DEAN

I have been impressed for many years with the value of corrugated furnaces for vertical boilers, but only recently have actually used them. By the use of such furnaces staybolts are done away with, and as there appear to be no disadvantages in the furnace, this is a most important feature. As many hundreds of staybolts are avoided in each boiler there are just so many less opportunities for breakage and needed repairs. In the staybolted firebox it is necessary for safety to drill holes in the ends of the staybolts in order to know when they are broken.

The simplicity of vertical boilers with corrugated fireboxes must commend them to owners and makers. In the boiler shop the operations of building are of the simplest and most rapid kind.

This type of firebox provides for expansion and contraction of the tubes in a safe manner, but on account of its somewhat flexible character it should be assumed that it is advisable to support the lower tube plate as near the edge as practicable. The ordinary firebox is rigid vertically and supports the edge of the lower tube plate, but as the corrugated firebox has slight elasticity it is best to hold up as much of the tube plate as practicable by the tubes and provide little or no elasticity in the tube plates. The flat and unstayed portions of the upper and lower tube plates should be made equal in diameter in order to balance.

The flanging of the fire door presents no difficulty, but it should be done so that the corrugations coalesce with the conical part.

The behavior of the firebox end of the boiler when under pressure led to some speculation, for the area of the fire door opening theoretically unbalances it. When under hydrostatic pressure, various gages were used for showing distortion, but none could be discovered.

In regard to sizes of such furnaces the catalogue of the American maker gives 60 inches as the maximum inside diameter, but in fact this company can make them up to 72 inches, and almost 1 inch thick. They have been made slightly larger in Germany and the furnace of the larger boiler illustrated was obtained in that country. If the inside diameter is 72 inches, the grate will be 3 inches larger or 75 inches, and the grate area 30.68 square feet.

* A paper presented before the American Society of Mechanical Engineers, New York, in June.

It is easy enough to generate 200 horsepower on a grate of this size with considerable capacity for forcing beyond this, and there is no difficulty in providing the heating surface for this horsepower.

In regard to pressure, a furnace 72 inches in diameter and 0.95 inch thick will carry 200 pounds. If there were sufficient demand for larger furnaces they would probably be forthcoming. The theory of heat transmission through

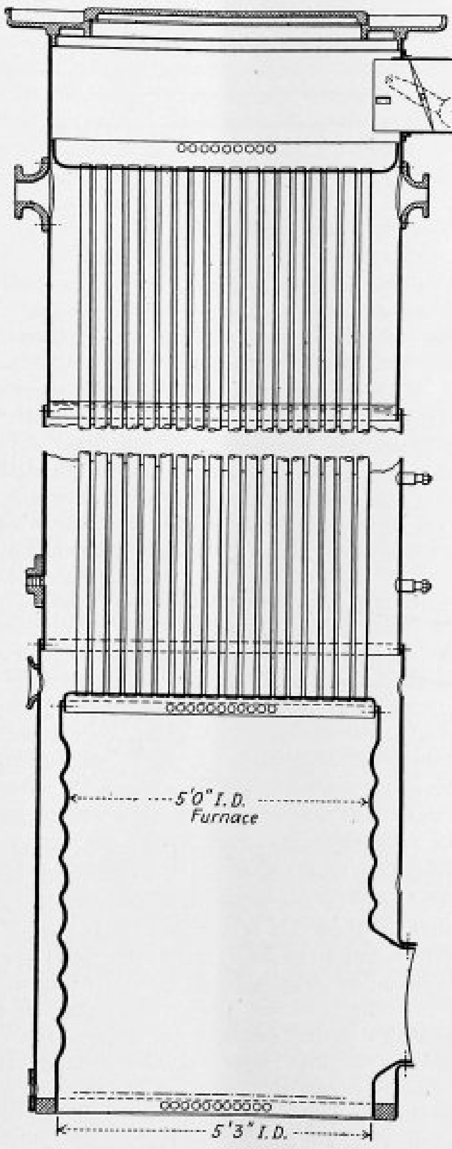


Fig. 1.—Simple Design of Vertical Boiler, with Corrugated Furnace

plates, and experience, show that thick furnaces, especially if without riveted joints, are unobjectionable.

The introduction of corrugated furnaces for the fireboxes of the vertical type of boiler is, I think, a real improvement in steam boilers. The type possesses the important qualities of giving maximum and permanent economy, superheating the steam from 20 degrees to 40 degrees, being free from brickwork and requiring small floor space per horsepower.

Fig. 1 shows a boiler of the simplest possible design, two of which have been in use for a year and a half, and Fig. 2 shows one with the interior accessible for inspection and cleaning, which has been in use a few months only.

Proportions of Locomotive Boilers*

Boiler and firebox proportions must be carefully studied and chosen so as to produce capacity as well as efficiency. These proportions are now being worked out on a scientific basis. Modern large engines have a ratio of tube heating surface to total heating surface as high as 20. On small engines with deep fireboxes this ratio formerly

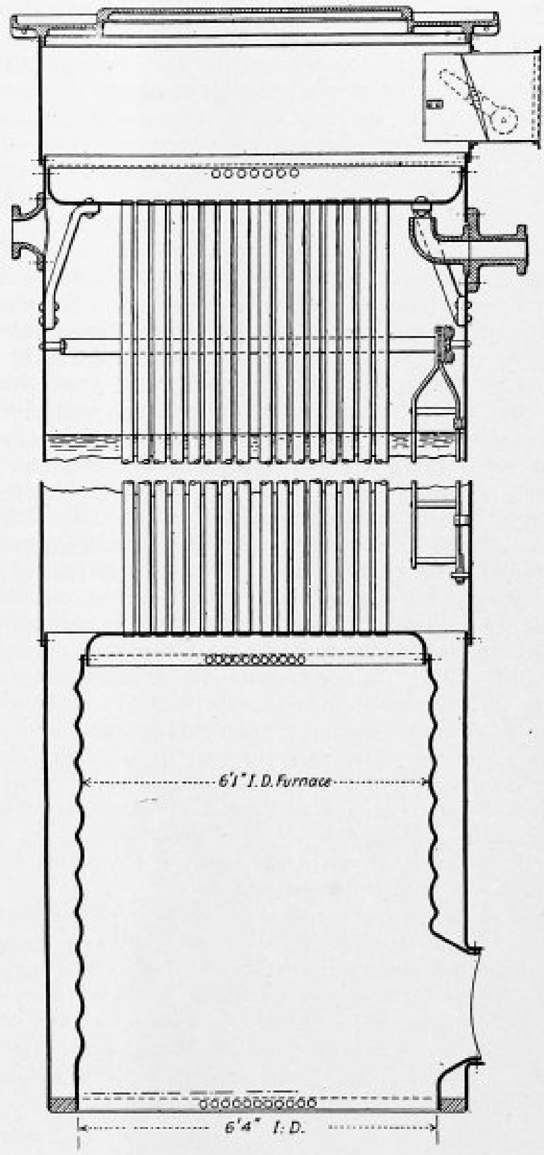


Fig. 2.—Larger Boiler of this Design, with Interior Accessible for Inspection

ran as low as 8. A desirable figure for this ratio is 12. This can be obtained by the use of a combustion chamber which lengthens the firebox and shortens the flues. Where large grate areas are required, as in the large Erie Triplex, it is almost impossible to provide a wheel arrangement that would not necessitate the firebox extending over the drivers. With the use of a combustion chamber this can easily be accomplished, as the mud ring may be as high or higher than the bottom waist line of the boiler. The ratio of total heating surface to grate area should not be

* Abstract of discussion by F. F. Gaines of paper on "Steam Locomotives of To-day," presented before the American Society of Mechanical Engineers.

over 80, and more economical results are obtained if it is 65.

With ample grate area and firebox heating surface the desired results cannot be obtained unless the affiliated parts are correctly designed. The grates should be of such mesh as the grade of fuel requires; the mesh being as large as possible without the fuel dropping through. The grates should also have the maximum of possible air openings as well as air openings in the side bearers. The opening on the top should be a minimum and expand as it goes down, so that any ash, slate or clinker that can pass through the top will easily pass through and not clog the grates. Ash-pan openings are generally restricted and do not admit sufficient air for economical or maximum combustion. The proper arrangement of front ends is very essential to the uniform drafting of the fire; the lower the exhaust pipe, the less the back pressure, and consequently the greater mean effective pressure.

In this country feedwater heating is confined to a limited number of cases and cannot be said to be recognized generally as a factor in fuel economy. Experiments made on several engines by the writer showed about 10 percent economy, which was considerably offset by difficulties in maintenance. Eventually, however, we will develop a type of feedwater heater that will eliminate the objections. It would appear that the most feasible plan would be a type of open feedwater heater, which would be located between the frames of the engine and underneath the boiler, using the exhaust from the air pumps, boiler feed pumps, and part of the main exhaust. In doing this it is thought that, ultimately, instead of using the present form of exhaust draft to effect combustion, with its consequent back pressure due to restriction of nozzle, a form of forced draft of the blower type will be used. Under these circumstances the exhaust openings from the cylinder to the atmosphere can be made without any restriction whatever, thereby greatly eliminating back pressure. The steam required for operating the auxiliary and forced draft would use but a small proportion of the horsepower gained. Previous experiments would also indicate that a type of centrifugal pump would be much more effective and positive for boiler feeding than one of the reciprocating type.

American railroad practice is averse to adding anything to the locomotive in the way of additional apparatus which complicates its operation or adds to its complexity. The demand for the utmost economy will eventually bring about a satisfactory method of feedwater heating, so that in connection with superheating, liberal firebox heating surface, and possibly compounding, we can obtain the maximum possible economy from the fuel used.

Convenient Form of Plate Caliper

Measuring up a boiler is one of the duties of an inspector when visiting a new risk that calls for the display at times of considerable ingenuity. Boiler data, to be of service in setting safe working pressures, must be exact. How to obtain it from the finished boiler is the question. Much might be written concerning ways and means for measuring rivet pitches, determining approximate rivet diameters, getting the areas of surfaces to be braced or stayed, etc. Each of these measurements presents an individual difficulty, different with the varying types and sizes of boilers. At this time we are concerned with the measurement of plate thickness. How shall we get at it in a finished boiler? The edges of seams are apt to be upset or bent from shearing, or on the outside they will be distorted by calking. (Fig. 1.) Moreover, plate edges are practically always beveled, so that a direct measurement of the plate edge is apt to be misleading. The plate may be calipered at openings to domes, or any other opening where the edge of the plate is exposed in such a way as to permit the application of a caliper, but such measurements are far from satisfactory, because plates used for boiler construction vary somewhat in thickness from the edges toward the middle of the sheet, due to the spring of the rolls between which the sheet was formed. It is, of course, necessary to base calculations of safe working

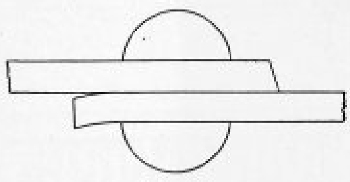


Fig. 1

pressure on the weakest portion of a boiler, and so minimum and not maximum plate thickness is what we desire, or in other words we must measure our plates near the edges.

Mr. C. R. Summers, assistant Chief Inspector in the Atlanta Department of the Hartford Steam Boiler Inspection and Insurance Company, has contrived the form of caliper sketched in Fig. 2. This tool, graduated to read in terms of plate thickness at the point of contact of the curved arm, is intended to be applied to the girth seams of a boiler, from the inside. The caliper arm projects far

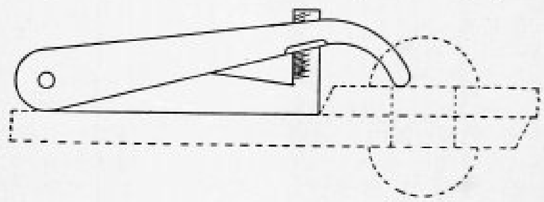


Fig. 2

enough to reach the overlapping plate at a point between the rivets, where both plates are most likely to be in contact, as the grip of the rivets will there be greatest. It is clear that no distortion of the plate edge can effect such a measurement, and results of ample precision are assured if care is taken to clean a place quite free from scale or sediment on which to rest the straight part of the tool. It will probably prove desirable to harden the tool to a spring temper, so that wear may be reduced as far as possible, for it is clear that wear of the contact point will gradually throw the readings on the scale out of truth. Any machinist should be able to make and calibrate such a plate caliper at small expense.—*The Locomotive of the Hartford Steam Boiler Inspection and Insurance Company.*

If draftsmen had more shop practice some bosses would cease to wonder why they have to figure so high on jobs.

When oiling your drill bear in mind that all the oil which runs down the sheet is wasted. That hurts the boss, does you no good, and messes up things.

When you look at the staging around boilers, even in good shops, you might think that the foreman was counting on his boiler makers being tight rope walkers or pole balancers as well as boiler makers.

Boiler Design and Construction*

Vital Points to be Considered in Constructing Safe Boilers

BY HENRY WILKINSON†

Boiler designing and construction are two branches of the boiler business that are to-day receiving more careful consideration by the engineer and the manufacturer than they have in the past. This is due, in a large measure, to the fact that several of the States throughout the country have, or are, enacting rules and regulations that will govern the construction of steam boilers and also, to a great measure, the design.

The proper designing of a boiler must necessarily involve a great many factors. It is essential that the designer should, if possible, have all the facts before him as to the conditions under which the boiler will be operated, so that it may be designed to conform to the conditions existing in that specific locality. Consideration must be given to the cost of fuel, also available draft, and, perhaps, restricted boiler room space, as well as the requirements of the steam plant in general. With this information at hand, the boiler can be designed with a sufficient amount of heating surface, and with ample bracing and staying of all the flat surfaces. The most careful consideration can be given to the designing of the joints, as well as to selecting the most suitable material applicable to the several parts of the boiler. The grate surface can be properly proportioned, and this is an item which is at all times essential for economy and continuous operation. The question of grate surface requires special attention if the boilers are intended to be "forced" at any time, and provisions must also be made for sufficient draft to give the proper combustion. The cost and evaporating qualities of the fuel available in the neighborhood of the proposed steam plant must be considered, so that the boiler can be designed to use the cheapest fuel possible that will give the necessary results. More failures of boiler plants result from the neglect of this point, and from a poorly designed boiler, than from almost any other cause.

It can be well said that a boiler correctly designed can be ruined in its construction, and at the same time a boiler, even if properly constructed, would be a failure if the design was not correct. The foundation of an efficient and economical boiler depends, to a great measure, on the ability of the designer, for a boiler, if poorly designed, even though it may be well constructed and properly installed, can never be considered an economical investment; furthermore, it cannot be expected that a boiler which has been found to be economical and efficient in one plant will necessarily prove efficient and economical if placed in another plant. This point has been illustrated many times when boilers have been moved from one plant to another. It is astonishing to learn of the number of misfit boiler installations that have been and are being placed in service. Such installations are often made on the recommendation of those whose past experience should teach them to know better. Much of this misapplication is caused by an unwillingness on the part of the owner to change the ancient order of things. Boiler manufacturers themselves sometimes make this mistake in recommending something that has proven successful elsewhere for conditions that are not at all the same.

Many boilers manufactured in the past have received little or no attention on the part of the maker as to the correct design. This is due partly to the fact that competition forced them to consider less heating surface per horsepower, and also tended to the use of a higher tensile strength in the material entering into the construction of the boiler. Higher tensile strength reduces the thickness of the plate and lowers the cost of the material in the boiler. If the purchaser of a boiler would give a closer study to the boiler plant than he usually does, it is more than likely that the poor conditions that exist would, in a great many instances, be ordered rectified, and the plant, in all probability, be made a money-saving proposition, but it is evident the boiler question in the majority of plants receives little or no consideration. It appears that the only plants where careful consideration is given to the boilers are those using a large number of units, or, in other words, the plants that employ men who have sufficient knowledge and experience of the subject to enable them to recognize the important part that the boilers play in the mechanical department. Such men know that the boilers should be one of the first things to receive careful study, as it is a known fact that the boiler is the "bread winner" of the establishment. A boiler poorly designed, improperly constructed, and incorrectly installed is a source of perpetual trouble and expense.

The Manager's Point of View

If the average manager in charge of a plant should be asked about his various products, he would immediately become interested, and possibly would give you the routine of his products from the raw material to the finished article. He would even go so far as to tell you where it comes from and how it is procured. He will give you the entire history previous to its arrival in the factory, and if time would permit he could take you step by step through the various processes until the product is completed, packed and ready for the market. He could, no doubt, give you an off-handed analysis, and possibly a close estimate of the cost. He could explain the high standard of efficiency he obtains from every machine, and how this degree of efficiency is actually kept up day by day, and above all he will tell you that the output receives his close and personal attention. Should you ask this average manager what consideration he had given to his boiler plant, with its furnaces that yearly consume thousands of tons of expensive coal, it would not be expressing it too strongly when it might be said that this part of the plant had received little or none of his consideration further than its first cost.

Were it not for the fact that the recently-established laws have regulated, to a great extent, the design and construction of boilers, designing and construction would be much the same as it has been in the past. Flat portions of the boiler would be insufficiently braced, and the riveted joints would be of a type and design unsuitable and unsafe for the pressure carried. At the present time there are many old boilers operating under pressures which were never intended to be carried when the boiler was built. The flat surfaces are insufficiently braced and stayed, the

* Lecture delivered before the Insurance Institute of Hartford, March 24, 1914.

† Designing engineer, The Travelers' Indemnity Company.

thickness of the material is much less than it should be, and the old type of lap joint is used. All of these detrimental features are being obviated at the present time. Manufacturers have, to some extent, come together and are endeavoring to establish a standard boiler specification which will fully cover the requirements of the different States and which will insure the purchaser a perfect boiler. A meeting for such purpose was held by the manufacturers, inspectors and insurance men at Pittsburg last October, a committee being in correspondence with the proper authorities in every State in the Union. As a result of this meeting, the near future may see the adoption of a standard specification. Such specification will require that boilers be properly designed, and will designate the proper material, type of joints, and quantity and quality of bracing and staying, etc.

Factor of Safety

The factors of safety on bracing and staying, as well as that on the shells of old boilers, have been so low that the past experience has been a bitter one, due to explosions and loss of life. The shop foreman in the old days, not being fully versed as to the required size of material for bracing, was often content to think that as long as the scrap pile was not exhausted he was in easy street, and it is not an uncommon thing to see an old boiler with the heads braced with a variety of iron of all shapes and sizes, hardly any two pieces being alike. This method of bracing is now being substituted at the present day for standard braces, mostly of the weldless type, and a sufficient number of such braces are being used to amply support the flat surfaces for the pressure intended to be carried. The stay-bolting of flat surfaces is also so proportioned and spaced that the probability of the plate bulging between stays is next to an impossibility, if the calculated working pressure is not exceeded. The old style of horizontal single and double-lap joint is also being discarded on almost every size of boiler for that of the butt-joint type, of which there are many designs. The lap joint has proven an unsafe design, due to the fact that the shells of boilers could not form a true circle when under pressure, this being the direct cause for dangerous cracks forming in the longitudinal seams which could not be detected with any degree of accuracy. With the butt-joint type it is possible to roll the shell to a perfect circle, and by butting the ends of the plate together and forming the covering strips to the curvature of the shell, the boiler shell takes the form of a true circle when the pressure is applied, and this gives the best form of design. The efficiency of butt joints can be designed so as to give 94 percent of the strength of the solid plate, as compared with 70 percent in the double riveted lap construction.

The proper spacing of the tube holes is also an important item, and should not be overlooked in endeavoring to increase the heating surface of the boiler by crowding a large number of tubes in the head. The placing of too many tubes in a given size of head necessitates the spacing of the tube holes much closer, and the bridging, or portion of solid plate between the tube holes, is not sufficient to stand the strain brought about by the continual expanding of tubes, which, after a time, causes the plate to crystallize and crack between the tube holes, eventually resulting in expensive repairs. It is, therefore, necessary to allow at least three-tenths the diameter of the tubes for the bridging between tubes, in heads such as are used for horizontal tubular boilers. This spacing should be increased if it is found that the condition of the feed water is bad, it being desirable to have as much space as possible between the tubes when such a condition is known to exist, so as to prevent scale lodging between them. Of course, it is understood that the conditions are changed according to the type of boiler. A marked improvement has also been made in the quality of the material used in reinforcing rings for manhole openings. It has been the practice for many years to use cast iron, but on account of its treacherous nature, reinforcing rings are now made of pressed steel plate and substantially riveted to shell. By using steel for such purposes the material around the opening is stiffened to such an extent that the strength of the shell is, practically speaking, restored to its original strength.

The material used in the construction of the shells and heads should be of homogeneous quality, and care should be taken that no flaws or defects of any nature are in the plate. It is also desirable that the material should not be too high in tensile strength, as very high tensile strength is liable to make the plate brittle. It is well known that steel plate of high tensile strength is hard and brittle and causes endless trouble from its want of ductility and power to yield under slight overheating, and rupture, without warning, is liable to occur. For that reason the manufacturers of boiler plate strongly advocate a low or medium tensile strength, for the reason that when the plate is rolled the center of the plate has a much higher tensile strength than the sides from which the test pieces are taken. A plate that would show a tensile strength of 57,000 pounds at the edge has been known to reach 69,000 pounds in the middle. Such a plate is liable later on to crack and cause trouble, if not danger. It is, therefore, most desirable to keep the tensile strength of all plates down as low as possible, so that too high a tensile strength will not be reached in the middle portion of the plate. The chemical and physical analysis have also much to do with the quality of the plate, the best plate showing a high percentage of elongation and high reduction of area.

Pitfalls to be Avoided

The fact that the boiler may have been properly designed and suitable material used does not, for one moment, warrant us in thinking that further trouble is eliminated, for much depends upon the treatment that the material receives during the construction of the boiler. Considerable of the unnecessary abuse of the material can be avoided by the proper laying out of the plates before actual construction commences. Great accuracy should be maintained in the laying out of all rivet holes to see that when boiler is assembled all the holes will come true, and that it will not be necessary to resort to the liberal use of the driftpin in order to bring the holes in line. Condemning the unnecessary use of the driftpin is commendable, but, at the same time, it is almost impossible to construct a boiler without a driftpin. In the constructing of boilers, the use of the driftpin should only be necessary to hold the plates in position while the erecting bolts draw the plate together, and if, for any reason, the holes should not come true, a reamer should be used. Considerable damage can be done to the material between the rivet holes by fairing up the holes with a driftpin, as this has a tendency to harden and crystallize the plate and eventually starts a fracture. If it is possible, preference should be given to the drilling of all holes from the solid plate rather than punching the holes small, and afterwards reaming them to full size. In the boiler shop, when the specifications call for the holes to be punched small, and the amount of material to be removed by reaming is not specified, the great tendency is to punch the holes almost full size, so that a sufficient amount of material cannot be taken out by the reamer to remove the fractured or crystallized portion of the plate around the rivet hole caused by punching the holes.

The proper flanging of the heads is also important. The best method of doing this part of the construction is either by the spinning process or by hydraulic flanging. Many of the present-day shops are not equipped with the tools required to do the work in this manner, therefore it is done by hand, but if the proper flange blocks and properly designed and constructed flange fires are used, operated by mechanics who are qualified to do this class of work, there is no reason why a perfect flange cannot be made. It may be found desirable to put in some of the tube holes before the head is flanged, although there is no reasonable excuse for doing so. There is no question but what it would be very much better to put the holes in after the heads are flanged and avoid any distortion of the flue holes, which is liable to occur in the flanging of the head, but in cases where very large heads are used, it has been found to be an advantage to have some of the flue holes in the head, so that strengthening bars can be used to prevent the head from buckling. In such a case it would be advisable to leave out one or more rows around the edge of the flange so as to prevent distortion of the outer tube holes, then, after the head is completely flanged, these holes can be put in the heads.

Cutting Tube Holes

Considerable trouble is often experienced with tube holes if the proper tool is not used, and when the tube holes are punched, as was the practice years ago, the die side of the hole is somewhat larger than the punch side, making a tapered hole into which it is impossible to roll the tubes absolutely tight. For this reason the best construction would require that tube holes be drilled with a solid cutter. This would insure the same diameter of hole on both sides of the plate, and would enable the tight rolling of the tubes. In beveling the straight edges of the plate, rotary shears are sometimes used. This is not considered desirable as it has the same effect upon the edge of the plate as the punching of a hole would have on the edge of the rivet hole. It crystallizes the plate, and in many instances is the direct cause of slight fractures which are not noticeable until the boiler has been in service for some time and subjected to the action of the fire. For this reason it is proper that the straight edges of all plates be planed on a straight planing machine, and by so doing prevent the possibility of the edge becoming crystallized, and, furthermore, prevent the starting of any visible fractures.

A large number of boilers at present in use give considerable trouble at the girth seam by the plate cracking from the rivet hole to the edge of the plate. The cause of this can be attributed, in a large measure, to the improper beveling of the edges of the plate. In constructing the longitudinal joints, as well as the girth seams, care should be taken that the diameter and spacing of all rivets should be such as to give an efficiency of joint, which will give the highest percentage of the original strength of the solid plate possible for the type of joint chosen. In rolling the plates the operator cannot be too careful to see that the shells are rolled to a true circle, and especially the edges of the plates that are about to pass from under the rolls. This part of the rolling takes considerable judgment on the part of the operator, and, unless properly done, will leave a flat portion unrolled, and when the shell comes to be riveted up it will cause no end of trouble. If the work has been properly done, however, there need be no fear but what the plates will rivet up without undue strain.

The proper riveting up of the boiler is most essential at all times. Care and judgment must be used to see that the plates are drawn up tight to each other before the riveting takes place. The holes must be true or in line and the rivets must be heated to a cherry red, then driven home tight and made to fill the holes completely. The pressure should be kept on the rivets until they have sufficiently cooled and shrunk, for unless this is done the plates are liable to spring apart and no amount of calking will keep the seam tight. In order to do this work properly the hydraulic riveting machine is the most adaptable. All shops doing first-class work are equipped with such a machine, and it is used on all parts of the boiler where conditions will permit. On other parts of the construction that will not permit the using of the hydraulic riveter the air gun is used, and although it is capable of doing good work it cannot be relied upon to give absolutely tight construction. All seams, after riveting is completed, should be thoroughly calked on the outside with a round-nosed calking tool to insure tightness, and when the tubes are placed in the boiler, and are expanded and rolled, and boiler otherwise completed, a hydrostatic pressure test should be applied, the water being lukewarm. This causes the several parts of the boiler to slightly expand, and any leaks that may show up should be lightly calked and made tight. After this test is completed it is desirable to subject the boiler to the steam pressure it is designed to carry, by making a connection from the boilers used in the shop, and should any further leaks occur, due to the expansion of the metal from the high temperature of the steam, all such leaks should be further calked and made tight.

If the construction receives the careful attention of the shop foreman, from the time the boiler is started until it is completed, and if the shop is equipped to handle a high class of work, if the material used is the best of its several kinds, and if the construction is not sacrificed for the paltry dollar, there is no reason why we should not have a boiler that will last for years, and that would be able to stand up to all the strains put upon it by ordinary usage.

How to Find the Water Level in a Locomotive Boiler

To find the water level in a locomotive boiler use a ½-inch hose 12 feet long; put a 16-inch water glass in each end and fill the hose full of water.

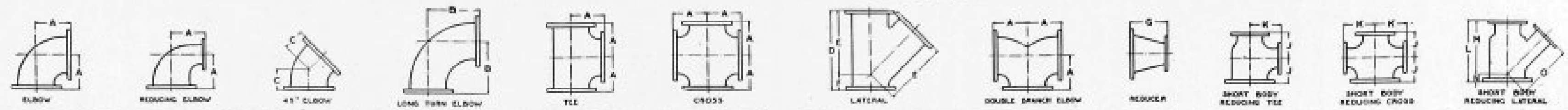
Lay the hose on the ground and hold the top ends of the water glasses up. Then lay two straight edges on the frame of the engine, have one end of the hose with the glass in it held up to one straight edge, and then bring the other end of the hose up until the water in it is even with the lower straight edge; measure the distance from the water to the straight edge in the other glass.

If you place the straight edges the same distance apart as the length of the firebox, you will then know how much out of plumb the water level will be. Note this down on a piece of paper so that it will not be forgotten; then go to the firebox and let one man go inside the box while another stays outside. The man in the box will place the end of his glass up to the crown sheet in the center and just back of the flue sheet. Measure the distance from the water in the glass to the crown sheet and add the thickness of the sheet.

The man outside will mark the back head at the water level shown in his glass. Then all that is left to be done is to add to this mark on the back head the distance with the thickness of the sheet added. This will give the highest point of the crown sheet. Then add the 3 or 3½ inches for the bottom gage cock or the bottom water glass cock.

J. H. Kearns.

THE 1915 U. S. STANDARD SCHEDULE OF FLANGED FITTINGS AND FLANGES



STANDARD WEIGHT 125 LBS. WORKING PRESSURE

SIZE	A	B	C	D	E	F	G	Short Body Red. Tees & Crosses: Size of Outlets	J	K	Short Body Red. Laterals: Size of Branches	L	M	N	O	Flanges: Diameter	Flanges: Thickness	Bolts: Diameter of Bolt Circle	Bolts: Number of Bolts	Bolts: Diameter of Bolts	Minimum Metal Thickness
1	3½	5	1¾	7½	5¾	1¾										4	7/16	3	4	7/16	5/16
1¼	3¾	5½	2	8	6¼	1¾										4½	½	3⅜	4	7/16	5/16
1½	4	6	2¼	9	7	2										5	9/16	3⅞	4	½	5/16
2	4½	6½	2½	10½	8	2½										6	⅝	4¾	4	⅝	5/16
2½	5	7	3	12	9½	2½										7	11/16	5½	4	⅝	5/16
3	5½	7¾	3	13	10	3	6									7½	¾	6	4	⅝	5/16
3½	6	8½	3½	14½	11½	3	6½									8½	13/16	7	4	⅝	5/16
4	6½	9	4	15	12	3	7									9	15/16	7½	8	⅝	½
4½	7	9½	4	15½	12¾	3	7½									9¼	15/16	7¾	8	¾	½
5	7½	10¼	4½	17	13½	3½	8									10	15/16	8½	8	¾	½
6	8	11½	5	18	14½	3½	9									11	1	9½	8	¾	9/16
7	8½	12¾	5½	20½	16½	4	10									12½	1 1/16	10¾	8	¾	⅝
8	9	14	5½	22	17½	4½	11									13½	1⅛	11¾	8	¾	⅝
9	10	15¼	6	24	19½	4½	11½									15	1⅛	13¼	12	¾	11/16
10	11	16½	6½	25½	20½	5	12									16	1 3/16	14¼	12	⅞	¾
12	12	19	7½	30	24½	5½	14									19	1¼	17	12	⅞	13/16
14	14	21½	7½	33	27	6	16									21	1⅜	18¾	12	1	⅞
15	14½	22¾	8	34½	28½	6	17									22¼	1⅜	20	16	1	⅞
16	15	24	8	36½	30	6½	18									23½	1 7/16	21¼	16	1	1
18	16½	26½	8½	39	32	7	19	12" and under	13	15½	9" and under	26	25	1	27½	25	1 9/16	22¾	16	1⅛	1 1/16
20	18	29	9½	43	35	8	20	14"	14	17	10"	28	27	1	29½	27½	1 11/16	25	20	1⅛	1⅛
22	20	31½	10	46	37½	8½	22	15"	14	18	10"	29	28½	½	31½	29½	1 13/16	27¼	20	1¼	1 3/16
24	22	34	11	49½	40½	9	24	16"	15	19	12"	32	31½	½	34½	32	1⅞	29½	20	1¼	1¼
26	23	36½	13	53	44	9	26	18"	16	20	12"	35	35	0	38	34¼	2	31¾	24	1¼	1 5/16
28	24	39	14	56	46½	9½	28	18"	16	21	14"	37	37	0	40	36½	2 1/16	34	28	1¼	1⅜
30	25	41½	15	59	49	10	30	20"	18	23	15"	39	39	0	42	38¾	2⅛	36	28	1⅜	1 7/16
32	26	44	16				32	20"	18	24						41¾	2¼	38½	28	1½	1½
34	27	46½	17				34	22"	19	25						43¾	2 5/16	40½	32	1½	1 9/16
36	28	49	18				36	24"	20	26						46	2⅜	42¾	32	1½	1⅝
38	29	51½	19				38	24"	20	28						48¾	2⅜	45¼	32	1⅝	1 11/16
40	30	54	20				40	26"	22	29						50¾	2½	47¼	36	1⅝	1¾
42	31	56½	21				42	28"	23	30						53	2⅝	49½	36	1⅝	1 13/16
44	32	59	22				44	28"	23	31						55¼	2⅝	51¾	40	1⅝	1⅞
46	33	61½	23				46	30"	24	33						57¼	2 11/16	53¾	40	1⅝	1 15/16
48	34	64	24				48	32"	26	34						59½	2¾	56	44	1⅝	2
50	35	66½	25				50	32"	26	35						61¾	2¾	58¼	44	1⅝	2 1/16
52	37	69	26				52	34"	27	36						64	2⅞	60½	44	1¾	2⅛
54	39	71½	27				54	36"	29	37						66¼	3	62¾	44	1¾	2 3/16
56	41	74	28				56	36"	29	39						68¾	3	65	48	1¾	2¼
58	42	76½	29				58	38"	31	40						71	3⅛	67¼	48	1¾	2 5/16
60	44	79	30				60	40"	33	41						73	3⅛	69¼	52	1¾	2 7/16
62	45	81½	31				62	40"	33	42						75¼	3¼	71¾	52	1⅞	2½
64	47	84	32				64	42"	34	44						78	3¼	74	52	1⅞	2 9/16
66	48	86½	33				66	44"	35	45						80	3⅜	76	52	1⅞	2⅝
68	50	89	34				68	44"	35	46						82¼	3⅜	78¼	56	1⅞	2 11/16
70	51	91½	35				70	46"	37	47						84½	3½	80½	56	1⅞	2¾
72	53	94	36				72	48"	40	48						86½	3½	82½	60	1⅞	2 13/16
74	54	96½	37				74	48"	40	49						88½	3⅝	84½	60	1⅞	2⅞
76	56	99	38				76	50"	42	50						90¾	3⅝	86½	60	1⅞	2 15/16
78	58	101½	39				78	52"	43	52						93	3¾	88¾	60	2	3
80	59	104	40				80	52"	43	53						95¼	3¾	91	60	2	3 1/16
82	60	106½	41				82	54"	44	54						97½	3⅞	93½	60	2	3⅛
84	62	109	42				84	56"	47	56						99¾	3⅞	95½	64	2	3 3/16
86	63	111½	43				86	56"	47	57						102	4	97¾	64	2	3¼
88	65	114	44				88	58"	48	58						104¼	4	100	68	2	3 5/16
90	67	116½	45				90	60"	50	61						106½	4⅛	102¼	68	2¼	3⅜
92	68	119	46				92	60"	50	62						108¾	4⅛	104½	68	2¼	3½
94	69	121½	47				94	62"	52	63						111	4¼	106¾	68	2¼	3 9/16
96	71	124	48				96	64"	53	64						113¼	4¼	108½	68	2¼	3⅝
98	73	126½	49				98	64"	53	65						115½	4⅜	110¾	68	2¼	3 11/16
100	74	129	50				100	66"	55	67						117¾	4⅜	113	68	2¼	3¾

All dimensions are in inches

EXTRA HEAVY 250 LBS. WORKING PRESSURE

SIZE	A	B	C	D	E	F	G	Short Body Red. Tees & Crosses: Size of Outlets	J	K	Short Body Red. Laterals: Size of Branches	L	M	N	O	Flanges: Diameter	Flanges: Thickness	Bolts: Diameter of Bolt Circle	Bolts: Number of Bolts	Bolts: Diameter of Bolts	Minimum Metal Thickness
1	4	5	2	8½	6½	2										4½	11/16	3¼	4	½	½
1¼	4¼	5½	2½	9½	7¼	2¼										5	¾	3¾	4	½	½
1½	4½	6	2¾	11	8½	2½										6	13/16	4½	4	⅝	½
2	5	6½	3	11½	9	2½										6½	⅞	5	4	⅝	½
2½	5½	7	3½	13	10½	2½										7½	1	5⅞	4	¾	9/16
3	6	7¾	3½	14	11	3	6									8¼	1⅛	6⅝	8	¾	9/16
3½	6½	8½	4	15½	12½	3	6½									9	1 3/16	7¼	8	¾	9/16
4	7	9	4½	16½	13½	3	7									10	1¼	7⅞	8	¾	⅝
4½	7½	9½	4½	18	14½	3½	7½									10½	1 5/16	8½	8	¾	⅝
5	8	10¼	5	18½	15	3½	8									11	1⅜	9¼	8	¾	11/16
6	8½	11½	5½	21½	17½	4	9									12½	1 7/16	10⅝	12	¾	¾
7	9	12¾	6	23½	19	4½	10									14	1½	11⅞	12	⅞	13/16
8	10	14	6	25½	20½	5	11									15	1⅝	13	12	⅞	15/16
9	10½	15¼	6½	27½	22½	5	11½									16¼	1¾	14	12	1	⅞
10	11½	16½	7	29½	24	5½	12									17½	1⅞	15¼	16	1	15/16
12	13	19	8	33½	27½	6	14									20½	2	17¾	16	1⅛	1
14	15	21½	8½	37½	31	6½	16									23	2⅛	20¼	20	1⅛	1⅛
15	15½	22¾	9	39½	33	6½	17									24½	2 3/16	21½	20	1¼	1 3/16
16	16½	24	9½	42	34½	7½	18									25½	2¼	22½	20	1¼	1¼
18	18	26½	10	45½	37½	8	19	12" and under	14	17	9" and under	34	31	3	32½	28	2⅜	24¾	24	1¼	1⅜
20	19½	29	10½	49	40½	8½	20	14"	15½	18½	10"	37	34	3	36	30½	2½	27	24	1⅜	1½
22	20½	31½	11	53	43½	9½	22	15"	16½	20	10"	40	37	3	39	33	2⅝	29¼	24	1½	1 9/16
24	22½	34	12	57½	47½	10	24	16"	17	21½	12"	44	41	3	43	36	2¾	32	24	1⅝	1⅝
26	24	36½	13				26	18"	19	23						38¼	2 13/16	34½	28	1⅝	1 13/16
28	26	39	14				28	18"	19	24						40¾	2 15/16	37	28	1⅝	1⅞
30	27½	41½	15				30	20"	20½	25½						43	3	39¼	28	1¾	2
32	29	44	16				32	20"	20½	26½						45¼	3⅛	41½	28	1⅞	2⅛
34	30½	46½	17				34	22"	22	28						47½	3¼	43½	28	1⅞	2¼
36	32½	49	18				36	24"	23½	29½						50	3⅜	46	32	1⅞	2⅜
38	34	51½	19				38	24"	23½	30½						52¼	3 7/16	48	32	1⅞	2 7/16
40	35½	54	20				40	26"	25	31½						54½	3 9/16	50¼	36	1⅞	2 9/16
42	37	56½	21				42	28"	26½	33½						57	3 11/16	52¾	36	1⅞	2 11/16
44	39	59	22				44	28"	26½	34½						59¼	3¾	55	36	2	2 13/16
46	40½	61½	23				46	30"	27½	35½						61½	3⅞	57¼	40	2	2⅞
48	42	64	24				48	32"	29	37½						65	4	60¾	40	2	3

EXPLANATORY NOTES

1. Standard and Extra Heavy Reducing Elbows carry same dimensions center to face as regular Elbows of largest straight size.

2. Standard and Extra Heavy Tees, Crosses and Laterals, reducing on run only, carry same dimensions face to face as largest straight size.

3. If Flanged Fittings for lower working pressure than 125 lbs. are made, they shall conform in all dimensions except thickness of shell, to this standard and shall have the guaranteed working pressure cast on each fitting. Flanges for these fittings must be standard dimensions.

4. Where long turn fittings are specified, it has reference only to Elbows which are made in two center to face dimensions and to be known as Elbows and Long Turn Elbows, the latter being used only when so specified.

5. All standard weight fittings must be guaranteed for 125 lbs. working pressure and extra heavy fittings for 250 lbs. working pressure, and each fitting must have some mark cast on it indicating the maker and guaranteed working steam pressure.

6. All extra heavy fittings and flanges to have a raised surface 1/16" high inside of bolt holes for gaskets. Thickness of flanges and center to face dimensions of fittings include this raised surface.

Standard weight fittings and flanges to be plain faced.

Bolt holes to be ⅛" larger in diameter than bolts.

Bolt holes to straddle center lines.

7. Size of all fittings scheduled indicate inside diameter of ports.

8. Square head bolts with hexagonal nuts are recommended.

9. Double Branch Elbows, Side Outlet Elbows and Side Outlet Tees, whether straight or reducing sizes, carry same dimensions center to face and face to face as regular tees and elbows.

10. Bull Head Tees or Tees increasing on outlet, will have same center to face and face to face dimensions as a straight fitting of the size of the outlet.

11. Tees, Crosses and Laterals 16 inches and smaller, reducing on the outlet, use the same dimensions as straight sizes of the larger port.

Sizes 18 inches and larger, reducing on the outlet, are made in two lengths depending on the size of the outlet as given in the table of dimensions.

12. For fittings reducing on the run only a long body pattern will always be used.

Y's are special and made to suit conditions.

Double Branch Elbows are not made reducing on the run.

13. Steel Flanges, Fittings and Valves are recommended for Superheated Steam.

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John, Geometry and a Smoke-Stack

The Manager Shows John How to Solve a Useful Problem with the Aid of Geometry

BY JAMES F. HOBART, M. E.

"Good morning, John! What is it this time? Anything alarming, which needs a little study and 'Yankee knowhow'?"

"It's stacks this time, Mr. Hobart; just plain, black, iron boiler stacks. The 'Old Man' wants me and Bill to fleet up a stage around a 75-foot stack so we can make some repairs to it, and also put on a lightning rod and do some other things. They call it a 75-foot concern, but nobody knows just how tall it is, for its pedigree is obscure and there are no plans to be found. We want to know approximately the height of the stack above the base, and

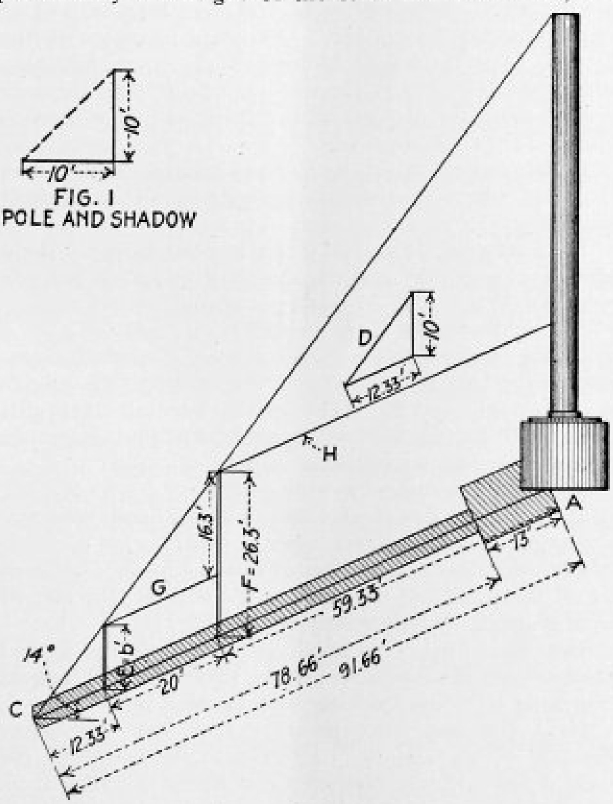


FIG. I
POLE AND SHADOW

Fig. 2.—Finding Height of Stack and Base

Bill and I have been figuring how to find the height without shinning up inside and dropping the steel tape down."

"Why don't you use a little geometry, John? You ought to know by this time that geometry can do about anything you ask of it, and if you ask it to tell the height of that stack, you may be pretty sure of a correct answer, if you go to work right. How about it, John?"

"I was talking with Bill about setting up a pole and then measuring the shadow, as shown by Fig. 1, but we could not quite figure out how to work this with the stack, because it stands on a steep side hill and there isn't anywhere near level ground enough to catch the shadow on, so we passed up the pole and shadow business and were thinking about the climb and tape business, but that is a dirty job and I don't like it a little bit!"

"The pole and shadow business is all right, John. It will work just as well on a side hill as on a level——"

"I don't see how that can be, Mr. Hobart, for we would, if working on a level, place the pole as shown by Fig. 1, and then wait until the pole, which projected 10 feet out of the ground, cast a shadow exactly 10 feet high. Then we would drive a stake at the top end of the stack shadow, say at *C*, Fig. 2, another stake at the top of the base shadow, *B*, and a third stake at *A*, parallel with the line drawn down the side of the stack, right through the base. But I don't see how we are to tell the height when the stack is on a side hill."

"Do the whole thing in almost the same manner, John. Drive the stakes the same as you told me, only drive them to one side of the base, and use a plumb bob and line to carry the line of the stack down to the ground. Just have some one hold the plumb line, or attach it to a tall leaning stake so located that you can sight the line at right angles to square with the vertical shadow plane. You can stand 10 or 50 feet from the stack to do this part of the work. Just get the line fair with the shadow side of stack, and place a stake at the bottom of the base, in line with the stack as shown by the dotted line at *A*, Fig. 2. Make all measurements from this point, parallel with the shadow—never going nearer or farther from it, but keeping at the same distance when measuring to *B* and to *C*."

"Say, Mr. Hobart, I see that Fig. 2 is marked to be 78.66 feet from *B* to *C* and 13 feet from *A* to *B*. I don't see how you get those figures. What gives them to you, anyway?"

"Those figures are not the height of the stack and base, John. They are simply the length of the shadows from *C* to *B* and to *A*. That's all they are."

"Then I don't see that you have got the height of the stack, for how do you know that the shadow is just as long as the stack and base?"

"We don't know that, John; and, furthermore, we don't care. In your method, shown by Fig. 1, you have to wait until the length of the shadow is the same as the length of the pole above the ground. In the scheme shown by Fig. 2, you don't have to wait for anything except to get ready and make the required measurements—and for the sun to shine!"

"I'm afraid, Mr. Hobart, that you'll have to 'show me' once again. I don't quite catch on to the way it is done!"

"All right, John, you have probably overlooked the little joker at *D*, Fig. 2. There, you may see, we have erected your pole, same as in Fig. 1, only it stands on the side hill where the slope is exactly the same as along the shadow of the stack."

"I see that, but how about that 12.33 feet marked along the shadow of the 10-foot pole?"

"That, John, is the length of the shadow cast by the pole. The 10-foot pole casts a 12.33 foot shadow, and there you have the key to the height of the stack and base."

"Oh, ho! That's the way, is it? Instead of waiting for the pole and shadow to become of equal length, you jump right in at any time, and call each 12.33 feet of stack shadow equal to 10 feet of stack? Is that the way you do it?"

"That's the way, John, $78.66 \div 12.33 \times 10 = 63.73$ feet, or about 63 feet 9½ inches. The base shadow measures 13 feet and figures to be 10 feet 6½ inches high. The total height of the stack and base amounts to 74 feet 4 inches."

"That 'shows me' all right, Mr. Hobart, and I see it all now, except what geometry has to do with it. I don't see where that science comes into the matter at all. You just figure the stack and stake on the same slope, to the same angle of shadow, and there you are. It is a slick way, all right, but where geometry comes in I can't see yet?"

"Geometry comes in first, last and all the time, John. And that's the great value of geometry. It is so useful that we use it everywhere and do not realize many times that we are using that great science. Now, John, how do we know that the shadow of the pole and the shadow of the stack are in proportion to the length of each? That is, how do we know that each 10 feet of stack casts 11 feet of shadow? Just tell me, John, how are we sure that such is the case?"

"Why, that is so on the face of it, Mr. Hobart. If we put up a 10-foot pole and a 20-foot pole, we know that when one casts a 11-foot shadow the other pole must cast a shadow 22-feet long. That is a self-proving fact, isn't it?"

"Don't see it that way, John. We must go to geometry for a proof that such is the case. Geometry shows us that when the angles of two triangles are similar, one for the other, that when two similar sides are in a certain proportion to each other, the second and third sides will also be in a similar ratio or proportion to each other. That's where geometry proves it, John—proves a thing which we see so plainly that we think it needs no proof. But that is the way with geometry, which can be made to prove and determine not only the very simple things, but to dig out and prove to us many hidden things which we could hardly ever work out were it not for the aid extended to us by geometry."

"By George, it seems to prove out, Mr. Hobart, so it must be right, only it seems so queer to do a lot of stunts with geometry when to look the matter over you can't see how that science could be possibly applied to the work!"

"It is much the same, only worse, with the calculus. It takes a whole lot of 'knowhow' to be able to apply calculus to everyday problems. Why it took me several years to get into the calculus far enough to be able to apply it to common problems. It used to seem as though the calculus ought to be used for calculating the motion of the planets, or something big like that. It didn't seem as though it could be applied to finding the areas of a lot of segments of circles, but after a while I found it could be so applied. You, John, are having the same trouble now, only in a lesser degree, in making geometry fit to your every-day work. But by and by you will get over that and be able to do anything—even to eat your dinner with geometry and trigonometry as well as with a knife and fork!"

"I hope so, Mr. Hobart. I'm making a bluff at it, anyway, but tell me—how can Bill and I find the height of that stack when the sun isn't shining to furnish a shadow for us? Guess that will make 'Old Geometry' hump itself a little!"

"Not a bit, John. All the sun did was to locate the point *C* in a line drawn from top of the stack to the ground at the same angle as the dotted line in Fig. 1. If we can find some other way of locating the line from the top of the stack, why, then, the sun can stay behind clouds all day as far as we care."

"Is there any way of doing that without instruments, Mr. Hobart?"

"There sure is, John, and Fig. 2 shows one way in addition to the shadow business. Just get two poles, a long one and a shorter one, then set up the longer one as shown at *F* and make it exactly vertical and solidly set so it will not sway in the least. A very good way to set up this pole is to use three light guy cords, and thus fasten the top of the pole securely. The bottom end may be placed on a board, which in turn may rest on the ground and be moved around until the pole stands exactly plumb, as determined by means of a plumb line and bob, and by sighting the pole past the line from two points 90 degrees apart."

"Why is pole *F* made that odd length, 26.3 feet?"

"Because, John, in this case we started with the 10-foot pole *E*, and set up pole *F* just 20 feet distant from pole *E*. Then we had to cut off the top of pole *F* to a sight line from top of pole *E* to the top of the stack. That is why pole *F* happened to be 26.3 feet long instead of some even number of feet. We could have varied the distance *G* or the length of the pole *E*, but it just happened that pole *F* was the one varied to bring the tops of both poles and the top of the stack in line with each other. That's all the reason!"

"Well, after we've got the poles all set and the distances measured, where does the stack height come in? I don't see that yet."

"Hold on a bit, John, and that will come to you. It's a mixture of geometry and trigonometry this time, but you never would know it, so don't get scared."

"All right—let the 'Trig' loose!"

"In Fig. 2 the distance between poles *E* and *F*, measured on the hillside, is 20 feet. Now, then, as one pole is 26.3 feet high, and the other one 10 feet tall, their difference will be 16.3 feet, will it not? And that difference 'runs out' in just 20 feet, does it not?"

"What do you mean by 'runs out'?"

"Why, look at line *G*, 16.3 feet on line *F*, and 'runs out' to nothing at line, or pole *E*. See it now?"

"Oh, yes! For each 20 feet of hillside distance between one of the poles and the stack, there will be 16.3 feet of vertical stack. Is that what you mean?"

"Just that, John. As usual, you have got the figures through your head without getting slivers in your fingers scratching it! Now, let's see you figure it out?"

"Here you are, Mr. Hobart! Just look this over: $26.3 - 10 = 16.3$, and as 13.3 feet is to the height of the stack, so 20 feet, the distance *G*, is to the distance from pole *E* to the stack. And in figures, it is like this:

$$16.3 : \text{stack} :: 20 : 79.33$$

$$\text{Then 'stack'} = 16.3 \times \frac{79.33}{20} = \frac{129.3079}{20} = 64.65 \text{ feet} =$$

64 feet 7.8 inches."

"But, John, the length of the stack is 74 feet 8 inches. What is wrong with your figures by the stake method?"

"You can search me, Mr. Hobart, and the figures too. I can't find anything wrong with them. Can you?"

"No, John, the calculations seem all right, and as 'figures don't lie' something else must be wrong. Now, can you find it?"

"Blamed if I can see it, Mr. Hobart, where is the 'cat in the meal' this time?"

"It's right on top of that 10-foot stake *E*, John. That's where you will find it, or must you be 'shown'?"

"Reckon you'll have to 'show me' already once, as Hans says. How is it, Mr. Hobart?"

"Well, John, when you figured on 'running out' a base line of 79.33 feet, aren't you really working from the top of pole E? And if you run along the line G until you came to the stack, wouldn't you hit it 10 feet from the ground? And if you should work to a base of 59.33 feet from pole F, would you not touch the stack at the end of line H, just 26.3 feet feet above the ground?"

"Reckon I would, Mr. Hobart, and I'll bet that the result—64.65 feet—is the distance vertically from the top of pole E to the top of the stack! Is it?"

"That's about what, John. That makes 74.65 feet for the stack height."

"But the real length of stack is 74 feet 8 inches, or 74.66 feet, while the calculated length from the two poles is 64.65, or 64 feet 7.8 inches. What makes the difference, Mr. Hobart?"

"The difference is very slight, John, only a small fraction of an inch, and it is as close as we can be expected to work in sighting over the tops of poles. Even if the lengths of the stack, computed by the two methods, corresponded within an inch, instead of within two-tenths of an inch, you could regard the results as exceedingly close under the circumstances. But coming as close as they do, they are exceedingly exact—much nearer than you have any reason to expect, and nearer than you would probably come again!"

"Does the geometry business come in the same as it did with the shadow calculations?"

"Pretty much the same, John. Look up in your geometry the propositions relating to angles which are equal to the same angle being equal to each other, and there you will find the reason why the pole business lets you find the length of the stack!"

"Gee! But geometry is sure some stunt, all right. Wonder if I could use it for planing up the calking edges of sheets?"

"You can use it there, all right, for setting the cutting tool at the best angle; and, John, some day I will have a talk with you on the matter of the best angle for planing the edges of sheets, also for the best shape of calking tools and the best angle at which to hold that tool. Geometry sure has a whole lot to tell you about these matters!"

Low Water Boiler Explosions

BY GEORGE SHERWOOD HODGINS *

In the preceding studies we have been considering the various methods employed by designer and builder for fortifying a locomotive boiler against the strains set up by the evenly distributed pressure of steam inside the containing vessel. These are structural matters and have to do with the ultimate strength of the boiler, and are also designed to guard against its very natural and inevitable deterioration. The effects of this deterioration may be held off, or delayed by careful design and good workmanship, but they cannot be permanently halted. If a boiler is so made that it will last out, safely, its allotted span of life, it is as much as we can expect. In endeavoring to secure this desirable condition it is always imperative that no chances shall be taken and no risks run.

A boiler explosion, from whatever cause, is one of the most deplorable of happenings, and yet it may take place in a boiler perfectly designed, as far as our knowledge goes, and built with the most conscientious care. The fact that a new and perfectly good boiler may be exploded by working it with an insufficient supply of water proves that the cause does not come under the head of structural defects, but relates to the operating of the boiler by those in charge, in the performance of their duty. It is, therefore, of importance to thoroughly understand how this ever-present menace to safety and life is to be guarded against. There is no mistaking the cause of a boiler explosion due to structural defects, or of one produced by low water. Each leaves unmistakable evidence of the cause of the disaster. Nowhere may Emerson's words, that "everything in nature is engaged in writing its own history," be more truly applied than in the contemplation of the wrecked and shattered plates of a boiler that has been blown up, when operated under a shortage of water.

The point of attack, if one may so say, is the crown sheet, as it is the flat surface which depends most of all on its staying. Experiments have been made which prove that the sudden introduction of cold water on hot plates does not cause an explosion, any more than the sudden forward surge of the water does when a quick stop is made by a powerful application of the brakes on a locomotive. During the few moments when the brakes go on hard, the water leaves the crown sheet bare, and banks up against the round head at the front of the boiler. When the train slackens speed, the water flows back, and the normal level is restored.

If, however, due to the constant evaporation of water, with supply cut off, the level of the water falls below the crown sheet, it becomes dry and begins to heat. During the heating process, the steam pressure does not diminish, while the plate becomes hotter and hotter. As it gains in heat, it gradually becomes soft, and eventually bags down between the stays. The plate therefore has stretched, and the ends of the stays also become hot, and their heads soft. The stretching of the plate, evidenced by the bagging down between stays, increases, and if it was possible to look at it in this condition there is no doubt that the sheet would look something like a blanket looped up at points like those where the staybolts have been screwed in.

When the bagging and stretching of the plate has become sufficient, the sheet draws off the staybolts, folding back the riveted heads and hardly impairing the threads in sheet or staybolts. The hole simply enlarges, while it preserves the number and the form of the threads. The sagged portion of the sheet is now without the support of the stays, and the large area bags down as a whole. Steam blows through the staybolt holes, and if in sufficient quantities may extinguish the fire, and possibly relieve the pressure of steam.

Generally, however, the exit afforded by the staybolt holes is not sufficient for this, and the hot sheet tears along a row of staybolt holes. Up to this point there has been no explosion, and the whole process has been gradual, and even slow. The shortage of water has produced a discoloration of the plates, and in several instances known to the writer this discoloration has shown that three or four tubes have been left dry before the disruptive force of the actual explosion has manifested itself. The torn plate has been reduced in thickness near the line of fracture and approximately assumes a "knife-edge" form. These unmistakable signs of the low-water cause is what we mean by saying that Emerson's words are applicable in this case.

When the sheet actually tears apart, paradoxical as it may seem, it is the sudden relief of the steam pressure which causes the explosion. The giving way of the sheet is the cause of the explosion; the explosion is not the cause of the tearing of the sheet. If a good boiler can be kept intact by reason of the maintenance of high water there is little or no danger of an explosion.

* Formerly Consulting Mechanical Engineer, National Transcontinental Railway. Member, American Society of Mechanical Engineers.

The reason why the sudden reduction of pressure causes the catastrophe is that water in a boiler at, say, 200 pounds pressure, contains a quantity of energy which, in the ordinary working of the machine, is used up slowly, and, while being used, is constantly being supplied with new energy. Water at 200 pounds pressure has a temperature of 388 degrees Fahrenheit. This is 176 degrees above what it would boil at in the open air. In fact, the water in a locomotive is boiled under a dense, heavy, hot atmosphere of steam. At this pressure, in order to boil at all, it is compelled to become as hot as 388 degrees.

A British thermal unit (B. T. U.) is the quantity of heat required to raise a pound of pure water through one degree Fahrenheit. Water at 200 pounds pressure therefore receives 176 thermal units per pound above water at 212 degrees before it can make any steam, and lesser pressures require fewer thermal units of heat. In this way, if a large boiler filled with water be brought up to 200 pounds pressure, it contains, as has been calculated, energy enough to lift the engine more than two miles in the air if the energy could be exclusively applied to that purpose without loss.

If a given amount of energy is stored up in the hot water at 200 pounds pressure (and less energy for a less pressure) it follows that any reduction of the 200 pounds pressure must result in the liberation of the energy which it held above that required to make it boil at the lower pressure. In the case of sudden release, as when a crown sheet tears apart the whole of the energy above 212 degrees F. is at once liberated and the 176 thermal units in every pound of water are instantly employed in vaporizing the water which remains in the boiler. So suddenly is this accomplished that the water is said to flash into steam and burst out into the atmosphere with shatteringly destructive force.

A mild and fully controlled example of the same phenomenon may be seen when a boiler is blown off through the whistle valve preparatory to the boiler being washed out. Here the flow of steam through the whistle gradually reduces the pressure and the stored-up heat liberated by this reduction vaporizes the nearby water and blows it away. The proof of all this is that if the water stood at a certain height when the blowing-off process commenced it will be found much lower at the conclusion of the operation. A boiler to be blown off is usually brought into the shop with as low a pressure as may be, and with both injectors working full, in the endeavor to "drown her out." If this liberation of energy and vaporization of water did not take place the water would stand at the same level at the beginning and ending of the blowing-off process, but it does not.

It is easy to imagine that if the cover of a large steam dome on a locomotive was to break up or be suddenly removed from an engine under 200 pounds pressure a miniature explosion would follow, which, if it did not damage the crown sheet or other parts, would probably prove disastrous to the roof of the running shed if the engine had been housed.

One sometimes sees a design intended to meet the very conditions outlined above. For example, one row of staybolts is simply riveted over in the usual way, while the next row has button-heads, and so on, each row of riveted and of button-head stays alternating over the whole area of the crown sheet. The object of such an arrangement is that if the crown sheet becomes overheated and pulls off the stays the button-heads will hold longer than the others, and so the belief, or rather, the hope, is that the whole sheet will not go down at once, but that a series of several pockets will be formed and the escape of steam through the staybolt holes, where the crown sheet has pulled off, will permit the gradual, or at least the restricted outflow of steam, which will put out the fire before the crown sheet has broken down.

Whether or not this would be the invariable action of button-head and riveted stays it is not possible to say for certain, as other conditions might arise which would defeat the object of this design. The crown sheet, when torn across by overheating and sagging, invariably shows a sheet thinned at the edges and broken at the thinnest part very similar to the appearance of a test piece when broken in a testing machine. There is the elongation of the piece, the thinning of the specimen down to the point of fracture, and these results of the strain are approximately reproduced in the boiler plate.

Where such appearances exist there is unmistakable evidence that the failure has been gradual, the actual explosion being the only comparatively rapid thing in the whole phenomenon. It is a question whether the holding of the button-heads could long enough delay the final tear so as to eliminate the explosion. In any case, the design is a conscientious effort to introduce what element of safety there may be had in such cases. If it were effectual in all cases we would have before us a most valuable safety appliance in boiler construction which it would be a grave error to ignore. The soft plate, heated to redness, is all too pliable and has a tendency to make the staybolt holes large, and the button-heads at the same time become soft, so that one is by no means sure that the enlarged hole and the easily deformed button-head may not effect a combination sufficient to defeat the undoubtedly excellent intention of the designer.

"Eternal vigilance is the price of safety," and those who operate boilers under pressure have only the gauge glass and the try-cocks to rely upon. While the low-water explosion is an operating defect and not a structural one, it behooves the designer to try every conceivable and reasonable method to protect the lives of men and to seek only the most approved practice, the best material and the highest grade of workmanship that money and earnest endeavor can possibly procure.

Milling Attachments for a Planer

Figs. 1 and 2 show a cheap but durable milling attachment for a planer, the object of which is the machining of various details, such as ring doors for boiler fronts, etc., which cannot be conveniently finished without the expense of installing a very large milling machine.

Fig. 1 shows the attachment mounted on the head of the planer, the clapper and clapper box having been removed. The spindle bracket on the head *A* is attached to the planer slide by four bolts and the spindle is driven through bevel gears by the driving shaft *B*. The driving shaft bracket *C* is bolted to the top of the saddle and remains stationary, supporting the bevel gear, while the head of the machine may be brought up or down, as the exigencies of the case require. For instance, in machining a casting which has an irregular surface the lowest portion may be found by observation and the spindle fed down to a depth suitable for machining it. The rest of the surface, higher of course, is thus taken care of.

The driving shaft has on it a pulley which is driven by a drum mounted on the arch of the planer, as the attachment has been designed to be fed across by means of the planer cross-feed screw, while the table takes care of the longitudinal feed.

Fig. 2 shows the general arrangement of the pulleys, shafting, etc. The countershaft *D*, which is driven by the line shaft and which in turn drives the main driving shaft E of the planer, shows a three-step cone, and it is therefore plainly seen that there are three changes of longitudinal feed. This ought to be enough for all ordinary cases, but more steps may be used if desired. On the drum shaft F there is a loose pulley to which the belt may be shifted when the attachment is not in use.

The cross feed screw of the planer should be furnished with a crank of sufficient leverage to allow the operator to turn it, and therefore feed across without over-exertion. A power cross feed may be applied, if desirable, by simply running a belt from the countershaft D to the feed screw. However, in feeding across, the operator must be on his job continually on account of the small width of the ordinary planers, and it is just as well that he feed it by hand.

From the foregoing one can readily see how it is possible to machine an object such as a ring door, which requires a cross and longitudinal feed simultaneously. There are numerous objects, such as fire doors and frames, on which there is to be machined a small, narrow strip. The cutter may be fed in all four directions, starting at one corner and going completely around the door or frame without stopping the machine.

The device is not patented, and anyone who desires to use the design is at liberty to do so.

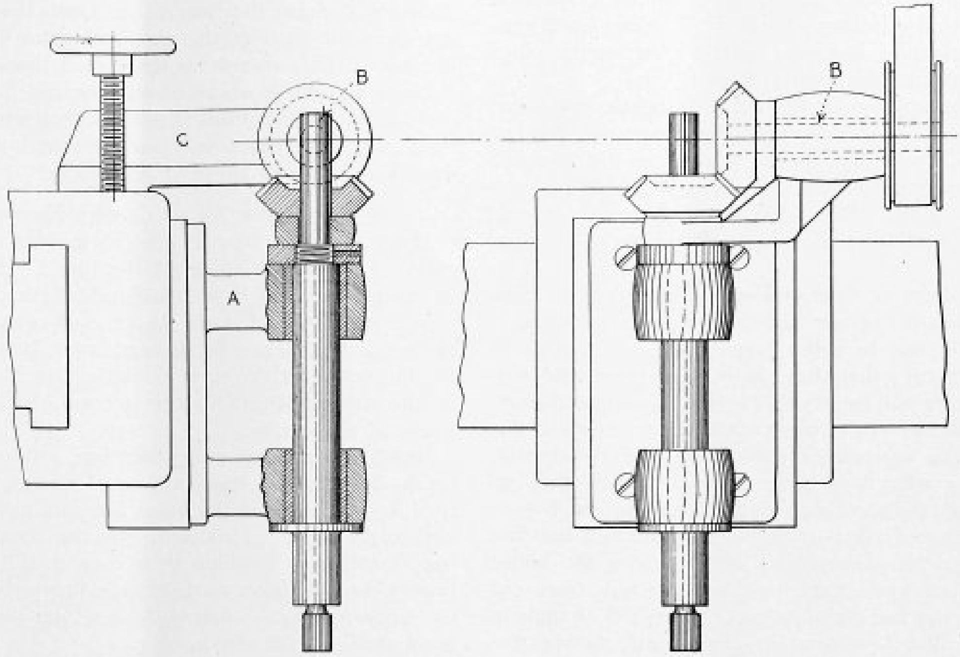


Fig. 1

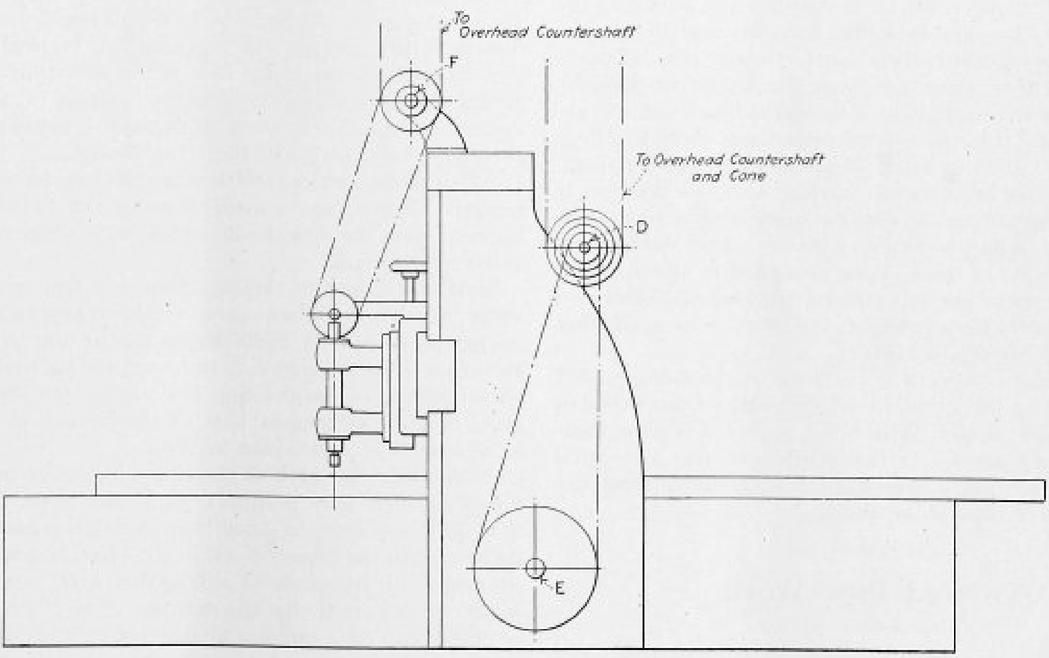


Fig. 2

New York. H. R. Smith.

Locomotive Boiler Inspection

According to a report in the *Railway Age Gazette, Mechanical Edition,* of the discussion of a paper read by the chief of the Federal Locomotive Boiler Inspection before the Pittsburg Railway Club, D. F. Crawford, general superintendent of motive power, Pennsylvania Lines West, expressed the following opinion:

"I don't quite agree with the very optimistic statement made by the chief of the Federal Boiler Inspection Bureau as to what his bureau has done. I hope he did it and I hope he will continue to do it, but there is an old Spanish proverb which states, 'What has not happened for two years may happen in two minutes." And it is quite correct.

"The Public Service Commission of the State of New York, whose members have had five years' experience in conducting a locomotive boiler inspection bureau, state in their report for 1913 that they doubt very much the wisdom of continuing the locomotive boiler inspection department, as the officers of the mechanical departments of the railways have so adequately performed their work that they do not see why it is necessary. And then they go on and show a tabulated statement as to the number of accidents before and after—really not before, but the first year, which can be assumed as being before the boiler inspection bureau was established, because any rules put into force had not had time to make a radical change in the conditions that had been in effect—and during five years from 1909, accidents were reported as follows: 1909, 12 accidents; 1910, 11 accidents; 1911, 36 accidents; 1912, 35 accidents, and 1913, 27 accidents. Now I do not for a minute mean to criticise the boiler inspection department of the federal commission. I am well acquainted with a number of the gentlemen connected therewith, and their work has been of the most meritorious character, but it is a question in my mind as to whether the public of the United States has got back the $225,000 paid those gentlemen for performing their work (which they earned) and whether they have got back the $6,600,000 paid by the railroads for improving a theoretical and not a practical condition. Do not misunderstand me; there has been improvement. The question is whether the improvement, or all of it, has been worth while. Another question is whether we cannot accomplish the same improvement with very much less documentary evidence. The Public Service Commission of New York remarked in the 1913 report: 'The mass of correspondence reaching this office and the number of reports reaching the office is so great that we could not inspect the boilers.'

"The Federal Congress at 4 o'clock one morning passed a law extending the authority of the chief of the Division of Locomotive Boiler Inspection over the entire locomotive and its parts. If the gentlemen who advocated that law knew what it means, they know more than any railroad man in the United States."

Twisted Pipe Work

BY GEORGE A. JONES

A job such as is shown here is often encountered around blast furnaces, as, for instance, between the blast lines and the bustle pipe around the furnace. Although it is twisted between the elbow and the branch, it is not very difficult to make.

Center Lines and Out Lines of Pipe

First erect a line as *A-B,* which represents a horizontal pipe, and in the proper position erect the line or axis of the bustle pipe, which is *T'-T'* in the elevation. At right angles to *T'-T'* draw the line *B-C*. On the line first drawn and below the elevation set down the distance *A'-B'*, which is the vertical height. The horizontal pipe is above the horizontal bustle pipe at right angles to *A'-B'* and through *A'* draw the line *A'-C*. Drop the line from *C* in the elevation to *C* in the plan and draw the line *B'-C* in the plan. This completes the center lines.

Draw the circle about *B'* and the out lines of the pipe. As *B-C* in the elevation is not the true length of this section, we must erect another vein and obtain the true length and proper angle of the elbow.

True Angle of the Elbow

Upon the base line of the horizontal pipe and to the right of the elevation, erect the line *C'-A*, equal to *B'-C* in the plan, which is the diagonal length. Erect the vertical lines *C'-C* and *A-B*. Make *A-B* equal to *A-B* of the elevation and it can be squared over from the elevation. Do the same with *C*, then erect the line *B-C* and this will be the correct length of this section and *A-B-C* the true angle of the elbow.

Draw the outlines and miter line about *A*. Also draw the half circle and space six equal spaces, then erect vertical lines upward to the miter line and number these lines and points 1 to 7. This completes the layout of the elbow, but in order to combine in one piece the elbow and the branch we will have to determine how much the developing lines for the branch will be set around in the pattern from those of the elbow.

To Obtain the Twist

Referring to the plan again, the line *B'-C* represents the axis and also the direction of this piece of pipe. Where the line *B'-C* passes over the circle will locate the throat and back of the elbow, as shown at 1 and 7, in which the point 1 is the throat and 7 is the back. Now, on the circle *B'* and between the points 1 to 7 space off six equal spaces, the same as in the elbow layout, Fig. 1. Through these points 1 to 7 in the plan vertical lines are run upwards to the miter line in the elevation and horizontal lines from similar numbered points in Fig. 1 are carried over. Where these lines meet determines points, through which draw the ellipse as shown.

All of these vertical and horizontal lines have not been drawn. These were omitted in order not to confuse the reader. But the manner in which it is obtained will be easily understood.

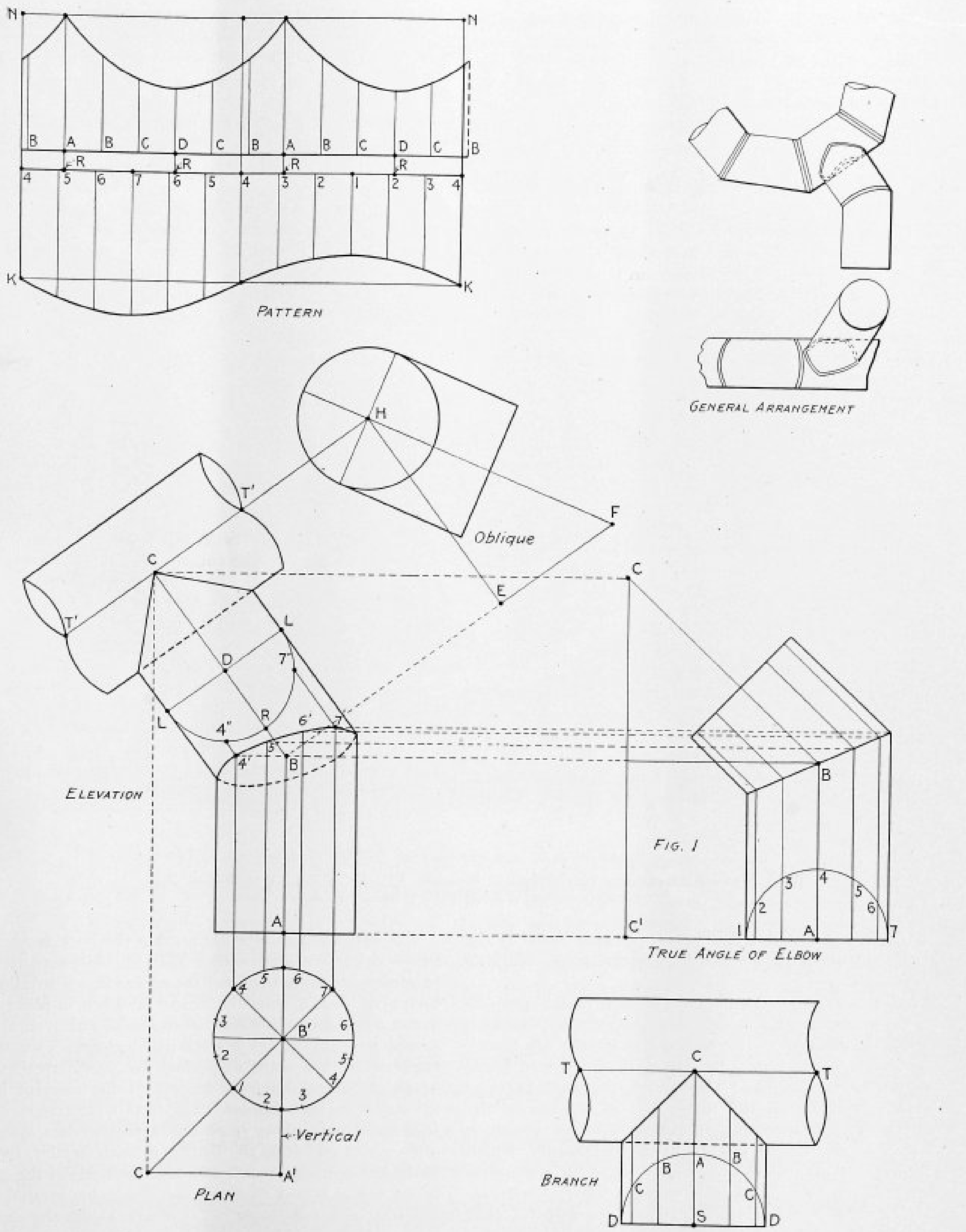
Now the ellipse in the elevation is a true view of the miter line of the elbow as it would appear when in its proper position. At right angles to the line *B-C* in the elevation draw the line *L-L* and erect the half-circle about *D* as shown. Now the line *D-C*, being the axis of this pipe, is also the longest part of the branch or that part as shown in branch layout as *A-C*.

As the side and back of the elbow have also been determined in their true positions, as 4' and 7' on the ellipse, it is only necessary to draw lines through points 4' and 7' parallel with the line *D-C* on to the circle about *D*. Now the length on the circle *D* will be the twist, as 4" to *R*, or *R* to 7". Also note that the distance 4" to 7" on the circle is one-fourth of a circle and will aid as a check this far.

Laying Out the Pattern

Draw the line *K* to *K* equal to the circumference of the pipe, then square up the plate and make the distance *K* to *N* in the pattern equal to *B C* in Fig. 1. Draw the lines 4-4 and *B-B*. Space the line 4-4 into twelve equal spaces and draw vertical lines through these points. As the elbow will be lapped on the side and as the side is No. 4 in the elbow layout, three spaces in from the side of the pattern will be point 1 or the throat of the elbow.

With the throat located as point 1, number these lines in rotation as 1 to 7 and lay out the elbow end in the regular way by taking lengths from Fig. 1. Now take the distance 4″ to *R* in the elevation, which is the distance between the side of the elbow and the longest part of the branch. It is also the distance between the back of the elbow and the shortest side of the branch. Lay this distance out in the pattern to the right of points 4 and 7 and 1 and locate *R* in the elevation. The point *R* to the right of 4″ is the long part of the branch, or *A* in the branch layout. Erect the vertical lines through the points *R* in the pattern and those to the right of point 4 will be point *A* of the branch. Those to the right of point 7 and 1 will be points *D* or the short side of the branch.



Layout of Patterns for Twisted Pipe Work

On the four quarters just located, as A to D on the line B-B, lay out three spaces in each quarter, or twelve in all and finish the branch in the usual way. Allow for laps and flanging and pattern is complete.

After the layerout checks up the circumference and holes, also the total length K to N and the twist 4 to R, he should see if the branch was started on the right lines. In measuring 4" to R in the elevation for the twist, it should be measured on a circle corresponding to the neutral diameter of the pipe being made.

Repairs to a Babcock and Wilcox Boiler

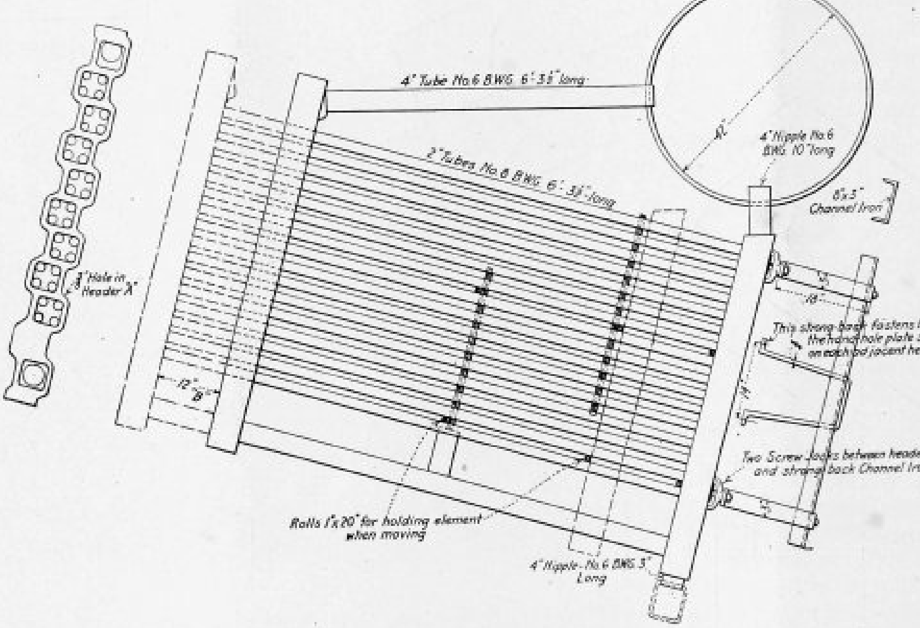
At about twelve hours forty-five minutes post meridian, January 26, 1915, while the U. S. S. *Nebraska* was steaming in formation at drill off the southern coast of Cuba, a violent noise caused by the escape of steam was heard in boiler No. 3. This gave no alternative save hauling fires with rapidity and trepidation. When this was completed, and safety permitted an examination to be made, it was found that water and steam were escaping between the fourth and fifth headers at the back of the boiler counting from the left.

When the vessel reached port as much of the asbestos as could be gotten at was dug from between the headers, showing the damage. The boiler was slowly filled until the defective header could be identified, which was found to be the fourth header. There were no spare parts of this kind available at the time, and on account of the strenuous duty necessitating the service of all power, it was decided to attempt repairs to the old header, which was then cut out, destroying thirty-six 2-inch seamless drawn tubes 8 feet 2 inches long, and two 4-inch seamless drawn tubes, one 6 feet 3½ inches long and the other 8 feet 2 inches long, a total cost of $51.50 (10/14/7).

The defect in the header was a hole about ⅜ inch in diameter which had blown in the curvature of the header, shown in the sketch and noted by the letter "A." The header was manufactured in 1900, and in making the curvature the metal had been drawn thin. As there is no means of cleaning the rust from between the headers, corrosion at these points is permitted to go on without abatement, thus rendering ruptures in old boilers to be expected, this being our third similar experience in two years.

After the header was cut out and sent to the repair ship the hole in the header was filled with metal by the oxy-acetylene process, so that metal projected into the header through the hole for a distance of 2 inches, the metal being built up on the outside only. The cost of rigging the header for a test being prohibitive, it was concluded to install the header without a test.

When the installation was completed, at a cost for material of $103 (21/9/2) and a labor cost of $44.52 (9/5/5), a test was put on the boiler and it was found to leak at a pressure of 150 pounds, the working pressure being 265 pounds. This looked like doing all of the work over again, which would have made the job cost, for material $154.50 (£31.7), labor $89.04 (£18.3), total $243.54 (£50). A realization of this fact made us adopt the following process, so as to save the tubes at least:



Sketch Showing Arrangement and Method of Removing Element of Babcock & Wilcox Boiler for Purposes of Welding Hole in Rear Header

The upper 4-inch tube connecting the back header with the drum was heated with a blow torch where it is expanded into the header and the end crimped to allow the tube to be drawn from the header and left in place in the drum. The front and back doors were removed and the casing in wake of the header lifted clear. Two strong-backs were then made of ¾-inch by 3-inch steel, shaped so as to bridge the front header of the element having the defective back header. The nuts were removed from four hand hole plates in the adjacent headers, one from the top and one from the bottom of each header, the dogs being left in place in each case and the heels of the strong-backs being bolted to the boiler front by means of the studs in the handhole plates, as shown in the sketch. This gave a good, rigid brace for the work.

A channel bar 8 inches by 3 inches was placed on the boiler side of the apex of the strong-backs, flanges pointing boilerward, and extending from one strong-back to the other, as shown in the sketch. Four bars of iron 1 inch in diameter and 20 inches long were placed in the boiler, as shown in the sketch, to form rollers to take the

weight of the element as it was shoved back and thus relieve the pressure on the baffles.

The upper and lower 4-inch nipples of the front header having been cut out, screw jacks were placed between the channel bar and the front header and were gradually set up. The whole element was thus moved aft, without much difficulty, until the defective back header was exposed in the rear of the boiler sufficiently to permit of being worked on. This is shown in the sketch at "B."

With the header in this position the oxy-acetylene welding outfit was again brought into play and the metal built up over the defect to a greater thickness and spread out more over the outer surface. It was impossible to put metal on the inner surface, since it was an under surface.

This being completed the element was forced back into place, the upper 4-inch tube rolled in, the upper and lower front 4-inch nipples renewed, the bracing removed and the casing replaced and boiler tested. A test of 400 pounds was applied without any indications of a leak, and subsequent service under forced draft has shown no derangement.

The baffles in the boiler had been put in alinement and held there by metal strips ¼ inch thick, 4 inches wide, and extending from the top row of 2-inch tubes to the bottom row and clamped to the tubes. This alinement made it possible for the tubes to slide through the baffles without breaking or deranging them, and also made a testing of the alinement of the baffles after the completion of the repairs a very simple and easy matter.

A comparison of the costs of the two methods is given below:

Method	Time	Material	Labor	Total Cost
Cut out header...........	6 days	$103.00 (21/9/2)	$44.52 (9/5/5)	$147.52 (30/14/7)
Jack back header..........	4 days	$6.96 (1/9/2)	$32.68 (6/16/0)	$39.64 (8/5/0)

Lieut. F. H. Sadler, U. S. N.

U. S. S. *Nebraska.*

It is astonishing how many boilers blow up with two full gages of water and much less than their authorized pressures—that is, if you take the word of the firemen who survive the accident.

Large Battery of Cooling Towers

The accompanying photographs (Figs. 1 and 2) illustrate a large battery of forced draft cooling towers, built by the Wheeler Condenser & Engineering Company, of Carteret, N. J., for the Texas Power & Light Company, Waco, Tex. Sargent & Lundy, of Chicago, were the consulting engineers, and an illustrated description of the large breeching and uptake for this plant was published on page 219 of our July issue.

The towers are of the steel shell type, arranged in a battery 100 feet long, 40 feet wide and 40 feet high. There are six pairs of 10-foot fans operating at 250 revolutions per minute, belt-driven by motors located above each pair of fans in small motor houses. The fan housings are extended and are provided with doors which may be opened to permit unobstructed entrance of air for operation by natural draft during the winter season. A platform reached by a ladder from the ground serves the three motor houses, and an upper gallery is built on the level of the water distributors and the water regulating valves which control the water discharge to each compartment. Any section may be cut off for inspection or cleaning without interfering with the operation of any of the others. The water piping is designed for an additional installation of six towers of equal capacity.

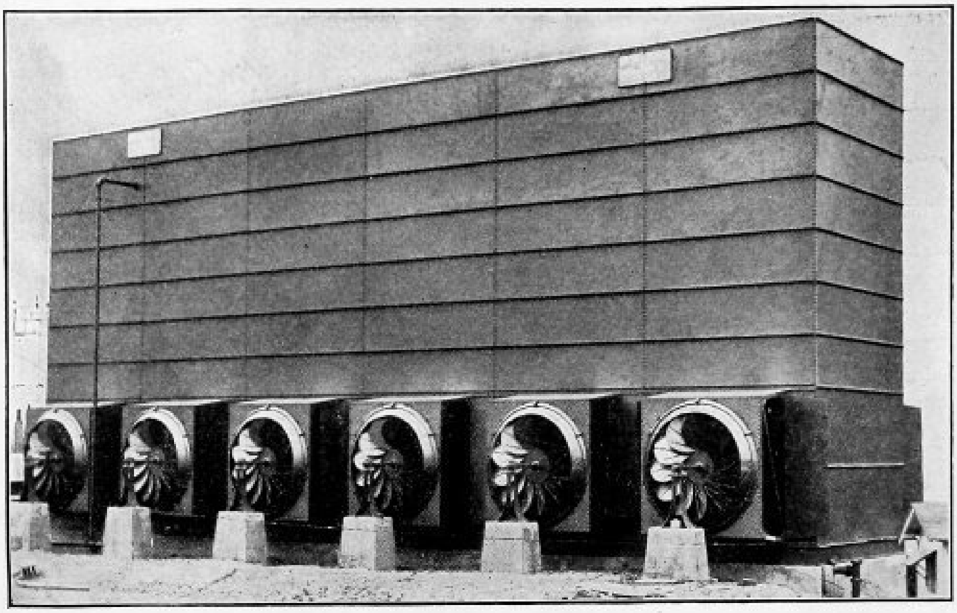


Fig. 1.—Battery of Six Large Forced Draft Towers; Capacity, 600,000 Gallons per Hour

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Poor Circulation in Boilers

One of the common ailments found in boilers is poor circulation. This is due to several causes. Some boilers are improperly designed, and no change that will remedy this trouble can be made after they are built; but one of the causes of poor circulation that the writer has occasionally met with, and which is curable, is the placing of too many tubes in a boiler, due to the desire of the designer to get as much heating surface in the boiler as possible without exceeding a specified diameter. A boiler is sometimes found with the tubes arranged as in the accompanying sketch. It will be noticed that the top and bottom rows of tubes in this design extend close to the shell of the boiler, and that there is no break in the rows.

In the case illustrated, the steam formed on the furnace sheets cannot rise to the top freely, being checked by the flow of water downward, there not being space for one to pass the other. This defect could be remedied by removing one tube from each side of the horizontal rows and one vertical row in the center. This may be objected to on the grounds of insufficient heating surface and also of restriction of the passage of the burnt gases, but all marine engineers know that it is common for a boiler with 150 or 200 tubes to have 15 or 20 of them plugged at one time without any appreciable difference in the steaming qualities of the boiler. If this is so in a boiler that has good circulation, it follows that if by removing the same number of tubes in a boiler that has poor circulation the circulation is improved, the increased quantity of steam generated by the better circulation will more than compensate for the decreased heating surface and restricted draft.

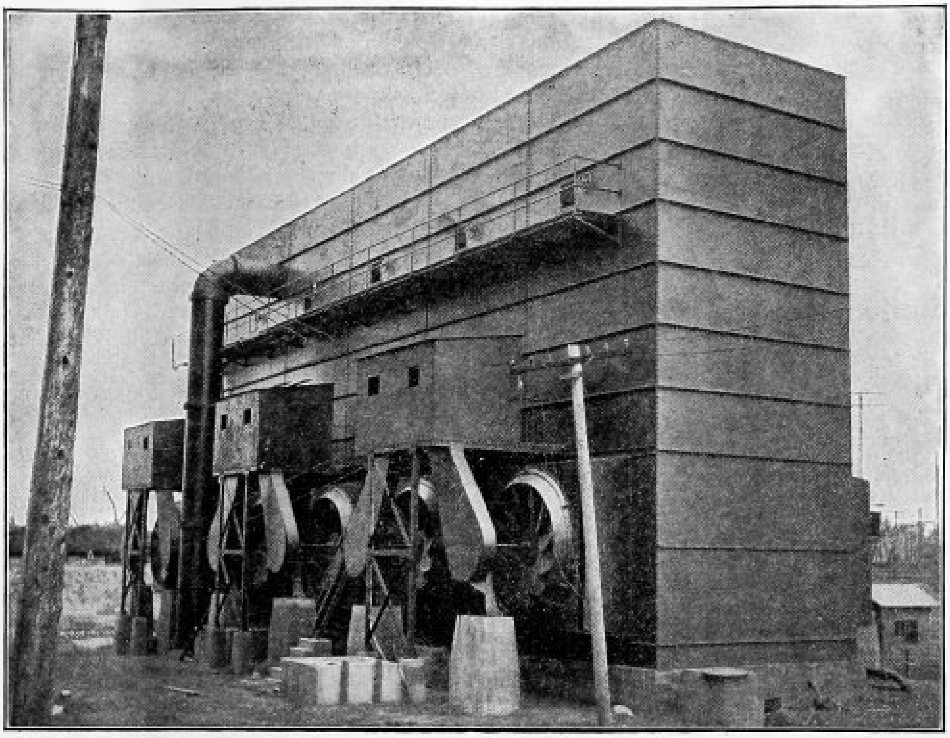
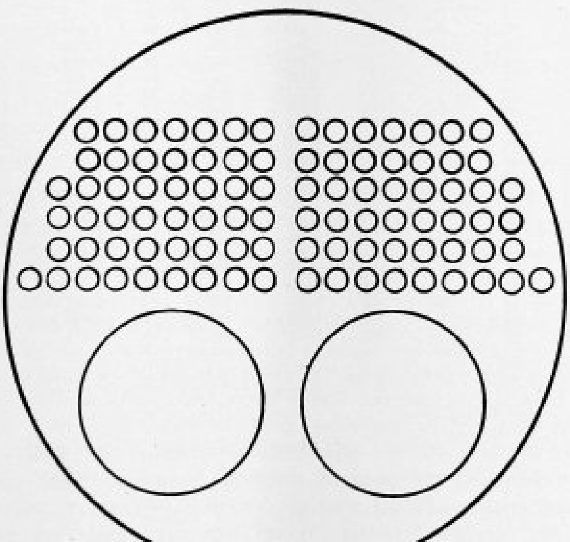


Fig. 2.—View from Opposite Side, Showing Motor Houses for Each Pair of Fans



Sketch Showing Arrangement of Tubes in Scotch Boiler

The boiler that has the more nearly perfect circulation, other things being equal, will generate the most steam. This admits of no argument, and anything that can be done to make the circulation better makes for better steaming qualities and economy of fuel.

The tubes in many cases are too close to the furnace crowns and the space does not permit perfect circulation. In some cases the tubes are too close together. Many boilers that have tubes 3 inches in diameter would do better work with tubes 2½ inches in diameter, spaced the same distance between centers, the better circulation more than compensating for the decreased heating surface, but these are defects that cannot be remedied once the boiler is built.

Poor circulation causes other defects besides decreased steaming qualities and waste of fuel. It is always found that boilers which have poor circulation are subject to corrosion and pitting internally, particularly under the back connections and bottoms of furnaces and flues. The water which lays stagnant in the bottom of a boiler soon becomes charged with all the elements of a galvanic battery and attacks the sheets with which it comes in contact. There are a number of good boiler circulators on the market, which circulate the water in the bottom of a boiler more or less effectively and are well worth the amount it costs to install them.

Another evil of poor circulation is the tendency of boilers so afflicted to foam. When there is insufficient space for the steam to rise to the surface of the water freely it accumulates near the heating surface, and when there is a sudden opening of the throttle, or lifting of the safety valve, the accumulated steam rises to the surface of the water rapidly and carries the water with it over into the steam pipe.

It is hardly necessary to mention the difficulty of keeping a boiler which is afflicted with poor circulation tight in the bottom seams. Every marine engineer is fully aware of this. Broken staybolts are another result of poor circulation. In raising steam on a Scotch boiler it frequently happens that the pressure rises to 100 pounds before the water in the bottom starts to circulate, and the sudden expansion of the bottom of the boiler when the temperature equalizes throws a severe strain on the staybolts that often causes them to break.

Practice and theory work splendidly together, much better than when used separately, and it would seem that all designers of boilers should study the practical operation of boilers as well as their theoretical efficiency. J. S.

Table of Boiler Heating Surface and Horsepower

We are rapidly drawing away from the horsepower method of rating boilers. This has come about through the working of two different tendencies, both of which diminish the value of such a statement of boiler capacity. In the first place, there no longer exists any particular equality between the horsepower of a boiler and the amount of engine power which it may be expected to serve, although at the time of the adoption of the present unit, in 1876, it was given a value about equal to the average steam consumption per horsepower of the engines exhibited at the Centennial Exposition, on the assumption that this would approximate average conditions at that time. Modern engines have so far improved in economy that it is now possible for one boiler horsepower to serve two to three engine horsepower of connected load under favorable circumstances. There is, moreover, another influence at work to lessen the value of the horsepower rating, namely, the growing demand for greater and greater boiler output per unit of heating surface, so that it is no longer a matter of special novelty to read test returns of boilers in regular operation at upwards of 200 percent of what a few years ago would have been considered a proper performance.

The result of these two changes in power plant economics is to make it more and more necessary to plan boiler plants on a heating surface and not a horsepower basis. The designing engineer first determines the rate at which he expects to be able to work his heating surface with the character of coal, draft setting, etc., which he expects to utilize. That is, he sets a figure for the amount of water which he may expect to evaporate on each square foot of heating surface in the particular plant he has in mind. It is then only necessary to add the combined water rates of the different steam consuming devices and divide by the evaporative rate, to arrive at the total heating surface, which he can divide among the proper number of boilers.

When an essentially non-technical buyer of boilers is obtaining competitive bids from boiler makers, he is apt to think and talk in terms of dollars per 100 or 150 (or some other number) horsepower. He naturally assumes that this is a proper basis upon which comparisons may be made. He will, of course, be disappointed if, having purchased the boiler from the lowest bidder, he finds to his surprise that this builder has bid on a boiler rated at 10 square feet to the horsepower, while perhaps his engineer, in deciding on the necessary size, has calculated on a 12 square foot to the horsepower rating. This is very confusing to the owner who is not an engineer or who is not familiar with the diversity which exists among boiler makers as to the proper rate of evaporation to use as the foundating for a catalogue rating. It is not at all uncommon for the condition outlined above to come about, resulting in the purchase of a boiler 20 percent smaller than either the buyer or his engineer desired.

Those of our readers who may have experienced this trouble, or who may encounter it in the future, will find the accompanying table of service in that it enables them to compare directly both the heating surface and the horsepower rating of a given boiler with any other boiler. It is only necessary to know the diameter of the boilers, and the diameter, length and number of tubes, to arrive at the data required, with the assurance that it is calculated upon the same basis and gives a fair comparison of the size of the units. The table should also prove of value in deciding how many boilers of a given size would be required to equal any desired fraction of the capacity of a plant, if the new boilers are to be run at the same rate of evaporation as the existing ones. For such purposes the comparison should be based upon heating surface and not horsepower.

TABLE OF HEATING SURFACE AND HORSEPOWER FOR STANDARD SIZES OF HORIZONTAL TUBULAR BOILERS WITH MANHOLES BELOW TUBES

Diam. of Boiler, Ins.	Tubes			Heating Surface				Horsepower
	Length, Ft.	Diam., Ins.	No.	Tubes	Shell	Rear Head	Total	
54	14	3	54	552	99	8	659	66
54	16	3	54	631	113	8	752	75
54	14	3½	44	526	99	8	633	63
54	16	3½	44	601	113	8	722	72
54	14	4	34	467	99	8	574	57
54	16	4	34	534	113	8	655	65
60	16	3	72	841	125	10	976	98
60	18	3	72	946	141	10	1,097	110
60	16	3½	50	684	125	10	819	82
60	18	3½	50	770	141	10	921	92
60	16	4	46	722	125	9	856	86
60	18	4	46	812	141	9	962	96
66	16	3	94	1,098	138	11	1,247	125
66	18	3	94	1,235	156	11	1,402	140
66	16	3½	70	957	138	11	1,106	110
66	18	3½	70	1,077	156	11	1,244	124
66	16	4	56	878	138	11	1,027	103
66	18	4	56	988	156	11	1,155	115
72	16	3	118	1,378	151	13	1,542	154
72	18	3	118	1,550	170	13	1,733	173
72	20	3	118	1,722	189	13	1,924	192
72	16	3½	94	1,285	151	13	1,449	145
72	18	3½	94	1,446	170	13	1,629	163
72	20	3½	94	1,606	189	13	1,808	181
72	16	4	70	1,098	151	13	1,262	126
72	18	4	70	1,235	170	13	1,418	142
72	20	4	70	1,372	189	13	1,574	157
78	16	3	140	1,635	163	15	1,813	181
78	18	3	140	1,839	184	15	2,038	204
78	20	3	140	2,043	204	15	2,262	226
78	16	3½	108	1,477	163	15	1,655	165
78	18	3½	108	1,662	184	15	1,861	186
78	20	3½	108	1,846	204	15	2,065	206
78	16	4	88	1,380	163	14	1,557	156
78	18	4	88	1,553	184	14	1,751	175
78	20	4	88	1,725	204	14	1,943	194
84	18	3	172	2,260	198	17	2,475	247
84	20	3	172	2,511	220	17	2,748	275
84	18	3½	136	2,092	198	17	2,307	231
84	20	3½	136	2,324	220	17	2,561	256
84	18	4	106	1,871	198	16	2,085	208
84	20	4	106	2,078	220	16	2,314	231

The above table is figured on the basis of 10 square feet of heating surface per boiler horsepower; the heating surface as calculated includes all of the *inside* tube area, one-half the area of the cylindrical portion of the shell, and two-thirds of the area of the rear head minus the combined cross-sectional area of the tubes.—*The Locomotive of the Hartford Steam Boiler Inspection and Insurance Company.*

Being late at the shop puts you on the list of those first to be laid off.

Any apprentice can punch a hole and do it just as well as any journeyman, but the skill comes in in knowing what size hole to punch, just where to punch it, and then punching it in that place.

The Boiler Maker

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5,000 copies of this issue were printed.

NOTICE TO ADVERTISERS

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

The attention of the Bureau of Standards, Department of Commerce, has been directed to the failure and deterioration of fusible tin boiler plugs in service. In some cases such plugs have failed to melt, and so give warning of dangerous boiler conditions, and investigation has shown that the tin filling in these cases had become oxidized to tin oxide (SnO_2), which has a melting point above 2,900 degrees F.

About 1,050 plugs, of which 100 were plugs which had been in service, were obtained through the courtesy of the Steamboat Inspection Service, Department of Commerce, and subjected to examination. This included inspection of design and construction, condition and purity of the tin filling and, in the case of the used plugs, their classification according to the type of deterioration undergone by them in service.

One pronounced and dangerous type of deterioration is the oxidation of the tin along the grain boundaries, by which is formed a network of oxide throughout the tin. This is shown to be due to the presence of zinc in amounts as low as 0.3 percent.

Lead and zinc are found to be the principal impurities in tin-plug fillings, and since all "failed" plugs contained these or other impurities, the conclusion is reached that if these impurities are eliminated by strict specifications and inspection, which will allow only admittedly superior qualities of tin, such as Banca and some others, the danger of failures of these plugs will no longer exist.

In a monograph on the subject issued by the Bureau of Standards directions are given for the testing of the purity of the tin in such plugs.

In accordance with the resolution passed at the Boiler Manufacturers' Convention on July 21, about twenty representatives of industrial concerns and associations interested in the general adoption of the American Society of Mechanical Engineers' boiler code, met at the Waldorf-Astoria Hotel, New York City, on July 28, and perfected plans for raising the sum of $12,000 per annum, which it is estimated will be needed to promulgate the boiler code.

An administrative council, to be known as the American Uniform Boiler Law Society, was organized, with Thomas E. Durban as chairman, to supervise the expenditure of the money. The council consists of E. R. Fish, representing the American Boiler Manufacturers' Association; T. E. Durban, the National Tubular Boiler Manufacturers' Association; C. E. Blake, the insurance companies; Isaac Harter, Jr., the watertube boiler manufacturers; F. W. Herendeen, the National Boiler and Radiator Manufacturers' Association; H. P. Goodling, the Traction Engine Manufacturers' Association; D. J. Champion, the boiler supply manufacturers and dealers; John H. Wynne, the locomotive manufacturers, and M. F. Moore, the steel, low-pressure boiler manufacturers. Four other members will be added to the council to represent the large users' interests (such as central stations), steam shovel manufacturers, crane manufacturers and hoisting-engine manufacturers. It is also understood that a member of the National Electric Light Association will be selected to represent the large users, while Walter Plehn and H. N. Covell will temporarily represent the steam-shovel and hoisting-engine manufacturers.

At this first meeting of the council it was decided that the allied interests should contribute toward the fund of $12,000 per annum in proportion to the amount to which each would be benefited by the standardization of boiler laws. Educational literature has already been sent to the governor of each State, together with a letter asking for support in securing legislative enactments, which will authorize the enforcement of the A. S. M. E. boiler code. Educational literature and requests for support have also been sent to several hundred other influential men throughout the country, and the co-operation of technical and trade journals has been solicited.

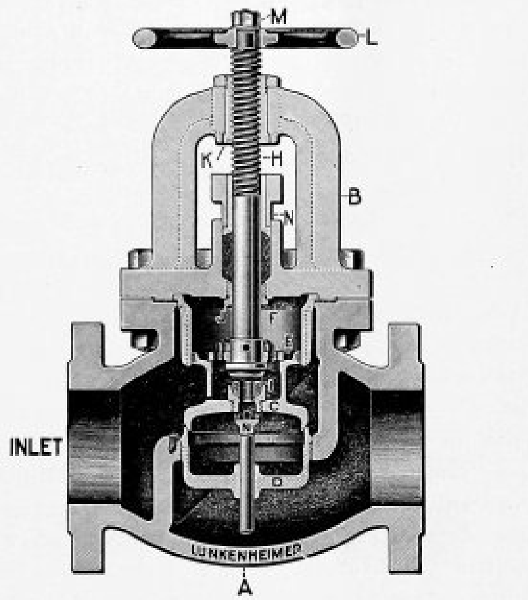
As all large interests are in favor of uniform boiler specifications and inspections, the efforts of the American Uniform Boiler Law Society should meet with ready support, and, with public attention throughout the country focused upon a general "safety-first" movement, satisfactory results should be achieved before many months have passed.

Engineering Specialties for Boiler Making

New Tools and Appliances for the Boiler Shop and Improved Fittings for Boilers

An Improved Balanced Throttle Valve

A valve of exceptionally free and easy operation combined with efficiency is, of necessity, required for engine throttle purposes. In the improved balanced throttle valve illustrated there are practically but three moving parts—the main disk, bypass disk and stem—and these, being of large proportion, it is claimed, will safely withstand the hardest service to which valves of this type are subjected. With ease of operation follows lack of friction, and as practically no force is required to open or close the valve, wear on all moving parts is reduced to a minimum.



Lunkenheimer Balanced Throttle Valve

Ease of operation of this valve is directly attributed to the improved bypass construction, which equalizes the pressure on both sides of the disk. The operation is as follows: Assume that the valve is closed and under pressure. As pressure will enter the balancing cylinder by passing the piston ring and also entering through the small hole in the bottom of the disk cylinder, the pressure above the disk is equal to that in the inlet of the valve. This pressure, it is claimed, aids materially in holding the disk *C* tightly to its seat, but unless some provision was made to relieve this pressure the valve would be extremely difficult to open.

The method of relief lies in the bypass *I*, the opening through which is covered by the bottom of the stem *H* when the valve is closed. A slight turn of the handwheel, however, uncovers this opening and the steam above the piston will then pass through the holes in the retaining ring *E*, thence through the hole in the bypass disk *I* and holes in the main disk guide stem *N*, immediately relieving the pressure above the piston. Any pressure that may escape past the piston ring or through the small hole in the bottom of the disk cylinder is also quickly relieved while the valve is being opened. There being practically no pressure above the disk, the operation of opening the valve is therefore an exceedingly easy one.

The main object of the small hole in the bottom of the disk cylinder is to drain water from condensation that may accumulate when the valve is connected in a horizontal position, with the handwheel up. When in a horizontal position, any water in the disk and balancing cylinders will drain past the piston ring. Both the main and bypass disk are operated simultaneously by one movement of a single handwheel, which not only facilitates the quick operation of the valve, but insures the opening of the bypass valve at the proper time.

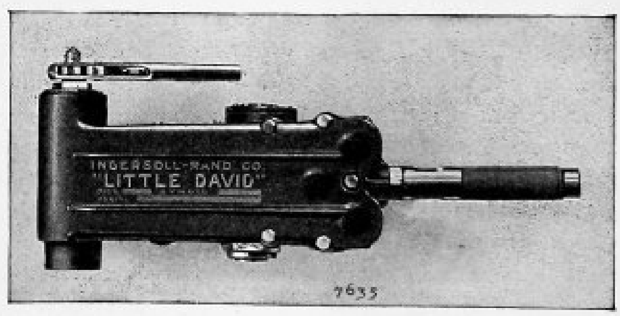
Provision is made for regrinding both the main and bypass disk seating surfaces, should they become worn. As all parts are renewable, the durability of the valve is increased. Expansion or strains may slightly distort the seat, but owing to the annular extensions on both the seat and disk, which provide spring seating surfaces, they will regularly accommodate themselves to any slight irregularity, and therefore a tight valve is at all times assured.

The body may be tapped anywhere above the seat or inlet end for drain connection, so that any water from condensation can be removed before the valve is opened. For the lubrication of the engine cylinder, the body can also be tapped on the inlet or outlet end, to which lubricator connection may be made.

This improved valve is made by the Lunkenheimer Company, of Cincinnati, Ohio, in sizes ranging from 4 to 10 inches, inclusive. To suit various conditions of superheat and pressure and meet the specifications of engineers who differ as to the materials used for the different parts, they are made in six combinations.

A New "Little David" Drill

The "Little David" close-quarter drill illustrated, which is manufactured by the Ingersoll-Rand Company, New York, is particularly adapted for working in cramped or confined positions where the regular type of four-piston, reciprocating, pneumatic drill cannot be used. The distance from the end of the casing to the center of the spindle is only 1 5/16 inches. The motor is of a novel, three-cylinder design, and operates in a bath of oil. The valve is of the rotary type, gear-driven from the pinion of a three-way crank-shaft, which is operated by three ratcheted levers which directly connect the pistons to the drill spindle. It is claimed that there is practically no strain on the crank-shaft, as the power is transmitted direct from the pistons through the levers to the ratchet spindle. The fact that the spindle has a triple-ratchet,

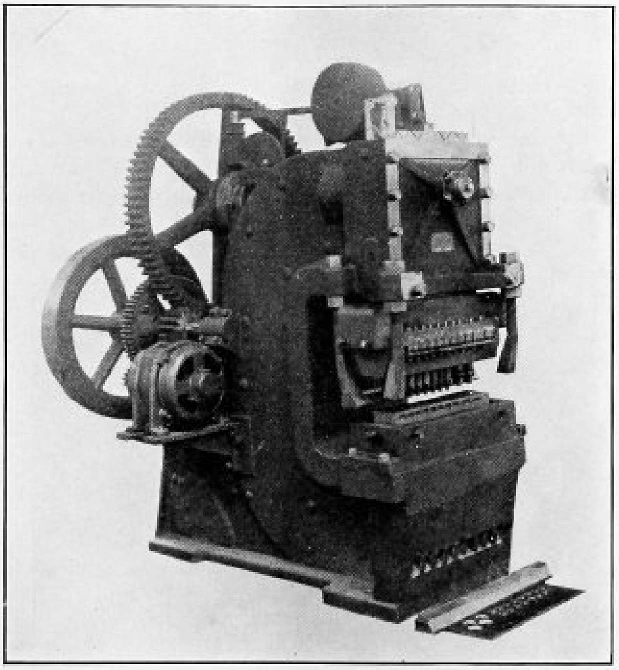


Close-Quarter Drill

so that one of the ratchets is engaged on the spindle at all times, makes it possible to develop more power and maintain a much more constant pull on the spindle. The casing is divided in such a way that the loosening of a few cap screws allows easy access to all moving parts, and the manufacturers claim that the drill can be dismantled and completely reassembled in thirty minutes. The drill is fitted with a No. 4 Morse taper socket, is rated for drilling up to 3 inches and reaming and tapping to 2 inches, and operates at a speed of 150 revolutions per minute.

Multiple Punch with New Features

The illustration shows a new multiple punching machine recently designed and built by Bertsch & Co., Cambridge City, Ind. It has a cored or box section frame. There are twenty punching units in the head, each one of which



Multiple Punch with Special Couplings

is gaged so that any number of punches from one to twenty can be either used or disengaged, as desired. Sixteen of the punches were too close together for standard couplings; therefore special couplings were used, clearly shown in the cut, on which the builders are applying for a patent.

Barnsley Automatic Wrench

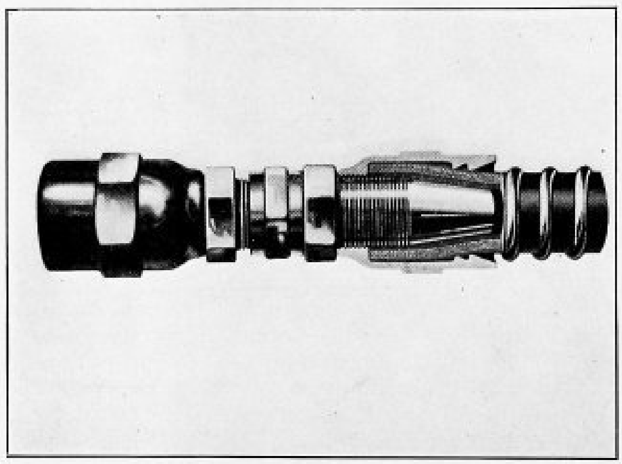
The Barnsley automatic wrench, manufactured by the Automatic Wrench Manufacturing Company, Inc., Boston, Mass., comprises only three parts—a jaw, handle and clutch. The automatic action of the wrench is brought about by an ingenious clutch arrangement. The clutch has a neutral position which allows the jaws to move freely in and out. To operate the wrench the object to be turned is placed between the jaws and the jaw either pressed in or drawn in with a thumb trigger under the handle until the jaw strikes the object where it is locked by the clutch. The harder the pull on the wrench the tighter is the locking action. To open the jaws, or to release the jaws from the object, it is only necessary to exert a slight pressure on the clutch when the jaws spring open, or, closing the jaws together releases the clutch and the jaw is self-opening. The clutch is made in one

New Automatic Wrench

piece and, it is claimed, is unaffected by oil or grease, making it impossible for the wrench to "freeze" on a nut. The wrench illustrated is 10 inches long when open, and fits nuts up to 1¾ inches. It is useful for any purpose where an ordinary monkey wrench is used.

Coupling for Compressed Air Hose

The National hose coupling, manufactured by the National Hose Coupling Company, Peoples Gas Building, Chicago, Ill., has been designed to eliminate the necessity of special clamps to effect a grip on the ends of the hose. The coupling consists of a malleable iron hose socket,

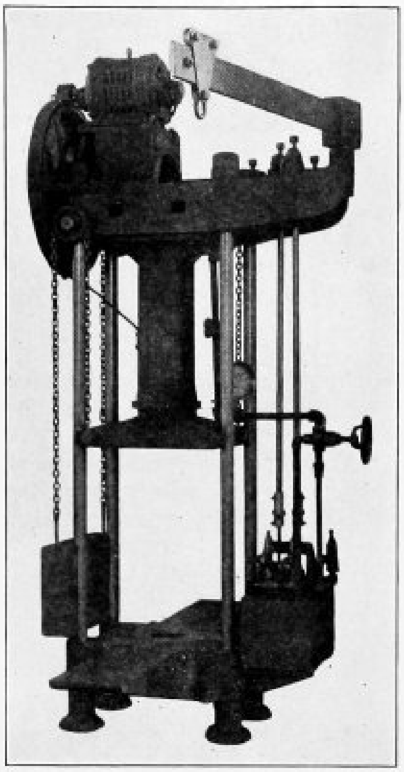


National Hose Coupling

sufficiently corrugated on the inside to provide a positive grip when the hose is expanded by screwing into the socket a steel taper expander which forces the hose outward and into position. No attempt is made to contract the outside of the hose, but all the stress is applied from the inside. The hose readily enters the socket and may be cut and recoupled as often as required. The edge of the socket and the end of the expander are smoothly rounded to prevent injury to the hose. A single wrench suffices for adjusting the coupling, making the operation of connecting or disconnecting simple and convenient.

60-Ton Self-Contained Inverted Hydraulic Forcing Press

The hydraulic press illustrated is a new design of inverted hydraulic forcing press brought out by the Hydraulic Press Mfg. Co., Mount Gilead, Ohio. It is used as a general utility press for forcing work, and is a self-contained unit which requires no auxiliary water or power supply. It is driven either by an electric motor or by belt. The press is equipped with a two-plunger vertical hydraulic pump whose plungers are ⅝ inch in diameter and have a stroke of 3½ inches. This pump is driven through two eccentrics which are operated by a 3 horsepower motor mounted upon the press. The lower platen, which is close to the floor, has a pressing surface 24 inches by



60-Ton Forcing Press

22 inches, with a hole in the center 6 inches in diameter, to take the end of the hub or shaft during the pressing operation. The movable platen of the same size is guided in its travel by babbitted bearings on the strain rods. The ram is returned after the pressing operation by a weight.

Welding Four Thousand Feet of Gas Main

At New Bern, N. C., the S. B. Parker Company has just completed the welding of 4,000 feet of 4-inch gas main for the New Bern Gas Company, a subsidiary of the International Gas & Electric Company, of Philadelphia. The main is 4-inch steel-line tubing made by the National Tube Company, of Pittsburgh, and was sent to the job with the ends beveled and ready for welding. The work was done on an extension between the Union Station at New Bern and Riverside, a suburb of that city.

On this work, Prest-o-Lite gas in 100 and 300 cubic foot cylinders, and Linde oxygen in 100 and 200 cubic foot cylinders were used. The S. B. Parker Company found that with reasonable care as to waste, they could get twenty or more 4-inch joints with each 100-foot cylinder of oxygen, and twenty-five or more 4-inch joints with each 100 cubic foot cylinder of Prest-O-Lite.

It was also found that the welds could be made faster and better when welding in the trench than on the level, as the torch seemed to draw an excess of oxygen from the air when burning in the wind, which, according to the S. B. Parker Company, had a tendency to burn the

Welding Sections of the Pipe

filling material. This difficulty, it was stated, would not be likely on the larger size mains.

Working in the trench, good joints were made in seven to ten minutes. In one afternoon, fifteen leakless joints were made with only one torch, the apparatus being moved a distance of about 20 feet after each weld. This pipe was

Joining the Sections in the Trench

tested under air pressure, using soap suds on the joints to detect leaks.

As a filling material, No. 8 gage, soft steel wire was used, as it was found that this material flows better, has less tendency to stick, than Norway iron.

In welding, the joint is left open about ⅛ inch and a tack is made which soon cools off and contracts, drawing the pipe together to about 1/16 inch.

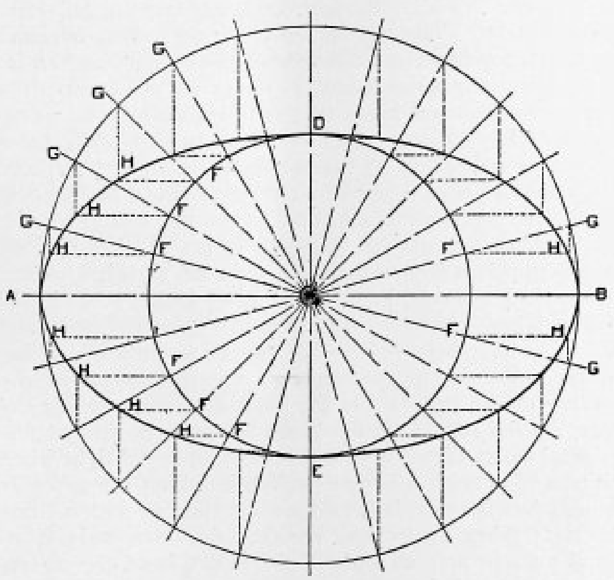
Letters from Practical Boiler Makers

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

How to Draw an Ellipse

"How to draw an Ellipse" is the title of the leading article in the Practical Letters Department of the July issue of THE BOILER MAKER, interesting because of the usefulness of that knowledge and also because of the various ways in which an ellipse may be drawn.

Perhaps the method shown in the accompanying illustration may be new to some of the readers, and acceptable as an additional bit of information. The description is as follows:



Method of Drawing Ellipse

Given, the major axis *AB* and the minor axis *DE*, on the center *C* describe two circles, with diameters respectively as the axis. From a number of points *G* in the larger circle draw radii to the center *C* of both circles, cutting the smaller circle at points *F*. From the points *G* draw perpendiculars to the major axis *AB*, and from points *F* draw parallel lines to the major axis, cutting their respective perpendculars at *H*. The intersections are points through which the curve of the ellipse may be drawn, as shown in the figure. The curve may be drawn by using a flexible steel, such as a scale.

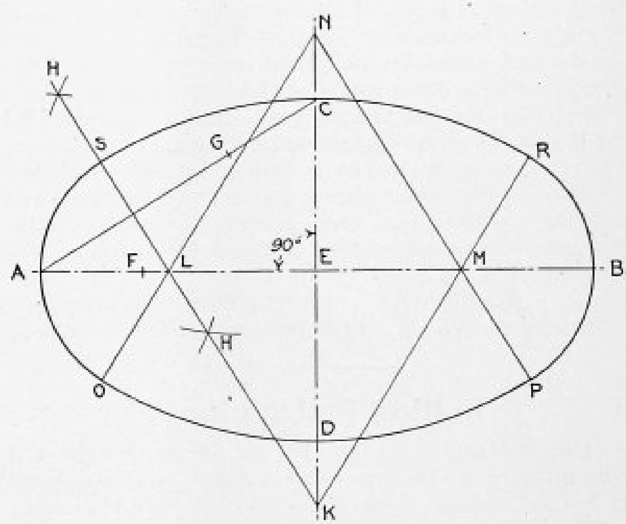
Scranton, Pa. CHARLES J. MASON.

I notice in THE BOILER MAKER of July, 1915, page 239, that Mr. E. C. Sherman says it is rather hard to draw an ellipse perfectly of any given size, but if he will follow my rule very closely he can draw an ellipse of any desired size accurately with the use of trams or dividers.

The size of ellipse I have drawn is 3 feet 3 inches by 5 feet 3 inches. Let *A-B* be the longest side and *C-D* the shortest side and *E* the center of the ellipse. These points must be 90 degrees.

Now draw the line *A-C* and take the distance of one-half of the smaller side, *E-C*, and place it on the line *E-A*, one-half of the longest side from *E* to *F*, and the remaining distance *F-A* place on the line *A-C* from *C* to *G*. Now set your trams to the distance *G-A* and strike the arcs *H* and *H* and through the intersection of these arcs draw the line that crosses the line *A-B* at *L*, and meets the line *C-D* at *K*. Now set your trams at *K* and strike the arc *C-S* and take another pair of trams and set it to the radius *L A* and strike the arc *S-A*. This will give one-quarter of the ellipse.

If it is desired to draw the complete ellipse, transfer the distance *L-E* from *E* to *M* and the distance *K-E* from *E* to *N*, then connect the points by lines as *N-M-P*, *N-L-O*, *K-L-S*, *K-M-R*. Then take the large trams set to the radius from *K* to *C* and strike the arc *S-C-R* from *K*, and from *N* strike the arc *O-D-P*. With *L-A* as a radius strike the arc *S-A-O* from *L* and from the point *M* strike the arcs *R-B-P*. This will give the complete ellipse and, if care is taken in striking arcs, the four established points will meet very accurately.



Ellipse Formed by Circular Arcs

I hope this rule will benefit some of the readers.

Baltimore, Md. GEORGE KUMMEL.

Do Boiler Compounds Cause Leaks?

In reading the July issue of THE BOILER MAKER, I take exception to a short article given on page 223, headed "Boiler Compound Does Not Cause Leaks," signed N. G. Near, New York.

Due to forty-three years' experience, I have found in many cases new boilers were nearly ruined by perhaps an overdose of compound, therefore I do not agree with Mr. Near as to what he claims at the close of his article: "Compound pumped into a new or clean boiler that does not leak will not cause leaks." If space would permit and the writer's memory would serve him during his period of time as boiler maker, I doubt very much but what two-thirds of the pages in THE BOILER MAKER would be filled with evidence to the contrary, as above claimed.

An overdose of compound, under certain conditions, will injure a boiler by buckling the sheets, burning and springing of seams, as well as an overdose of oil. Recently I received a hurry-up call to the city of Plymouth, a distance of about sixteen miles from Sheboygan, Wis., on account of leaky boilers. When I arrived I found that one boiler was entirely out of commission due to a bulge over the grates, and the other one beginning to bulge over the fire. I immediately noticed a white color around the try cocks, and on investigation found that some gentlemen came along and induced the Plymouth Pea Canning Company to use compound in their boiler to prevent scale. All readers are aware of the fact that pea canning factories operate only eight or twelve weeks in a year, consequently no scale collects except from very limey water, and lots of instances similar to this could be given to prove that Mr. Near is very much mistaken.

If he desires to take this discussion up with the writer, in a few articles I believe to be able to convince the readers, if not himself, that he made a serious mistake in claiming it not to be true that compound in a new or clean boiler will cause leaks. I believe that every writer should be very cautious in what he writes along these lines, and not deceive, especially the young engineers who are sincere in trying to learn from THE BOILER MAKER.

The only practical and most economical way, provided the size of the power plant will warrant, is to treat the water before it enters into the boiler instead of treating the scale in the boiler after it has collected to the plates and tubes. This has been proven at various plants through this and other States where water softeners have been installed.

J. HENRY OPTENBERG,
Sheboygan, Wis. President Optenberg Iron Works.

Rolling Boiler Flues

Being a constant reader of THE BOILER MAKER, and having followed with keen interest the articles contributed to this very valuable journal by men of wide experience and knowledge, such as Mr. Frances, Mr. Young and Mr. Hodgins, also the article on "Rolling Boiler Flues" contributed by Mr. Near, Mr. Lacey, "Flex Ible" and Mr. Young, I beg now to contribute my little mite.

As far as I can see, Mr. Lacey is correct as regards watching the scale form on the flue sheet around said flue, and he backs his argument up by noticing the metallic ring of pin when being driven into the flue. I have carried out these same ideas in my experience in rolling flues and have had fairly good success in using these two methods.

Mr. Near wants to know about old work. From my experience I know that we could not notice scale forming on the sheet of boilers that are to be repaired, as the scale is pretty well worn off in service. As to rolling flues on old work, I would notice the metallic ring of flue pin when being driven into the flue, then have a stop fastened on to the flue pin to insure that the flue is rolled and will stand the test. I have rolled a large number of flues in this manner on old work, both with air motors and by hand. Do not use a stop on new work, as it does not require it. I believe I understand what Mr. Near is trying to get at. Say he had ten or twenty boilers and he wanted these flues rolled and wanted them rolled right and in the quickest time possible. His idea is to have some one arrange the rolls in such a manner that the flues will be rolled right and in quick time, and to roll all flues in the same manner so that a novice, after a few instructions, could go ahead and finish the job.

Articles of this nature are very instructive, especially to the young boiler makers growing up in our shops today.

I would like to hear from Mr. Near as to whether or not I have come any way near the point that he raises.

Youngstown, Ohio. WM. J. KELLY.

Rolling Boiler Tubes

The following remarks are in reply to Mr. N. G. Near's letter, asking boiler makers to give their ideas on how a boiler tube should be expanded so that it will be tight enough to stand the required amount of hydrostatic test pressure.

In the case of a boiler designed for a working steam pressure of 200 pounds per square inch, the hydrostatic test pressure should be 1½ times the safe working pressure, or 300 pounds per square inch. The writer has had years of practical experience with expanders of all types, such as the Tomkins, Prosser, Dudgeon and the self-feeding expander. The last-named expander, when operated by an air machine, is as dangerous in the hands of an incompetent man as a loaded revolver in the hands of a child who does not know that it is loaded. In my experience, I have known of cases where in expanding tubes in cast iron headers of the old style Babcock & Wilcox, National and other types of watertube boilers, the headers have been burst or cracked by using the straight roller Dudgeon type expander, although to my mind this is the best expander when set properly and used with judgment.

Great care should be taken when replacing tubes in old boilers where ferrules were not used in the first place and the tubes have been rolled expressly on account of leaking of the tubes due to the presence of scale or oil or the forcing of the boilers. If the holes are too large for the tube a shim should be used, scarfed at each end as fine as possible, and fitted so that the tube will sound tight when given a blow with a hammer. When rolling the tubes by hand, when the tube is in and made a tight fit with a shim, the next thing to do is to see that the tube projects an equal amount at both ends, if the boiler is of the watertube type; but if it is a firetube boiler, the end of the tube nearest the fire should extend beyond the tube sheet just enough to be beaded or flared. If the tube extends out too far beyond the tube sheet the bead will have a small groove in it between the edge of the head and the head. If on a firetube boiler the end of the tube is simply flared, it does not pay to leave too much of the tube extending out beyond the tube sheet, as the part from the end of the tube to the head is unprotected from the fire and the tube rapidly deteriorates. If any reader does not believe this, let him try to knock one over that has been in operation a few months; especially on the end nearest the fire.

After setting the tube to the proper length for beading or flaring, which is about 3/16 inch on a firetube boiler, and which may be one-half or five-eighths inch on a watertube boiler (as in this case the tubes are protected by the water in the headers or water legs), put in the expander, which should be of the straight roller type, with tapered pin square on the end to be turned with a square-handled or ratchet wrench instead of with a small, thin pin, as the former method is much easier and quicker.

When driving in the pin, sometimes the tube will move in or out a trifle, and sometimes it will be necessary to take out the expander and set the tube again. To avoid the moving of the tube when putting in the expander and pin, hold the pin with the left hand, at the same time pushing the pin in with your left hand and driving in the pin with your right hand, using a chipping hammer which is heavy enough for the purpose. If the tube is fairly tight in the hole, the pin tight to the rolls and the rolls tight to the tube, it cannot come out or go in more than one-thirty-seconds inch, and a few light blows will bring the rollers to the tube and the tube to the head. It is far better to have to roll a tube a second time than to roll it too much the first time; even if the tube should be tight after excessive rolling, the defects will show up when the roller is in operation.

In ordering a firetube boiler for myself I would insist that the ends of the tubes nearest to the fire should be a driving fit in the tube holes. The opposite end of the tube seldom leaks, even when the boiler is being forced, owing to the low temperatures in the smokeboxes as compared with the fireboxes. When the tubes are tight, in the first place, they need but very little rolling, if it is done with care.

I have very little use for rolling tubes with an air machine and with self-feeding expanders. On tubes from 2½ to 4 inches diameter you have to have a fairly powerful machine. In some self-feeding expanders the rollers are so short and at such an acute angle that with a high-speed machine the tube is rolled very quickly. Sometimes a machine will stop and it will not feel as though the tube is rolled round. Reverse the machine and then run it in again, and it will seem as though the rollers have gone over a lump. If some device were put on the expander pin so that when the pin has traveled just so far it will reverse the machine, it would be far better even if one or two tubes leak on the test. They could afterwards be rolled tight, and it would be far better than stretching the tube sheet and the tube, which is very often done even by good men on tubes over 2½ inches diameter.

For first-class work on firetube boilers, I believe that the tube should be a driving fit on the end nearest the fire, expanded by hand with a straight expander of the Dudgeon type with straight rolls—not a self-feeder, but a driving expander with rolls set and adjusted properly. If such an expander is put in the hands of a competent man the tubes can be rolled properly and there will be no doubt about their being tight and not over rolled.

In putting in tubes with a Prosser, the tube holes should be champfered inside and outside to take off the shearing stress that would be set up by sharp corners of the tube holes. This also gives the end of the tube a better chance to turn over so that the fit will be tight up to the head, which is a point not to be slighted. All tubes that are to be prossered should be rolled lightly at first to bring the tube tight in place. This eliminates half of the hard work that is often done when the tubes are prossered first and then rolled afterwards. If they are not prossered first, and if they are not lipped over a little they will draw, unless they are tight in the hole. I believe in rolling one end lightly and then prossering same end before expanding the opposite end so that if there is any drawing in of the tube it is free to move.

I would like to hear from a few of the boiler makers, superintendents and foremen as to what in their opinion is the best way to prosser a tube that has no ferrule in the end, as in the case of the smokebox end of a locomotive boiler.

The leakage of tubes may be due to a number of causes, such as scaling, oil or ingredients in the boiler water, which make the boiler foam. I have seen boilers foam badly when there is a certain amount of salt in the water, but there is one thing that causes all boiler tubes to leak, and that is unequal expansion and contraction. Take a locomotive boiler, for instance; the center of the head has a chance to "breathe," but at the flanges it is almost stationary, showing that there must be a severe tension or forcing pressure on the outside tubes, having a tendency to displace the expanded joint of the tube in the head, while the center of the flue sheet seems to have a chance to "breathe" and give and take with the extension of the tube. This action cannot take place near the flanges. If it were possible to take care of the unequal expansion and contraction in the boiler lots of our troubles would be over, but, due to the manner in which boilers are made and with varying temperatures at different parts of the boiler, there is naturally unequal expansion and contraction of the various parts, and it will be a long time before we can overcome it.

From years of experience, many boiler troubles are being eliminated. "Flex Ible" has the right idea about the tube hole and swagged tubes. I wish other boiler makers would discuss this important subject, for no one man knows it all. As a rule, it is the majority that counts. We do not have to fight about our opinions, but let us get together and reason it out. Two heads are better than one in many cases. Discussion of these questions in The Boiler Maker is just what we all need. It brings men all over the country to a better understanding and different methods can be compared. What we all want is to be able to do first-class work, and it will be for our own interests, as well as for our employers,' to discuss these questions thoroughly. I would like to hear from a few readers about prossering tubes with an "air gun" or chipping and calking with an air machine or handling a "rivet gun."

New Haven, Conn. E. Williams.

It is very gratifying to me to see so many readers of The Boiler Maker interested in the subject of rolling boiler tubes. It shows that men at points very far apart are taking notice of what is appearing in the pages of The Boiler Maker, and, before the subject is closed, I trust we shall arrive at an understanding as to the right way of installing flues. If it is right to have the flue holes in the front flue sheet ⅛ inch larger than the flue to be used, let it be known that we have been doing the work in the wrong way these many years when we gave but 1/64-inch clearance in that end. On the othr hand, if we are satisfied that 1/64 inch is enough clearance on new flue sheets for the front end, then let it be proclaimed broadcast that this amount is sufficient, and that all holes with more clearance than that should be lined up in the old way, which we were taught (when boys) was the only and sure way of procuring good and lasting jobs.

The point raised by me was that it was improper to do work in the way described by Mr. Young as being done on the Southern Railway. I am not questioning his ability as a boiler maker, and still maintain that I was right when I said if we look at this subject in the proper light I think that the readers will all agree that Mr. Young has sounded the keynote of flue failures on many, if not all, of our railways when he says that they tolerate such a fit between the flues and the flue sheet on the Southern Railway.

Now, for the sake of argument, we will suppose that the flues used by Mr. Young are of the kind usually installed in large locomotives, which are of 11 B. W. G., which, in plain figures, equals .125, or ⅛ inch. Now, we have a flue hole in the front flue sheet 2⅛ inch diameter, and a flue to fill that hole 2 inches O.S.D., thus giving us the ⅛ inch between flue and sheet, spoken of by Mr. Young, so that, in order to make a tight fit, we are compelled to stretch the flue end until it is reduced in thickness to one-half the original thickness, or 1/16 inch. It is apparent to any right-thinking man, therefore, that in reducing the flue end, as above described, it is practically cut in half. With old flues, however, this operation would be out of the question, for they would burst long before stretching the amount required to make a fit, and we have the same conditions mentioned by Mr. N. G. Near in the January issue of THE BOILER MAKER.

Again, I say that I am aware that there are flues made that will stand battering about in a most extraordinary way and never show a crack. This, of course, is done to prove the quality of material to the satisfaction of the makers, and not that any boiler maker should take advantage of the good quality of the flue.

There are special flues made with enlarged ends expressly for such cases as the one before us. Why not use them and avoid all the extra trouble of unnecessary rolling? If, as Mr. Mason says, they failed to enlarge the flue ends when hot, it is very evident that it cannot be done cold, and the stand taken by Mr. Young is therefore untenable.

I will explain what I meant when I said not to drive the pin in the rolls with all a man's might. It is a well-known fact that the markets of all kinds of flue rollers supply with each roll a rolling and a pulling pin. In many shops throughout this country the pin supplied with the rolls is thrown away, and one of ⅝-inch tool steel, with the end drawn down to a point to fit the rolling pin, and 20 inches or more long, used in its place. Now, with the pin furnished with the rolls it is possible to roll any flue and make a good job, and the blows required to tighten the pin in the rolls are very light, but with the substitute pin, with its larger average, the blows required to make the rolls take hold must be much harder, and it is a fact, which I can verify any day, that men do drive the pin in the rolls with a hand hammer 2½ pounds in weight, and then have to put their weight on the lever to start the rolls; for they have buried the rolls in the flue just the way Mr. Young says. We all know that this is wrong, and that was my reason for drawing the attention of the readers of this magazine to the fact that such a state of affairs existed, hoping that foremen and master mechanics would take notice and abolish the practice in shops where it is used.

Regarding the point raised by Tad Talin, I have this to say: Some twenty-five years ago this point was raised by the Master Mechanics' Association, and pretty well threshed out in the pages of *The American Engineer* and *Railway Journal*, and it was settled to their satisfaction that the best way to finish a flue was to *bead* before rolling. For this reason it had been proved by demonstration that beading the flue after the final rolling *loosened* the flue from its seating, hence the practice of beading before rolling.

Mr. Young says that we boiler makers serve four or five years to learn that sure way. Now, I think that I can go him one better, for I served seven years to learn the sure way, and have passed through all the branches of the trade, and am still very actively engaged at it. For my own part, I have always tried to impart to the young boiler makers and apprentice readers of this magazine something that will help them when they go out into the world and are up against the hard knocks which will surely come their way from time to time, and in all of my letters to this journal during the last four years I have written nothing but my own experience and the experience of men well known to myself, the veracity of whose words cannot be doubted.

Let us give to the younger men of our craft the best that we possibly can, tell them the easiest and the best way to do certain jobs, and, by all means, avoid casting a doubt in their minds by raising foolish questions. Let us not forget that the shops that are engaged in work of the open market are running their affairs much different from that of many of our railway shops, where the owners look for results, especially from young men, who are watched, and, for the least break they make, are dismissed. Many railway shops overlook little slips made by new men, making allowance for differences in shop practice. I know of no better medium than this journal through which the young are to know that the shop they learn the trade in *does not* give them the *only* way of performing the various operations in boiler making. FLEX IBLE.

Pittsburgh, Pa.

Should Shell Plates Be Punched or Drilled Before Rolling?

I submit the following to the attention of readers of THE BOILER MAKER who are boiler experts and boiler inspectors. There are people in the United States just as capable of making new laws for boiler construction as there are in European countries, where boiler inspection is much more strict than in the United States, with the exception of a few States.

My suggestions concern the rolling of boiler steel plates after the holes are in the material. I think that the boiler shell should be rolled to form before the holes are put in the material. When a shell plate is put in the rolls and rolled, there is a take up in the steel, which, of course, any boiler maker knows. When a plate of any thickness is rolled, the inside of the plate is crushed together while the outside stretches to some extent. This is why I think the rivet holes are weakened when they are drilled or punched before rolling, especially when they are punched. Yet there are some States that have no laws concerning punched holes.

The strain on the outside part of the plate might cause flaws from the rivet holes to the calking edge, for it often happens that cracks are found from a rivet hole to the calking edge. I have found also several cracks in shell boilers extending from one rivet hole to another in the brace holes on the shell. On one occasion I worked on a Scotch marine boiler that was split from one end to the other while it was under water pressure test. At the end of this crack there was found a crack running through the center of the rivet hole to the calking edge, and back into the plate as well. These cracks and flaws, I believe, may be caused from rolling after the sheet has been punched or drilled.

When a butt strap is rolled, where there are four to six rows of holes, the butt strap will make straight bends through these holes instead of rolling even, unless the butt strap is put inside another plate to give it an even circle. When the outside of the butt strap has a strain on it from the "take up" of the inside of the butt strap, it must weaken all these holes.

On another occasion I saw a mud drum rolled to a 15-inch circle, and after it was rolled I took a rivet and tried it in some of the holes and found that it would enter the hole all right, but when it got to the inside of the hole it would be a tight fit, and have to be tapped with a hammer to make it go through. When this job was riveted up the same holes were opened up with a drift pin in order to get a hot rivet into the holes. The use of a drift pin is something a boiler inspector doesn't like, and, furthermore, boiler makers do not like to be bothered using one, but they have to do as they are told, for some companies do not care how they get the work done as long as it is done in a hurry. This is another case where holes, if put in after the plates are rolled, would be an improvement.

There are drill presses that will drill boilers after they are rolled with very little more expense than to drill the flat plate. I would like to have others discuss this subject in The Boiler Maker, as I would like to see this method adopted as a boiler law some day.

Bay City, Mich. Glenn Lacey.

Explosion of Traction Boiler

Figs. 1 and 2 show the boiler of a 20 horsepower traction that blew up a few miles out of Springfield, Mo., on July 10. The photographs were taken a few hours after the explosion occurred.

The traction engine had been purchased thirty days before the accident occurred, and was a rebuilt machine

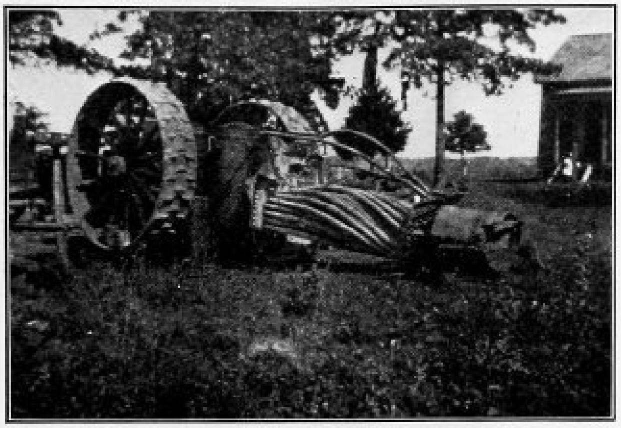


Fig. 1

Fig. 2

with new flues, etc. Fig. 1 shows the boiler with the barrel sheet torn off and the flues given nearly a half twist. The sheet was straightened out and was thrown 300 feet from the machine, one edge burying itself 2 feet in the ground. From Fig. 2 it will be noted that the horizontal seam is intact with the rivets still in place, but at the edge it is torn off.

Upon examining the boiler I found that 2 inches from each end, where it was riveted to the throat sheet and head, the metal was wasted away over 3/32 inch down to a feather edge and in a space of 18 inches was eaten through and had been welded up by a railway boiler maker in Springfield. It was claimed that it would have cost too much to put on a patch the full length of the barrel, and the boiler maker from the railroad shops informed them that he could weld it up cheaper and do a better job. The result of this work was the explosion, as the firebox was in good condition and the engineer had plenty of water.

These accidents can be avoided by having repair work properly done by practical boiler makers instead of by handy men who are unable to distinguish a weak boiler from a new one. Such accidents also demonstrate the fact that in contract work boiler makers, who work on anything of a nature where steam pressure or compressed air is to be used, should be mechanics and the work should be examined by a practical man, just as all steam boilers should be inspected by Federal or State inspectors. According to the fireman, this boiler had a steam pressure of 110 pounds per square inch, but the pop safety valve was

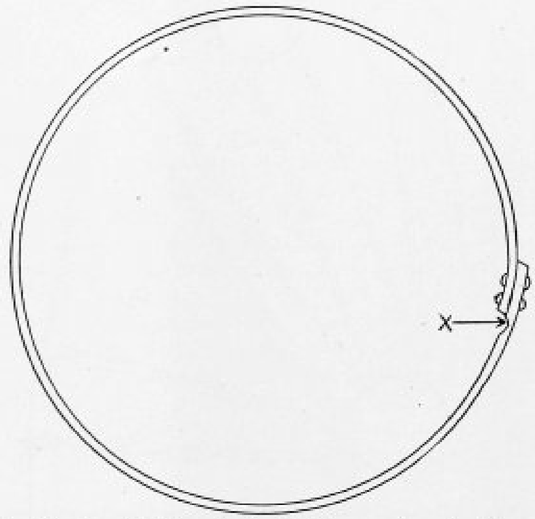


Fig. 3.—Section of Boiler Shell. X Shows where the Plate Was Eaten Through

screwed down to pop at 140 pounds pressure.

An upright Keystone boiler of 12 horsepower, located south of Springfield, was blown up three or four days later, but the writer was not allowed to get photographs of it. The explosion was caused by low water. In spots the flues and shell were as thin as paper.

In both explosions no one was killed, but several were badly scalded.

L. J. Kent,
Proprietor, Kent Boiler & Sheet Iron Works.
Springfield, Mo.

PERSONAL

J. J. Davenport has been appointed general foreman boiler maker of the San Pedro, Los Angeles & Salt Lake Railway shop at Las Vegas, Nevada, vice W. H. Ruvane transferred to Los Angeles.

In our July issue it was erroneously stated that Arthur S. Burden has been elected president of the Burden Iron Company. Mr. James A. Burden was re-elected president of the company and Mr. Arthur S. Burden was re-elected as a director of the company.

To avoid misunderstandings and subsequent explanations it would be a good thing if on the heading of boiler manufacturers' bills was printed in red ink: "Patrons will please remember that our boiler makers have not as yet grown wings, so it is impossible for them to fly to a repair job in a second: they must walk or take the trolley and we have to pay for their time and their carfare."

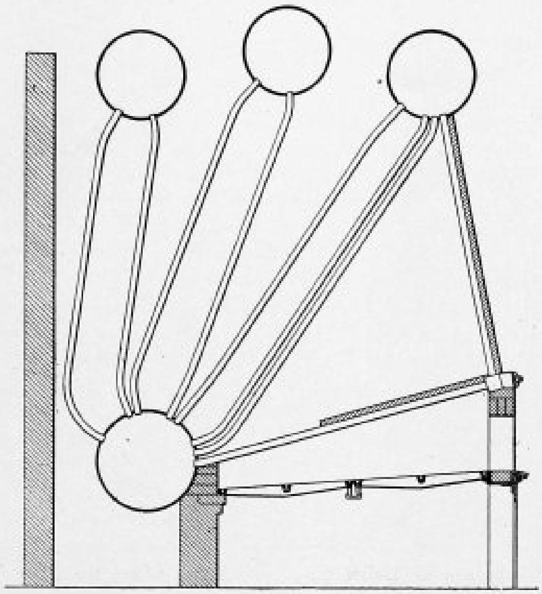
Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
Millerton, N. Y.

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

1,140,406. STEAM BOILER. MINOTT W. SEWALL, DECEASED, LATE OF NEW YORK, N. Y., BY SUSANN E. SEWALL, EXECUTRIX, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

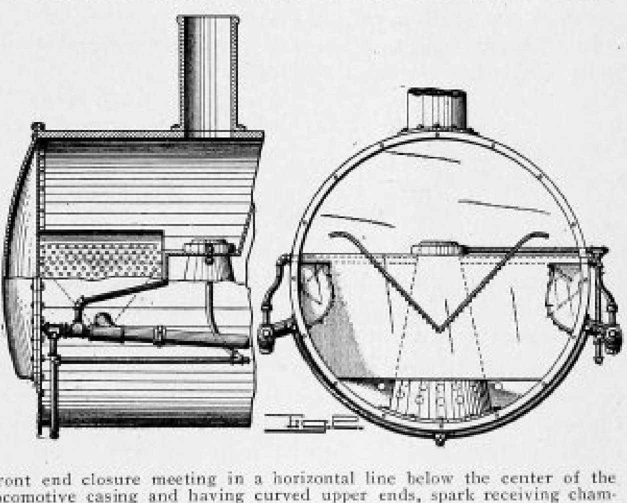
Claim 1.—A watertube boiler having upper transverse steam and water drums and a lower mud drum, banks of generating tubes connecting said drums, a transverse water chamber intermediate the levels of the upper



and lower drums, a row of tubes connecting the mud drum and said chamber and extending over the boiler furnace, and a row of tubes connecting said chamber with one of the upper drums. Three claims.

1,140,911. SPARK ARRESTER. HOUGHTON L. NEEDHAM, OF CHICAGO, ILL.

Claim 1.—A spark arrester for locomotives having a steam exhaust nozzle arranged below the locomotive smoke stack, two laterally inclined perforated deflecting plates arranged between the exhaust nozzle and



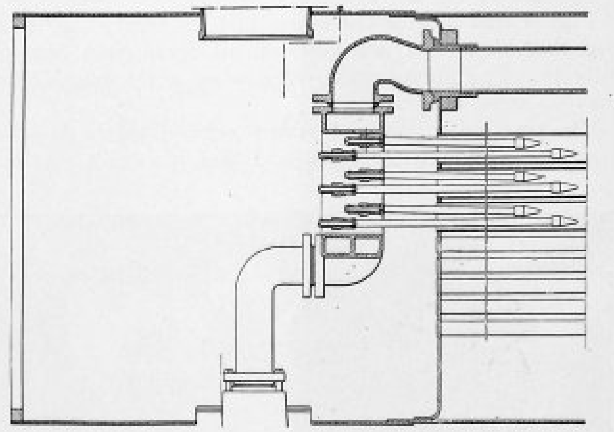
front end closure meeting in a horizontal line below the center of the locomotive casing and having curved upper ends, spark receiving chambers arranged on the interior of each side of the front end below the upper extremities of each deflecting plate, alternately arranged inwardly projecting baffle plates in each spark receiving chamber, a returning pipe on the exterior of each side of the locomotive casing leading from each spark chamber to the firebox, a steam injector on the forward end of each return pipe in the advance of its connection to the spark chamber, and a connection from the steam exhaust nozzle to each steam injector. Four claims.

1,141,304. BLOWER FOR BOILERS. JAMES C. BENNETT, OF DETROIT, MICH.

Claim 1.—In a steam blower for boilers having a flue sheet, an ejector head adjustable in its longitudinal dimension and in a plane parallel with the flue sheet of the boiler, and manually operated means in said head for adjusting said head during the injection of steam. Fourteen claims.

1,142,254. SUPERHEATER. GEORGE R. HENDERSON AND WILLIAM I. CANTLEY, OF PHILADELPHIA, PA., ASSIGNORS, BY MESNE ASSIGNMENTS, TO LOCOMOTIVE SUPERHEATER COMPANY, OF WILMINGTON, DEL., A CORPORATION OF DELAWARE.

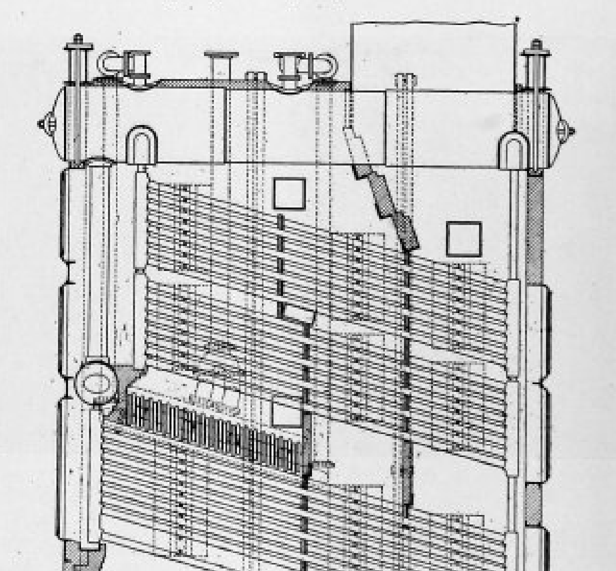
Claim 1.—The combination in a boiler having a smoke box and tubes, of a superheater having a header mounted in the smoke box and pipes extending from the header into the tubes, the header having a manifold



at the top and bottom and a series of columns spaced apart, said columns being hollow, the alternate columns connecting with the upper manifold and the other columns connecting with the lower manifold, with a head on the end of each pipe, said heads being located in the space between the two columns, and means for forcing the heads apart and against the columns so as to make a steam tight joint between the heads and the columns. Thirteen claims.

1,141,520. WATERTUBE BOILER. JOHN E. BELL, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—In a steam boiler, the combination with upper and lower banks of substantially longitudinally disposed tubes, a steam and water



drum, said banks being provided with separate connections for conducting the steam generated therein directly to the steam and water drum, means for causing the products of combustion to make serial passes transversely over said tubes, and a superheater located between the banks. Ten claims.

THE BOILER MAKER

SEPTEMBER, 1915

Oxy-Acetylene Cutting and Welding

Practical Hints from an Experienced Man in the Shop

BY C. E. LESTER

The recent issues of mechanical papers, particularly THE BOILER MAKER, have illustrated many practical and ingenious jobs done by the electric arc and oxy-acetylene processes, the advocates of both processes extolling, quite naturally, the particular ones in their favor at the time of writing. There are doubtless many motives behind this publicity which may be lumped into about three general heads. These are the papers by the man who has something to sell or a means to an end in an advertising campaign by the manufacturers; papers written by professional writers as a means of livelihood, with no particular interest in the subject except for the pay received for writing it, and lastly, the man in the shop who, through daily contact with the process he is using, becomes enthused with its possibilities and desires that others may profit by his knowledge and to gain knowledge from discussion of his subject. To the latter class the writer very smugly attaches himself. It may be safely added that the prices paid for such papers materially assist the writers' philanthropic impulses.

The writer has been handling oxy-acetylene work for a number of years, and has seen it develop from a time when he covered the bed of the Atlantic Ocean under the Million-Dollar Pier at Atlantic City with unsuccessful welds (when no one was looking) to the present, when there seems to be no limit to what can be accomplished.

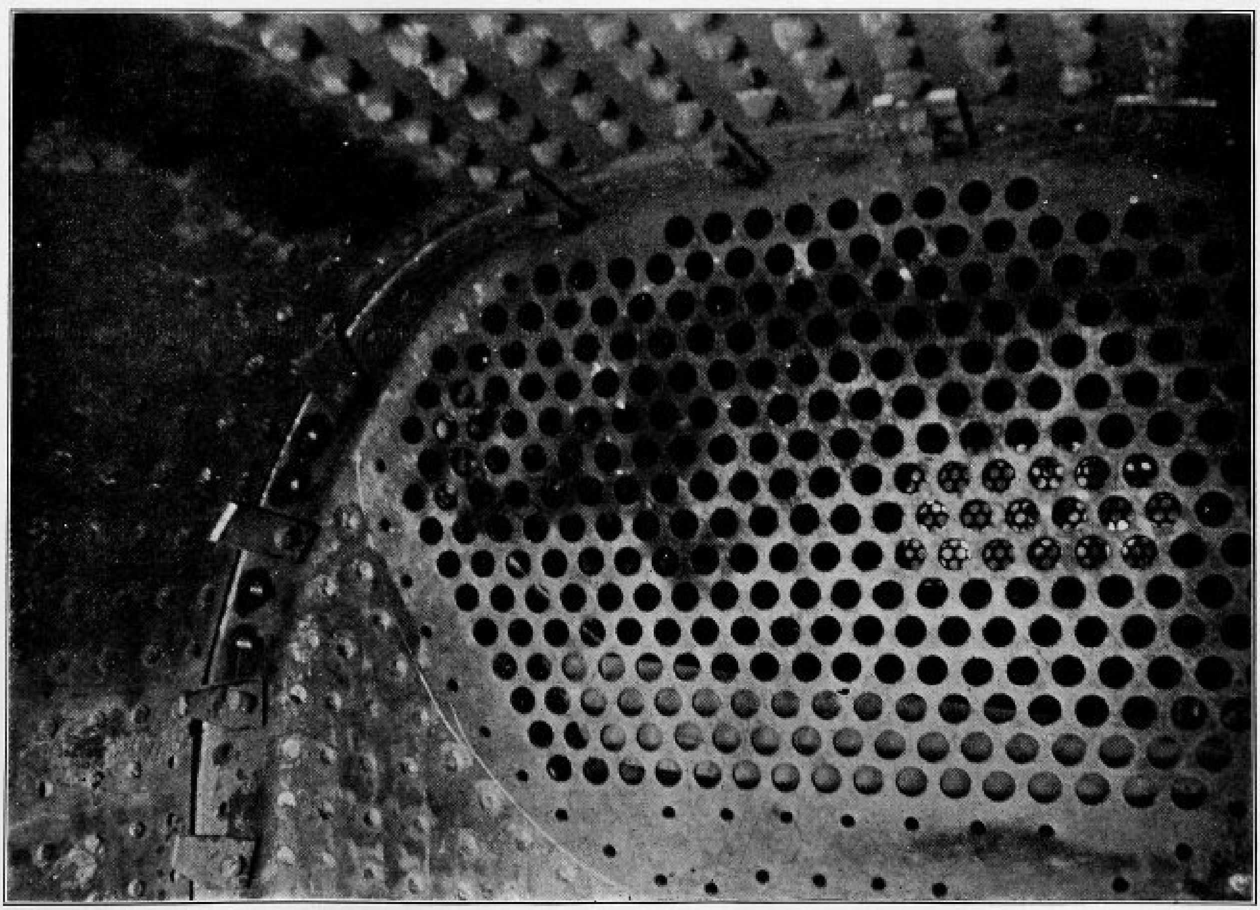


Fig. 1.—Flue Sheet Fitted Up for Oxy-Acetylene Welding

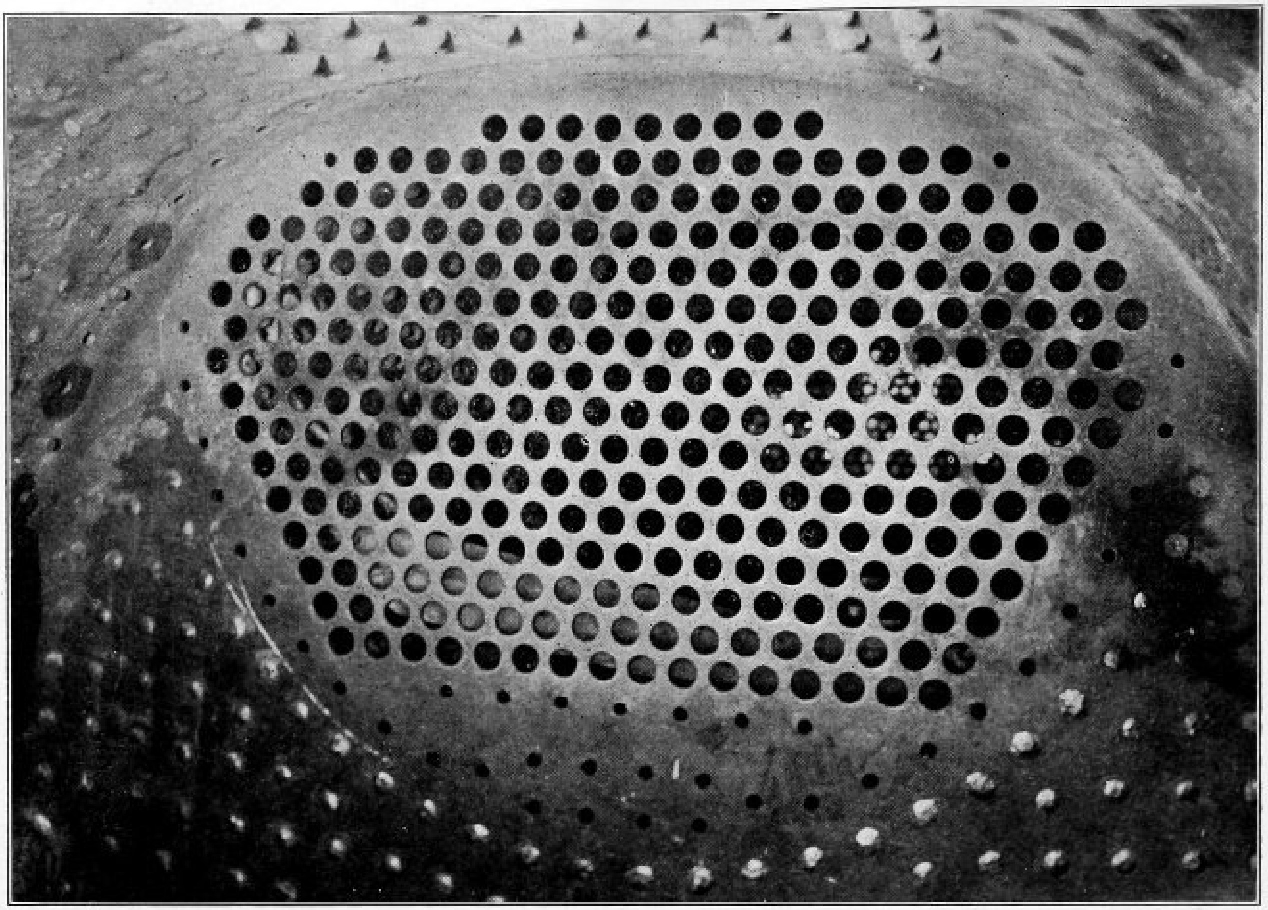


Fig. 2.—Flue Sheet Welded by the Oxy-Acetylene Process

It is not the intention to discuss the merits or demerits of any particular process, but merely an exposition of what can be done by careful thinking and by the application and trying out of new ideas.

Welding Plant

The plant used in the shop where the writer is employed is the Oxweld with two 350-pound generators, using ¼ inch carbide and delivering gas at a tip pressure of about 9 ounces. The oxygen is supplied from two storage supplies of about 3,800 cubic feet each at a maximum pressure of 1,800 pounds (absolute) per square inch. This is, of course, reduced on the line to a maximum of about 90 pounds per square inch. The object in having two units is that recharging may be done without stopping operations.

The gases are piped all through the shop to each engine pit and various other points, so that job work may be done without having to use a portable plant. The drop pipes are brought down alongside of the columns to within about 6 feet of the floor, at which point globe valves are placed and on the acetylene line a flash back device. The pipes are then extended down under the floor to the pits, where another shut-off valve is placed on each line. This precludes the possibility of gas losses with various results. From 6 feet above to the floor the oxygen pipe is painted green and the acetylene red to distinguish them from pipe lines carrying oil, air, etc. A warning, "Keep open lights away," is painted in large letters near the valves.

In performing boiler welding, it is beginning to be found that the simplest and easiest manner of doing the work is usually the best. All this "dropping one end of the patch" and "offsets in patches" is really excess labor. The so-called difficulties experienced in welding were discussed pro and con at the recent Master Boiler Makers' Convention, and some contended that side sheets or long patches could not be welded in without dropping one end of the sheet. It is a fact, however, that in the shop where the writer is employed no such thing is done, and that the percentage of failures is less than one-tenth of one percent. In fact, the only failure in six months' time was two patches embracing about the bottom third of front flue sheets. Both these failures were detected before the engines left the shop, the patches were cut out, made a little larger, and rewelded successfully.

Welding Patches

The patches in question took in the flange and all the flues about seven rows up and were welded across the bridges. The row of flue holes next to the weld is not applied until after the weld is made. It was found after these patches had failed, that the acetylene pipe was clogged with scale and residue and gas was delivered at a very low pressure, and that the welds were probably made with an excess of oxygen and were therefore oxidized welds. Since giving the lines a thorough cleaning, no further trouble has been experienced.

In fitting up side sheets and patches, we apply the sheet the same size as the one removed; both plates are beveled to an angle of about 45 degrees, with about ⅛ inch opening at the apex of the angle. The old plate also has a light thin chip taken off extending back from the base of the angle about ½ inch. This cleans the plate thoroughly of rust, scale or other impurities that might affect the weld. Each welder is equipped with an air-chipping hammer to dress the work when necessary. Before welding sheets or patches, the staybolts are all applied and all driven except the row each side of the weld. These are not driven until after the weld is made. The rivets are usually not applied until after the weld is made. They may and have been applied before, but it has been found that less trouble is experienced making nice, clean jobs by leaving them out until the weld is made.

An ingenious method of caring for broken mudring corners has been worked out very successfully where a rapid job is desired. A flat patch about ¾ inch wider than the mudring, and extending 4 or 5 inches each side, is patch-bolted to the bottom of the ring. The patch is beveled the reverse of what it would require to calk it and the patch is then welded fast to the mudring and sheets. The patch is finally calked down and the engine is ready for service. The job complete takes only six or eight hours and with no stripping, only a couple of grates and an ashpan corner. This practice is not recommended for back shop work, as the welding of the ring at the smith shop or in position is to be preferred to this method for a durable job.

It is also the practice at this shop when applying new fireboxes to weld the mudring corners; that is, the mudring, the rivets, and corner plugs are applied in the usual manner without calking. The calking edge of the sheet is then welded to the ring inside and out for a distance of about 6 inches each way from the corner. The rivets and plugs are then calked down. This makes an exceptionally good job, as a leak from shopping to shopping is an unusual thing in one of these corners.

There are now in service two back flue sheets welded in old fireboxes. The one illustrated has now been in service about seven months without a fault of any kind.

Welded Firebox

The view of the firebox model shown is a different view of one illustrated in the July issue of THE BOILER MAKER and exhibited at the last Master Boiler Makers' Convention. This is a duplicate in miniature of three that have been in service nearly two years. These boxes have not a rivet in them, only along the mudring. The oldest of these boxes just passed through the shop without a flaw being detected.

It will be noted by careful observation that the door holes are welded instead of patch-bolted or riveted. This feature will undoubtedly reduce cracked door holes, for in the writer's opinion about all cracked door holes are from the following causes, either singly or in conjunction:

Too much rigidity caused by the riveted joint; too much joint lap, causing rigidity and over heating; mud and scale accumulating around the rivet heads, keeping the water away and causing overheating. The welded hole is elastic and free from protuberances to collect scale. The foregoing may also be said of the points where the door sheet and flue sheet connect to the wrapper sheet. The old flue sheet flange, riveted, has always been and is still a prolific source of trouble. The welded joint eliminates all the old troubles. It does not leak; it does not collect; it allows freer circulation than the riveted joint, due to its smoothness.

In welding these sheets, it has been the practice to extend the flue sheet and door sheet flanges to take in one row of staybolts, to get the weld within the stayed portion of the sheet and away from the peculiar expansive movement of the flange knuckle; it also facilitates welding. The writer believes, however, that this precaution is unnecessary, as the flange is self-supporting, and that the weld on a flange of 2 or 3 inches will do as well as when extended.

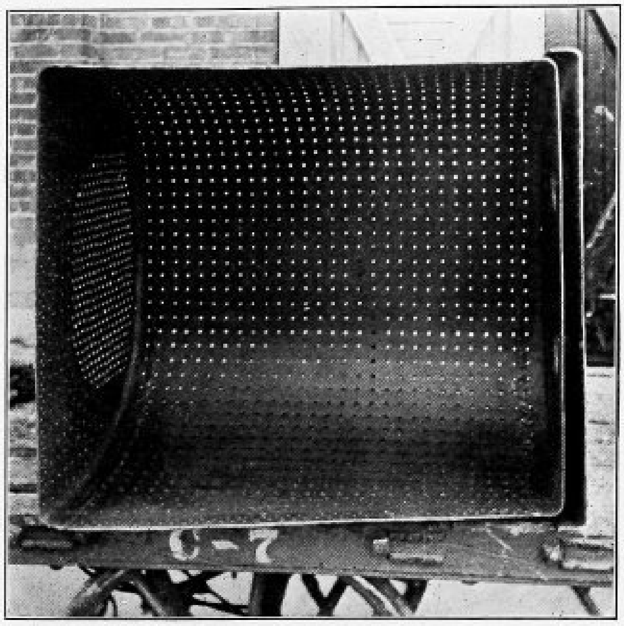


Fig. 3.—Model of Welded Firebox

An unusual piece of work—i. e., welding in the flue hole section of a back flue sheet—has been done successfully several times. Several flue sheets have been found where the flue hole section was bad and the remainder of the sheet in good order. A cutting torch was used to remove the bad section, cutting between the outer row of flue holes and the brace bolts and cutting through to the crown sheet at the top. The section was replaced and welded before the crown sheet was riveted. These jobs have been uniformly successful and have been done at an average saving of about $50 per boiler.

An operator with a cutting torch is an almost indispensable part of the organization. The time and money saved daily are almost incalculable, as a few minutes here and there are saved a hundred times a day. Patches are burned out, braces burned off, "thermit risers" burned off, frames V'd out for welds, all staybolts burned off, etc.

It has been found that better staybolt service is obtained with staybolts burned off than those "nicked and broken down." The last named operation has a tendency to flatten the threads and elongate the holes with leaky staybolts as a result.

Cleaning Soot from Boiler Tubes

In reply to a question asking how often the tubes of a boiler should be blown out to keep them free of soot, the *Electrical World* says:

"The frequency with which the blower should be used depends on the type of boiler, the soot-producing qualities of the fuel, the efficiency of firing, and on whether a hand blower or a mechanical blower is used. If the blower is of the mechanical kind that is fixed permanently in place and that blows all the tubes at one time, the labor required to operate it is reduced, and blowing may be done two or three times in a day of twenty-four hours. But if the hand-operated, single-jet blower is used, the labor involved reduces the number of cleanings to one a day. It seems to be generally conceded that the tubes should be blown at least once a day. But if much soot is formed it will be found economical to blow them out oftener, even at the expense of additional labor."

Steam Boiler Explosions*

Causes of Boiler Explosions—Inspection and Factors of Safety

BY WM. H BOEHM, M. M. E. †

Every year there occur in the United States between 1,300 and 1,400 serious boiler accidents, of which 300 to 400 are violent explosions. These accidents kill between 400 and 500 persons, injure 700 or 800 more, and destroy more than a half million dollars' worth of property. In a single explosion, that of the R. B. Grover Shoe Company at Brockton, Mass., 58 persons were killed, 117 more were injured, $250,000 worth of property was destroyed, and an aggregate of $280,000 was claimed in the personal injury and death suits that were brought.

These disasters have but scant respect for types—they occur with watertube boilers, although with them violent explosions occur less frequently than with fire-tube boilers; they occur with low-pressure boilers as well as with high-pressure boilers; with fired boilers as well as with unfired steam tanks; with small kitchen boilers as well as with hot-water heaters, and I may add that they also occur even with the ordinary peanut roasters so familiar on crowded street corners.

These facts emphasize: the necessity of constructing and installing steam vessels and their appurtenances in as nearly perfect a manner as possible; the importance of preventing carelessness in their operation; the wisdom of having them inspected at regular intervals by disinterested experts; and the forethought of securing an adequate amount of insurance to pay the loss in case explosion occurs.

Design and Construction

It is of the utmost importance that boilers be carefully designed, that the stresses to which they are subjected be accurately computed, that suitable material be specified, that the material be critically examined for flaws or defects, that specimens of the material be tested to determine its strength, that no abuse of the material be allowed in the process of constructing the boiler, and that the completed boiler be subjected to a thorough inspection and a hydrostatic test before being put into service.

Stress in Girth and Side Seams

The stress in the girth seams of a boiler may be obtained by the formula

$$S = \frac{r p}{2 t}$$

in which S is the stress per square inch to which the material is subjected, r the radius of the boiler, p the steam pressure carried, and t the thickness of the shell. Stated in words the formula means that if we multiply the shell radius by the steam pressure, and divide the product by twice the shell thickness, the result will be the stress in pounds per square inch to which the material in the girth seams is subjected.

The stress in a side seam of a boiler may be obtained by the formula

$$S = \frac{r p}{t}$$

which stated in words means that if we multiply the shell radius by the steam pressure and then divide the product by the shell thickness, the result will be the stress in pounds per square inch to which the material in a side seam is subjected.

An inspection of these formulæ shows that the stress in a side seam is just twice as great as the stress in a girth seam. It is for this reason that the side seams are usually double riveted when the girth seams are only single riveted.

Bursting Pressure

The pressure required to rupture the shell of a cylindrical boiler is given by the formula

$$P = \frac{s t}{r} e$$

in which P is the bursting pressure in pounds per square inch, s the tensile strength of the material in the boiler, r the radius of the shell, and e the efficiency of the riveted side seam. Stated in words the formula means that if we multiply together the tensile strength of the material, the thickness of the shell, and the efficiency of the riveted side seams, and then divide the product so obtained by the radius of the shell the result will be the steam pressure at which explosion will occur.

If it so happens that the efficiency of the girth seam is too low by reason of improper design, then the girth seam may fail instead of the side seam as assumed above, in which case the bursting pressure is given by the formula

$$P = \frac{2 t s}{r} e'$$

which stated in words means if we multiply together twice the thickness of the shell, the tensile strength of the material, and the efficiency (e') of the girth seam, the result will be the steam pressure at which explosion will occur. It is to be observed, however, that the girth seam is not likely to fail before the side seam, because to do so the efficiency of the girth seam would have to be less than half that of the side seam—a weakness that should not exist in a boiler of proper design and construction.

Factors of Safety

It is particularly to be observed that the formulæ expressed above give the pressure at which the boiler will explode and not the pressure at which it may be safely operated. It is usual in boiler practice to fix the allowable working pressure for a new boiler at *one-fifth* the computed bursting pressure and to decrease the pressure allowance as the age of the boiler increases.

This is equivalent to saying that the factor of safety applied to a new boiler is usually not less than *five*. The term "factor of safety," however, is so often misunderstood that I have thought a better name for it would be "factor of ignorance." It really is as much a factor of ignorance as it is a factor of safety.

Take, for example, the case of a new boiler operated with the safety valve set at 100 pounds. If the computed bursting pressure be 500 pounds, then the assumed factor of safety is *five*. The assumption, however, is based upon the tensile strength stamped in the plate by the steel maker and this strength is only true of that particular part

* Lecture delivered before student branch of American Society of Mechanical Engineers at Cornell University, Ithaca, N. Y.

† Superintendent, Department of Steam Boiler and Fly Wheel Insurance, the Fidelity and Casualty Company of New York, and member American Society of Mechanical Engineers.

of the plate from which the test specimen was cut and not necessarily true of any other part.

As a matter of fact, it is current practice to cut the test specimen from the outer edge of the plate and the strength there is almost invariably greater than the strength at the center of the plate. The reason is that after liquid steel is poured into a mold its solidification in forming an ingot proceeds in much the same manner as does the solidification of water in forming a block of ice. That is to say, the impurities and gases are driven toward the center, as almost every one has observed when looking through a clear block of manufactured ice. Boiler plates made by the rolling of such an ingot will, therefore, have more impurities and less strength at the center of the plate than at the outer edges, and this variation in strength is very considerable. Then, too, it should be borne in mind that the stress at which the elastic limit of the material is reached is little more than *half* the stress at which rupture occurs.

Besides our ignorance of the dependable strength in all parts of the plate, there is also our ignorance of the character of the workmanship in the boiler. We cannot be certain that all rivet holes come fair, or that incipient cracks have not been set up by an abuse of the material during the process of construction.

It is seen, therefore, that factors of safety are really made up of two parts—one part a true factor of safety, the other a pure factor of ignorance. If this matter were better understood, boiler owners would themselves insist upon a computed factor of safety of not less than five and they would not be so persistent, as many are, in demanding that their boiler insurance company grant an unwise increase of pressure.

Causes of Boiler Explosions

Boiler explosions may be attributed to improper construction, improper installation, or incompetent or careless operation.

Improper construction may consist: of unsuitable or inferior material; poor workmanship; abuse of material, as when unmatched rivet holes are drift-pinned to place, or uncylindrical shells are sledged to form; of employing the more dangerous lap joint for the side seams instead of the more safe and more sensible butt joint, etc.

The lap-joint is dangerous because this form of construction promotes the formation of incipient cracks in the upper surface of the lower lap where they may be impossible of detection. These cracks extend from rivet hole to rivet hole and gradually deepen with the continued raising and lowering of the steam pressure until the metal, no longer capable of resistance, gives way and causes a violent explosion.

The lap joint is given the preference over the butt joint solely because it appears at first thought to be cheaper. Its labor cost doubtless is lower, but its lower efficiency makes necessary the employment of thicker plates to withstand the required steam pressure; and so the greater cost of the material, together with the heavier freight charge, really makes the lap joint the more costly of the two. There is, therefore, no excuse for its existence, and its employment in the construction of new boilers should be prohibited by law in all states, as it now is in some.

Improper installation may consist of so supporting the boiler and its piping as to allow temperature changes to set up dangerous stresses in the material, of improperly attaching the usual appurtenances such as safety valves, steam and water gages, check, blow-off and stop valves, etc.

Incompetent or careless operation may consist in allowing the steam gage to get out of order, in allowing the water-gage connections to become so clogged as to indicate ample water when there is none in the boiler, in allowing the safety valve to become so stuck to its seat as to fail to blow at the pressure for which it was set, in allowing grease to enter or scale to accumulate in the boiler, in allowing large quantities of cold water to be impinged against hot plates, in allowing the water to be driven from the heated surfaces by forced firing, in allowing a large valve to be opened too suddenly, in allowing two boilers to be cut in on the same steam main when their pressures are unequal, and in allowing minor repairs to be neglected until they endanger the whole structure.

It is significant that many violent boiler explosions occur either just prior to the starting of the engines in the morning, or while they are idle at the noon hour, or shortly after they have been shut down for the day. The reason is that when steam is not being drawn from the boiler it accumulates rapidly, and if the safety valve fails to relieve the pressure, explosion soon follows.

The rapidity with which the bursting pressure is reached may be shown as follows:

Let T equal the time in minutes required to reach the bursting pressure, W the weight of water in the boiler, t the temperature of the steam at bursting pressure, t' the temperature of the steam at normal working pressure, and U the number of heat units per minute supplied by the furnace and absorbed by the water. The heat balance is then represented by the equation:

$$UT = W\,(t - t')$$

$$T = \frac{W}{U}\,(t - t')$$

which, stated in words, means that if we multiply the difference between the temperature of the steam at bursting pressure and at normal pressure by the weight of the water in the boiler, and then divide the product by the number of heat units supplied per minute by the furnace, the result will be the number of minutes that will elapse from the time the openings are all closed until explosion follows.

Take, for example, a 100-horsepower horizontal tubular boiler containing at normal level 10,000 pounds of water and suppose it uses 50,000 heat units per minute when evaporating 50 pounds of water per minute. Then if the normal gage pressure be 85 pounds, the corresponding temperature of the steam is 327 degrees, and if the bursting gage pressure be 485 pounds, the corresponding temperature of the steam is 467 degrees, and the time required to reach the bursting pressure with all steam openings closed and the safety valve stuck is:

$$T = \frac{10{,}000}{50{,}000}\,(467 - 327) = 28 \text{ minutes.}$$

That is, with a stuck safety valve, only 28 minutes would elapse from the time the engines were shut down until the explosion followed.

Explosive Energy in Heated Water

The temperature of the water in a boiler is approximately the same as the temperature of the steam with which it is in contact. If the fire be drawn when the openings are closed, ebullition ceases. If a valve be opened, ebullition starts again, even though there still be no fire under the boiler.

It is plain, therefore, that with the openings closed it is the pressure on the surface of the water that prevents further generation of steam. It is also plain that if a small rupture occurs below the waterline a violent explosion may not ensue. But it ought to be evident that if a large outlet above the waterline be suddenly opened, as, for example, when a steam pipe fails, then the sudden liberation of the pressure on the surface of the high temperature water will allow it to flash suddenly into steam and cause a violent explosion and water hammer that will disrupt the strongest possible construction.

It is in this manner that most violent explosions are produced. The violence is incomprehensible to the layman, who sometimes jumps to the conclusion that dynamite instead of steam caused the disaster. There is, however, no warrant for such a conclusion. A cubic foot of heated water under 60 to 70 pounds pressure contains about as much stored-up energy as a pound of gunpowder, and it has been estimated that the heated water in an ordinary cylindrical boiler contains enough energy to project the boiler to a height of two miles!

Grease in Boilers

The action of grease in a boiler is peculiar. Grease does not dissolve or decompose in water, nor does it remain on the surface. Heat in the water and its violent ebullition causes the grease to form in sticky drops which adhere to and varnish the metal surfaces of the boiler. This varnish, by preventing the water from coming into intimate contact with the metal, prevents the water from absorbing the heat, and this causes a blistering or burning of the plate that often results in a serious rupture or a violent explosion.

Scale in Boilers

If scale is allowed to accumulate to any considerable thickness in a boiler, a bag or rupture of the boiler is inevitable, unless, perchance, the scale happens to be of a spongy formation, which is not often the case. Just why this is so, is shown by the following simple experiment:

Take an ordinary granite iron or tinned iron stewpan and firmly glue to its underside a postage stamp. Pour water into the pan and place it on a gas stove so that the postage stamp will be in direct contact with the flame. Leave the pan on the stove until the water has boiled violently, and then examine the stamp. The stamp will not even be charred, much less burned. In fact, it may be removed from the bottom of the pan and used to post a letter in the regular way. And this notwithstanding the fact that it was on the underside of the pan and in direct contact with the hottest part of the flame.

Now put into the pan a mixture of water and Portland cement half an inch thick. This, when set, will be the equivalent of half an inch of scale. Repeat the experiment made before and it will be found that the stamp will burn up very quickly.

The reason that the postage stamp on the bottom of the vessel is not charred by the flame when no scale is present is that the water, being in immediate contact with the thin bottom of the vessel, absorbs the heat as fast as it is put into the vessel by the flame. The result is that, no matter how hot the flame may be, the bottom of the vessel remains practically the same temperature as the boiling water with which it is in contact. In an open vessel the temperature of boiling water, of course, is 212 degrees, and this is not sufficiently high to char paper. When scale is present, the water cannot absorb the heat as fast as it is put into the vessel by the flame, as a result of which the temperature becomes greater than 212 degrees and burns the postage stamp.

It is the same with steam boilers. If the water comes in direct contact with the thin plates, the heat is absorbed, the temperature of the plates remains practically the same as the water, and no harm is done. If there be a considerable thickness of impervious scale in the boiler, the water cannot absorb the heat as fast as it is put into the plates by the furnace, and so the plates become overheated, get red, become plastic, and finally give way to the force of steam pressure, causing a bag, or a rupture, or a violent explosion of the boiler.

Scale endangers the safety of boilers in other ways. It clogs the feed pipes, preventing the feed water from freely entering the boiler. It clogs the connections to the water gage, causing it to indicate ample water when none at all is in the boiler. Pieces of it get under valves and prevent their closure. A blow-off valve, for instance, screwed down hard and thought to be shut, recently allowed all the water to leak out of the boiler, and caused its burning into a mass of warped plates and bent tubes unfit for further use. Then, too, scale decreases the efficiency and increases the fuel consumption of the boiler.

Scale in boilers, therefore, is a serious matter. In order to prevent its accumulation, it is good practice to eliminate the scale-forming matter from the feed water before allowing it to enter the boiler. This can be accomplished either mechanically by means of separators, or chemically by treating the water in vats especially arranged for the purpose. If preferred, compound may be fed with the water into the boiler, but in such case the water should be analyzed, and the proper compound prescribed by a chemist making a specialty of such matters. Kerosene fed into the boiler has proven beneficial in many instances.

Inspection and Insurance

It is an almost universal custom for boiler owners to have their boilers insured and inspected. The insurance serves as a guarantee that the inspections will be intelligently and carefully made and the inspections lessen the chance of accident.

When boiler insurance is carried, an inspector of the insurance company visits the plant at regular intervals. He critically examines the boilers, both internally and externally, hammer-testing them thoroughly in order to discover defects or weakness. If he finds oil or scale in the boiler, a remedy is prescribed to eliminate it and to prevent its reaccumulation. He notes the exact condition of the boilers and secures all data necessary to determine the maximum steam pressure at which they are safe. He examines the brick setting, tries the safety valves, tests the water gages, and standardizes the steam gages by comparing them with his standard test gage. And he inspects the piping, injectors, feed pumps and other apparatus auxiliary to the boiler.

Immediately upon completing his examination, the inspector makes a verbal report to the owner of the plant, and sends a written report to the insurance company. The insurance company then renders a written report to the owner confirming the verbal report already delivered by the inspector.*

The value of this system is reflected in the experience of The Fidelity and Casualty Company, the inspectors of which during the past ten years made 1,101,140 examinations and reported 140,989 defects, many of which consisted of dangerous fractures in or near the riveted seams. It is significant that one boiler out of every eight examined contained defects serious enough to warrant their being reported.

Many States wisely have passed laws providing for the examination and licensing of stationary engineers, and

* The system here described is that of The Fidelity and Casualty Company.

for the compulsary inspection of steam boilers. Such laws very properly exempt from State inspection boilers inspected by boiler insuring companies. One of the best of these laws is the Massachusetts law. It has been used as a model by the State of Ohio and by other States.

Unfortunately the State laws are not uniform. A boiler built in accordance with the laws of one State may be rejected if shipped into an adjoining State; and a State that has no such law may become the common dumping ground for old, worn-out and dangerous boilers rejected from a State that has such laws.

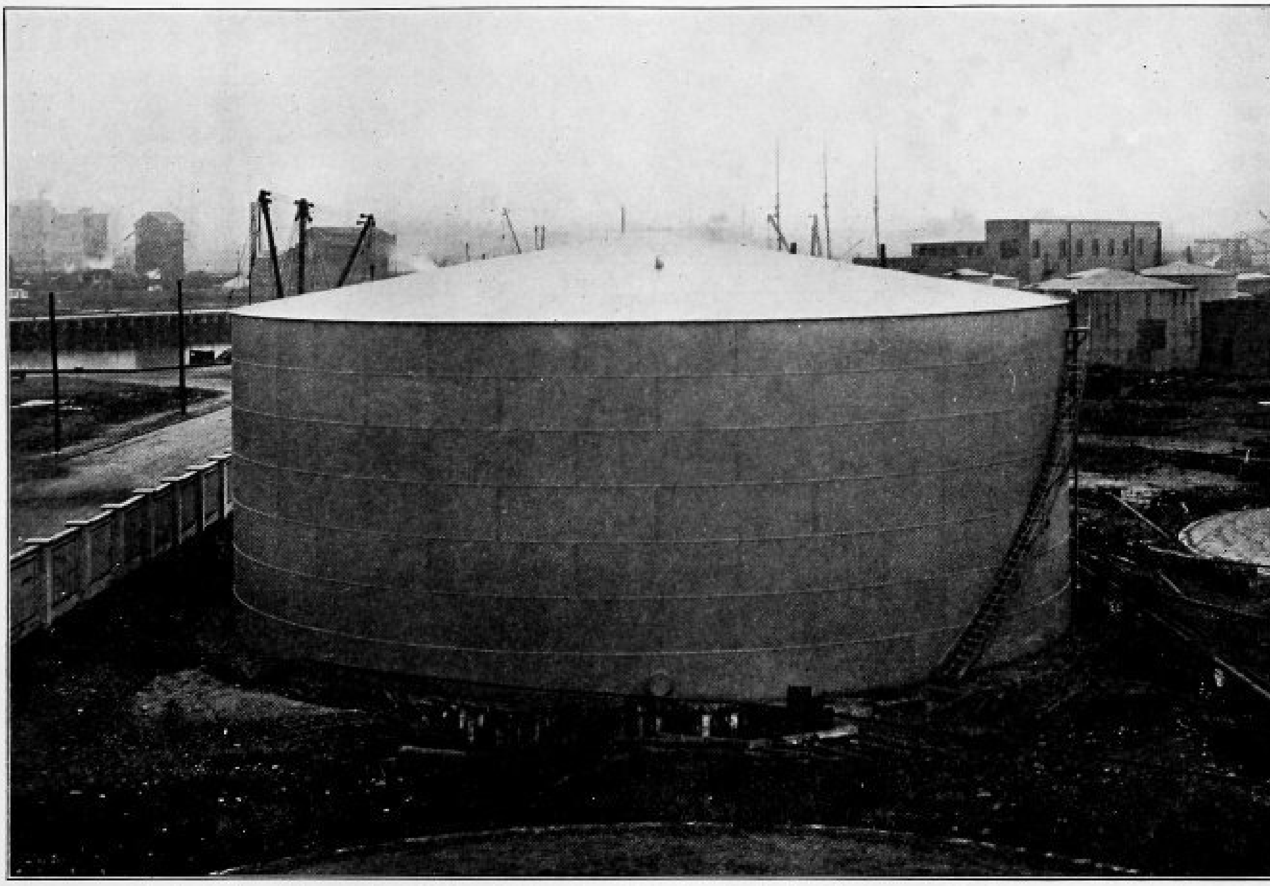
Uniform laws are, therefore, greatly to be desired, and in an effort to secure uniformity, the American Society of Mechanical Engineers has adopted a Standard Boiler Code. It is hoped that steam users will want, and manufacturers will build, their boilers in accordance with the A. S. M. E. standard; that the States will adopt it as their standard, and that eventually complete uniformity will thus be brought about.

Modern Steel Plate Oil Tank Construction

BY FRANK C. PERKINS

The construction of the conical steel oil tanks with all steel roofs erected in the Isthmian Canal Zone, as well as at Brooklyn, N. Y., may be noted in the accompanying illustration. These tanks for oil storage measure 93 feet in diameter and 35 feet in height. They were designed by the engineers of the Petroleum Iron Works Company at Sharon, Pa., and about a score of these oil storage tanks have been built for the Standard Oil Company of New York at the Stone & Fleming Works, Brooklyn, N. Y., and elsewhere.

Four of these oil storage tanks were erected for the Isthmian Canal Commission at Mount Hope and Balboa. The latter tanks are almost identical in construction, with the exception that the Mount Hope tanks have a heavier bottom ring upon the shell. These tanks are made with ⅜-inch bottom, the shell varying from ½ inch to 5/16 inch and 3/16 inch roof. The roof is supported by a structural steel framework.

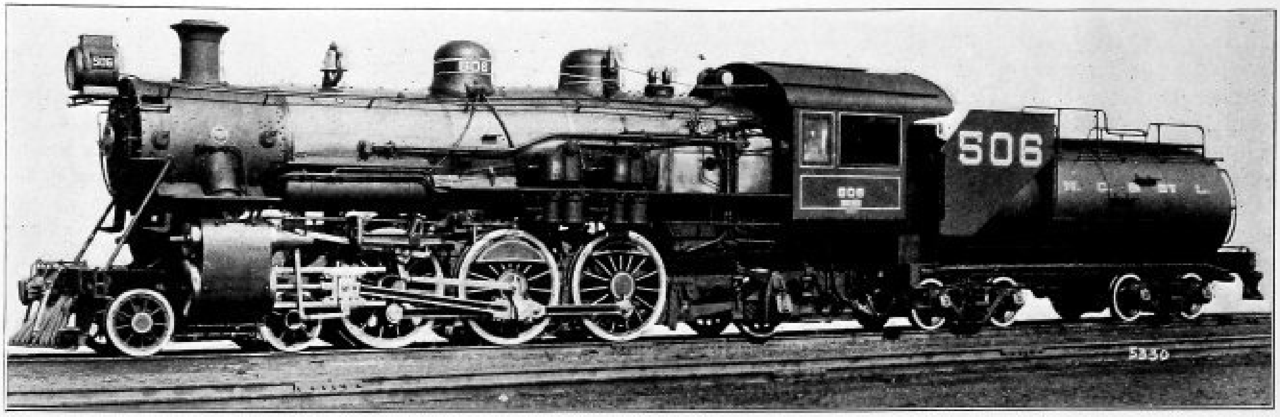


Oil Storage Tank, 93 Feet Diameter by 33 Feet High, Erected for the Standard Oil Company by the Stone and Fleming Works, Brooklyn, N. Y.

Novel Superheated Passenger Locomotive

The Nashville, Chattanooga & St. Louis Railway recently placed in service a novel superheated passenger locomotive, equipped with a Schmidt superheater having a superheating surface of 592 square feet. The engine has cylinders measuring 23 inches by 28 inches and valves of piston type 13 inches in diameter. The boiler is of the wagontop type of a diameter of 66 inches, the thickness of sheets being 9/16 inch and ⅝ inch. The working pressure is 185 pounds and the fuel used is soft coal.

The fire box is of steel, with a length of 114⅛ inches and a width of 66 inches, the depth front being 74 inches and the depth back measuring 63 inches, while the thickness of sheets, sides, back and crown is ⅜-inch and the tube sheet ½ inch. The water space front is 5 inches and sides and back 4 inches. There are 186 tubes, having a length of 20 feet 6 inches. The heating surface of the fire box is 186 square feet and of tubes 2,678 square feet, giving a total of 2,891 square feet, the grate area being 52.4 square feet.



Passenger Locomotive Equipped with Schmidt Superheater, Built for the Nashville, Chattanooga & St. Louis Railway

The driving wheels have a diameter outside of 69 inches, and the engine truck wheels have a diameter of 36 inches front, the diameter back being 44 inches. The wheel base of the total engine is 34 feet 1 inch, and of the total engine and tender 69 feet 4 inches. The weight on driving wheels is 143,500 pounds, while the total engine is 219,550 pounds, and of the total engine and tender about 375,000 pounds. The tender has eight wheels of a diameter of 36 inches. The tank capacity is 8,500 gallons and the fuel capacity is 14 tons.

A Four-Cylinder Compound Italian Locomotive

BY FRANK C. PERKINS

A four-cylinder compound prairie locomotive, shown in the accompanying illustration, was constructed at Milan, Italy, at the works of the Societa Italiana Ernesto Bred, and is in use by the Chemins de Fer de l'Etat Italien. This engine has four cylinders 16.8 inches in diameter, with a stroke of 26 inches. The diameter of the driving wheel is 6.07 feet and the fixed wheel base measures 6.31 feet, while the total is 27.52 feet.

The boiler has a total heating surface of 2,613 square feet, of which 1,917 square feet represents the heating surface of the tubes and 564 square feet the steam superheater surface, while the area of the grate is 38 square feet. This engine develops 1300 horsepower and has a maximum traction effort of 23,382 pounds.

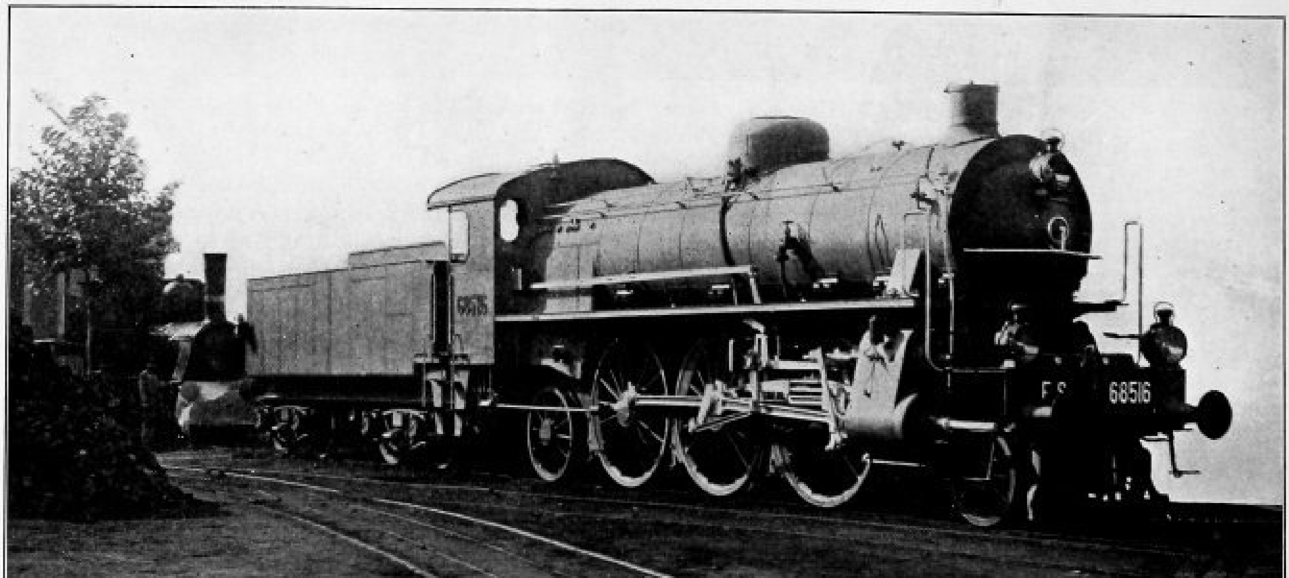
The total weight of the engine and tender combined is 266,084 pounds, the weight of the tender in service being 109,616 pounds and of the locomotive 156,468 pounds.

An Unusual Confirmation of the Colburn-Clark Theory of Boiler Explosions

The first really satisfactory hypothesis of the mechanism of a boiler explosion was published by Zerah Colburn in 1860, though it is supposed that the idea originated with Mr. D. K. Clark. This view supposes that the average explosion, "although seemingly instantaneous, may actually be a succession of operations, three or four at least, as the following:

"(1) The initial rupture under a pressure which may be, and probably often is, the regular working pressure; or it may be an accidentally produced higher pressure; the break taking place in or so near the steam space that an immediate and extremely rapid discharge of steam and water may occur.

"(2) A consequent reduction of pressure in the boiler, and so rapid that it may become considerable before the inertia of the mass of water will permit its movement.



Four-Cylinder Compound Italian Locomotive

"(3) The sudden formation of steam in great quantity within the water and the precipitation of heavy masses of water, with this steam, toward the opening, impinging upon adjacent parts of the boiler and breaking it open, causing large openings or extended rents, and often shattering the whole structure into numerous pieces.

"(4) The completion of the vaporization of the now liberated mass of water to such an extent as the reduction of the temperature may permit, and the expansion of the steam is formed, projecting the detached parts to distances depending on the extent and velocity of this action.

"This series of phenomena may evidently be the accompaniment of an explosion to whatever cause the initial rupture may be due. . . . A local defect well below the waterline would simply act as a safety valve, discharging the contents of the boiler without explosion."

While it is, of course, true that any such picture of what happens in an explosion is artificial and speculative, still the experience of more than half a century has so largely confirmed it that it remains to-day by far the most probable of all the theories.

Every now and then the circumstances attending an explosion are of such a nature that they permit us to reconstruct by inductive reasoning some portion of the rapid succession of events. Such a case occurred recently in the explosion of a boiler at a soapstone quarry at Arrington, Va. In accordance with the Colburn-Clark theory, a rupture below the water line *need* not be attended

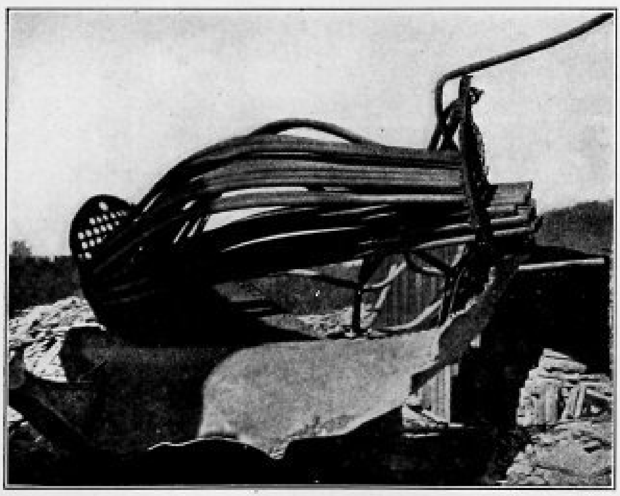


Fig. 1.—Exploded Boiler at Arrington, Va.

with violent results, while if the rupture is *below* but *near* it should be possible for both sorts of action to take place, first an outflow of water without violent disruption of the boiler until the water line is lowered to the immediate neighborhood of the break, followed by a violent explosion when that point is reached. This possibility is in no way at variance with that type of explosion where a large rupture takes place well below the waterline in, say, a vertical boiler, and the reaction of the issuing jet of steam and water is so great that it lifts the boiler bodily, projecting it to a considerable distance, exactly as the issuing stream of water or steam propels a turbine wheel, or the issuing gases propel a sky-rocket, for in this latter case the explosion is not violent in the sense that the boiler is torn and disrupted as if by a blow, but is only the natural consequence of the powerful jet action following a very rapid outflow below the waterline.

It so happened that the boiler which exploded at Arrington was of the horizontal return tubular type made of two sheets, a single top and bottom sheet. This necessitated two continuous longitudinal seams the length of the boiler located at approximately the horizontal diameter of the heads. These seams were of lap riveted construction. So it will be seen that the longitudinal seams were located be-

Fig. 2.—Showing the Destruction of the Boiler House at Arrington, Va.

low the waterline, and indeed below the upper rows of tubes. The appearance of the boiler after the explosion, indicated that the initial rupture took place at a seam crack in one of the longitudinal seams, of the type familiarly associated with the lap riveted construction.

At the time of the explosion one of the employees of the plant was in front of the boiler which failed. Fortunately, though seriously injured, he was not killed. His story furnishes the clue to what must have taken place. He says that prior to the actual explosion came a dull roar, and streams of water poured out of the furnace and ash pit. He seems to have started for safety when a second and much more violent disturbance took place, after which he was overtaken by falling débris, under a wagon where he had plunged for safety.

Assuming the substantial accuracy of his statement, this accident furnishes an almost absolute substantiation of the details of the theory which we have just set forth, the lap crack, which had no doubt been a long time forming, finally reached such a length and depth that the seam could no longer sustain the ordinary stresses due to the working pressure. A rupture followed through which water flowed with comparative quietness until the level came down to that of the crack, then followed the rapid outflow of steam and the sudden destructive "water hammer" action, described in the paragraphs quoted above, with the violent disruption of the boiler. The violence of this particular explosion, coming as it did from a rupture below the normal waterline, was undoubtedly due to the large volume of hot water, and hence available heat energy still remaining in the boiler, when the second stage of the explosion arrived.

Otherwise the accident, while destructive, presented no unusual features. One man who was between the exploded boiler and an adjoining one, was killed, and the plant was seriously damaged, as indicated in Fig. 2.—*The Locomotive of the Hartford Steam Boiler Inspection and Insurance Company.*

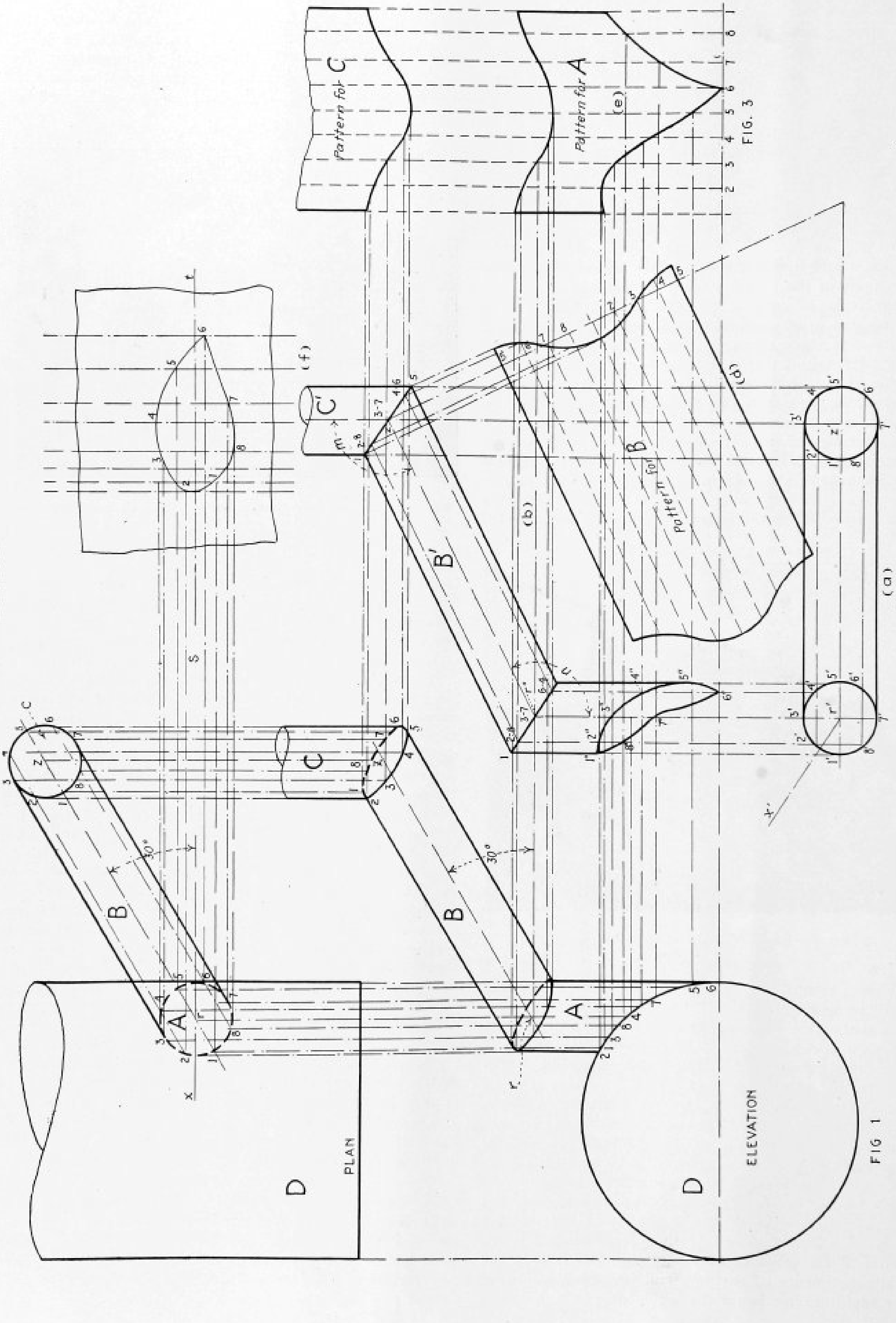


FIG 1

FIG. 2

FIG. 3

Plan, Elevation and Development of Patterns for Oblique Pipe Intersection

Oblique Pipe Connection

Layout of Unusual Pipe Connection —Method of Finding Miter Lines

BY C. B. LINSTROM

An inspection of Fig. 1 shows connected four cylindrical pipes, *A, B, C* and *D*. Pipe *D* is the large main pipe and it lies in a horizontal position; from it is extended the smaller pipes to form the desired connection. Pipes *A* and *C* lie, in the same plane, which is perpendicular to the horizontal plane and parallel to the vertical plane. The pipe *A* intersects pipe *D* off center so as to have it run tangent at point 6, as shown in the elevation, Fig. 1. To connect the other vertical pipe *C* with pipe *A* it was necessary to run a pipe *B* of the same dimensions obliquely. Its projections in this example are shown at 30 degrees to the planes in both views, plan and elevation.

Development of the Pipes

It is required before the patterns can be laid off to find *first* the true relationship between the pipe sections, which will show pipe *B* in its true size and angles it makes with pipes *A* and *C*; second, to show the true miter lines between all the pipes so that when their patterns are developed and assembled in their proper positions they will all fit properly and make the desired connection. Hence, the first step is shown in Fig. 2.

Transfer the line *r-z* from the plan view to the horizontal position *r'-z'*, as at view (*a*). Make this line equal in length to the horizontal projection of pipe *B*, Fig. 2, and then draw the two circles to locate the position of pipes *A* and *C*. Divide these circles so as to correspond with the divisions 1, 2, 3, 4, 5, 6, 7 and 8 of the plan, Fig. 1. Project vertical lines from *r' z'* to view (*b*), then from points *r* and *z* of the elevation draw horizontal projections to intersect the vertical lines in points *r''* and *z''*. Connect these two points, which gives the true length of the axis of pipe *B*.

Next draw the vertical lines shown from points *r''* and *z''* and make them indefinite in length. These vertical lines are the center lines of pipes *A* and *C*. Determine the true miters between *A' B'* and *B' C'* by bisecting the angles *m* and *n*. Then develop the curve 1'', 2'', 3'', 4'', 5'', 6'', 7'', 8'' of pipe *A* by extending vertical projection lines from 1', 2', 3', 4', etc., of view (*a*) to view (*b*), then from points 2, 1, 3, 8, 4, 7, 5 and 6, which are located on the circle representing a view of pipe *D*, draw horizontal construction lines to intersect the vertical ones just drawn. This curve in pipe *A* gives the required position of the connection so as to form the necessary arrangement of the pipes when assembled together.

Development of Patterns

Having made the view (*b*) lay off the patterns for pipes *A, B* and *C*. These patterns are laid off at right angles to the pipes' axes in this case, as in views (*d*) and (*e*). The stretchout line 5-5, view (*d*), and 1-1, view (*e*), are drawn first equal to the circumference of the profile of the pipes. Divide the stretchouts into the same number of spaces as in either of the circles, in this case 8, numbered as indicated in the views (*d*) and (*e*). Then, by parallel projectors, lay off the camber lines which give the shape of the miters to make the connections between the pipes. Patterns *B* and *C* should be rolled so that the construction lines are on the outside of the pipes when finished. Pattern *A* is to be rolled so that they will be on the inside; this is done to get the needed position of the upper miter on pipe *A* so that pipes *B* and *C* will lie in their proper positions.

Development of Opening in Pipe D

To connect pipes *A* and *D* it is required to find the true shape of the opening where pipe *A* joins pipe *D*. In view (*f*) the method of development is illustrated. First draw the line *s-t* indefinite in length, upon it lay off the arc lengths between points 2-1, 1-3, 3-8, 8-4, 4-7, 7-5 and 5-6 of the elevation Fig. 1. Draw perpendicular lines to *s-t*, through these points. Then from the plan view, Fig. 1, extend horizontal lines from the points 1, 2, 3, 4, 5, 6, 7 and 8 to intersect the vertical lines in points 1, 2, 3, 4, etc., of view (*f*), thus locating sufficient points for drawing in the outline of the opening in the pattern for pipe *D*.

Annealing Chains

For many years the Travelers Insurance Company has recommended the periodical annealing of chains that are subject to severe usage, such as those that are used on cranes and chain hoists, and for slings and for other heavy work. We are aware that chain manufacturers, engineers, and others are not agreed as to the value of annealing, and in fact there are many prominent authorities that firmly believe that such treatment is inadvisable. A recent canvass of a considerable number of chain manufacturers shows that those in favor of the annealing process outnumber those opposed to it by about five to one, although the advocates of annealing are not in harmony as to the methods employed, the frequency of annealing, the temperature to which the chains are to be subjected, or the length of time required to insure good results.

All chain manufacturers, and practically all chain users, are aware of the fact that rough usage, shocks and twists tend to weaken chains. A change gradually occurs in the molecular composition of the material, and the strength of the chain becomes seriously impaired. This is known as "fatigue" of the metal. There may be no visible evidence of this deterioration, although a careful microscopic examination would doubtless disclose a multitude of small cracks; but a person accustomed to the use of chains knows that deterioration is going on, and that eventually the chains will fail. When a chain has been in service for a sufficient length of time to make it unsafe for use at the load for which it was originally designed, it would be desirable to discard it, or at least to use it only for lighter loads; but such a course is not always practicable, nor, according to the views of the advocates of annealing, is it necessary, because the process of annealing counteracts the effects of fatigue and restores the chain to nearly its original strength.

In view of the preponderance of opinion in favor of annealing chains, the Engineering and Inspection Division of the Travelers Insurance Company will continue to advocate the process, at least until some definite and convincing proofs of its inadvisability are forthcoming.

It remains, then, to determine the proper methods for doing the work. It must be confessed that it is practically impossible to make any specific recommendations with regard to it, however, because so many factors enter into the problem. It is the general consensus of opinion that the most satisfactory results in annealing are obtained by the use of a suitable furnace, and by employing a pyrometer to make sure that the temperature is properly regulated and maintained for the required period. In many places where chains are used, however, no furnaces are available, and other methods are adopted. It is customary, under these circumstances, to heat the chain to a cherry red in a wood fire, and to maintain it in this condition for a considerable period, after which the fire is allowed to die and and the chain is left to cool in the ashes.

The principal objection to the use of open fires for annealing chains lies in the fact that the temperature attained can only be guessed at, and moreover it is quite difficult to maintain an even temperature during the time necessary to complete the operation. Furthermore, the correct temperature for annealing depends upon the composition of the chain metal, and it is difficult for anyone but an expert to determine the grade of iron or steel of which a chain is composed. The Committee on Heat Treatment, of the American Society for Testing Materials, has recommended the following range of annealing temperatures for steel of varying carbon content, and this conforms approximately to the practice of various chain manufacturers and users.

Carbon Content	Annealing Temperature
Less than 0.12 percent.	875 to 925 deg. C. (1607-1697 deg. F.)
0.12 to 0.25 percent.	840 to 870 deg. C. (1544-1598 deg. F.)
0.30 to 0.49 percent.	815 to 840 deg. C. (1499-1544 deg. F.)
0.50 to 1.00 percent.	790 to 815 deg. C. (1454-1499 deg. F.)

Various methods for testing chains are employed by persons who have no faith in the annealing process. The method advocated by the Yale & Towne Manufacturing Company, and also followed by the Brown & Sharpe Manufacturing Company, is to make use of a gage three feet long. Every new chain is marked with a prick-punch at intervals of three feet, and at each subsequent inspection of the chain the prick-punch marks are compared with the gage. If it is found that a section of the chain between two of the marks has stretched by an amount equal to one-third of the length of a link, the chain is considered unsafe and is condemned, or is used in some place where it will be subjected only to light loads. It is sometimes found that only a single section of the chain must be discarded. The experience of users of chains who have adopted this method for testing them has been satisfactory, in the main, and accidents from breaking chains have been materially reduced by it. Manifestly, however, it would not apply without modification to chains having unusually large links.

Many authorities on chains, even though admitting that sling chains should be annealed, insist that block chains that pass over sheaves should not be treated in this way. The danger from molecular changes caused by overloading the chains may be greatly diminished by proper annealing, but when distortion of the links occurs in block chains the chains no longer fit the sheaves, and excessive wear results, often accompanied by severe and badly distributed stresses. No amount of annealing can restore the links to their original lengths, and the only practical remedy, when such distortion has occurred, is to substitute new chains.

Both the advocates and opponents of the annealing process realize and readily admit that the care of chains is exceedingly important, and all are striving to discover the most suitable and practical method for treating them. Comparative tests have been made of the breaking strength of annealed and unannealed chains that have been subjected to similar loads, but these tests have not been sufficiently numerous or exhaustive to be conclusive in either directly proving or disproving the value of the annealing process. It seems desirable that further tests of this kind be made, and that they be continued until a definite conclusion can be reached.

The practical immunity from chain accidents secured by the railroads and dock yards of Great Britain proves beyond doubt that the methods there employed are exceedingly valuable. Their chains must undergo severe proving and breaking tests, and they are also subject to frequent inspections, and are annealed by competent men who keep complete records of their work. The value of these precautionary measures is clearly shown by the experience of a certain firm which had had considerable trouble from chain accidents. They were persuaded to give their chains a thorough overhauling, and found that from 25 to 30 percent of them were defective. A general system of inspecting, testing and annealing was then instituted, with the result that no further accidents of this kind have occurred for more than two years.

The care of all the chains used about the plant should be assigned to some one competent, experienced and careful person, whose judgment should be depended upon, regarding the frequency with which the annealing should be done. He should have a general knowledge of all the work done in the plant that requires the use of chains, and all chain slings should be kept by him under lock and key when not in use, only those being given out that are suitable for the work in hand. He should see that the slings are returned to him as soon as the work is finished, and should keep a record showing how often each sling is used, and the kind of work for which it is employed.

Every chain sling should be inspected each time it is returned to its storage place, and all other chains should be inspected frequently and at regular intervals. Each chain should be marked or numbered in some way, so that it can be easily identified, and a record should be kept showing the date of each inspection and annealing, as well as the safe working load under which the chain may be used.—*The Travelers Standard.*

Belgium Agency for American Products and Manufactures

Several competent Belgium business men have created an organization having a double object: first, to introduce in Belgium as soon as the war is over all American products and manufactures, etc., and, second, to employ as agents, representatives, etc., a large number of Belgium manufacturers and business men who have been partly ruined by the war, but still possess enough capital and can give the necessary guarantees as agents, dealers, etc.

It is believed that after the war is over Belgium will offer a profitable selling field, because everything there must be rebuilt and re-established. In grouping the agencies of the most important American firms the strength of the whole organization will greatly diminish competition and assure to each house that it represents exceptional advantages. In order to avoid direct competition, the organization will accept the agency of only one firm for each article. The contract with each firm will be for two years or more if desired.

American manufacturers and business men interested in this organization should address their inquiries to Mr. Willy Lamot, Shardhighs, Halstead, Essex, England.

When ordering a T, give the sizes of the straight run first and then the side outlet. These are usually called "bull heads." To illustrate: 3½ x 4 x 2 means that one side of the run is for 3½-inch pipe, the outlet directly opposite is 4 inches and the side outlet is 2 inches.

Construction of 400-Foot Steel Stack*

Details of Design and Construction of Largest Self-Supporting Steel Stack in the World

BY L. W. BARKER†

The stack of the United Verde Copper Company at Clarkdale, Arizona, is the largest self-supporting steel stack in the world. It has an inside diameter of 30 feet and a total height of 400 feet.

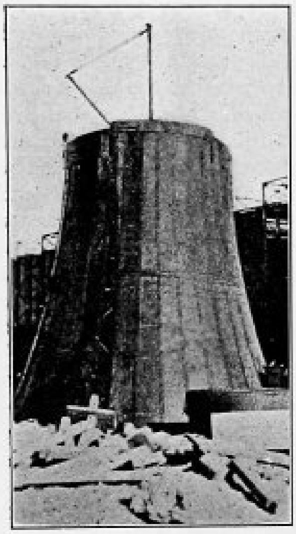


Fig. 1

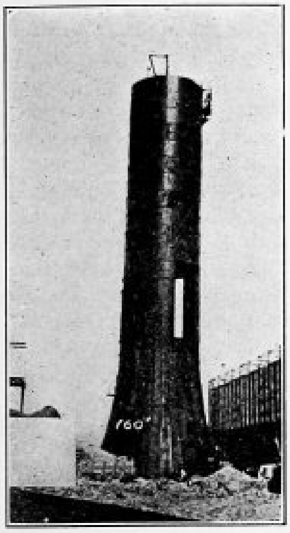


Fig. 2

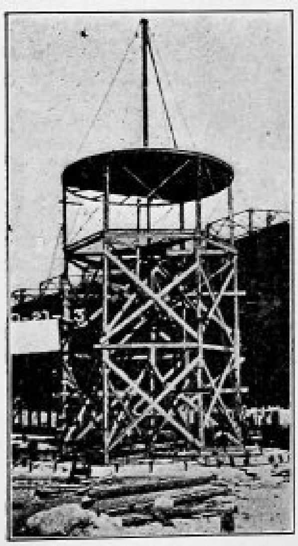


Fig. 3

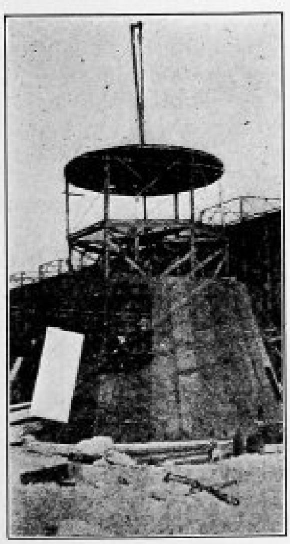


Fig. 4

The following assumptions were used in design: Assumed loads—wind, 50 pounds per square foot, or 25 pounds per square foot of projected diameter; Lining, 3,750 pounds per vertical foot of chimney; unit stresses in steel, tension 16,000 pounds per square inch of net section; compression, 10,000 pounds per square inch of gross section; shop rivets, shear 10,000 pounds per square inch; bearing, 20,000 pounds per square inch; field rivets—shear, 8,000 pounds per square inch; bearing 16,000 pounds per square inch.

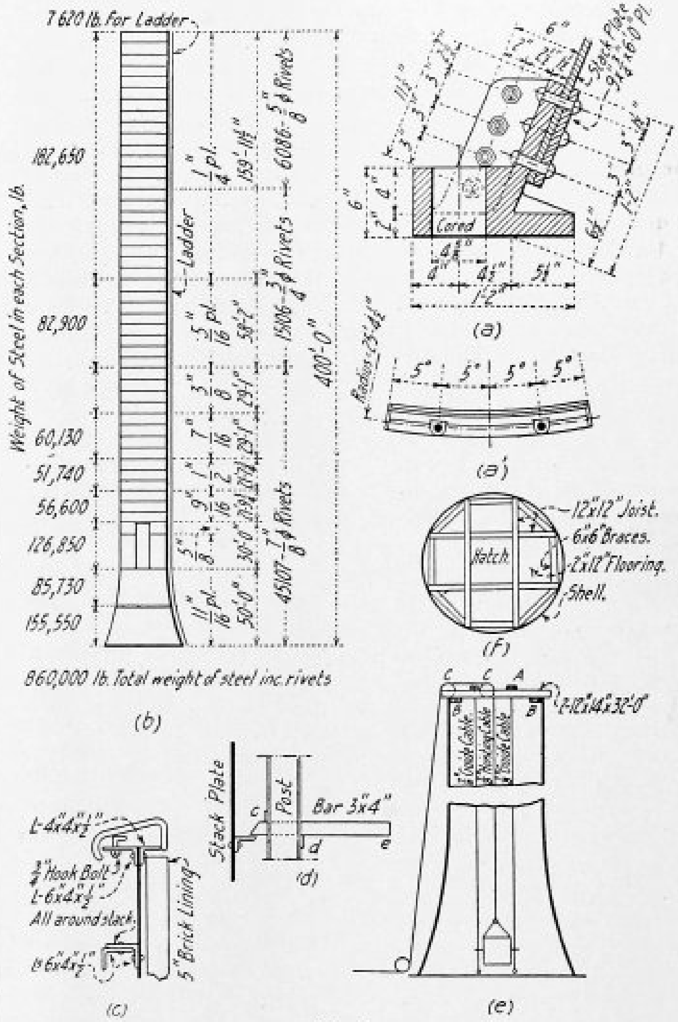


Fig. 5

The shell of the stack is cylindrical in shape, with the exception of the lower 50 feet, which is belled out to form the base, as shown in Fig. 2. There are three flue openings coming in at the same level, necessitating radical strengthening features in the base and a three-way deflection partition to prevent back pressure in the different flues.

The foundation is of concrete and octagonal in form. It is 15 feet deep and 58 feet wide, measuring from opposite faces. This concrete was made of a 1:2½:5 mix, containing large stones thickly distributed throughout, in addition to a grillwork of heavy rails, set at right angles to each other in about the center of the mass. Three large truck loads of scrap iron were also included. The sand and gravel were thoroughly washed and graded and were carefully mixed with the cement in a Milwaukee,

* From the University of Colorado *Journal of Engineering*, May, 1915.
† Contractor, Barker Construction Company, Clarkdale, Arizona.

½-yard mixer. The mixer was set up at one side and had a movable spout capable of reaching over the entire foundation. The concrete was put on in thin layers and thoroughly tamped and spaded before more was added. Thirty-six anchor bolts, spaced 10 degrees apart on a 25-foot, 4½-inch radius, were set in the concrete at a depth of about 6 feet, leaving about 18 inches exposed.

The bell is composed of two rows of 11/16-inch plates riveted vertically, butt jointed both vertically and horizontally, each plate being 25 feet long by 53 inches wide. This gives 36 plates in each row. The butt plates are 7 inches by ⅜ inch, with a single row of ⅞-inch rivets in each plate. The bottom edge of the lower row of plates is riveted to a cast iron base flange (Fig. 5a), and a splice plate which is symmetrical about the joints of the cast iron segments. The splice plates are 9 inches by ¾ inch by 6 feet long. The length of the flanges is twice the width of the plates. They are bolted together, end to end, with four 1-inch machine bolts, as shown in Fig. 5a. In addition, each flange is bolted to the concrete foundation by means of two anchor bolts, spaced 5 degrees from the end of each flange. This spacing gives thirty-six anchor bolts in the entire job. The anchor bolts, 4 inches in diameter, are upset to give 18 inches of 4¼-inch thread, and a standard square head on the lower end. There are two rows of ⅞-inch staggered rivets spaced two inches, binding the stack plate to the flange and splice plate.

The strengthening around the opening consists of a combination of plates, angles and channels to give in effect a plate girder across the top and bottom and a column down each side. By this method the stress in the plates above the opening is transferred down through the columns and back through the plate girder to the plates below the opening.

From the top of the openings to the top of the stack the construction consists of one ring on top of another, butt jointed, with size of plates, rivets and weights, as shown in Fig. 5b. At every other joint on the inside there is a 4-inch by 3-inch angle riveted to the shell to support the lining. The ornamental top consists of a series of cast iron segments set on two angles, riveted to the top, as shown in Fig. 5c. These segments are held in place by ¾-inch hook bolts.

The lining of the stack is made of brick set in a cement clay mortar, having a mixture of one sack of Portland cement to four barrows of brick clay, similar to that from which the brick were originally made. Each barrow was carefully filled and scraped off to give as nearly a homogeneous mixture as possible. The efficiency of this mortar was later tested, when it was found necessary to remove some of the brickwork, in order to use the air guns in riveting the baffle walls to the shell. It was impossible to break the brickwork from the mortar, the cleavage plane running irregularly through the brick and the mortar.

The lining in the bell has 9 inches of brickwork, with 1 inch of mortar between the brick and the steel plates. The inch of mortar was simply to keep the brick clear of the rivet heads, thus avoiding irregularities in the brickwork. The original design called for a 5-inch lining in the base, but it was found upon construction that the large diameter—50 feet—made it necessary to have at least two brick bonded together, in order to stand at the angle required by the slope of the base. This double thickness was carried up only to that point where a constant diameter was obtained. From this point on only 4 inches of brickwork was used, being supported every 15 feet by a 4-inch by 3-inch angle riveted to the shell. These angles transferred the stress, due to the weight of the brickwork, to the shell.

In order to start the steel work of the bell it was first necessary to build a hexagonal false work, conforming to the lines of the concrete foundation, as shown in Fig. 3. The posts were 4-inch by 6-inch timbers, with 2-inch by 12-inch cross braces and ledgers. On top of this false work, which was 40 feet high, was the working platform, supporting the platform for handling the sheets. The platform was used throughout the construction of the shell and was built of six posts, each composed of two 6-inch channels 10 feet long, placed back to back and separated by 3-inch fillers (Fig. 3). Fastened to the top of these posts were curved 6-inch channels, forming the circumference of the floor supporting members. The floor supports, formed of fifteen sets of two 4-inch channels back to back, radiated from the center plate to this system of curved channels. The bottoms of the posts were connected by 5-inch channels, which were also attached to the center plate by 2-inch by ½-inch flat bars. The top and bottom center plates were connected by a 6-inch pipe, attached by means of pipe flanges bolted to the plates, and through which ran the cable used for power on the derrick. The cross bracing was formed of 1-inch round bars, on each post, at both points *A* and *B* (Fig. 5d), set 4 inches apart vertically, leaving room to slip in the bar *E*, as shown. These trip bars held the platform in a manner explained later and were so placed that the center of gravity came on the inside of the post, thus preventing the bars from falling.

There were two cages, similar to the one shown in Fig. 4, handled from the derrick, as shown in the photographs, and two large hooks at the top of each cage, by which they could be hung to the plates while the plates were being riveted.

When the bell was completed the rigging was moved upward with the addition of each new ring. These rings were about 7 feet 6 inches in height, and on every other joint there was riveted a 4-inch by 3-inch angle, to support the lining as described before. After one ring had been added to the bell shown in Fig. 1, one of these angles was riveted to the bottom of the plate. Six 3-ton chain blocks were then hooked to the platform, and the top edge of the shell and the platform was thus drawn up until the trip bars at *A* (Fig. 3) were resting on the topside of the angle. This held the platform so that the chain blocks could be removed, but after the riveting was completed the blocks were again hooked to the top of the plates and the platform drawn up until the trip bars at *B* rested on the supporting angle. A new ring was then added and the above process repeated until the top was reached. The working cages were also used to raise and lower the men, as shown on Fig. 4.

The first 5 feet of brickwork was laid from the concrete, but from there on it was necessary to use a hoisting rig and platform, constructed of two 12-inch by 14-inch sticks of Oregon pine, 32 feet long, placed across the top of the stack and anchored there by blocks *BB* (Fig. 5e), which were firmly bolted to the main timbers *A*. Two 18-inch steel sheaves, *CC*, were placed between and on top of the timbers and served as a guide for the hoisting cable. This cage was boarded up on three sides and covered, to prevent accident from falling debris.

The platform consisted of four main timbers, 12 inches by 12 inches (Fig. 5f), placed as shown and lapped to give a plane surface. These were connected at the ends by 4-inch by 6-inch struts, to give additional support to the 2-inch floor planking. As the supporting angles were about 15 feet apart, and the chain blocks had a run of only 10 feet, it was necessary to use solid rods, 8 feet long and made of 1 inch iron, turned on each end to form a hook, to reach from the ends of the chains to the holes in the angles. The operation of this platform, although seemingly awkward, was in fact exceedingly simple and efficient. Starting at the bottom of one of 15-foot blocks of brick with the platform hanging from the rods and blocks, about 4 feet of brick was laid, bringing the wall up as high as could be conveniently worked. Then the bricklayers and helpers each took a block and pulled the platform up to within six inches of the top of the wall, which took on an average about one minute. This was continued until the platform was within 10 feet of the supporting angle, when one by one the blocks were loosened, the rods removed, and the blocks replaced, directly connected to both angle and platform. One man was able to make this change without interfering in any way with the bricklayers or tenders. When the blocks had been pulled up together, the reverse operation was carried out and the rods replaced. On the last raise special hooks were used to fit over the cast iron ornament at the top.

When the lining had been completed it was necessary to remove the rigging. As the angle irons were covered up, the method used for raising could not be used in coming down, and it was necessary to devise a new scheme. Upon calculation it was found that the staging, exclusive of all loose material, weighed approximately 6 tons. The timbers at the top were good, theoretically, for only 4 tons, concentrated at the center, so it was necessary to strip the platform of all but the main timbers. This brought the weight down to about 2 tons and the platform was lowered as far as the flue openings, where it was anchored by hooks and chain blocks to the edges of the openings, and the construction of the baffle walls was concluded.

The final part of the work consisted of removing the two beams at the top, but as they weighed about 2 tons it was not advisable to drop them. The ladder up the outside of the stack was on the opposite side from the engine, and the two timbers were in approximately the same plane. One block was rigged solidly to the top of the ladder and another between the timbers on the opposite side, and the main hoisting cable was then run through the block on the ladder and back to the timber, to a point just short of center, where it was attached. A snub line was run through the block on the opposite side from the ladder, with one end attached to the front end of the timber and the other back to the ladder, where a man was stationed to handle the line. As a strain was taken on the hoisting cable the timbers moved away from the engine until the front end was clear of the stack wall. The snubbing line was then slowly loosened until the timbers hung vertically down the inside of the stack. It was then a simple matter to lower them to the bottom, where they were taken out through the cleanout door. The whole operation took but three hours. The small blocks and tackle were then lowered by a tag line and the hoisting cable was allowed to drop over the side, leaving the stack clear of all construction material.

Building Boilers—and Reputations

The Part Played by Men and Machines —Where the Responsibilities Lie

BY JAMES FRANCIS

You can build good boilers and good reputations, or bad boilers and poor reputations, but you can't build poor boilers and good reputations. Neither can you build good boilers and poor reputations, for nobody will believe it if you try! Building good boilers means obtaining good material and putting it together correctly with good workmanship. Building good reputations is done when you build good boilers and deliver them on time at an honest price according to agreement. Building bad reputations is done when you build bad boilers by using poor material, poor work and failing to keep agreements or to live up to the spirit as well as to the letter.

Good boilers and reputations—and bad ones as well—begin with the designer and extend right down to the rivet boy and the dolly-bar engineer. The layerout, the planer men, punch operators and every man Jack in the shop all have a say and a go at the boilers and the reputations which pass through their hands.

The designer slips a decimal point or the layerout slips one leg of his dividers while spacing a sheet, and slip goes a good boiler and a dent in our reputations as well. The purchasing agent, when he buys material for our shop boilers is buying our reputations also, and every time he runs in sheets which have the "jinx" mark on them for quality, he is putting the "kibosh" on a little bit of the shop reputation at the same time.

Likewise, when the buyer procures first-class material or gets hold of some just a little better than is actually necessary, then he is putting a belt of good, strong armor plate around our good ship just at the waterline, where it will do the most good.

When Sam lays out the sheets and measures and spaces so accurately that no reaming or crowding of holes is necessary, then he is putting clean rivet holes in the shop character as well as in the boiler plates. Henry, with his edge planer, sets the calking edges at just the right angle to make good seams in boiler and reputation or bad ones which leak steam, water, credit and good will.

The big pneumatic riveter and the rivet boy are both out ready to build good, tight boilers and solid character or to make scamp shells and shady reputations. All through the shop, each man and machine has the capacity to do good work or poor, to build good or bad reputations and characters, and now how are we to keep all of them going upon the side of good? Who is to say and see that the good is done and the bad avoided and let severely alone from superintendent to water-boy?

The answer may require a bit of thinking to bring it properly to mind, but it is a mighty short answer and one of immense strength. The answer is—*everybody!* Yes, everybody from the manager down must be working for the good of the shop and of the shop's reputation. Each man or machine which does not work for or in the best interests of the shop at all times, is working for evil and against the reputation of the shop.

It is vitally necessary that the management be upon the side of honesty and good work, for if they are scamps the shop will be a scamp shop from top to bottom, no matter how good the individual workers may be. And, if the head be always in favor of good work, he is badly handicapped and often defeated by the scamping of those under his authority.

It is not to be even imagined or thought for a single minute that there are boiler shops which will purposely turn out dishonest or unsafe work; but there are shops which turn out better work than other shops and it is due to the things noted above that the better work is done in some shops, while not as good an output comes from other boiler shops. If you are making the best boilers in the world in your shop, then other shops, while making very good boilers, are not making quite as good ones as you are turning out. That is the way in which these remarks are to be taken, not that some shops are doing scamp work days and dodging detectives of nights!

To make the best boilers in the world, what shall we do and how shall we do it? What share shall be the part of each man and each machine in the shop from general manager to gateman? First, it shall be the work of the manager to see that his salesmen and representatives take orders only for the best class of work. They should be instructed to leave the cheap, inferior class and cater only to demands for the best, first class kind of work.

And then the manager should see to it that his superintendent and the lesser officials are in line with the same "best ever" policy and that they will keep up the slogan of "best only" all through their several shop or office departments. The manager will select for his staff those men who can obtain and hold good workmen and who can inspire the workmen to give the best there is in them—to do their best work for the interests and honor of the shop, and use their influence upon their shopmates to do the same.

"Knockers" Not Tolerated

The superintendent must select a force of workmen who will become parts of a great big machine and who will do "team work." They must work together to help build the best boilers and the best shop reputation. There is no room for any "knockers" in the boiler shop outside of the riveters, and it has been found that squeezing is even better than knocking for riveting or for anything else.

The shop foreman receives the stock and the order for the new boiler and it is up to him to take his men and that material and do the best possible with both. And it is his further duty to see that the purchasing agent has not been imposed upon or mistaken in his selection of material. He shall act as a checker upon all that has been done in the matter before it reaches his hands. He shall look closely to the plans and check them thoroughly; for we are all liable to error, and the shop draftsmen and designers are no exception to this rule.

All this checking and overlooking previous work shall be done, not for the sake of finding fault or for detecting and proving some one to be in error so we can "knock" him, but for the good of the job and the shop name. Should an error exist, and the superintendent or anybody else finds that error before it has caused damage, then there is cause for good feeling all around, instead of ill-tempered remarks to the man who made the error. The finding of an error in time should be the cause of rejoicing by the men who made and found the mistake, and, in fact, by the whole shop force.

Not long ago I happened in a shop where big work was being carried on and chanced to overhear something of this kind. The foremen called the designer, who chanced to be passing, and called his attention to an error in the drawings which might have caused a good bit of loss in material had it gotten into the shop. The two men shook hands and the foreman said: "Glad I found that 'bug' for you, Mr. Evans—mighty glad to be able to do that much for the good."

"Mighty glad you found it before the boiler makers did," replied the designer, "and the cigar is yours, John. It's worth a good many cigars to find mistakes before they do damage, and the joy of detecting an error without cost to the shop covers entirely the sting of making a mistake, for there is no man on earth who does not make mistakes, if he makes anything. It is a part of the human make-up and the man who never makes mistakes is not able to make anything, or he is fit to be either 'pushing clouds' above or 'wheeling brimstone' below. He is out of place on this earth and the sooner he is transplanted the better for those left behind!"

Shop Spirit

This little example well illustrates the shop spirit which builds best boilers and reputations. How different the spirit which, I am sorry to say, I have sometimes found in other shops where, when an error is found, the finder pats himself on the back and goes to his cronies and says: "I just put it all over the head draftsman to-day, Bill. Found a big blunder in his drawings! Oh, I tell you, Bill, these dude draftsmen are not so much, after all. They can make nice pictures, but they couldn't make a boiler to save their necks. It takes us boiler makers, Bill, old boy, to make the good boilers and show dude draftsmen their mistakes!"

The less of this business in the shop the better, and when the foreman, superintendent or manager finds it sprouting out in any part of the shop, then he should apply the pruning knife at once and lop off the "sucker" which is doing the damage, just as the farmer lops off the "suckers" which spring out upon the bodies of his fruit trees. These two kinds of "suckers" are both bad in their way and must be cut off promptly and entirely. They must not be tolerated on tree or in shop, for only evil in either shop or tree can ever result from their presence. Apply the pruning knife promptly in either case, no matter how promising the growth may look in other respects. Cut it off at once, for it is only a "sucker," after all, extracting the life blood from tree or shop and giving nothing in return but trouble. Remove them at once and there is even a better way than to cut suckers off. Just tear 'em out bodily by the roots. That's the way the farmer often does, and a "sucker" once removed in that manner never grows again. It is dead for all time in either tree or shop.

You can't get from any shop the kind of boilers and reputation which we have been considering, unless there is a "shop spirit" similar to that of a college, an advanced school or some military organizations. The fraternal orders are built and exist entirely with this spirit, "For the good of the order," and unless we can get it started and rooted in the shop, there will be no possibility of ever working up the ideal shop noted above. But once get such a spirit—such a feeling—started, then foster it by all means and it will live, thrive and give the confidence in and love of the shop which causes each and every man to do his best and remain loyal to the shop at any sacrifice.

Loyalty

Each and every man who comes to work in your shop has this feeling of loyalty when he comes in. He has a desire to be and do something which will be worth while and which will make the shop a place for him to live in and love and develop his best work and feelings. But how long does this feeling last in the majority of shops? How long is it before each man has had all that feeling of uplift ruthlessly trampled under foot and knocked out of him?

I am sorry to say that in most shops the feeling is a

very short-lived one and is ruthlessly broken down the very first time the new man comes up against the management or the "system" upon which the shop is run. Cold water, figuratively speaking, is thrown upon the man at his very first encounter with those who should do all they can to encourage and foster the feeling in question.

The man feels the rebuff keenly. He is grieved and abashed and his confidence in the company receives a rude shock right then and there, and it is often broken entirely by the reception of his enthusiasm and his ideas, or, if not destroyed outright, the feeling is so dwarfed, subdued and overshadowed that it seldom manifests itself again and the man soon reaches that state of feeling where he says: "To hell with the company. All they will do for me is to pay as small wages as they can. They won't do anything for me or let me do anything for them, so what's the use of trying to look after anything more than four o'clock and pay day?"

I have seen many an instance where loyalty was stamped out of a man, instantly and for all time, by a reception of some idea by foreman, superintendent or manager—perhaps some trivial matter or suggestion of little or any value, but which was evidence of the man's loyalty and that he wanted to serve the company to the best of his ability and to do all he could for it and for its success.

In cases of this kind, the foreman or superintendent make a grievous mistake when they turn down the man with his idea without giving it a trial and convincing him that it is of no value. In order to establish and maintain the "esprit de corps"—shop spirit—the foreman should have spent a little time with the man and led him to demonstrate for himself that the idea was worthless. It will pay the shop large returns to spend a little time in this manner, for by so doing the loyalty of a workman is secured and cinched for all time and that workman will thenceforth be more eager to bring something else of value to the company's notice. His failure with the first application has put him on his mettle, so to speak, and he wants to do something worth while to make up for the thing he was mistaken in before. And he will do it every time if his first effort is received in the spirit in which it was offered.

And, on the other hand, the workman, when offering his suggestion, should not be too thin-skinned. He should not take it to heart too much when his effort is turned down. He does not know one-half the worries and nerve-racking things the officers and foremen have to contend with. He does not know that while he is bringing his ten-cent proposition to the attention of the superintendent, that he is keeping that official from a study of a $1,000 proposition which he hopes to close next day, and had he, the workman, had as much on his mind at the time as the superintendent did, the workman would have been simply wild and would have shouted that he had no time to bother with such things!

The officers of a company and their executives should at all times, or at certain fixed times, hold themselves open to meet the workmen to receive these offers of good will and earnest endeavor to help the company, for in many instances it pays even better than getting a contract for a $1,000 boiler plant. It keeps up the shop spirit, that intangible thing without which we cannot do the best work, make the best boilers or make and hold the best reputation.

Here and there in any shop is found a man or two who is all the time looking eternally after the interests of the company—who will never let a piece of work go through his hands until he knows beyond doubt that said work has been done properly and is in the best condition possible. Such a man is on the job early and late. He doesn't know there is a clock in the factory. All he knows is that there is work here to be done and that it is up to him to see that it is done right. This is the spirit we should one and all work to foster—that we should do ourselves and help others to do. Then, and not until then, shall we have a shop which makes the best boilers and has the best reputation.

Sensible Scientific Management

Very often, in talking to manufacturers, we hear the expression, "Scientific management is mostly *poppy cock.*" They seem to think that it is "high brow stuff." But when you come right down to it, and think it over carefully, you will come to the conclusion that scientific management is about 100 percent common sense. Perhaps you have come to that conclusion already.

How many readers of THE BOILER MAKER believe it to be just plain applied common sense? I am convinced that a great many do—perhaps all. I proved it to my own satisfaction by looking through that section through which all wide-awake boiler makers should always look—the advertising section. In that section I found page after page of forceful up-to-date matter addressed to boiler manufacturers and users of boiler tools, which in many instances deal with problems allied very closely to scientific management. How to do things quickly, how to do them safely, how to do them at least expense, how to make them best—all of those phases of work are correlated to scientific management.

There is nothing new about seeking higher efficiencies. That has been preached into all of us from childhood up. But it remained for Fred W. Taylor to show the world how important the "small" things are in scientific management. By making a thorough motion, speed, height, distance, depth, cause and effect study of every engineering problem, all economic slack may eventually be taken up. Surely Mr. Taylor was highly gratified in noting the new impetus he has given to improvement in almost every phase of the industrial world.

I could easily go through the various advertisements from front cover to back cover and point out the earmarks of scientific management in each, but that would make a long, drawn-out article; and, besides, this is not an article on advertising. I merely want to prove, with advertisements as a basis, that most readers of THE BOILER MAKER are scientific managers, to some extent at least. And what is more, they may be unconscious of the fact. Each advertiser makes an exhaustive, scientific study of its own field. It tells the results of its studies in THE BOILER MAKER to prospective customers. The customer reads, buys, follows advice, and thus unconsciously becomes a scientific management disciple. Such a method is certainly the natural, logical, common-sense method.

Also, to be most efficient a contribution like this should be as short and concise as possible. I must not waste words; you cannot afford to spend your time reading worthless stuff. I think I have made my point clear. These advertisements are real, not imaginary. They are typical in representing the spirit of present progress. If there were no demand among readers of THE BOILER MAKER for machines that fulfil the theory of scientific management these advertisements would not be written as they are. Everybody is gradually swinging into line with the beliefs of common-sense scientific management. The class that once shouted "poppy-cock" is practically extinct.

New York. N. G. NEAR.

The Boiler Maker

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We have an average of 2.31 paid subscribers per boiler shop (railway, contract and marine) in North America.

Our subscription books are always open for inspection.

5,000 copies of this issue were printed.

NOTICE TO ADVERTISERS

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

In accordance with the Act of Congress passed last March, extending the authority of the Inter-State Commerce Commission over the inspection and testing of the entire steam locomotive and tender instead of the boiler only, the railroads through a sub-committee of the American Railway Association on relations between railway legislation and operation compiled a tentative draft of rules governing this work, and at the same time the Division of Locomotive Boiler Inspection of the Inter-State Commerce Commission formulated rules and regulations for the same purpose. To bring these two sets of rules into agreement a conference was held in Washington on August 23, attended by representatives of these two bodies. In all sixty-one rules were considered, and all but three were finally drafted in such form that they were accepted by the representatives of the railways, subject to the approval of the railways themselves. These rules, together with substitute rules for the three objected to by the representatives of the railways, will be submitted to the Inter-State Commerce Commission by the Division of Locomotive Boiler Inspection for adoption in accordance with the Act which went into effect on September 4.

The rules as printed in a fifteen-page pamphlet cover ash pans, brake and signal equipment, cabs, warning signals and sanders, draw gear and draft gear, driving gear, lights, running gear, tenders and throttle and reversing gear. The three rules objected to by the railways related to the arrangement and equipment of bells and headlights on locomotives.

One rule of interest to boiler makers provides that locomotives built subsequent to January 1, 1916, shall have the ash pans supported from the mud rings or the frames. Locomotives built prior to January 1, 1916, which do not have the ash pans supported from mud rings or frames, shall be changed when the locomotive receives a new firebox. No part of the ash pan shall be less than 2½ inches above the rail. Each locomotive and tender shall be inspected after each trip, or day's work, and the defects found reported on an approved form to the proper representative of the company. In these reports particular attention is paid to the condition of injectors, water glasses, gage cocks, safety valves and the pressure of main reservoirs and brake pipes.

To fulfil the requirements of these rules it is evident that the work of the Federal Inspection Department will be enormously increased, for monthly reports for each locomotive must be filed with the United States Inspector, and once each year a report of the tests required showing the general condition of the locomotive must also be filed with the inspector. This extension of authority on the part of the Federal Inspection Service, however, should not lead to the subordination of the qualifications of a Federal locomotive boiler inspector. The work of boiler inspection should be, first and last, entrusted only to experienced boiler makers.

In discussing at the spring meeting of the American Society of Mechanical Engineers the paper on "The Use of Corrugated Furnaces for Vertical Fire Tube Boilers," which was printed in our last issue, it was pointed out that the greatest trouble experienced with vertical fire tube boilers is tube leakage at the crown sheet, and the question was raised as to whether a flexible furnace will tend to increase or diminish tube leakage. It was stated by Mr. W. F. MacGregor that an attempt was made in the early Manning boilers to provide for the differential expansion between the tubes and shell by connecting the barrel of the boiler to the outer furnace sheet with an ogee ring, but this was found to be impracticable.

It is conceded that experience alone will settle this question, and if any of our readers have had experience with this or a similar construction it would be of great benefit to boiler manufacturers and users to have this brought out and the subject thoroughly discussed. The question of the effect of flexibility in the furnace on tube leakage applies with even more force to locomotive boilers. We know that differential expansion in the firebox of a locomotive boiler begins immediately after the fire is lighted and continues with varying intensity until the fire is dead and the boiler cold. We urge our readers to discuss this important subject thoroughly.

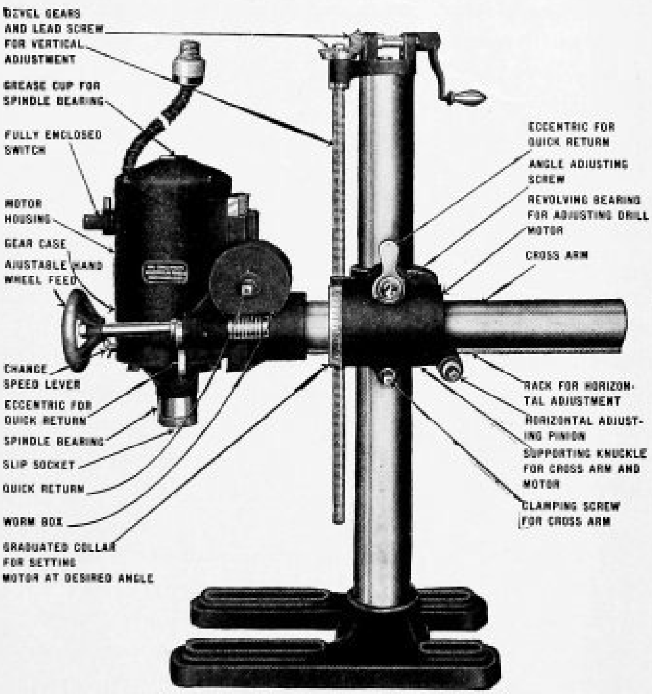
Engineering Specialties for Boiler Making

New Tools and Appliances for the Boiler Shop and Improved Fittings for Boilers

Cincinnati Portable Scotch Radial Drill

A handy tool which is in general use in machine shops, construction work, navy yards, arsenals and on board naval vessels is manufactured by the Cincinnati Electrical Tool Company, Cincinnati, Ohio, known as the "Cincinnati" improved type portable electrical Scotch radial drill. Driving power is obtained from an ordinary lamp socket, so the tool can be used wherever electric power is available.

The motor drill and the knuckle have a vertical adjustment on the upright column by means of a worm and



Cincinnati Portable Radial Drill

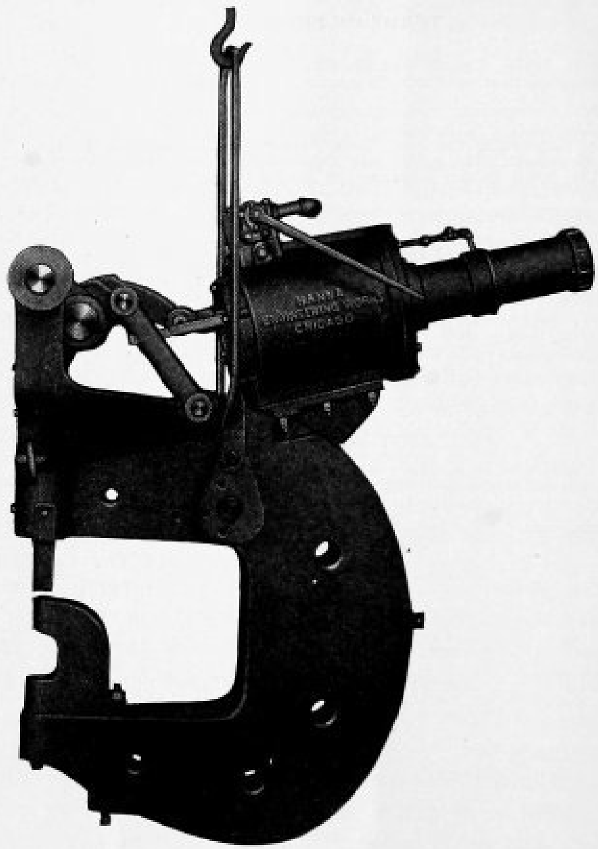
worm wheel through a 34-inch lead screw and a horizontal adjustment by means of a rack on the cross arm and pinion in the knuckle. The revolving bearing in the knuckle which supports the cross arm has a graduated collar, so that the operator can set the drill at any desired angle. This is done by means of the worm and worm wheel in the knuckle, which also prevents the motor from turning or dropping while adjusting it.

The motor is of a heavy duty type, air cooled, fully enclosed and dirt and dust proof. It can be set at any angle and has a circle radius of 24 inches. It has a 10-inch feed through a hand wheel with quick return. The hand wheel and worm box are adjustable to drill in either a horizontal or vertical position, allowing the operator to get into close corners. All adjustments it is claimed, are positive and under immediate control. The motor is equipped with a special type slip socket, doing away with the drift key and drift holes in the spindle and spindle bearing, preventing dirt and borings getting into them.

This drill is made in three sizes, 1¼, 2 and 2½-inch capacities, with single and two speeds.

Hanna Combination Yoke Riveter and Punch

The Hanna Engineering Works, 2059 Elston Avenue, Chicago, Ill., has recently placed upon the market the combination yoke riveter and punch illustrated. As a riveter this machine is well known and is being extensively used in the fabrication of steel throughout the country. A description of a 100-ton riveter of this type appeared in the May issue of INTERNATIONAL MARINE ENGINEERING. The machine illustrated is arranged with special die and anvil for punching flanges of 6-inch to 10-inch channels. An auxiliary dash-pot mechanism automatically absorbs all



Hanna Yoke Riveter and Punch

shock after the die has passed through the plate. For punching bent ship channels, it is claimed, the machine will effect considerable savings in time and labor over the usual method of routing this work through the shop.

The punch or rivet die in this machine is operated through the combined toggle and simple lever motion which is characteristic of all Hanna pneumatic riveters.

New Type Navy Boiler

The eight boilers recently purchased by the Navy Department under Navy Schedule 7865, class 141, have been delivered by Charles L. Seabury & Company, of Morris Heights, New York City, after passing every test. Four

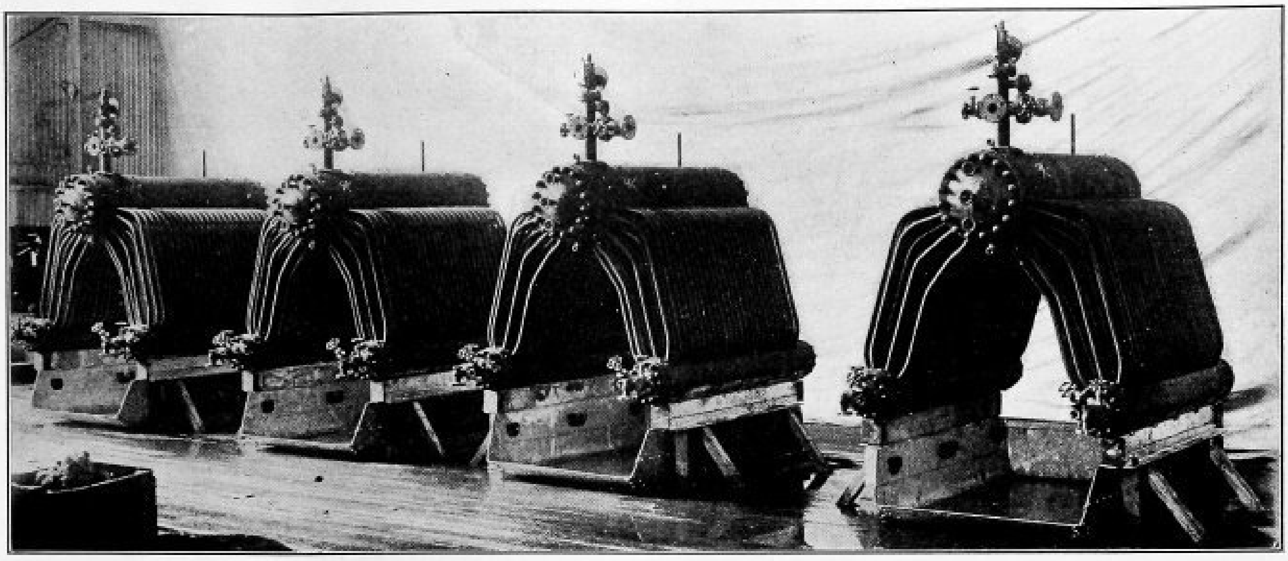


Fig. 1.—New Type Navy Boilers, Built by Charles L. Seabury & Company, Morris Heights, New York

of these boilers are illustrated in Figs. 1 and 2. They are of the "Seabury" safety watertube type, designed to operate under 165 pounds steam pressure, though a hydrostatic pressure of 500 pounds was successfully applied. The dimensions are as follows:

Length of casing, 4 feet 3½ inches; width, 4 feet 4 inches; height, including ash pan, 5 feet 6½ inches; grate surface, 12.5 square feet, and heating surface, 240 square feet. The upper or steam drums were of 15 inches outside diameter, lap-welded steel plate ½ inch thick, and the lower or mud drums were of the same material, 8⅝ inches outside diameter, and 5/16 inch thick. The generating tubes were of 1 inch O. D., No. 12 B. W. G. of seamless drawn steel cold bent to shape.

The boilers were fitted with flanges, in accordance with the Bureau of Steam Engineering Standard Flange List No. 8-A, and complete with fittings and casing, weighed each, dry, 3,800 pounds.

Canadian Company Secures Order for Locomotives.—The Canadian Locomotive Company, Kingston, Ont., has secured an order from the Russian Government for fifty locomotives, which will keep the works employed for about three months.

Welding Defective Cores in a Paper Mill

The St. Croix Paper Company, of Woodland, Me., was formerly throwing all broken and defective paper cores on the scrap pile. Much of this material was sold as junk at the best prevailing market prices. Many carloads of broken and defective cores had been disposed of in this manner before it was discovered that all of them could have been made as good as new by employing oxy-acetylene welding.

By using the Prest-O-Lite process of oxy-acetylene welding, broken cores are now repaired in nine minutes. No filling material is used, as a method has been found for handling the welding operation so that sufficient strength can be obtained with the material flowed into the weld from the pipe itself. Occasionally, however, a small quantity of filler has to be added to insure a joint that will will be as strong as the rest of the core itself.

The two sections of pipe are prepared by simply cutting

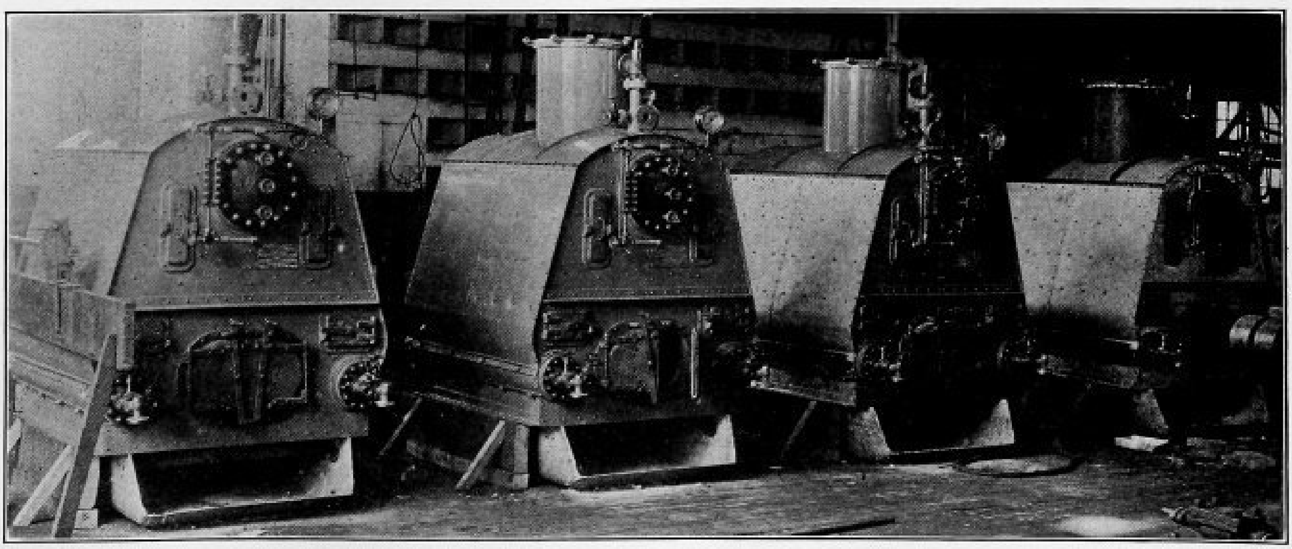


Fig. 2.—Four of New Type Navy Boilers Complete, With Casings and Fittings

off in a machine with the regular cutting-off tool. The ends of the pipe are not beveled, as the extra metal is needed where filling rod is not added.

The cores are steel tubes 3 inches in diamter and average about 50 inches in length. During the welding operation they are slipped over an iron arbor of the same diameter as the shaft on which the roll is designed to run, to insure perfect alignment with the longitudinal center.

As these cores accumulate very rapidly in the enormous production of the St. Croix Paper Company, it is stated that enough material, heretofore scrapped, is now on hand to furnish several years' supply of new cores without making it necessary to draw on any new material at all.

Tests of welded paper cores indicate that the reclamation process does not affect the original strength in the least—the welded portions stand the punishment incident to rough handling during continual shipping, although frequently the original metal in the tube is broken.

Former methods of repairing these damaged cores were very unsatisfactory. One method was to make a hammered weld in a blacksmith forge, first preparing the ends of the rolls by beveling one piece on the inside and the other on the outside so that they fit together snugly, making what was practically a lapweld. This method necessitated the workman continually standing over a very hot fire, resulting in some cases in the loss of the services of good workmen, because they were required to do that kind of work. It is estimated that 250 pounds of coal were used daily in maintaining the fire for the blacksmith's welding operation, and only a small number of cores could be repaired in a day as compared with the more economical method of welding by the oxy-acelylene process.

In view of the low cost of the oxy-acetylene welding equipment required, and the greater speed with which the repair of broken cores is accomplished, the saving effected by the St. Croix Paper Company is considerable.

Shell Nosing and Banding Hydraulic Presses

For finishing steel shells after they have been forged and drawn into shape, two hydraulic pressing operations are necessary; that of nosing the shells and then pressing or shrinking the copper band around them. The Hydraulic Press Manufacturing Company, Mount Gilead, Ohio, is building a number of hydraulic presses for both of these operations, as well as for the forging and drawing operation, for both United States and Canadian manufacturers who are engaged in the production of steel shells.

Fig. 1 illustrates an upward pressure type of press which is used for nosing or pointing the shell after it has been formed from the solid steel billet, drawn into shape and later machined. The end of the shell is heated and set in a centering die on the platen of the press. A die having a conical shape to correspond to the nose of the finished shell is attached to the head of the press. The shell is then forced into this die and the edges turned in. A two-arm revolving loading attachment works upon one strain rod. This revolving attachment has a capacity for receiving two shells, one on each end, thus enabling the operator to have a shell in constant waiting to undergo the nosing operation.

The nosing press is capable of exerting a maximum pressure of 150 tons. The press is solidly built, steel being used throughout in its construction. The press is operated either direct from an independent pump or from an accumulator system.

After the shell has been pointed the next pressing operation is that of shrinking the copper band around the base of the shell. For this operation this company is building a 4-cylinder, horizontal press. Fig. 2 illustrates this press. The rams from the four cylinders press in from

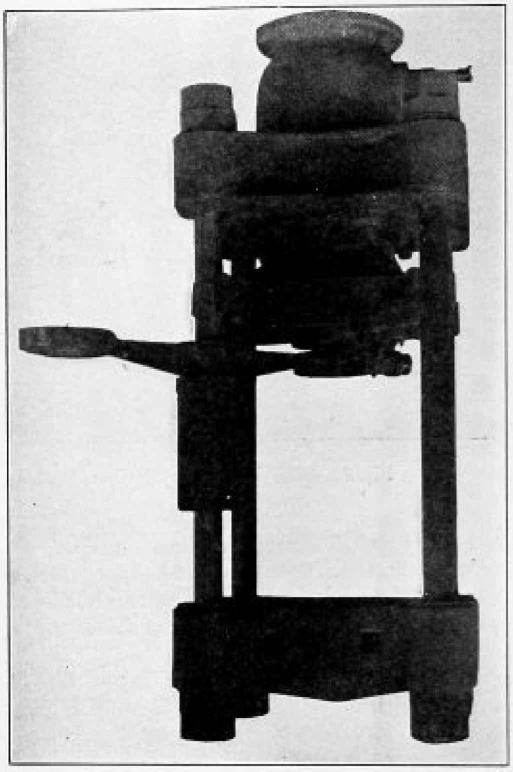


Fig. 1.—150-Ton Forming Press with Revolving Die Holder for Nosing Steel Shells

four directions, thus pressing on four sides of the band at once.

To properly secure the band at all points the shell is turned two or three times. From 20 to 75 tons pressure is necessary for this work. During the pressing operation the shell is supported in the center of the press by an adjustable table or stand from beneath the heads of the rams.

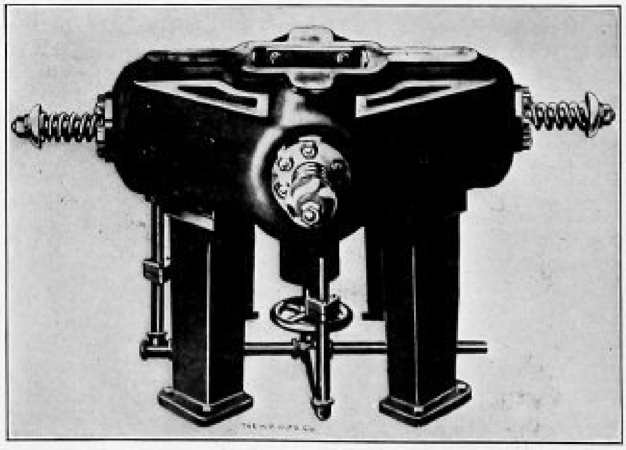


Fig. 2.—Four-Cylinder Horizontal Shell Banding Press

The maximum pressure capacity is 75 tons. The press is operated from either an independent pump or from an accumulator system.

Cutting Sheet Steel Piling

The Florida East Coast Railway Company is just completing the construction of a large drawbridge which spans the St. John's River at Jacksonville, Fla. Lackawanna sheet steel piling has been used in the construction of the protection piers. This piling is driven down in sections. Each sheet or section consists of a 3/8-inch web, being about 2¼ inches thick on the lock joint.

In all, approximately 860 feet of piling had to be cut off at a uniform height. An oxy-acetylene cutting blow-

Operator Cutting Sheet Steel Piling with Prest-O-Lite Outfit

pipe was used, employing Prest-O-Lite gas and compressed oxygen, both in portable cylinders.

On account of the peculiar construction of the lock joints the operator was handicapped in making speed, although the work was completed at an enormous saving over the old method of sawing through, which would have been an extremely slow and tedious operation.

At the lock joint practically four sections of metal had to be cut through, requiring frequent changes in the adjustment of the blow-pipe. Nevertheless, it is stated that between forty and fifty lineal feet of piling was cut in seven hours, one man handling the entire job. This is many times faster than the speed of the ordinary hacksaw, which on such a job would require the services of at least two men.

The cutting followed the pile drivers closely, so that virtually no time was lost.

When expanding flues, do not try to do the work too quickly; the metal must have time to flow in front of the rollers.

The taper of pipe threads is ¾ inch to the foot—that is, 3/8 inch each side of the central line. All pipe threads above 2 inches have 8 threads to the inch. One to 2-inch pipe threads have 11½ threads to the inch. Three-fourths and half-inch pipe threads have 14 threads to the inch, 3/8 and ¼ have 18 threads to the inch, and 1/8-inch pipe has 27 threads to the inch.

CURRENT NEWS ITEMS

Orders for Locomotives

The Erie Railroad has ordered five locomotives from the American Locomotive Company and the Atlantic Coast Line and the Nashville, Chattanooga & St. Louis, ten each from the Baldwin Locomotive Works.

The Pennsylvania Railroad has begun construction at its Altoona shops of the ninety-four locomotives called for in its 1915 program. Of these, twenty-six are to be freight and sixty-eight switching engines.

The Servian government is reported to have ordered fifteen Pacific type locomotives from the American Locomotive Company.

Large Boiler Contracts

The Standard Oil Company has recently placed with the Henry Vogt Machine Company, Louisville, Ky., an order for 10,000 horsepower in watertube boilers consisting of twelve 500 horsepower boilers for installation at Whiting, Ind., and eight 500 horsepower units for Wood River, Ill.

The boiler contract is the largest the company has ever received, and the company also has orders for two 200-ton refrigerating machines for installation at the Whiting plant as well as nine chilling machines, also an order for a 100-ton refrigerating machine from the Louisville Provision Company, now remodeling its plant, and for a 110-ton refrigerating machine from the Winter Garden Company, Pittsburgh, operating a permanent exposition building.

A New Welding Company

The Cave Welding & Manufacturing Company, a new Massachusetts corporation, has purchased the business of the Autogenous Welding Equipment, at times known as the Welding Company and the Cave Welding Company, Springfield, Mass.

The new company will continue to represent the Davis-Bournonville Company for the sale of welding and cutting equipment and supplies and will also represent the Commercial Acetylene Railway Light & Signal Company for the sale of dissolved acetylene.

It is the intention of the new company to give special attention to the use of welding in manufacturing. It will also continue to manufacture "Weldco" products.

Reyerson's Hagar Plant Enlarged

Joseph T. Ryerson & Son, Chicago, have recently completed an addition to their Hagar plant at St. Louis, which to a large extent provides the warehousing facilities for the stock of iron and steel products that was added to the established Hagar line of mill supplies when that business was taken over.

The new building and beam yard occupies a site of 82,000 square feet. In the building, which is traversed by a 10-ton crane serving the full span, are stored the universal, sheared tank and flange plates in long lengths and stock sizes. Capacity is provided for carrying a stock of 5,000 tons of plates and there is installed a plate shear of a size and capacity adequate to cut plates 92 inches wide and 1 inch thick.

The structural steel yard which parallels the plate warehouse is equipped with a Pawling & Harnischfeger single leg gantry crane having a span of 80 feet, or the full width of the yard. This crane serves a yard storage capacity of about 6,000 tons.

PERSONAL

James F. Gallagher, foreman of the boiler shop at the Fore River Shipyard, recently made an interesting trip to the Harlan & Hollingsworth Corporation, Wilmington, Del.

Frank N. Hill, formerly in charge of repair work and inspection of the Syracuse & Auburn Division of the New York Central Railroad, has been promoted to the position of foreman boiler maker at the Rochester engine house.

R. Baylor Hickman, Lawrence Jones and A. T. Hert, who recently purchased control of the stock of the Ewald Iron Company, Louisville, Ky., have organized the Ewald Iron Company with $1,500,000 capital stock under the laws of Delaware. Mr. Hickman is president, Mr. Hert is vice-president and Mr. Jones chairman of the board. The Ewald Iron Company's plant, it is understood, will be considerably enlarged.

In the photograph printed below are shown the manager and foremen of the boiler shop of the Wallsend Slipway & Engineering Company, Wallsend-on-Tyne, England, the top row, reading from left to right, being Messrs. T. Carr, C. Johnson, T. Kindly and J. McNaughton, and the bottom row, Messrs. Thomas Armstrong, William Hume (manager) and J. Irving. The staff and workmen of this boiler shop have subscribed most generously to the war funds of Great Britain, over $1,000 having been forwarded to the various funds from this department alone since the outbreak of international hostilities. The men whose portraits are given have been specially active in connection with the collection of this large sum, particularly Mr. Hume, the manager.

Manager and Foremen of the Boiler Shop at the Wallsend Slipway

William C. Coffin, formerly structural engineer of the Jones & Laughlin Steel Company, Pittsburgh, Pa., has been elected vice-president of the Knox Pressed & Welded Steel Company of Pittsburgh, Pa. Mr. Coffin was vice-president of the Ritter-Conley Manufacturing Company from 1898 to 1908, and since then has been with the Jones & Laughlin Steel Company. Mr. Coffin's new office will also include the duties of general sales manager. The officers of the Knox Pressed & Welded Steel Company now are Luther L. Knox, president; William C. Coffin, vice-president and sales manager; Irving F. Lehman, secretary and treasurer. The new plant of the Knox Pressed & Welded Steel Company will be given over to riveted and welded steel plate work, while the present plant at Farrell, Pa., will be continued for the manufacture of the Knox patented water-cooled devices for open-hearth and heating furnaces.

OBITUARY

Dorman J. Sinclair, of Steubenville, Ohio, a director in the La Belle Iron Works, was killed on August 6 by a train on the Cleveland & Pittsburgh Railroad, which passes through the company's plant.

Allan Strale, chief engineer of the Inland Steel Company, Chicago, from the inception of the Indiana Harbor Works until two years ago, when he became chief engineer of the H. Koppers Company, died suddenly in that city on August 5 of heart failure, aged fifty-four years.

William Graver, president and founder of the William Graver Tank Works, East Chicago, Ind., died at his home in Chicago on August 25, aged seventy-three years. He leaves five sons, all of whom are active in the business of the Graver Tank Works.

John A. McNab, for more than half a century head of the McNab & Harlin Manufacturing Company, of Paterson, N. J., with offices at 55 John street, New York, died at his summer home in West Oakland, N. J., on August 28, aged seventy-one years. He had retired from business several years ago.

BOOK REVIEWS

ELEMENTARY MECHANICS FOR THE PRACTICAL ENGINEER. By John Paul Kottcamp. Size, 5½ by 8¼ inches. Pages, 181. Illustrations, 85. New York, 1915: McGraw-Hill Book Company, Inc. Price, $1.50 net.

The subject matter of this book comprises a series of thirty lessons published in *Power* as part of an engineer's study course. The aim of the entire course is to present only those principles of mechanics which could be directly applied to the various phases of power-plant operation.

WORK, WAGES AND PROFITS. Second edition. By H. L. Gantt. Size, 5 by 7¾ inches, Pages, 312. Illustrations, 27. New York, 1913: The Engineering Magazine Company. Price, $2.00.

In bringing out a second edition of this well-known volume, the subject matter has been thoroughly revised and enlarged by the inclusion of additional instances of the application of scientific methods to labor problems, and also by giving more detailed developments of some features of the work and the summation of the argument into a comprehensive and complete outline of a plan of systematic management, based on the policies and methods defined by the author.

GRAPHIC METHODS FOR PRESENTING FACTS. By Willard C. Brinton. Size, 7 by 10 inches. Pages, 371. Illustrations, 255. New York, 1914: The Engineering Magazine Company. Price, $4.00.

Anyone who may have occasional charts to prepare for reports, for magazine illustration, or for advertising will find this work a very useful handbook, as the great variety of methods for presenting facts graphically which are given cover almost any arrangement which may be necessary. Furthermore, the right and wrong methods of presenting facts graphically are fully illustrated. The subject is treated in simple language and the contents have been carefully arranged, so that any part of the work is immediately accessible for any desired purpose.

Letters from Practical Boiler Makers

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

Some Home-Made Tools

Recently, while on a vacation trip in Central Ohio, I happened upon an oil country boiler shop devoted entirely to repair work. The owner very kindly showed me around the shop and yard, pointing out the various jobs just completed. The tools that he used were interesting, one of them being a flue-testing machine (Fig. 1).

The following are the dimensions of the frame: 2½ by 2½ by ¼-inch angles, 10 feet long; distance between the frame, 12 inches; legs of the same, 2½ by 2½ by ¼-inch angles, 24 inches high. The top ends and sides are well braced with cross pieces ¼ inch by 1½ inches flat iron to keep the framework square at one end.

It will be noticed there is a tank 12 inches by 12 inches by 48 inches fastened securely between the frames. From the bottom of the tank a pipe connection leads to the test pump or for draining purposes. To the top of the frame is fastened a larger cap (3-inch pipe fitting), in the center of which a hole has been drilled and tapped to receive the pipe leading from the force pump.

At the other end of the frame a cap of the same kind (but without the hole) is fitted to a piece of angle iron. One end (left-hand side) of the angle is loosely bolted to the frame; to the other end is connected the reach rod (¾-inch round iron), while the other end of the rod is connected to the lever at quadrant. This cross piece with the cap on can be adjusted to any length of flue up to 9 feet long by moving it along the frame to suitable holes

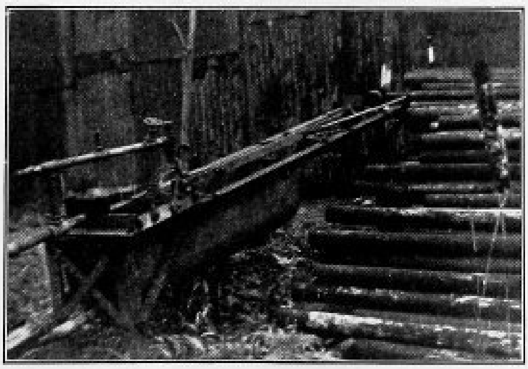


Fig. 1.—Flue-Testing Machine

in the frame, the reach rod being made adjustable also. The lever and quadrant were taken from an old grain cultivator.

Now, to test a flue the lever is thrown into the forward position, the flue ends entered in the caps, the lever drawn back and the dog dropped into the ratchet which holds the flue in position. Heavy rubber in both caps assures a good joint. When the pressure is applied it will be noticed that there is a nipple on the arrangement of pipes to attach a test gage. The usual pressure applied on old flues safe-ended is 90 pounds per square inch.

Before this apparatus was made, I was told, flues frequently leaked at the weld after being installed and had to be removed. This entailed a journey back to the shop, sometimes 50 miles away. Feeling the necessity of some means of testing his work at the shop, the tool described was the result. The cost of construction was not great, as the tool was made from old material, with the exception of the tank, which was made of ⅛-inch sheet steel.

Another tool (Fig. 2) shown me was a splitting shear. By some means not explained to me he got possession of some parts of an old hand power shear (which were practically scrap iron) and, being in need of a shear, he got

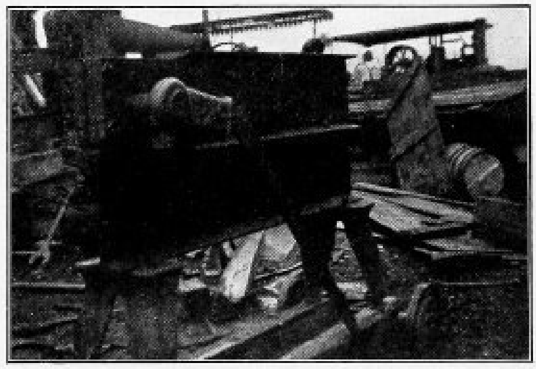


Fig. 2.—Splitting Shear

two pieces of I-beam, ⅜ inch by 4½ inches by 10 inches by 48 inches long, and cut away the flanges on one end of each beam. Both beams were joined together and bolted on the jaws or checks of the old shears with levers and knives attached. Then the beams were bolted to the old legs and the whole thing fastened to a wooden frame on wheels, so that the machine could be hauled around the yard.

With this machine he was able to shear a 5/16-inch sheet, which was the thickest plate he used. The cost of material, labor, etc., for making this very useful machine was $17.50.

Flex Ible.

Pittsburg, Pa.

Do Boiler Compounds Cause Leaks?

With reference to J. Henry Optenberg's criticism of my letter in the July issue, relating to the above title, I must say that Mr. Optenberg is right. He is right because I did not detail my ideas enough.

For example, somebody may say to me, "There is no harm in drinking water," and let it go at that. But I immediately pick up my cudgel and say: "You are dead wrong. A man might drink too much water. He might drink so much that he will die. There, therefore, *is* harm in drinking water."

It is evident that this is exactly where we stand on the boiler compound question. The only thing I can do now, therefore, is to detail my meanings—make them clearer. One of the big faults of most of us is that we leave it to the reader to intuitively understand what we mean to say, and fill in those things that were left unsaid.

I meant, boiler compound does not cause leaks if it is of such chemical nature that it will not attack the boiler shell itself. And the compound must be fed in such doses that it will never of itself form a deposit on the boiler's bottom or on the tubes. The compound must always be in suspension or solution. Besides, the boiler must be cleaned out every once in a while in order to keep the precipitate off of the bottom, for it is the precipitate that usually causes burning and buckling, and not the compound. To be sure, the compound may be mostly responsible for the fact that the precipitate lies on the bottom in the boiler in a sort of loose pile, but such a condition surely should not be allowed to exist.

To feed compound into a boiler constantly without ever cleaning the boiler would be manifestly unmechanical and illogical. So, to sum the whole thing up in as few words as possible, perhaps it would have been more to the point had I said: "A good boiler compound will not cause leaks in a boiler that is kept clean." I am sure Mr. Optenberg will agree with me on that point.

I am sure most readers understood what I "meant," and I surely do not want any young engineer to get the impression that he can feed boiler compounds into a boiler with recklessness and impunity without sooner or later suffering the consequences.

Too much pie or cake, also, is bad.

New York. N. G. NEAR.

Shop-Made Tools for the Layerout

A very handy gage for marking lines on angle steel, bar iron or any structural bar work which is gaged from the edge of bar or back of the flange is shown in Fig. 1. Take a piece of 3/32-inch sheet steel 1½ inches wide and about 9 inches long and punch out the slot shown with 5/16-inch punch, filing out the burrs. This makes a guide slot for the angle piece, which is made from the same kind of steel. Bend down 1¼ inches from the end and drill a

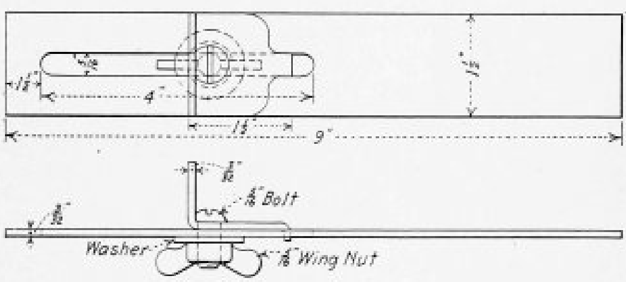


Fig. 1

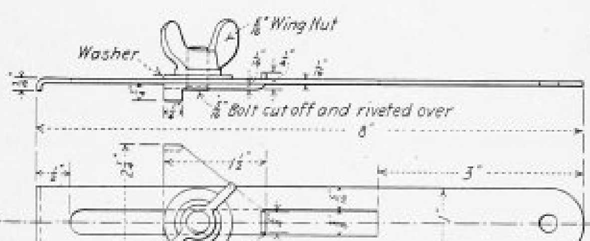


Fig. 2

11/32-inch hole even with the inside of the flange, the opposite side shaped out as shown in the sketch (Fig. 1) to allow a small hook to be bent upward through the slot and keep the angle piece from turning. File off one side of a 5/16-inch screw bolt, get out a small washer about the same thickness as the rest of the tool and a 5/16-inch thumb-nut finishes up the requirements. From the sketch the assembling should be plain to anyone, and once made and used this tool is hard to get along without.

Another gage made very similar to Fig. 1 is shown in Fig. 2. This gage is used to lay off the flange allowance on flanged heads or flue sheets. The template, being made to the required outline of a flanged head or flue sheet, is placed on the new sheet and the layerout marks the outline from the template. Now the gage shown in Fig. 2 has two hooks which are bent down to catch the edge of the template and guide the pencil, which is held at the end of the blade shown bent down 3/16 inch (Fig. 2), thus making the shear line on the new sheet. It will be noted that the two hooks are placed rather far apart—2¼ inches in the sketch shown, which is made from the gage which has been in use by the writer for a number of years and has given excellent results, as the points make allowance for inside and outside curves in the template. When it comes to an inside curve, it allows a little less than where the edge is straight. The construction of the gage is a little different from that of the one explained above, but from the sketch it should be easily understood.

PHIL. NESSER.

Columbus, Ohio.

Fuel Ecomony and Good Steaming Locomotives

As the saving of fuel is becoming a matter of importance on railroads and is one in which foremen boiler makers are interested, I hope this letter will lead others to give their ideas on fuel economy.

At the present time railroads have a coal inspector, it being his duty to instruct all concerned in the saving of fuel. He also arranges for "coal meetings" on the different divisions of his road, notifying those men he thinks necessary, such as master mechanics, train masters, chief dispatchers, conductors, brakemen, engineers and firemen. You will notice that in nearly every meeting the most important men, such as roundhouse foremen or general foremen, are left out. The most important of them all, however, is the boiler maker foreman, and he is very seldom given any attention whatever. The reason for this is more than I can understand. Probably the railway officials do not know the importance of this one man in the line of saving fuel.

We all know that a fair steaming locomotive will burn more coal than a good steamer. Ask your engineer what the trouble is and, if his engine is burning too much coal, nine times out of ten he will say that the nozzle is too small. If you open up the nozzle, the engine will not steam. If you raise the diaphragm plate the front end will fill up. If you lower the diaphragm plate, the draft is too severe at the front of the firebox and tears holes in the fire. As a matter of fact, you would be wasting tons upon tons of coal that could have been saved if you had gone to the boiler maker foreman and told him how this engine burnt her fire, and how she steamed on an average over the division. There is no doubt in my mind that he would have had a good free steamer out of this engine instead of a coal eater.

I do not mean to say that an engineer cannot help in saving coal. He can help in this way by using his allowance of valve oil. For instance, on most roads they are allowed one pint per 80 miles, and you will find engineers making as high as 120 miles per pint. They do not take into consideration, however, that for every pint of valve oil saved a ton of coal is wasted.

Ask the conductor why the engine uses so much coal. Ask the brakeman. Their answers are always the same, viz., too much tonnage. Now what, if any, results do you get out of men at "coal meetings who are not directly connected with the mechanical apparatus that uses this fuel. I doubt very much if enough coal is saved in this way to pay for these meetings.

The writer has had a great deal of experience with the drafting of locomotives, and makes the assertion that he can take any large railroad and save from $50,000 to $100,000 in coal in twelve months' time. The writer would also suggest that all coal inspectors be given a boiler maker foreman who thoroughly understands the drafting of locomotives for an assistant to accompany him on the different divisions of the line to redraft engines that are not giving good results, as a poor steaming engine means a stronger blower, a few more leaks, more coal and poor service.

J. F. Eischeid,
Foreman Boiler Maker, C. B. & Q. Railway.
Wymore, Neb.

Useful Rig for Drilling Out Staybolt

The problem of how to rig up something in the firebox to drill out staybolts has confronted every boiler maker, from those in an up-to-date shop down to a single-stall roundhouse, where a man is expected to renew a staybolt and to make a showing. They all, as a rule, will comply with the order, but in the effort to do the work quickly, although they may have a motor and air to do it with, and, if not that, a ratchet, they find that to study out what to get to put behind the motor or ratchet takes too long. As a result they take the air hammer and cape chisel, or a chipping hammer and hand cape, as a last resort to get the bolt or bolts out and get the engine out on time, regardless of the danger of getting an eye knocked out and also of spoiling the hole in the sheet and perhaps making it necessary to tap out the hole twice its original size.

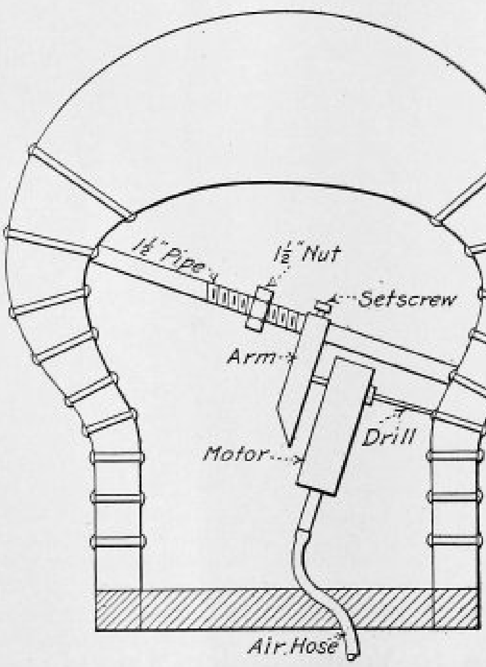


Diagram of Brace for Air Drill in Firebox

This trouble may all be avoided by using the handy device described herewith, which is inexpensive, as it consists of only a piece of round iron 1½ inches diameter by about 3 feet long, one foot of it threaded standard thread and the other end countersunk to go over almost any size staybolt head. On the smooth part of the bar is a loose fitted arm, with a set screw to tighten the arm on the bar at any distance suitable for the drill and motor. Now take a 1½-inch piece of double strength pipe and slip one end on the threaded part of the bar, and the other end over a staybolt head on the opposite sheet. Then tighten up the nut good and solid, put up the motor and move the arm to the feed screw of the motor and tighten the set screw in the arm to hold it secure on the bar. It may be well to have about six different lengths of pipe in the tool room for fireboxes of different widths.

This device will do away with having on hand several drills, although sometimes you must use blocks back of the motor. I believe this tool is new, as I have not seen any shop using it, nor have I seen anything published about it. I have found it very useful.

Oscar Rydman,
Foreman Boiler Maker, C. & N. W. Shops.
Council Bluffs, Iowa.

Another Case of Leaky Boiler Tubes

Referring to N. G. Near's article in the December, 1914, issue, the following is another cause of tube leakage, a leakage that often occurs in European plants where dished heads are much used for tubular boilers instead of flat heads.

In this construction the tubes near the center of the head are simply rolled because at this point the tubes are nearly

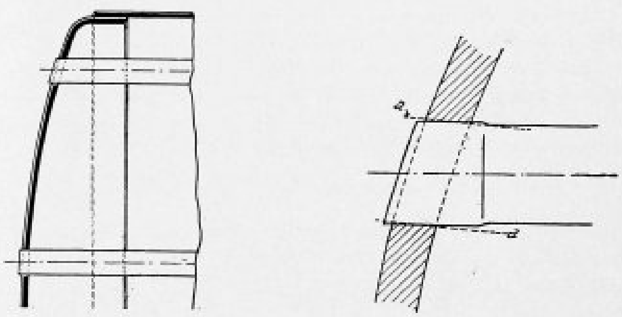


Fig. 1 Fig. 2

perpendicular to the boiler head. The outer tubes, however, join the sheet at an angle, as is shown in Fig. 1.

Fig. 2 shows the tubes well rolled, but if the man who rolls the tubes does not do the work carefully the roller will get out of line, forcing the tube into the position shown by the dotted lines. If this happens, the edges of the tube hole become round instead of sharp and the whole tube hole becomes oval, so that the tube cannot be made tight.

The above trouble happens most frequently in the case of rerolling the tubes, which is often done by the fireman who has charge of the boiler and seldom by good boiler makers. Such a practice saves a little time and money at the start, but, as the tubes continually leak more and more, a boiler maker must be sent for and the cost of repairs soon becomes very great.

Graz, Austria. Johann Jaschke.

Rolling Boiler Tubes

William J. Kelly asks whether or not he comes anywhere near the point I raised when he says: "Say he had ten or twenty boilers and he wanted these flues rolled and wanted them rolled right and in the quickest time possible. His idea is to have some one arrange the rolls in such a manner that the flues will be rolled right and in quick time, and to roll all flues in the same manner so that a novice, after a few instructions, could go ahead and finish the job." That is my point exactly.

Mr. E. Williams offers the suggestion of using an automatic reverser. On new work I should think this could be applied so well that a second rolling would be unnecessary. Mr. Williams says: "If some device were put on the expander pin so that when the pin has traveled just so far it will reverse the machine, it would be far better if one or two tubes leak on the test. They could afterwards be rolled tight, and it would be far better than stretching the tube sheet and the tube, which is very often done even by good men on tubes over 2½ inches diameter."

Flex Ible's arguments anent sizes of tubes and stretch necessary to make them fit their holes are certainly based on sound logic. If it would be possible to make tubes in such a way that they would need no stretching on installation, such tubes would be a godsend, providing the cost of installation would not be much more than the present cost of installing tubes that must be rolled or prossered.

In structural iron work, as in the construction of bridges, frames for steel buildings, etc., girders and columns are condemned that have been bent cold to the extent that the elastic limit has been passed. That is, as soon as a piece intended for the structure has been permanently deformed it will not be used.

Tubes rolled into boilers are purposely deformed, as it is the only method, to date, that is practical. Therefore, I argue, if deformation is necessary although deleterious, let us make the degree of deformation as small as possible. The closer the fit, then, before rolling, the better.

Again, in support of Flex Ible's arguments, I might point out that the steel used in structural steel work can also be bent, twisted and battered in a thousand shapes without evident harm, just as is the case with boiler tubes. Yet, as I have said, they won't allow a bit of it in actual practice.

I am pleased to note that the discussion on rolling tubes has reached the proportions it has. It has been most interesting and educative to me.

New York. N. G. Near.

Working Old Flues

As Mr. Near wants to hear from the boiler makers on the subject of working old flues, I will give my ideas and show just how I work it when I have to have a helper on the job with me instead of a boiler maker.

A man with experience is the best on old work, for your experience is the best judgment on how to tell when an old flue ought to be tight. Mr. Charles J. Mason is right when he says an experienced man can roll a flue with his eyes shut. You could give an experienced man a self-feeding expander with a ratchet handle and he could roll a whole set of tubes blindfolded and make a good job of them.

The whole idea on flues is speed. You must handle the job to keep yourself and helper busy and do the work quickly. When the foreman starts a boiler maker on a flue job, the next thing he tells you is that the inspector will be here to-day or to-morrow to test the boiler; also they say that some other boiler maker did a job just like this in such a time and you must do as well or better, so it takes experience to get the idea when a flue is properly rolled and speed and head work to finish in a reasonable length of time. Time is the whole thing on the job after you know how the work ought to be done.

When retubing an old boiler, the boiler maker generally finds the flue holes in the back head to be of different sizes. On account of the old flues being rolled at different times, some are rolled more than others, according to where they happen to leak. Each time these flues are expanded the tube holes are also expanded a little. Now to make a good job of the flues and to make fair time I find it a good policy to put in copper ferrules, and by using ferrules of different gages to fill the flue holes I make the tube holes very nearly a uniform size, which gives the flue a neat fit in the hole. The ferrules can be put in the boiler and then a slight roll with an expander will hold them in place. The boiler maker can start to put in the ferrules, and as soon as he has a few in to make room for his helper or apprentice the helper can start rolling them. As it takes but very little rolling, the helper will be able to keep the boiler maker moving to keep ahead of him. An apprentice or a helper that has some practice at the work can put these ferrules in alone after being shown how to do it on two or three tube holes.

After these ferrules have been set and the tubes put in place ready for rolling the boiler maker can take the expander and roll one or two flues to get an idea of about how far to let the expander go in. Then he can hand it to the helper and let him get to work with it, showing him how to work it for a few flues and about the distance to let the pin go in. The helper will be able to roll the flues while the boiler maker is cutting off the flues on the front end and doing the beading.

If it is not desirable to put in the copper ferrules, you can put the flues in place and take some soft iron strips and cut them in pieces long enough to fill in around the flue and scarf each end down even and thin so the expander rolls will roll over without blocking. The helper can get this packing ready while the boiler maker is packing the flues. After the flues are all packed you can give the helper the same instruction as when putting the ferrules in place and finish the job in the same manner.

I have used these methods when out on repair jobs, where I had to use a helper instead of a boiler maker, and I have found them to give satisfaction in time on the job and my work tested satisfactorily. When I roll flues on old boilers, either by hand or by machine, I roll them just enough so that it makes the flue solid and smooth. I do not go to extremes by rolling a flue very hard, because that is only waste of time, besides weakening the flue. I do not expect a set of flues to stand the cold-water test without having a few flues sweat a little. I would rather roll a few flues when the test is on than to go to extremes, and I find it the cheapest method. I have done several jobs where I have had perfect tests and other jobs where I might have five or six flues to roll a little after testing.

Bay City, Mich. Glenn Lacey.

Talks to Young Boiler Makers

A boiler under 250 pounds pressure had not let go in the office, but the noise that was coming out of the door could be compared to it. What was making the noise was a man. In one hand he held a document ornamented with a nice little blue ribbon sewed in and out through eyelet holes. There was an engraving of the U. S. Patent Office right near the top and the man's name was beautifully written below it. In his other hand was a nice morocco case with his name in gold letters across the top, and in much larger letters the name and address of some patent attorneys.

About a year before the man had received in the mail this nice case with the patent that the United States had granted him inside it. He felt pretty sure that now he had the world by the tail and he was a very proud citizen. He was very grateful to the patent attorney for placing a fortune in his hand. The noise he was now making was cussing out the government of the United States, the patent office and patent attorneys to the limit because he had discovered, not that the tail of the world had slipped from his hand, but that it had never had a tail at all. He swore that he had been misled and robbed.

Now, my readers, all over the country every day in the year there are men doing just what this man was doing, and I write what follows with the hope that I can make clear what was this man's trouble and so perhaps avert some of yours in the future.

The whole trouble came about by the man's total misconception of what a patent is, and in this condition he is far from lonely. Ask any man what a patent is and he is likely to answer that it is a monopoly granted to a man for a term of years by the Government for his sole benefit, or perhaps he will say it's a fraud for which the Government has charged him $35.

Neither answer would be correct. The Government says that anybody that gets up a new and useful invention will be granted a patent for seventeen years on the ground that a new and useful invention will be of benefit to the community at large. In order to encourage people to do good to the community and to stimulate inventions the Government offers a patent, knowing full well that otherwise people would not be inclined to spend their time and money in producing something new and useful unless they themselves had a chance to reap a special benefit in being given a certain protection for the risk run.

A patent consists, first, of a declaration telling who you are and where you live, next what the nature of your invention is and its object. Then follows a description accompanied by drawings, which usually must be sufficiently clear, so that when taken together they will enable one "skilled in the arts" to produce the invention. Finally, there are the claims.

Now, the Government does not guarantee in granting the patent that the invention is new and useful. In fact, it does not guarantee anything except that in so far as the patent office records go, and in the judgment of the examiners, it is new and useful.

It is often asked why the Government does not guarantee a patent? The answer to this is that it could not, even if it had unlimited means at its disposal. It would be utterly out of the question, upon finding no previous invention like the one asked for among their own records, to send out men all over the country to look for anticipations of the patent prayed for. This search would be never-ending and could never be exhausted. Technically, the patent office would be obliged to issue a patent, if the records of the office did not show that the application had been anticipated, were it not for the fact that what is termed common knowledge intervenes. To illustrate, I heard a well-known patent attorney say that he believed that the common sewing needle would be granted a patent, if applied for, as there would be very little chance of a drawing, description and claim of a needle being filed in the patent office, but here is where common knowledge would come in, as everybody knows a needle and no action could be taken on that account.

The patent attorney who obtained the patent for our roaring and disgusted friend belongs to a class of men who are precisely like all other classes of men—that is, there are among them rascals and frauds, as well as conscientious, honorable men, and these are in the great majority. A good patent attorney will explain clearly to his client just what he thinks he should obtain as claims on the invention and will point out precisely what the Government is willing to allow the inventor. This is usually much less than the inventor asks for. When the inventor is new or taking out his first patent, the attorney has his work cut for him. This is how the thing works:

Mr. Jones has an idea of improving something, we'll say a staybolt. He is a boiler maker and has had trouble with staybolts breaking. He thinks that if he makes the middle of the staybolt smaller in diameter than the rest of the body he will obtain flexibility, so he proceeds to have one made. He shows this to his friends—that is, the people whom he thinks are his friends—and they all tell him that it is a big thing, except one man, and he sets that man down as a blamed fool. He does not know anything about patent attorneys, but he remembers that there are several in town, so he hunts up one who is very glad to see him, and he starts in and explains to him the virtues of his staybolt.

The attorney tells him that the first thing to do is to have a preliminary search made which will cost him from $5 to $10, according to the usual charges of the attorney. After expatiating further on the great value of his invention, he is told to call again in about a week or ten days. Generally he returns upon the third day, as he has got nervous by this time, fearing that somebody is going to steal his invention. The attorney does not seem to be alarmed, so he goes away more contented. Finally the attorney tells him that he has got the report and hands him eight or ten patents which show staybolts so exactly like his that his heart goes away down in his boots. But the attorney tells him that on making certain changes he thinks that a patent can be obtained and suggests that perhaps by changing the hole in the staybolt he can get something novel.

The inventor thinks this over and decides that it would be a big advantage if he reduced the size of the hole in the staybolt in the middle just where he reduces the outside of the staybolt, leaving holes in the ends the usual size. This, he points out to the attorney, will allow him to reduce the staybolt further in the middle without decreasing the area of metal to a dangerous extent. This the attorney thinks will go through, and it does.

A fee of from $30 to $75 is then requested, $15 of which is the first governmental fee and the rest is for making the drawings and writing the specifications. Often the attorney only asks for his share of these amounts until the patent is all prepared.

The inventor finds that the attorney is mighty clever and understands exactly what the invention is, as he describes it so well. The inventor has to sign the application, and after several weary months and some changes in the claims the patent is allowed. If he wants to patent it in other countries he has a certain length of time to make his application and he has six months from the date of the allowance of the patent to pay the final governmental fee of $20. When the patent is issued to him, sometimes the search fee of $5 or $10 is deducted from the attorney's fee.

After the patent is allowed, then disappointments begin. As a rule none of his friends who thought so much of the idea is willing to put a cent into the enterprise of making the staybolts. Staybolt makers do not seem inclined to help him, either. Some do not take the trouble to answer his letters, while others say it is too expensive or they think it is an infringement. His drooping spirits are somewhat revived by letters, always from distant cities, from persons or companies who have noticed the issuing of his "valuable patent," and that he or they are in a position to sell it on a commission. He even gets telegrams from these parties asking the price at which he will sell his patent. Further correspondence develops the fact that while the patent is only sold on a commission, it will have to be advertised, as nobody can be expected to buy something they know nothing about. And for this advertising a fee of from $5 up is asked "to pay for illustration and printing."

My experience is that the best way to sell a patent is by personal exertion.

One thing more before I close on this subject of patents, and that is concerning caveats. A caveat is generally supposed to be a protection to an inventor. It is really no protection at all. When you file a caveat the Government simply agrees to let you know if anybody else applies for a patent on what is shown on your caveat, and then you have to show the patent office "priority" of invention—that is, you and the other applicant have to show proof as to when the invention was made by each, and the one who can positively prove that he was first in the field will be granted the patent.

Now one word more. All patents are not worthless. Many are very valuable, but their value has to be proved like all other things, and the law courts have to decide exactly what is the meaning of the patent. Mr. C. J. H. Woodbury, of Boston, searched the United States records of patents that come before the law and found that 72 percent of them were upheld—a pretty good showing for the patent office. The patent office pays money into the treasury of the United States in large amounts, and it is abominable that money paid by the inventors of the United States is not used to increase the facilities of the patent office and the pay of the examiners, thereby preventing the long and wearying waits before a patent can be acted on.

New London, Conn. W. D. FORBES.

The Uniform Boiler Rules Versus The Foreman Boiler Maker

Of course we all know a boiler maker's judgment, or his opinions, do not amount to very much in the eyes of the leading engineers of the country, particularly the ones engaged in formulating rules and regulations for the safe construction and operation of steam boilers. But it is safe to say that if the boiler maker was consulted more frequently, and his ideas given more consideration by these gentlemen, there would not be so much dissension among the different parties concerned, and that a set of rules could be compiled that would meet with the approval of nearly all the States, with the exception of Massachusetts, perhaps, and past experience has led me to believe that no one's opinions, outside of his own Commonwealth, matters much to them.

But I do not want to criticise anybody in particular, nor give out the impression that I know more than the ones engaged in formulating the different rules, but I will say that I know a bonehead inconsistency when I see it, and I also say that if practical as well as educated boiler makers were well represented on the board of the boiler rules such things would not appear, and then when the foreman or layerout got out a boiler they could do so in an intelligent manner, and not have to put in or leave out some insignificant thing just because the law reads that way. This does not mean that there are many insignificant parts about a steam boiler; quite the contrary, because every detail of boiler construction is important and should be carried out in as careful a manner as possible. However, it means that there are a lot of insignificant details in some of the present boiler rules that had better be left out, or substituted by others that are more correct and practical.

So I will predict this for the new A. S. M. E. code: that it will never become a uniform law until the contents of the book of rules, regulating the construction of steam boilers, is made consistent with the really practical ideas of the foreman boiler makers throughout the United States. *For this reason*: in the boiler shop the foreman is looked upon as the highest authority when it comes to the construction of a boiler, and if he *did not* know his business he would not be a foreman. So when the officials want to know anything pertaining to the boiler or its construction, where do they go to find out? Do they go to their chief draftsman to find out whether a certain operation is practicable? Do they go to him and discuss with him the minutest details concerning the different boiler codes and rules? Very seldom; the man the officials of the company pick out to get their information of this kind from is the *foreman boiler maker*, and if he sees that the present A. S. M. E. rules are inconsistent with his ideas and convinces his superiors to that effect, the officials will then see that it will not become a law in their respective States.

In order to gain the co-operation of the foreman the first and most important thing that would have to be done is for the foremen to co-operate with themselves, and this can only be done by forming an organization composed of all contract shop foremen, layerouts and inspectors, after which a committee could be picked out of this vast number of practical men that could be relied upon to represent the sentiments of every man in the entire organization, and with this committee of practical boiler makers in co-operation with the A. S. M. E. committee, I say they could formulate rules that would be beyond dispute and make possible thereby the adoption of a uniform boiler law.

JOHN T. LEE, Layerout.

The Brownell Company, Dayton, Ohio.

Height of Front End of Crown Sheet

The front end of the crown sheet of the firebox of a locomotive boiler is made higher because it is nearest the center of the boiler and the water level changes less at the center of the boiler than elsewhere. This difference is based on the percentage of the grades so as to keep the water level uniform.

While working the engine hard on a grade the water is raised, and when the engine is over the grade and the power is shut off, the water subsides to its natural level. With the engine going down the grade the crown sheet is brought more nearly into a horizontal position, while if the crown sheet was level in the first place it would be necessary to have the water up out of sight while going up grade to have any water in sight going down the grade.

This can be proved by taking a long, deep pan, filling it two-thirds full with water and drawing a line about 1 inch below the water level; then slant the pan and it will be almost impossible to get the water below the line in the center, while it is easily lowered at each end.

Francis, Okla. J. H. KEARNS.

CONVENTION OF ILLUMINATING ENGINEERS.—The ninth annual convention of the Illuminating Engineering Society will be held at the New Willard Hotel, Washington, D. C., September 20-23. The numerous papers which will be presented are replete with new and valuable information on practically every phase of lighting. Many of the papers cover extensive special investigations conducted by authorities of high standing.

Selected Boiler Patents

Compiled by

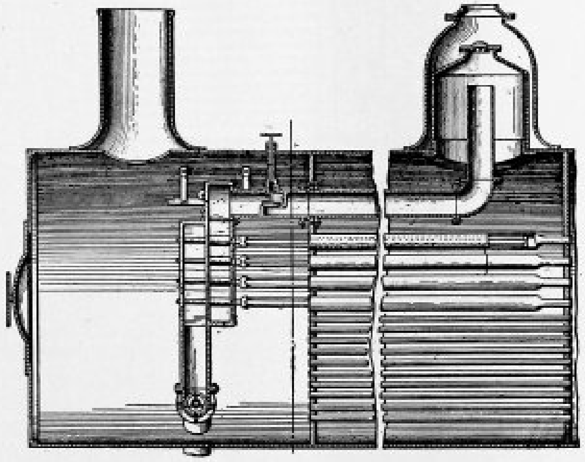
DELBERT H. DECKER, ESQ., Patent Attorney,

Millerton, N. Y.

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

1,140,956. SUPERHEATER FOR BOILERS. GEORGE COOK, OF BUFFALO, N. Y.

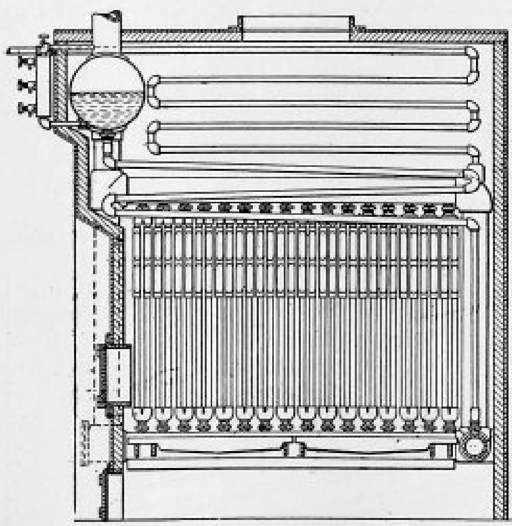
Claim 1.—A superheater for boilers comprising a casing divided transversely into an inlet chamber and an outlet chamber, one arranged in advance of the other, a series of steam pipes arranged in pairs and secured to said casing, each pair comprising an inlet pipe and an outlet



pipe, a fitting for connecting the inlet pipes of each two pairs of steam pipes with said inlet chamber, and a fitting connecting the outlet pipes of each two pairs of steam pipes with said outlet chamber. Six claims.

1,142,229. STEAM BOILER. JOHN H. BIGELOW, OF BROOKLYN, N. Y.

Claim 1.—In a watertube steam boiler the combination of a system of lower manifolds comprising side and rear manifolds, a system of upper manifolds, large return pipe connections between the two systems of manifolds for downward flow of water from the upper manifolds to the lower manifolds, a steam drum arranged at a higher elevation than the upper system of manifolds, tubular connections between said steam



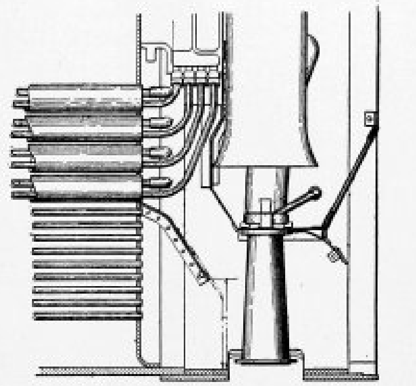
drum and the said upper system of manifolds, a plurality of small watertubes rising from each of the lower side manifolds of the lower system of manifolds and extending over the firebox space in return bends and connecting with the upper manifolds, and a plurality of watertubes rising from the rear manifold of the lower system of manifolds and extending forward above the return bends of the side tubes and connected at the front with the steam drum above the upper system of manifolds, said tubes providing tubular bounding walls and crown to the firebox, whereby all of the watertubes and systems of manifolds and main watertube circulating elements are below the water level in the boiler, and the steam and water in the steam drum are removed from the main water circulating zone of the boiler. Three claims.

1,142,721. DRAFT REGULATOR AND SMOKE PURIFIER. JOHN A. McFERRAN and MILTON L. McFERRAN, OF LOUISVILLE, KY.

Claim 1.—A draft regulator and smoke eliminator comprising a series of intake pipes, valves in said pipes, said pipes leading into the smoke box and from thence through into the firebox, and means for discharging the heated air and oxygen over the fire grate, a fire door, and connections between said fire door and the intake valves to open the latter when the fire door is opened and a regulator to prevent the valves from being closed immediately when the fire door is closed. Three claims.

1,142,686. DRAFT-REGULATING DEVICE IN LOCOMOTIVE FRONT ENDS. THAYER B. FARRINGTON, OF COLUMBUS, OHIO.

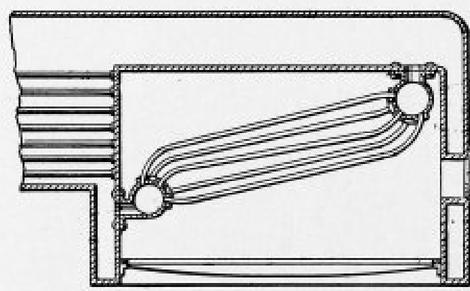
Claim 1.—In a locomotive boiler comprising a set of upper flues containing superheating coils and a lower set of flues with unimpeded passages with both sets of flues communicating with a common smoke box,



a smoke arch in the smoke box extending over the openings of both sets of flues into the smoke box, and a baffle plate secured in the smoke box under the smoke arch between the two sets of flues and extending downwardly over the openings into the smoke box of the lower set of flues to form with the smoke arch a free and unobstructed passage, except for the superheater coils, from the upper set of flues into the smoke box, said baffle plate operating to restrict the draft through the lower set of unimpeded flues and to increase the draft through the upper set of flues containing the superheating coils. Two claims.

1,142,731. BOILER ATTACHMENT FOR LOCOMOTIVE FIREBOXES. EMIL C. RUDOLPH, OF SPRINGVILLE, N. Y.

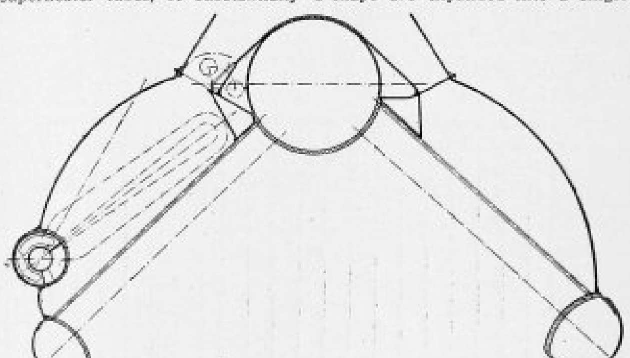
Claim.—A locomotive boiler having a firebox, a water jacket surrounding the top, back and front portions of the firebox, a hollow cylinder connected to the upper wall of the firebox and communicating with the



water jacket above said wall, a hollow cylinder connected to the rear wall of the firebox and communicating with the water jacket at that point, and a series of tubes extending from one cylinder to the other and communicating therewith, said pipe being inclined from one cylinder to the other.

1,143,476. SUPERHEATER FOR WATER-TUBE BOILERS. HAROLD EDGAR YARROW, OF SCOTSTOUN, GLASGOW, SCOTLAND.

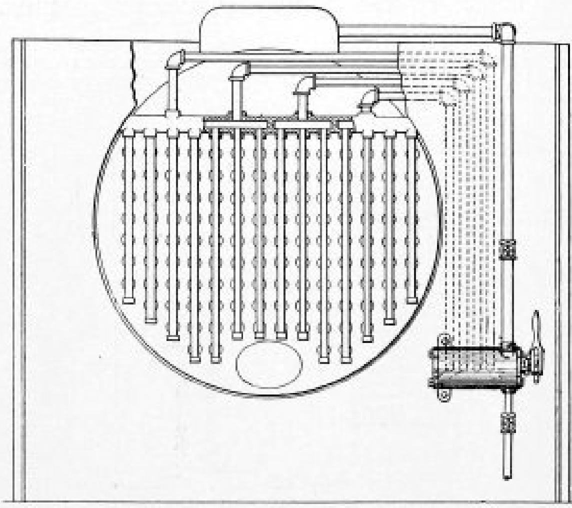
Claim 4.—A superheater for water-tube boilers of the kind in which superheater tubes, of substantially U-shape are expanded into a single



steam drum with the tubes projecting upwardly, wherein the drum is adapted to be rotated about its longitudinal axis either with or without removal of the side casing of the furnace so as to project the tubes forward or outward to render them accessible for the purpose of removal or replacement. Seven claims.

1,143,409. BOILER-FLUE-CLEANING APPARATUS. GEORGE S. KYLE, OF CHAMBERSBURG, PA.

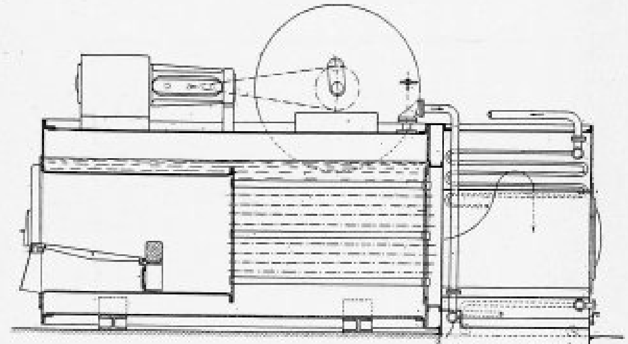
Claim 1.—A boiler flue cleaning apparatus having a casing provided with a cylindrical chamber, and a rotatory tubular valve mounted in and in communication from its interior with the chamber, said valve being of lesser length than the chamber, said casing being provided with a series



of outlet ports and one steam inlet port, the steam inlet port being beyond one end of the valve and said valve being provided with one port for each outlet port of the casing, said ports being disposed in staggered relation to each other, and with a plurality of alined ports for registration simultaneously with the outlet port, and means for selectively rotating the valve. Six claims.

1,143,501. SUPERHEATER AND ECONOMIZER FOR HORIZONTAL SMOKE-TUBE BOILERS. FRANZ BÜRGER, OF MANNHEIM, GERMANY, ASSIGNOR TO THE FIRM OF HEINRICH LANZ, OF MANNHEIM, GERMANY.

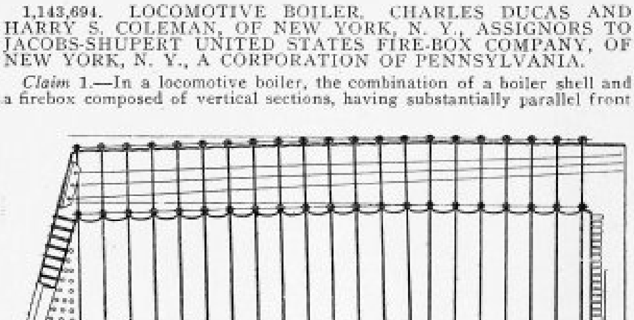
Claim 1.—The combination with the smokebox of a horizontal smoke-tube boiler, of a system of superheater tubes and a system of economizer



tubes, both of which are arranged in a single transverse zone within said smokebox. Six claims.

1,143,694. LOCOMOTIVE BOILER. CHARLES DUCAS AND HARRY S. COLEMAN, OF NEW YORK, N. Y., ASSIGNORS TO JACOBS-SHUPERT UNITED STATES FIRE-BOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF PENNSYLVANIA.

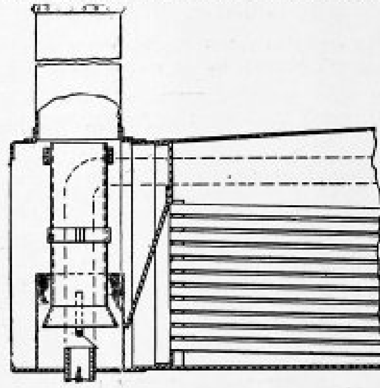
Claim 1.—In a locomotive boiler, the combination of a boiler shell and a firebox composed of vertical sections, having substantially parallel front



and rear sides, of a wedge-shaped section located at the point where it is desired to have an incline at the top of the crown sheet begin. Four claims.

1,143,917. DRAFT REGULATOR. HOSEA E. REECE, OF McMECHEN, W. VA.

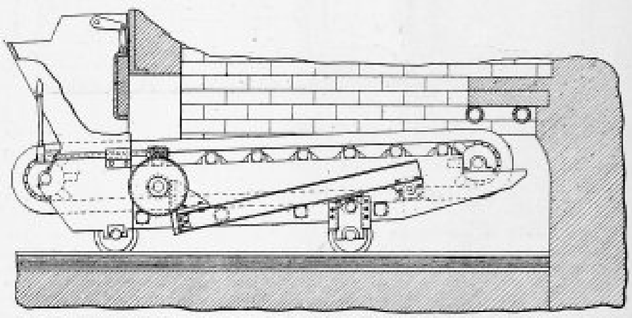
Claim 1.—The combination with a boiler, of an exhaust nozzle which extends into the smokebox of said boiler, a tubular shell suspended over said nozzle and communicating with the smokestack, said shell having a bell mouth located over said nozzle and in relatively close proximity to



the bottom of said smokebox, means for introducing live steam into said shell, and a cylindrical screen disposed in close encircling relation both to the mouth of the shell and to said nozzle, said screen occupying a relatively small space and permitting access thereby to the rear end of the smokebox. Two claims.

1,144,502. ELEVATION ADJUSTING MEANS FOR CHAIN GRATES. HERMAN A. POPPENHUSEN, OF HAMMOND, IND.

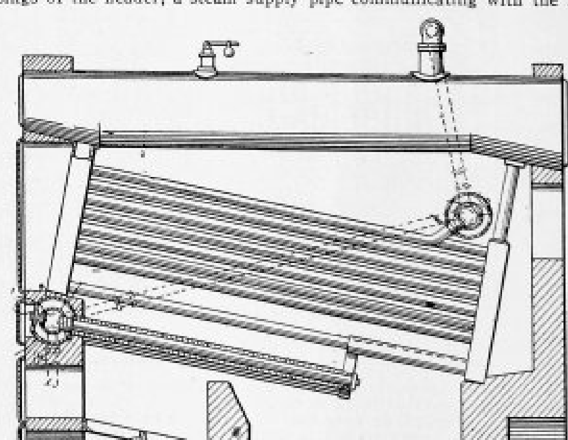
Claim 1.—In a furnace, the combination of a traveling grate, a frame carrying said grate, track engaging wheels supporting said frame, the wheels adjacent to one end of said frame having adjustable connection



with said frame, and an elevating device mounted on said frame adapted to be operated to raise and lower one end of said frame and grate relative to said adjustably connected wheels. Eleven claims.

1,144,911. SUPERHEATER. WALTER A. MOFFAT, OF ERIE, PA.

Claim 4.—A superheater for steam boilers including an upper header and a lower header, each of said headers comprising concentric casings, superheater tubes projecting from the respective headers and each formed to provide distinctive channels communicating respectively with the casings of the header, a steam supply pipe communicating with the inner



casing of the upper header, a steam outlet pipe establishing communication between the outer casing of the upper header and the inner casing of the lower header, a steam feed pipe leading from the outer casing of the lower header, an air pipe communicating with the inner casing of the lower header, and an air pipe establishing communication between the outer casing of the lower header and the inner casing of the upper header, whereby a circulation of air may be maintained throughout the superheater at will. Four claims.

The Boiler Maker

OCTOBER, 1915

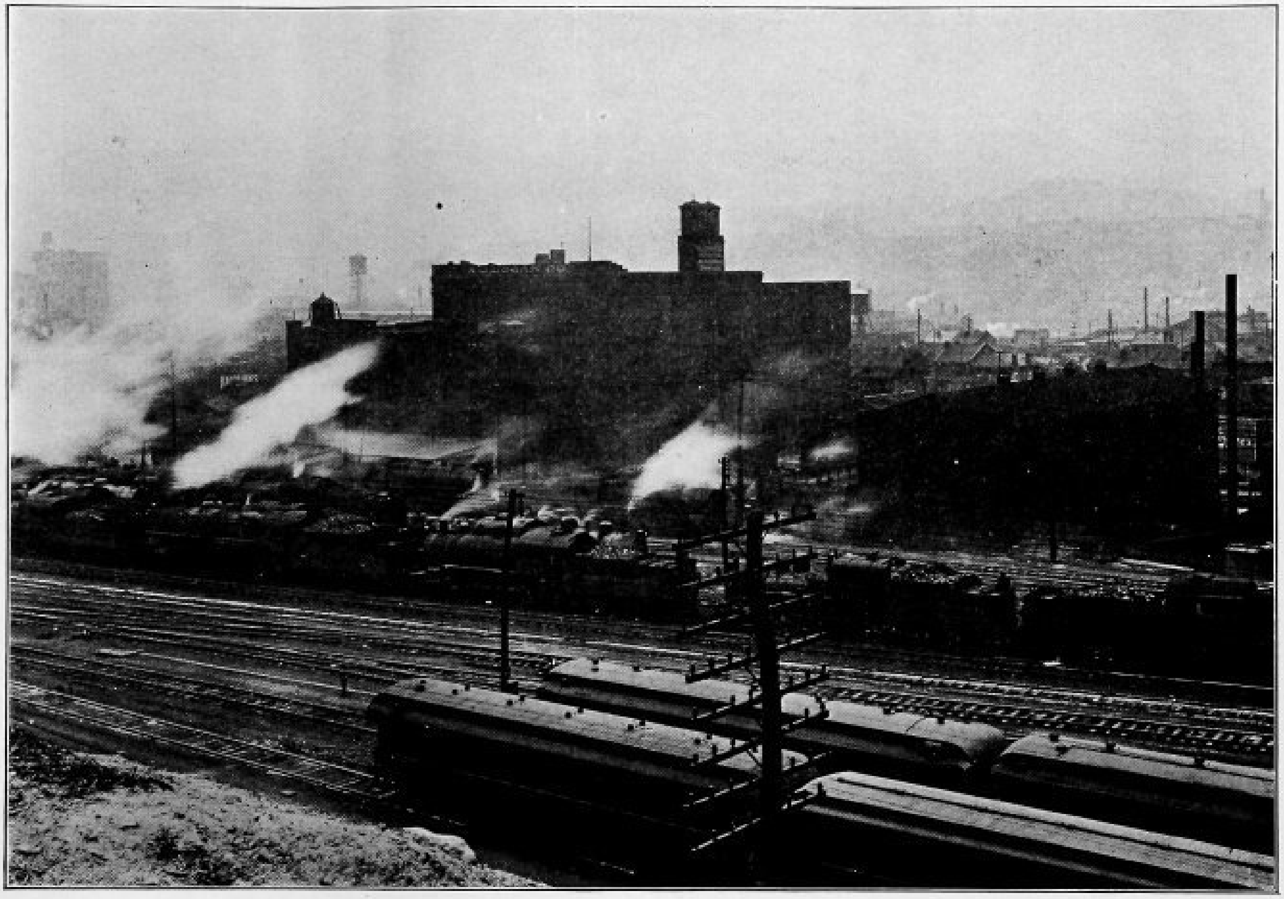


Fig. 1.—View of Railroad Yard, Free of Dense, Black Smoke from Locomotives. Only White Clouds, Largely of Steam and of no Detriment, Now Appear

Smoke Abatement of Steam Locomotives

Results Obtained by Pittsburg Bureau of Smoke Regulation—Objectionable Smoke From Locomotives Practically Eliminated

BY FRANK C. PERKINS

The accompanying illustrations supplied by Bureau Chief J. W. Henderson, of the City of Pittsburg Bureau of Smoke Regulation, Department of Public Health, give some idea of the smoke nuisance for the abatement of which an ordinance has been enacted producing excellent results by its rigid enforcement.

In this article the regulation of railroad smoke only is considered, other industrial smoke abatement being considered later. In considering the value of photography in smoke abatement, Mr. Henderson says: "It is unnecessary for us to advise as to how locomotives burning soft coal can smoke, but we can say that the taking of pictures has been a great help to this Bureau. One set of these pictures will serve to show just what was possible in the way of smoke emission from locomotives handling a single freight train previous to the railroads realizing that it was the intention to regulate railroad smoke as well as that of the stationary plants.

"Up to this time the railroads had abated smoke only with their mouths, but investigations in other cities proved conclusively that it was possible for the railroads to operate entirely within the limits of the ordinance, which

Fig. 2.—A Pittsburg Railway Yard Before the Smoke Regulation Ordinance Went Into Effect

would prove eventually to their own advantage by reason of the economy, but, strange to say, these same railroads professed not to know what their own company was doing in this regard in other cities." Mr. Henderson further states that: "Realizing what a hard proposition the railroads are to deal with and finding out that arguments with them were not productive of results, it became necessary for the council of this city to threaten enactment of an ordinance requiring that the railroads discontinue the use of bituminous coal on their locomotives within the corporate limits of the city of Pittsburg.

Objectionable Black Smoke Eliminated

"Upon realizing that they were up against something, they soon signified a willingness to demonstrate that it was entirely possible for them to meet the requirements of our ordinance, which we can say they have done to such an extent that we believe Pittsburg is as free from objectionable smoke from railroad locomotives as any city in the country where they use bituminous coal for fuel."

The photographs were used to indicate the smoke nuisances, the later illustrations showing the dense, black smoke eliminated, only white clouds appearing, which are largely steam and of no detriment. The recent photographs indicate the improvement made in the railroad yards, where they are now even building fires in these locomotives without producing objectionable smoke. Further, Bureau Chief Henderson declares that the railroads have all put on inspectors of their own, and each inspector sends a daily report of the operation of all locomotives under his jurisdiction, while some of them send photographs, as well, of locomotive operations.

It is claimed that the elimination of the railroad smoke has been a very material factor in the production of a clearer atmosphere and a great help to the Department of Health in Pittsburg, but the Bureau of Smoke Regulation finds that in order to keep up this good work it is necessary to keep after the violators relentlessly. Strange to say, the railroads have been able to do away with their smoke without the addition of any stoking or other appliances. They have simply put it up to the men, holding the engineer equally responsible with the man on the end of the shovel, and a violation of the law means a reprimand in the first instance and a suspension of from two to ten days for both members of the engine crew for any repetition. The infliction of this penalty a few times had a very wholesome effect on the attitude of the men regarding the violations of the smoke ordinance, but, of course, they did not take to it kindly at first.

The Pittsburg ordinance No. 257 reads as follows:

Section 2.—The production or emission within the city of smoke the density or shade of which is equal to or greater than No. 3 of the Ringlemann chart, from any stack, except that of a locomotive or steamboat, for a period or for periods aggregating two minutes or more in any period of fifteen minutes, and the emission of such smoke from any locomotive or steamboat for a period or periods aggregating one minute or more in any period of eight minutes, except for a period not to exceed twenty consecutive minutes, not to exceed once a day, while a new fire is being built therein, is hereby prohibited.

The Ringlemann smoke chart is placed sufficient distance from the eye to cause the lines to merge similar to the appearance of smoke to compare with the density of the smoke under observation. Ordinance 257 provides penalties for the production or emission of smoke equal to, or of a greater density than, scale No. 3 of the Ringlemann chart. The lines of the chart merge at from fifteen to twenty feet from the eye.

The recent report of the Pittsburg Bureau of Smoke Regulation points out that the achievement of smoke regulation is an economic proposition. This is a fact, because

Fig. 3.—Poorly-Fired Freight Locomotive, Emitting Dense, Black Smoke

smoke and its accompanying products of combustion affect health, cost of cleaning, permanence and appearance of building and household materials and the growth of vegetation. Its emission from "stacks" is, generally, an indication of inefficiency and an exhibition of fuel waste.

The total of all the items of cost amounts to something like $20 per year for every man, woman and child in Pittsburg. A report by the United States Government states that smoke causes more than $500,000,000 damage each year in the destruction to merchandise, the defacement of buildings, tarnishing of metals, injury to human and plant life, the great increased labor and cost of housekeeping, and the losses to manufacturers due to imperfect combustion of coal. This means a per capita loss of $17 to every man, woman and child who lives in the great and middle-sized cities.

Savings from Smoke Elimination

The report states that a saving in laundry bills only of an average of a little less than four cents per week per inhabitant of Pittsburg equals more than $1,100,000 saved per year. It may readily be conceived this has been accomplished. Careful investigation will indicate even more than this. In fact, the proportion of smoke elimination from railroad operations alone might account for a saving of about $2 per person per year, or $1,100,000 in the aggregate.

Utility demands abbreviation of reports of this character. Should we disregard this requirement, it would still be difficult to make known, in detail, the elimination of smoke from the "stacks" within the city limits during the year 1914, alone, as a result of action urged upon the owners and operators of locomotives, boiler furnaces and other furnaces connected with stacks.

In Pittsburg it is stated that there is scarcely a single case of even one isolated "stack" that has not had, during the year, personal attention with a view of furthering smoke elimination therefrom.

It is pointed out that the regulation of the production and emission of smoke from locomotives operating within the city limits has been brought about by the railroads and others operating such equipment to an extent that deserves recognition. The railroads have found it possible to accomplish smokeless operation of locomotives for Pittsburg, equal to their best performance anywhere, using similar fuel. The most effective change has been in the method of firing. Accompanying this, for smokeless operation, is the selection of the fuel. These two factors, together with keeping the locomotives up to standard otherwise, make smokeless operations possible within the limits provided in the city ordinance.

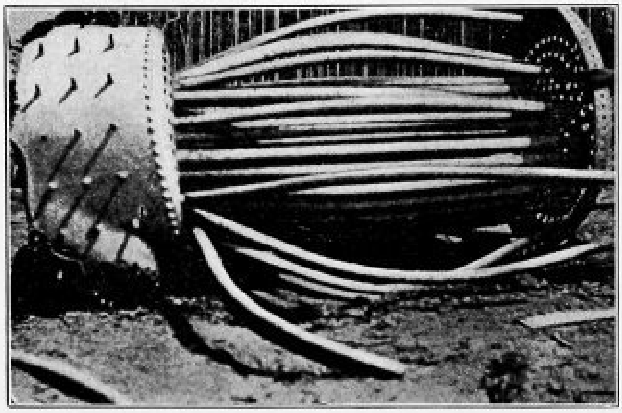
It is claimed by the Bureau chief that brick arches, superheaters and other devices applied to locomotives here do not in themselves constitute the means for compliance with the provisions of the city ordinance. Stokers eliminate the "human element" and make smokeless operations easily possible. Such locomotives, however, with cold boilers, are more difficult to start new fires in without excessive smoke than is the case without the mechanical stoker.

Ells can be obtained with side outlets.

An ell with a back outlet is not called a T, but an "ell with a back outlet." When you order this, give the size of the ell and then the size of the outlet; thus, 3-inch ell with a ½-inch back outlet.

The Inevitable Result of Patching a Lap Crack

For a lap crack to disclose itself in a peaceful fashion is unusual enough, but when a boiler owner attempts to cover up this defect in a boiler which has been considerate enough to disclose the fact without a violent explosion, he is surely tempting Providence in his efforts to get further service from his equipment. It is indeed hard to realize that there are boiler makers and boiler operators who do not know the seriousness of cracking along the longitudinal seams of a lap-riveted boiler, but no other



Remains of Patched Lap Seam Boiler

explanation would seem to cover the conditions presented by the case before us. Surely no sane man, whether boiler maker, boiler owner or boiler operator would intentionally set a death trap, and the patching of a lap crack sets a death trap as surely as the setting of a spring gun.

The explosion which has suggested the warning which we have just enunciated was that of a vertical tubular boiler, used on a lumbering operation in Washington, on June 12. This boiler was used to furnish steam for pumps, which supplied feed water for several boilers, scattered through the woods, and used for logging. The boiler was some seventeen years old, 48 inches in diameter, and 8 feet 8 inches high. Built of iron shell plates, with steel heads, it presented no unusual features, either of construction or design. When new it had been attached to a double hoisting rig, and was said to have operated at a pressure of from 160 to 170 pounds. This may have contributed to the formation of the crack, for this pressure was higher than would ordinarily be allowed an insured boiler of similar size and material, and so the breathing action, to which the formation of lap cracks is usually attributed, would no doubt have been accentuated.

Some time ago a crack about 5 inches long developed parallel to the longitudinal seam, and near the inner row of rivets. The crack opened enough to permit leakage, and so it was repaired by stitching with plugs, and covered with a patch secured with patch bolts. The lumber company seems to have suspected that perhaps the boiler was not so vigorous as it had been, for they removed it from the hoist after the repairs, and relegated it to the pumping service described above.

In its new position it was fitted with a safety valve, though we were unable to ascertain the load which the valve carried. Those familiar with the plant agreed that not more than 90 or 100 pounds were required to run the pumps. The boiler had not been in use for a week or so prior to the explosion, but on the morning of the accident, orders were given to fire up. Just before the explosion the safety valve was heard to blow freely. The break came about one and one-half hours after the fire was started. The operator was instantly killed and horribly mangled. When found he held the hand wheel of the feed valve tightly clutched in his hand, and this lent color to the immediate local verdict of cold feed introduced into an overheated and nearly dry boiler as the cause of the trouble. It is surprising how tenaciously the non-technical public and the average newspaper account refer to this as the absolutely certain cause of almost all boiler explosions, in the light of the many unsuccessful attempts that have been made to blow up an experimental boiler in this way.

Examination showed that the outer lap was cracked at the edge of the inner sheet for a distance of possibly five feet. The shell was hurled for about 200 feet, stopping finally because of an encounter with a stump. The remainder of the boiler, which is shown in the illustration, traveled about 20 feet from its foundation. The shell unwrapped itself completely from the top head, shearing all the rivets. The fracture then proceeded downward from the patch and passed around the boiler through the fire door, leaving part of the lower section of the shell attached to the firebox. All the staybolts pulled through the shell sheet.

This boiler was not insured, and it is doubtful if it was ever inspected except by local boiler makers who made repairs. While it is true that the most rigid inspection sometimes fails of discovering a lap crack in time, still it is hard to believe that any boiler inspector would have sanctioned the patching and continuing in service in the manner described of a boiler which had given evidence of such a crack to the extent of developing a leak. Thus one more reason appears for the inspection and insurance of all boilers, no matter where located, nor for what service they may be used.—*The Locomotive, of the Hartford Steam Boiler Inspection and Insurance Company.*

Stop and Non-Return Valves on Boiler and Engine Steam Pipes*

BY L. A. COLE

In several States and cities the boiler inspection laws require that where more than one boiler is connected to a common steam header and the pressure is over one atmosphere per square inch, there shall be two stop valves on the branch from each boiler; one of these valves should be of the automatic stopcheck type. The idea is to lessen the danger to the attendants of being scalded by escaping steam if a tube should burst, and to make it impossible to turn steam into a cold boiler if it is standing idle or undergoing repairs, and to prevent a boiler from being cut-in to the line when the pressure is somewhat lower than the line pressure.

Rules formulated by the Industrial Commission of Ohio state that each steam outlet from a boiler which is over 2 inches in diameter (except a safety valve connection) shall be fitted with a stop valve or valves of the outside screw and yoke type, located as near the boiler as practicable. A non-return valve equipped with an outside screw and yoke attachment is considered equal to a stop valve.

The two stop valves of the outside screw and yoke type, with an ample valved drain between them, having an open discharge, shall be placed on the main steam pipe of a boiler having a manhole, and set in battery, when the pressure allowed on any boiler in the battery exceeds 135 pounds.

* From a paper read before the Ohio Society of Mechanical, Electrical and Steam Engineers.

All these rules apply to the boilers only. I think rules should be applied to the steam lines as well, for, if a steam pipe burst or if an engine is wrecked, the resulting loss of life and the property damage will be much less where there is the proper installation of automatic valve.

Boilers are often set where there is limited room; the same may be said of the steam pipes and the stop valves. In such cases if anything happens to the boiler or if a fitting breaks, it is impossible to close the stop valves on the main steam line until all steam is off the plant. For this reason non-return valves should be installed. But the law has nothing to say of the steam pipes and fittings in the plant as a whole.

Take a plant arranged with the overhead loop system of large size having connection to each boiler and all other steam machinery, except the boiler feed pumps. These take steam from an independent steam line. Now as the law only requires two stop valves to be put on main leads why not put on one stop valve and one compound or double-seated stop and check valve near the steam main, for the safety of all persons and for the plant as well?

To go a little further, I believe that there should be automatic valves on all engine branches, and, if the automatic valve is not used, there should be a quick closing gate valve with chain attached and chain hung so as to be easily reached by the engineer. The automatic valve is best at this point, for a sudden flow of steam would close this particular line; but the question is, could one of these valves be so adjusted as to remain operative and not close if there should be a sudden demand upon the engine?

I think this subject should be given more consideration than it generally gets in the power plant.

An Investigation of Fusible Tin Boiler Plugs*

BY G. K. BURGESS AND P. D. MERCIA

The fusible boiler plug consists usually of a brass or bronze casing filled from end to end with a fusible metal or alloy. Its function is, as its name indicates, to give warning by fusing and blowing out, of overheating in the boiler. Such plugs are used in many locomotive and marine boilers in this country, and are required by the Steamboat Inspection Service to be installed in all boilers subject to their inspection.

Tin is generally used as the fusible material of these plugs, and has many advantages in this respect, but carelessness in its use and inspection has led to boiler accidents, which can be traced to failure of the tin plug to function properly, and investigation of these cases and of a large number (approximately 1,100) of such plugs, both new and used, at the Bureau of Standards, has shown that, unless the tin used in such plugs is pure, it is subject to deterioration by oxidation when in service. The oxide has a melting point of above 1,600 degrees C. and forms often in such a way as to prevent the blowing out of the remaining tin when the latter fuses.

The oxide formed may take several forms, two of which are illustrated in Figs. 1 and 2. In Fig. 1 the oxide has assumed the form of a network throughout the tin, starting from the water side of the plug, whereas in Fig. 2 a solid oxide mass has formed at both ends. The tin in all cases in which such oxidation has occurred is impure, containing from 0.3 percent to 5 percent of zinc or lead, and in no plugs of the 150 odd examined, which contained pure tin, was any trace of oxidation of these types noticed. In particular, it was shown both by examination of used plugs and by service tests of plugs at the Bureau that zinc in amounts as low as 0.3 percent may be the cause of the "network" oxidation of tin in boiler plugs.

The effect of zinc may be ascribed to the fact that it does not form a solid solution with tin, but is present as practically pure metallic zinc, which forms upon long heating at around 180 to 185 degrees C. a coalesced network structure. Certain boiler waters (alkaline ones, for example) will attack the zinc and corrode their way into the tin, forming the honeycombed oxide structure referred to.

From the results of the investigation it is shown that pure tin must be specified for such plugs, and when such tin is used, the danger of oxidation of these plugs is probably entirely eliminated. The safest practice would be to specify tin to be 99.9 percent pure and to contain less than 0.01 percent each of zinc and lead, which would admit only Banca and one or more others of the purest varieties. It is, however, probable that tin of 99.8 percent purity, containing less than 0.01 percent of zinc and 0.50 percent of lead, is sufficiently pure for use in fusible plugs, and such a specification includes most of the high grade tin brands on the market.

Fig. 1

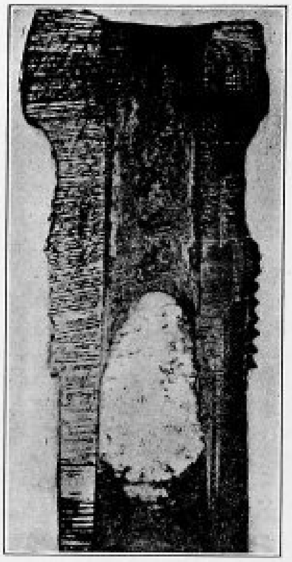


Fig. 2

A quick and convenient method of determining whether a tin sample contains amounts of impurities as great as 0.1 or 0.2 percent is that of the determination of its melting or freezing point. Such a method is well adapted for use whenever a chemical analysis cannot be conveniently made.

* A paper presented at the annual meeting of the American Institute of Metals, Atlantic City, September, 1915.

Standard, heavy, extra heavy and hydraulic pipe of any given size do not vary in outside diameter, but only in the inside diameter.

Remember that half-inch bolts and screws sometimes have 12 threads to the inch and sometimes 13. This often makes trouble and all hands should get together and agree on one or the other pitches.

The more awkward the place you have to work in, the greater the care you should take to be sure of making a good job. Such conditions show whether you are an honest workman and know your trade.

Boiler Patches and Diagonal Joints

How to Figure the Working Pressure, Factor of Safety and Strength of a Diagonal Seam in a Boiler Patch

BY C. B. LINSTROM

The methods of making patches shown in Figs. 1 and 2 were presented with the request for data showing how the working pressure, factor of safety and strength of diagonal seams are worked out. Before taking up the discussion of these points, however, it is well to explain a few things in connection with the matter of patching boilers.

In figuring on making a patch, the following factors must be considered so as to handle the work to advantage:

1. The character of the injury.
2. Extent of its defect and location.
3. Size of patch, its thickness and arrangement of rivets or patch bolts.
4. Working pressure on the boiler.
5. Allowable pressure after the patch is made.

Whenever a part of a boiler shell is removed for making repairs, it should be the aim to make the patchwork as strong as possible within the bounds of good practice, so as to insure the strength of the boiler at the weakened part. All riveted joints in patches should not be stronger than is necessary beyond required strength, as it is needless to go to the extra expense and make patch seams stronger than the other riveted joints. In calculating the efficiency of joints for patches it is a good plan to observe the construction of the boiler joints under repair.

Patches are applied inside or outside the boiler plate, and from the way they are attached two shop terms have been derived, namely, *soft* and *hard* patches. The soft patch is usually a temporary one and made without removing the damaged plate, and it may be held with patch bolts. The hard patch is applied after the defective plate has been removed; it is riveted and should be carefully calked to make it steam tight. Inside patches are found to be faulty in this respect. The lap of the patch prevents the water or steam from coming in contact with the lap of the boiler; as a result the boiler lap is soon overheated and burns away. If another patch is then made the burnt plate must be removed, making it necessary to have a larger patch. A patch placed on the outside prevents this and it is usually much easier to handle outside patches.

By referring to Fig. 1 will be seen the general arrangement of the patch and its joints. This patch was designed for reinforcing a pitted shell. Its longest dimension on line *a-b* is to be fitted to the curvature of the boiler. Line *c-d* is in the plane of the centerline of the shell. The view (*a*) gives the pitch of the rivets and their arrangement, which are staggered and double riveted. View (*b*) is a section through the center of the patch on line *c-d*; it shows the shell *e* and a ½-inch inside patch *f* and a ½-inch outside patch *g*. The method of making such a patch is unusual; it is unnecessary to reinforce a pitted shell with two plates. The cost is also great. Owing to the thickness of plates *e* and *f* water cannot come in contact with plate *g*, hence the outside patch will soon become overheated and burn off. This will also affect the

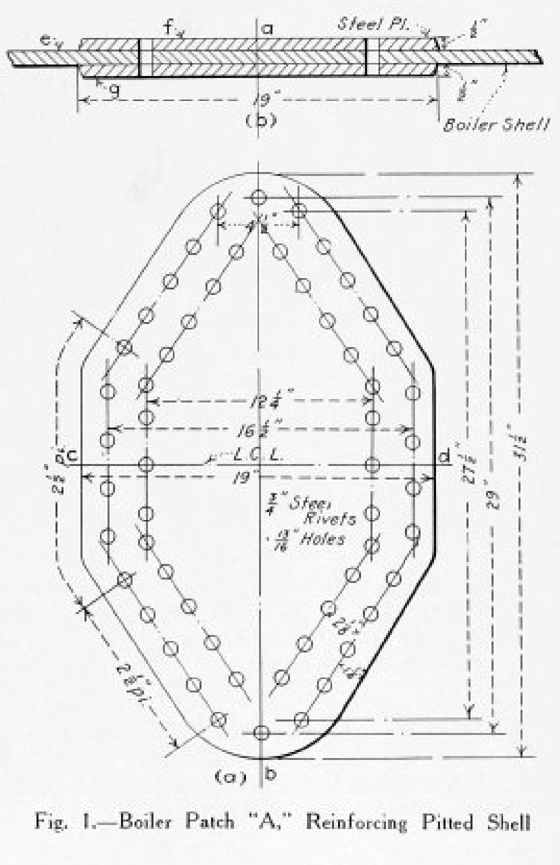


Fig. 1.—Boiler Patch "A," Reinforcing Pitted Shell

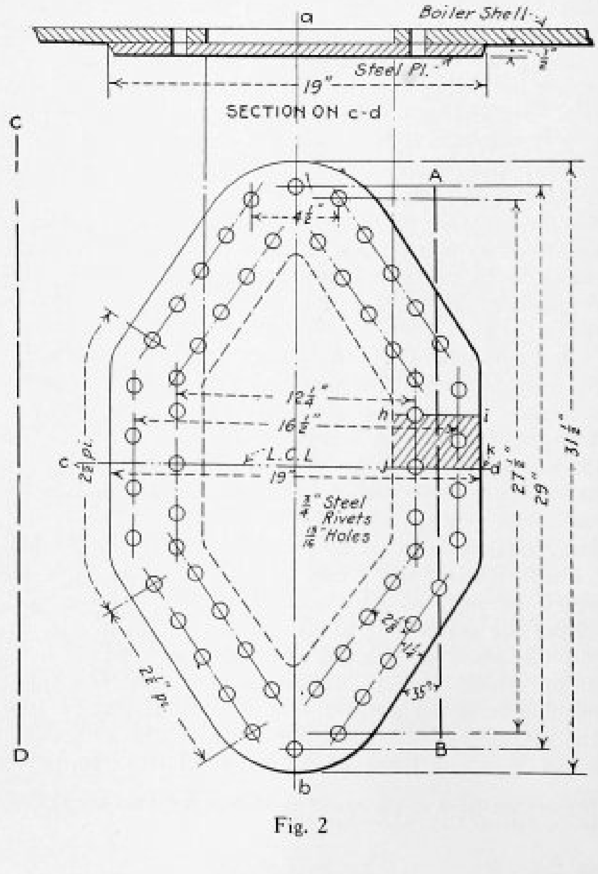


Fig. 2

shell plate *e*, which, within a short time may meet the same result, consequently entailing additional expense, inconvenience, and the time lost when the boiler is out of commission during repairs.

Very often a boiler becomes pitted and worn, but it is not always desirable to discontinue its use to make repairs when it is needed. In such a case, the thickness of the damaged plate should be found and the pressure reduced so that the boiler is safe. The following method of finding the allowable pressure may be used:

Rule—Multiply the original working pressure by the thickness of the damaged plate and divide by the original thickness of the plate.

Example—Boiler pressure equals 200 pounds, plate thickness equals 9/16 inch, pitted part of shell equals 7/16 inch in thickness, find the allowable pressure. Applying the rule:

$$\frac{200 \times \frac{7}{16}}{\frac{9}{16}} = 155\frac{1}{2} \text{ pounds.}$$

In making a patch to be strong enough to carry a pressure of 150 pounds, as required in Fig. 1, we will consider it from the standpoint of good practice. Therefore, instead of using two patch plates, as in Fig. 1, one plate will be employed, as in Fig. 2.

The damaged plate is removed first and the patch made of sufficient size to fit the opening in the shell plus the necessary allowances for lap. The rules employed in calculating the efficiency of patch joints are the same as those used in boiler design.

The first step in this example is to establish the strength of the diagonal seams of the patch, as it can be proved that for a given pressure the stress in the shell of a boiler is twice as great in the longitudinal seam as in the girth or circumferential seam. For this reason the girth seam need be only one-half as strong as the longitudinal seam. This explains why girth seams are usually single riveted. The efficiency of the joint along the girth *AB*, as compared with the solid plate through *CD*, Fig. 2, can be readily figured as follows:

Using the data in Fig. 2, find the strength of the net sections of plate is one unit of length of the patch as at *h-i-j-k*. It is the customary procedure to work from the unit length, as the joint is made up of a number of these units; and if the strength is established for one unit, its efficiency is used for the whole joint. The efficiency of the net section of plate as compared with the solid plate may be found in two ways, first by this formula:

$$\frac{P - d}{P} = E,$$

where P = pitch of rivets,
d = diameter of rivet holes,
E = efficiency.

Substituting values given in Fig. 2, we have:

$$\frac{2\frac{1}{2} - 13/16}{2\frac{1}{2}} = 67\frac{1}{2} \text{ percent.}$$

Or the efficiency of the net sections may be calculated by first finding the strength of the solid plate and the net section of plate. Then divide the strength of the net section by the strength of the solid plate. In this example let 60,000 equal the tensile strength of plate. Then 60,000 × ½ × 2½ = 75,000 pounds, strength of solid plate, if no rivet holes are punched in the plate.

The net section of plate = 2½ — 13/16 = 1.6875 inches; 1.6875 × ½ × 60,000 = 50,625 pounds, strength of net section; 50,625 ÷ 75,000 = 67½ percent. So far the joint's efficiency has been figured only for the net plate section. The strength of the rivets as compared with the solid plate must also be found, and upon the weakest efficiency of the joint is based the allowable pressure on the boiler; ¾-inch steel rivets are used in the patch, but in figuring their shearing resistance use their driven size, which is 13/16 inch in this case. Let 45,000 pounds equal ultimate shearing strength of rivets per square inch.

In the net section *h-i-j-k* there are two rivets in single shear. Area of rivet 13/16 inch in diameter = .52 square inch. .52 × 2 = 1.04 square inches, area of two rivets. 45,000 × 1.04 = 46,812 pounds, strength of two rivets

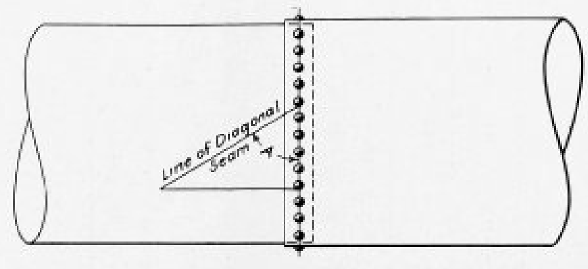


Fig. 3

in single shear. Divide the rivet strength by the solid plate strength to find the efficiency of rivets as compared with the solid plate. Then 46,812 ÷ 75,000 = 62.4 percent, approximately.

The rivet efficiency is less than the net plate efficiency, therefore it will be used in making the calculations for the diagonal joint efficiency. It is evident that the effective strength of the seam on *AB* is .624 × 2 = 1.248 times as great as the solid plate of equal unit length along the longitudinal line of the boiler. As the joint also runs in a diagonal direction, its effective strength lies between 62.4 and 124.8 percent, when compared with a constant unit of solid plate of equal length. Its efficiency will vary according to the angle that the joint makes with the circumferential seam. The following formula has been derived by trigonometry for finding factors to be used for the different angles given in the accompanying table.

$$\text{*Factor} = \frac{2}{\sqrt{\text{sine of angle of inclination}^2 \times 3 + 1.}}$$

The following table gives the factors for angles met with the most in practice:

Angle	Factor
30°	1.51
35°	1.42
40°	1.34
45°	1.27
50°	1.20
55°	1.15
60°	1.11
65°	1.08

In using these factors for finding the efficiency of a diagonal joint proceed in this way:

First determine the efficiency of the diagonal joint as for a longitudinal joint. Then measure the angle that the diagonal seam makes with the circumferential or girth seam; in this case it equals 35 degrees. From the table take the factor corresponding with the angle and multiply the efficiency found for the longitudinal joint by the factor which gives the efficiency of the diagonal joint. Then

* NOTE—Sine of angle of inclination equals sine of angle with girth seam as angle *A*, Fig. 3.

in this example the diagonal joint efficiency equals 62.4 $\times$ 1.42 = 88.6 percent.

The factor of safety is the ratio between the bursting and safe working pressure allowed on the boiler. The

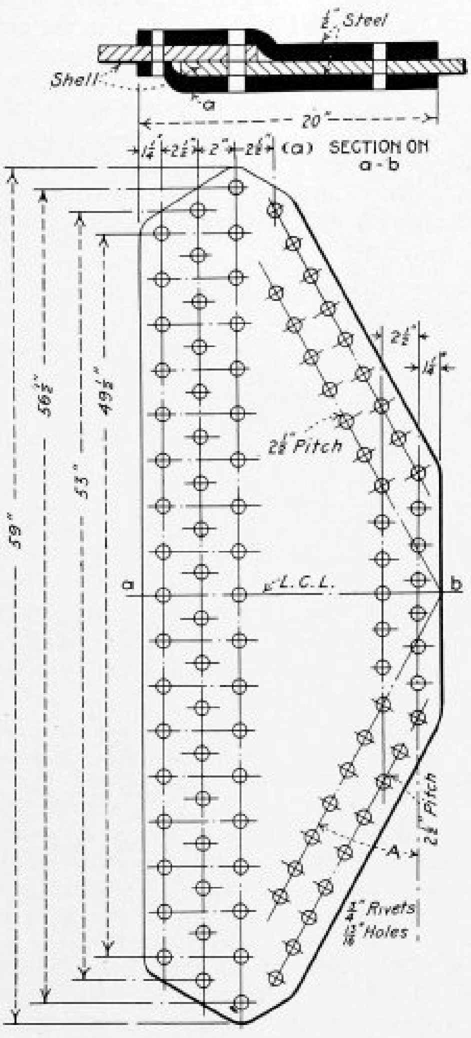


Fig. 4.—Boiler Patch "B." Patch Applied to Cover Pitted and Grooved Shell

bursting pressure for a cylinder without seams may be found according to formula:

$$P = \frac{T \times t}{D}.$$

Where P = bursting pressure,
t = two thicknesses of plate in inches,
D = diameter of boiler in inches,
T = tensile strength of plate in pounds.

Example—Find the bursting pressure that will break a boiler 50 inches in diameter, when tensile strength of plate equals 60,000 pounds, plate thickness equals ½ inch. Substituting values and using the formula given, the bursting pressure equals:

$$\frac{60{,}000 \times \frac{1}{2} \times 2}{50} = 1{,}200 \text{ pounds.}$$

Consider in the example given that the boiler pressure is 150 pounds per square inch; find the factor of safety; then 1,200 ÷ 150 = 8, factor of safety.

For a boiler of this size and working pressure of 150 pounds a triple-riveted lap joint having an efficiency of 75 percent can be employed. If the boiler is made with such a seam the bursting pressure that would rupture it would be 75 percent of the bursting pressure found in the preceding example; then 1,200 $\times$ .75 = 900 pounds.

900 ÷ 150 = 6 as the factor of safety.

The safe working pressure that may be allowed on a boiler may be determined by this formula:

$$P = \frac{T \times E \times t \times 2}{D \times F}.$$

Let T = tensile strength of plate in pounds,
P = allowable pressure in pounds per square inch,
E = efficiency of longitudinal joint,
t = thickness of plate,
D = diameter of boiler in inches,
F = factor of safety.

Substituting values given in the previous example to find the working pressure, we have:

$$P = \frac{60{,}000 \times .75 \times \frac{1}{2} \times 2}{50 \times 6} = 150 \text{ pounds.}$$

When patching a shell, as in Fig. 4, it should be borne in mind what effect the heat will have upon the patch and rivets next to the fire. Assuming plate *a* of the section view (*a*) to be on the outside, or fireside of the shell, it will be evident that, on account of the shell plate thickness and inside patch, that the plate *a* will not have any of the cooling effects of the water; hence this plate will burn off within a short time, which will affect the safety of the boiler at the weakened part.

Good practice to insure safety should be followed, and what was said in regard to Fig. 1 is applicable to the patching of the plate in Fig. 4. The rules for finding the efficiency of lap joints, as applied for Fig. 2, should be used in this example also. The pitch and size of rivets, thickness of plate, size of boiler and working pressure are the same for Fig. 4 as for Fig. 2. Then if the damaged plate is removed and one patch plate is employed as described for Fig. 2, the diagonal joint efficiency would be determined in the same manner. The angle *A*, of Fig 4, between the girth and diagonal seam, is 28 degrees in this case, so by applying the formula given to find the factor we have:

$$\text{Factor} = \frac{2}{\sqrt{(\text{sine } 28^\circ)^2 \times 3 + 1}} = \frac{2}{\sqrt{.454^2 \times 3 + 1}} = 1.57$$

The strength of the diagonal seam in percentage as compared with solid plate when in a horizontal position in this case, as in Fig. 2, equals 62.4 percent. Then 62.4 $\times$ 1.57 = 98 percent efficiency of diagonal joint when at an angle of 28 degrees with the girth seam.

The formula given for finding the factor used in calculating the efficiency of diagonal joints is an approximate one, but may be relied upon to give results on the side of safety, providing such joints are properly proportioned with respect to plate and rivet efficiencies as described for longitudinal joints.

Referring to Fig. 4 again, it is evident that such a patch would be stronger than if one patch plate is used, as shown in Fig. 2, for the following reasons, *first*, because the rivets are in double shear, which increases their shearing resistance 1.85 more per square inch than when they are in single shear; *second*, the plate is stronger, as the resistance of the shell plate and the inside patch relieves the pressure on the rivets and outside patch. But the fact that such a patch connection is strong from this point of reasoning, it is not good practice in view of what has been said with regard to the number of plates so arranged.

Layout of Elliptical Tank Bottom

Patterns for Bottom Plates of Large Cylindrical Tank With Bottom of Elliptical Section

BY J. L. WILSON

The half plan and elevation of an elliptical tank bottom to be made up of ten plates is shown in Fig. 1. The tank has an inside diameter of 25 feet and the bottom is 6 feet 3 inches deep.

To lay out the ellipse with *D-F* and *D-E* as the semi-axes, construct arc *E-H* and lay off distance *H-F* along *E-F* as *E-G*. Now, through the center of *G-F* draw a right line by cutting arcs *m* and *n* about *G* and *F* with any convenient radius. Extend the line *m-n* so drawn until it cuts the axis of the tank as at *A*, giving both *A* and *B* as

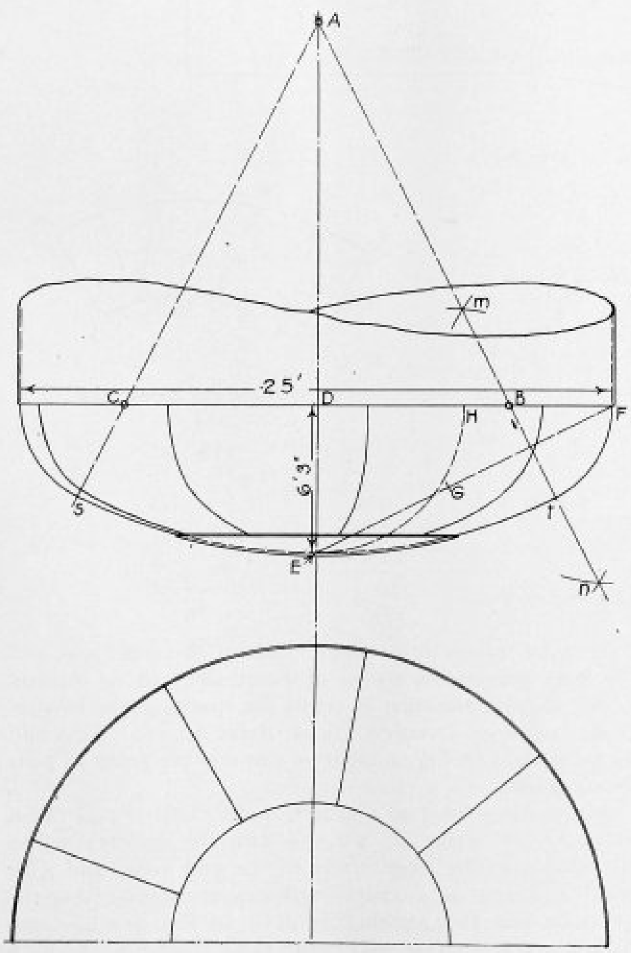


Fig. 1

centers for the arcs forming the ellipse; i. e., arc *F-t* about *B*, and arc *t-s* about *A* with respective radii.

The same is done for the other side, givng *C* as a center for the remaining portion of the ellipse.

Dividing the Surface

In Fig. 2 the outline of the surface is shown with *A-B* as the axis of the tank and *A-C* the extent or depth of the bottom. The extreme bottom is formed of a circular, dished plate, which in this case may be made as large as is convenient in handling.

The dished plate is formed from a flat, circular plate with radius equal to *A-m*, shown in the elevation, Fig. 2. The layout of this plate is shown in Fig. 3 as a circle about *A* as a center.

In Fig. 2 the remainder of the surface is divided into nine equal parts by radiating straight lines in the plan to points 1, 2, 3, etc., and by the corresponding curved lines projected into the elevation, as shown clearly by the construction and projection lines in the figure. All of these parts of the surface are similar in size and shape to the rivet line, so that the layout of one will be sufficient.

Through the center *A* of the plan a radius *A-g* is drawn

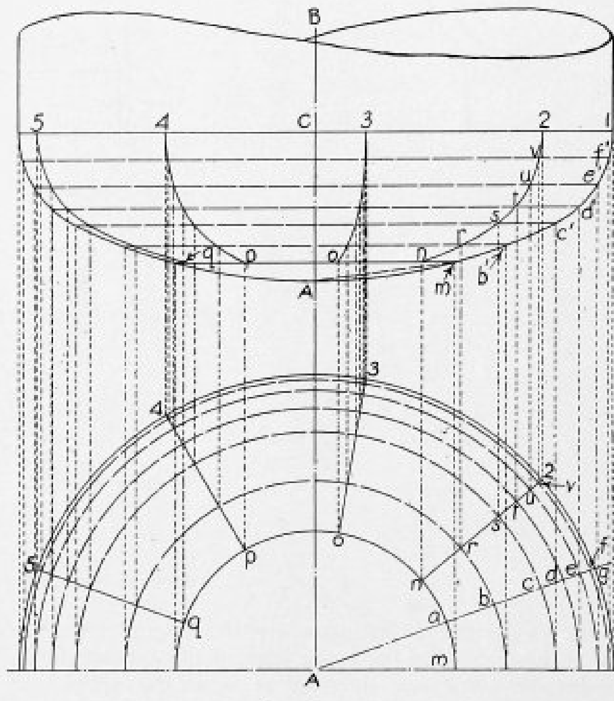


Fig. 2

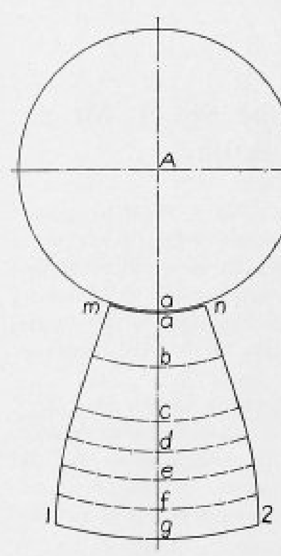


Fig. 3

as a center line of one of the plates. This line is shown in its true length and form as the arc of the ellipse in elevation as 1-*m*-*A*, Fig. 2.

Developing the Pattern

In Fig. 3 a straight line, *A-g*, is drawn equal in length to the arc 1-*m*-*A* in the elevation, Fig. 2. The length of this arc may be found by spanning it with the spanners set at a small distance apart and counting the number of spans to complete the arc.

Along the line *A-g*, Fig. 3, corresponding spots are marked off for points *m*, *b′*, *c′*, *d′*, *etc.*, measured along the arc in the elevation of Fig. 2. Through these spots in Fig. 3 arcs are drawn as shown about *A* as a center. Then about the center line *A-g* the widths of the pattern are laid off on these arcs by transferring them from the corresponding points on the center line in the plan, Fig. 2. In each case the width is measured along the arc by spanning, or some convenient method, and laid off along the arc, as shown in Fig. 3.

By joining the spots so found we obtain an outline of the layout of the plate as 1-2-*n*-*m* in Fig. 3.

It is seen in Fig. 3 that the arcs where the two plates join have different radii, but an inspection of the elevation Fig. 2 explains the difference, since the straight line *A-m* is the radius for the dished plate and the length of the arc *A-m* is the radius for the lower edge of the curved plate.

Sufficient allowance must be made at the upper and lower edges of all side plates where they join inside of the tank and dished plate. The other joints will probably be formed with butt straps.

Development of a Slope Sheet for a Locomotive Boiler

BY J. H. BROOKS

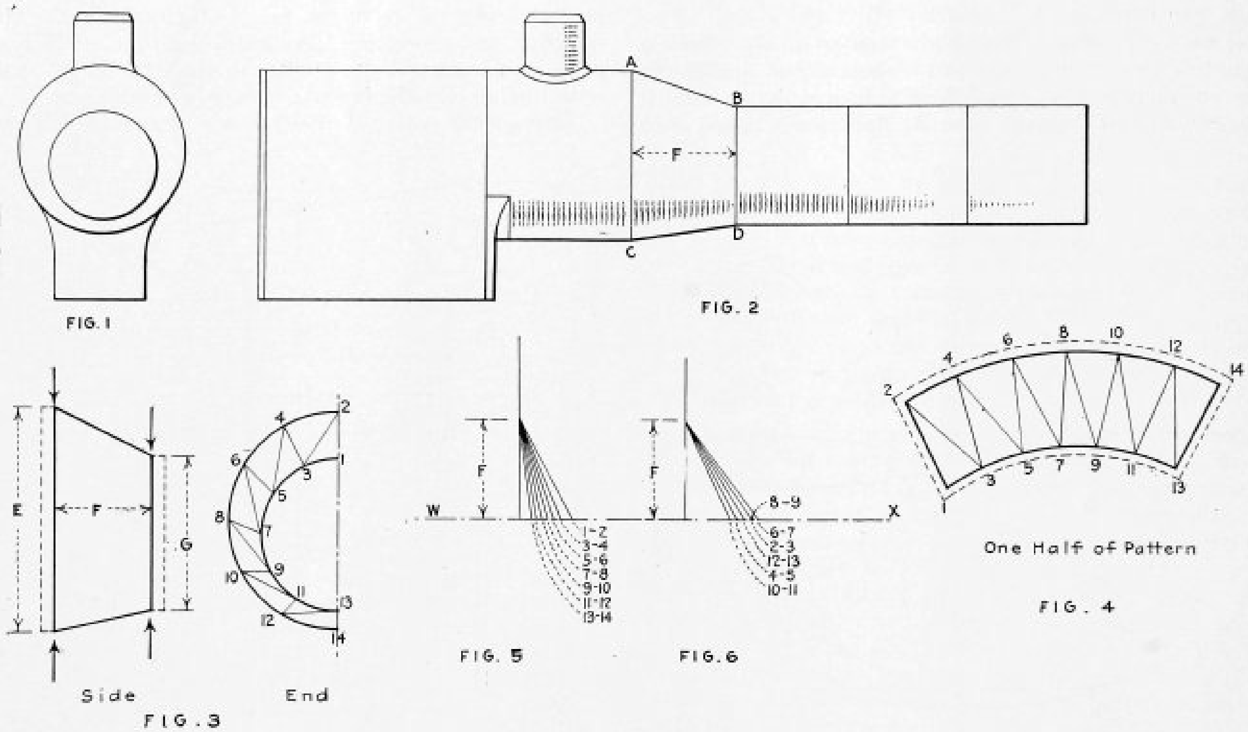
The development of the pattern for a slope or gusset sheet of a locomotive boiler is considered by some to be a very intricate problem. I present to the readers of this magazine a very simple and accurate method of laying out this sheet. Before beginning the explanation of the drawing, however, I desire to state that these drawings are not drawn to scale.

Draw the two views of the sheet, as shown in Fig. 3. Suppose the seam to be at *A-B*, Fig. 2, and the sheet to be made in one piece. Divide the semicircle in the end view into any number of equal parts, in this case six. The greater number of these divisions, the more accurate will be the results.

Join the points 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9, 9-10, 10-11, 11-12, 12-13, 13-14, as shown in the end view. The end view should be drawn with measurements from the center of the iron. This view should be constructed very accurately, as on it depend all future measurements.

Now construct Figs. 5 and 6, make *F* in Figs. 5 and 6 equal to *F*, Fig. 2. Draw *W-X* at right angles to *F*. On this line lay off the distances 1-2, 3-4, etc., in Fig. 5, these to be taken from end view. Now lay off the distances 2-3, 4-5, etc., in Fig. 6, these to be taken from end view also.

We are now ready to lay out the templet or pattern. Erect the line 1-2, Fig. 4, which is taken from and is equal to *A-B*, Fig. 2. Now with 2 as a center and a radius (2-3) taken from Fig. 6 strike an arc. Set two pairs of dividers,



Layout of Slope Sheet of Locomotive Boiler

one to the spaces in the large circle of the end view, and the other pair to the spaces in the small circle of the end view. With a pair that is set to the spaces in the smaller circle, and 1 as a center, Fig. 4, strike an arc. This will locate point 3 in Fig. 4 and give you another point in your development.

Now with point 3 as a center and a radius (3-4) taken from Fig. 5, strike an arc and with the dividers set to the spaces in the large circle of the end view, and with point 2, Fig. 4, as a center, strike an arc intersecting the previous arc and locating point 4 in the development. Continue this process, taking the radii from Figs. 5 and 6 alternately until the point 14 is reached. This completes the development of one-half of the pattern.

You will note that these points locate the flange line and that the lap for riveting must be added as shown in the dotted lines in Fig. 4. This is shown more plainly in Fig. 3 by the arrows. Line 13-14 at the end of the pattern is the rivet line.

In business watch your competitors. No one man has a monopoly of all the best brains and methods. Let competition be an incentive to your energy and ambition. Give the other fellow a fair, square deal and beat him out on your merits.

Differences in Layouts of Two-Piece Elbow with Butt and Lap Seams

BY E. EATON

A practical and experienced layerout is always and ever on the lookout for every new job he has in hand. He must not overlook any detail, for if he does he is likely to make a very serious mistake. An apprentice must also look twice and then look again to be sure that he knows what he is to face before he starts to lay out the object.

If we are to lay out a two-piece butting elbow, as shown in Fig. 1, we have only to lay out one course and use the first one as a templet for the second one. Bear in mind, however, that when you are about to lay out anything, always use the neutral diameter, which is the diameter to the center of the thickness of the iron to be used. Also use the rivet line as a guide. Looking at Fig. 1 again you will notice that I am using the neutral diameter, which is midway of the inside and outside diameters.

Having constructed Fig. 1, which is a butting elbow, let us take up the lapping elbow, Fig. 2. In the layout of Fig. 2 you will notice that there is quite a noticeable difference in the outlines, also in the spacing of the holes compared with that of Fig. 1 (the thicker the iron the greater the difference).

The drawing work in Figs. 1 and 2 is very simple and self-explanatory in all its details, and, if intelligently followed, will give all the necessary information required.

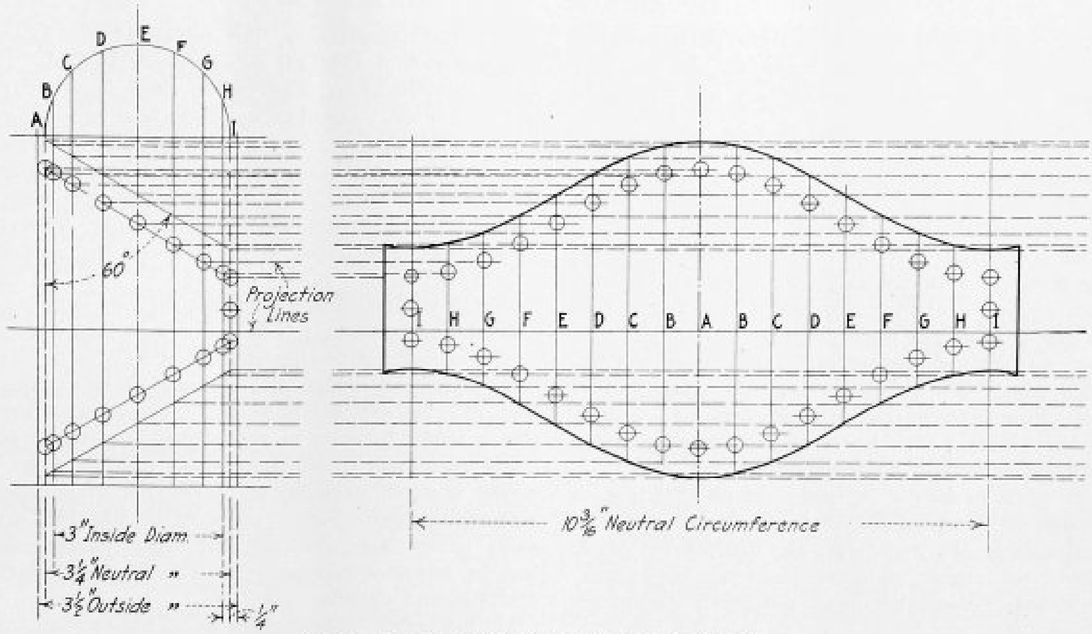


Fig. 1.—Layout of Two-Piece Elbow with Butt Seams

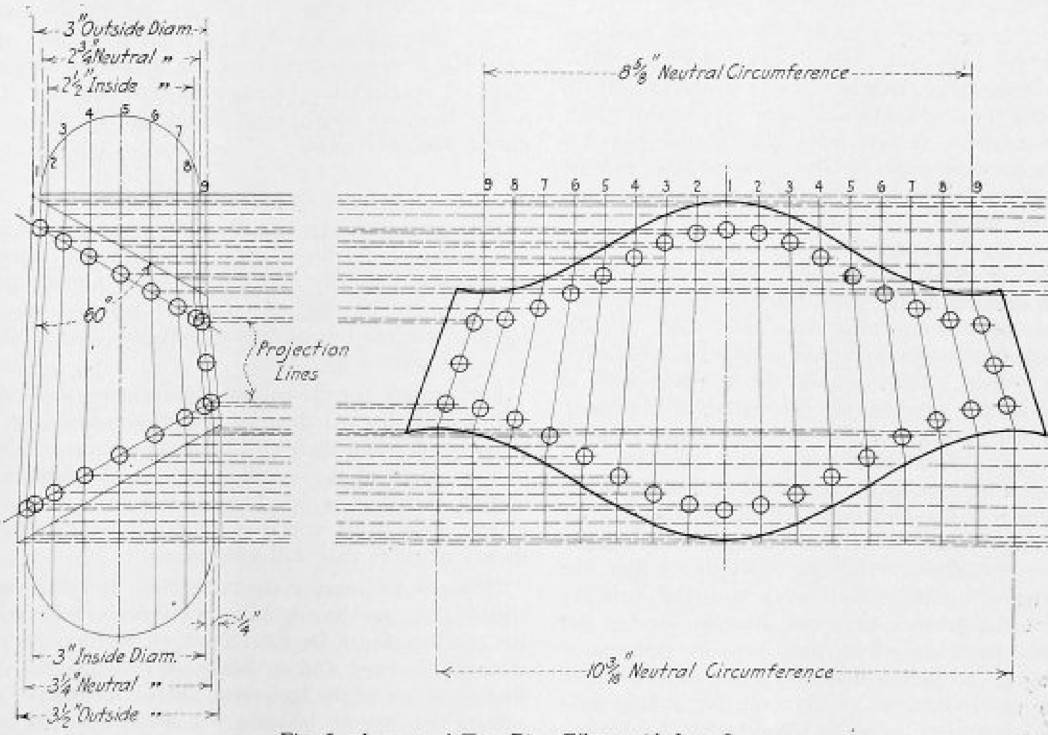


Fig. 2.—Layout of Two-Piece Elbow with Lap Seams

Relation Between Production and Costs*

Proper Distribution of Overhead Charges in Manufacturing —Principles That can be Applied to Boiler Making

BY H. L. GANTT

Manufacturers in general recognize the vital importance of a knowledge of the cost of their product, yet but few of them have a cost system on which they are willing to rely under all conditions.

While it is possible to get quite accurately the amount of material and labor used directly in the production of an article, and several systems have been devised which accomplish this result, there does not yet seem to have been devised any system of distributing that portion of the expense known variously as indirect expense, burden or overhead, in such a manner as to make us have any real confidence that it has been done properly.

There are in common use several methods of distributing this expense. One is to distribute the total indirect expense, including interest, taxes, insurance, etc., according to the direct labor. Another is to distribute a portion of this expense according to direct labor, and a portion according to machine hours. Other methods distribute a certain amount of this expense on the material used, etc. Most of these methods contemplate the distribution of *all* of the indirect expense of the manufacturing plant, however much it may be, on the output produced, no matter how small it is.

Distribution of Overhead Charges

If the factory is running at its full, or normal, capacity, this item of indirect expense per unit of product is usually small. If the factory is running at only a fraction of its capacity, say one-half, and turning out only one-half of its normal product, there is but little change in the total amount of this indirect expense, all of which must now be distributed over half as much product as previously, each unit of product thereby being obliged to bear approximately twice as much expense as previously.

When times are good, and there is plenty of business, this method of accounting indicates that our costs are low; but when times become bad and business is slack, it indicates high costs, due to the increased proportion of burden each unit has to bear. During good times, when there is a demand for all the product we can make, it is usually sold at a high price and the element of cost is not such an important factor. When business is dull, however, we cannot get such a high price for our product, and the question of how low a price we can afford to sell the product at is of vital importance. Our cost systems, as generally operated at present, show under such conditions that our costs are high and, if business is very bad, they usually show us a cost far greater than the amount we can get for the goods. In other words, our present systems of cost accounting go to pieces when they are most needed. This being the case, many of us have felt for a long time that there was something radically wrong with the present theories on the subject.

As an illustration, I may cite a case which recently came to my attention. A man found that his cost on a certain article was 30 cents. When he found that he could buy it for 26 cents, he gave orders to stop manufacturing and to buy it, saying he did not understand how his competitor could sell at that price. He seemed to realize that there was a flaw somewhere, but he could not locate it. I then asked him what his expense consisted of. His reply was labor 10 cents, material 8 cents, and overhead 12 cents. My next question was: Are you running your factory at full capacity? I got the reply that he was running it at less than half its capacity, possibly at one-third. The next question was: What would be the overhead on this article if your factory were running full? The reply was that it would be about 5 cents; hence the cost would be only 23 cents.

The possibility that his competitor was running his factory full suggested itself at once as an explanation.

The next question that suggested itself was how the 12 cents overhead, which was charged to this article, would be paid if the article was bought. The obvious answer was that it would have to be distributed over the product still being made, and would thereby increase its cost. In such a case it would probably be found that some other article was costing more than it could be bought for; and if the same policy were pursued, the second article should be bought, which would cause the remaining product to bear a still higher expense rate.

If this policy were carried to its logical conclusion, the manufacturer would be buying everything before long, and he would be obliged to give up manufacturing entirely.

The illustration which I have cited is not an isolated case, but is representative of the problems before a large class of manufacturers, who believe that *all of the expense, however large, must be carried by the output produced, however small.*

A Fallacious Theory

This theory of expense distribution is quite widespread, and clearly indicates a policy which in dull times would, if followed logically, put many of our manufacturers out of business. In 1897 the plant of which I was superintendent was put out of business by just this kind of logic. It never started up again.

Fortunately for the country, American people as a whole will finally discard theories which conflict with common sense and, when their cost figures indicate an absurd conclusion, most of them will repudiate the figures. A cost system, however, which fails us when we need it most is of but little value and it is imperative for us to devise a theory of costs that will not fail us.

Most of the cost systems in use, and the theories on which they are based, have been devised by accountants for the benefit of financiers, whose aim has been to criticise the factory and to make it responsible for all the shortcomings of the business. In this they have succeeded admirably, largely because *the methods used are not so devised as to enable the superintendent to present his side of the case.*

Our theory of cost keeping is that *one of its prime functions is to enable the superintendent to know whether or not he is doing the work he is responsible for as economically as possible*, which function is ignored in the majority of the cost systems now in general use. Many accountants, who make an attempt to show it, are so long in getting their figures in shape that they are practically

* From a paper read before the American Society of Mechanical Engineers, Buffalo, N. Y., June, 1915.

worthless for the purpose intended, the possibility of using them having passed.

In order to get a correct view of the subject we must look at the matter from a different and broader standpoint. The following illustration seems to put the subject in its true light:

Let us suppose that a manufacturer owns three identical plants, of an economical operating size, manufacturing the same article—one located in Albany, one in Buffalo and one in Chicago—and that they are all running at their normal capacity and managed equally well. The amount of indirect expense per unit of product would be substantially the same in each of these factories as would be the total cost. Now suppose that business suddenly falls off to one-third of its previous amount and that the manufacturer shuts down the plants in Albany and Buffalo and continues to run the one in Chicago exactly as it has been run before. The product from the Chicago plant would have the same cost that it previously had, but the expense of carrying two idle factories might be so great as to take all the profits out of the business; in other words, the profit made from the Chicago plant might be offset entirely by the loss made by the Albany and Buffalo plants.

If these plants, instead of being in different cities, were located in the same city, a similar condition might also exist in which the expense of the two idle plants would be such a drain on the business that they would offset the profit made in the going plant.

Instead of considering these three factories to be in different parts of one city, they might be considered as being within the same yard, which would not change the conditions. Finally, we might consider that the walls between these factories were taken down and that the three factories were turned into one plant, the output of which had been reduced to one-third of its normal volume. Arguing as before, it would be proper to charge to this product only one-third of the indirect expense charged when the factory was running full.

Correct Theory of Expense Distribution

If the above argument is correct, me may state the following general principle: *The indirect expense chargeable to the output of a factory bears the same ratio to the indirect expense necessary to run the factory at normal capacity, as the output in question bears to the normal output of the factory.*

This theory of expense distribution, which was forced upon us by the abrupt change in conditions brought on by the war, explains many things which were inexplicable under the older theory, and gives the manufacturer uniform costs as long as the methods of manufacture do not change.

Under this method of distributing expense there will be a certain amount of undistributed expense remaining whenever the factory runs below its normal capacity. A careful consideration of this item will show that it is not chargeable to the product made, but is a business expense incurred on account of our maintaining a certain portion of the factory idle, and chargeable to profit and loss. Many manufacturers have made money in a small plant, then built a large plant and lost money for years afterwards, without quite understanding how it happened. This method of figuring gives a clear explanation of that fact and warns us to do *everything possible to increase the efficiency of the plant we have, rather than to increase its size.*

This theory seems to give a satisfactory answer to all the questions of cost that I have been able to apply it to, and during the past few months I have laid it before a great many capable business men and accountants. Some admitted that this viewpoint would produce a very radical change in their business policy, and are already preparing to carry out the new policy.

It explains clearly why some of our large combinations of manufacturing plants have not been as successful as was anticipated, and why the small, but newer plant, is able to compete successfully and make money, while the combinations are only just holding their own.

The idea so prevalent a few years ago, that in the industrial world money is the most powerful factor, and that if we only had enough money nothing else would matter very much, is beginning to lose its force, for it is becoming clear that *the size of a business is not so important as the policy by which it is directed.* If we base our policy on the idea that the cost of an article can only legitimately include the expense necessarily incurred either directly or indirectly in producing it, we shall find that our costs are much lower than we thought, and that we can do many things which under the old method of figuring appeared suicidal.

Cause of Confusion About Costs

The view of costs so largely held, namely, that *the product of a factory, however small, must bear the total expense, however large,* is responsible for much of the confusion about costs and hence leads to unsound business policies.

If we accept the view that the article produced shall bear only that portion of the indirect expense needed to produce it, our costs will not only become lower, but relatively far more constant—for the most variable factor in the cost of an article under the usual system of accounting has been the "overhead," which has varied almost inversely as the amount of the product. This item becomes substantially constant if the "overhead" is figured on the normal capacity of the plant.

Of course a method of accounting does not diminish the expense, but it may show us where the expense properly belongs, and give us a more correct understanding of our business.

In our illustration of the three factories, the cost in the Chicago factory remained constant, but the expense of supporting the Buffalo and Albany factories in idleness was a charge against the business, and properly chargeable to profit and loss.

If we had loaded this expense on the product of the Chicago factory, the cost of the product would probably have been so great as to have prevented our selling it, and the total loss would have been greater still.

When the factories are distinctly separate, few people make such a mistake, but where a single factory is three times as large as is needed for the output, the error is frequently made, with results that are just as misleading.

As a matter of fact it seems that the attempt to make a product bear the expense of plant not needed for its production is one of the most serious defects in our industrial system to-day, and farther reaching than the differences between employers and employees.

The problem that faces us is then first to find just what plant, or part of a plant, is needed to produce a given output, and to determine the "overhead" expense on operating that plant or portion of a plant. This is primarily the work of the manufacturer, or engineer, and only secondarily that of the accountant, who must, as far as costs are concerned, be the servant of the superintendent.

In the past, in almost all cost systems the amount of "overhead" to be charged to the product, when it did not include *all* the "overhead," was more or less a matter of judgment. According to the theory now presented, it is not a matter of judgment, but can be determined with an accuracy depending upon the knowledge the manufacturer has of the business.

Following this line of thought it should be possible for a manufacturer to calculate just what plant and equipment he ought to have, and what the staff of officers and workmen should be to turn out a given profit.

If this can be correctly done, the exact cost of a product can be predicted. Such a problem cannot be solved by a cost accountant of the usual type, but is primarily a problem for an engineer, whose knowledge of materials and processes is essential for its solution.

Having made an attempt to solve a problem of this type, one of the most important functions we need a cost system to perform is to keep the superintendent continually advised as to how nearly he is realizing the ideal set, and to point out where the shortcomings are.

Many of us are accustomed to this viewpoint when we are treating individual operations singly, but few have as yet made an attempt to consider that this idea might be applied to a plant as a whole, except when the processes of manufacture are simple and the products few in number. When, however, the processes become numerous or complicated, the necessity for such a check becomes more urgent, and the cost keeper who performs this function becomes an integral part of the manufacturing system, and acts for the superintendent, as an inspector, who keeps him advised at all times of the quality of his own work.

This conception of the duties of a cost keeper does not at all interfere with his supplying the financier with the information he needs, but insures that information shall be correct, for the cost keeper is continually making a comparison for the benefit of the superintendent, of what has been done with what should have been done. Costs are valuable only as comparisons, and comparisons are of little value unless we have a standard, which it is the function of the engineer to set.

Lack of reliable cost methods has, in the past, been responsible for much of the uncertainty so prevalent in our industrial policies; but with a definite and reliable cost method, which enables us to differentiate between what is lost in manufacturing and what is lost in business, it will usually become easy to define clearly the proper business policy.

The Manufacture of Circular Tanks

Special Problems Involved in Making Circular Tanks for Various Purposes—Galvanizing—Black Tank Work

BY A. L. HAAS

The making of tanks, while not involving problems of boiler importance, yet has some peculiarities of interest.

Modern boiler practice tends toward more exact methods with drilled holes, high-grade plates and first-class workmanship. For tanks to hold standing liquid and used for storage purposes, boiler methods are too refined and costly. The object aimed at in the tank trade is least cost combined with efficient tightness.

Customary practice in tank shops is influenced and largely made by reason of the thin gages employed. Multiple punching machines take sheets of considerable dimensions, and this gives exact alinement of holes with the economy incident to punching.

Whatever size of rivet is used it is hand closed by one man; even ⅝-inch rivets are thus treated. It is work of strenuous character to knock down rivets of this size single-handed, but such is the custom of the trade. Pitches and relative size of rivets used differ materially from usual boiler and structural practice. Pitches are closer and rivets larger than usual elsewhere; one thing only is aimed at—tight seams. It is obvious with the thin material employed that percentage strength of rivet area must necessarily exceed that of the plate.

Two distinct classes of workmanship are in evidence in tank work and separate the labor in two sections, one for black and one for galvanized work.

When the job is to be subsequently coated it is a mistake to make it too close and exact; in fact, if the job is too good the spelter may miss a hair crack, while if the aperture is more marked it is certain to be filled. Needless to say, no calking is done in the black where the job is to be subsequently galvanized. To calk would tend to defeat the merits of the later process.

There are troubles and problems incident to galvanizing. Some few tank firms do their own, but it is more the ordinary practice to send the work away to the specialist.

Galvanizing in its infancy was a secret process jealously guarded, and even to-day there is a tendency to wrap up the art in mystery; it is remarkable even now how few plate workers have any real knowledge of the matter or who have seen the operation. In every plate shop at least one responsible man should have the opportunity to spend a few hours watching the dipping, which, in truth, is a simple enough business so far as it concerns the plate worker's craft.

Current ignorance on the subject is emphasized by the following instance which came under the writer's notice. A quantity of steel welded drums of 150 gallons capacity were to be made up and subsequently galvanized. These were duly finished, having one 2-inch bung in the center of body sheet. It was a surprise of an alarming and astonishing character to the concern who made up the articles when the galvanizers declined to coat the job at any price, stating it was a physical impossibility to perform the work at all.

A hurried visit to the galvanizing firm followed, as the order had to be filled somehow and large quantities were involved. Had the makers of the drums been aware of the process, much trouble and expense would have been saved. It was evident from the most cursory examination that to get the molten spelter into the interior would be almost impossible and to get it out again more difficult still. In addition to the other drawbacks was the serious risk to the men arising from pocketed air, which would probably blow the molten spelter over them. The men absolutely declined to take the risk of injury, and their employer to waste his metal and spoil the drums.

To overcome the difficulty 3½-inch bungs were fitted to center of body sheet and a 2-inch bung located in end opposite position of the bung in bilge close up to flange

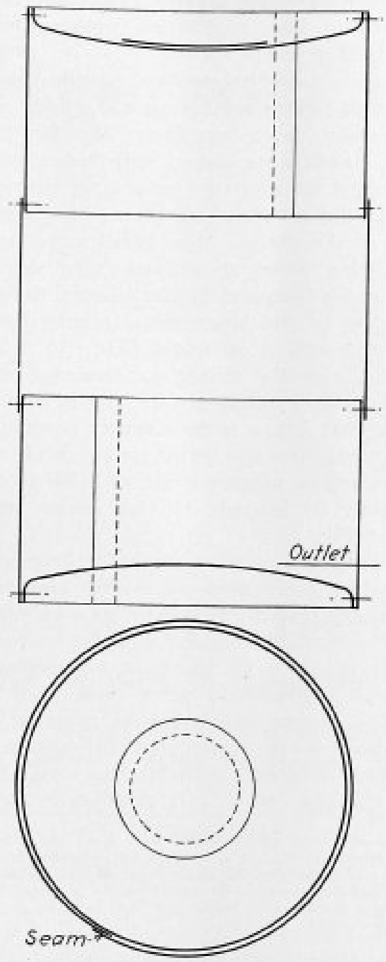


Fig. 1

of the end. Even so fitted it is sometimes difficult to get the metal out with sufficient speed. With spelter at its present price a few extra pounds per article would mean bankruptcy to the galvanizer who failed to allow for the circumstances of the case.

From similar considerations a few rivets are invariably left out of the bottom of even open top storage tanks. If this is not done, the galvanizer promptly removes them before starting operations. Such holes are usually tapped and galvanized slot head screws fitted afterwards.

Questions such as the foregoing are less likely to arise where the process has actually been watched in being by a common-sense individual, and if privileged to see a variety of articles dipped the experience has a real and definite value. No difficulty should be experienced in getting permission to view the process when placing orders for galvanizing; it could even be made a condition that such opportunity be granted.

Everyone realizes the necessity for a pattern maker to be in close touch with actual foundry practice, and while the necessity is not so marked every plate worker would benefit by at least one visit to the galvanizer.

To come to the question of black tanks. Unlike work to be subsequently coated, it is impossible to make these too good. Considerable skill and care are necessary to turn out tight black work in thin material. In fact, a tank maker whose experience is exclusively with work to be afterwards treated makes a poor fist when first started at black work.

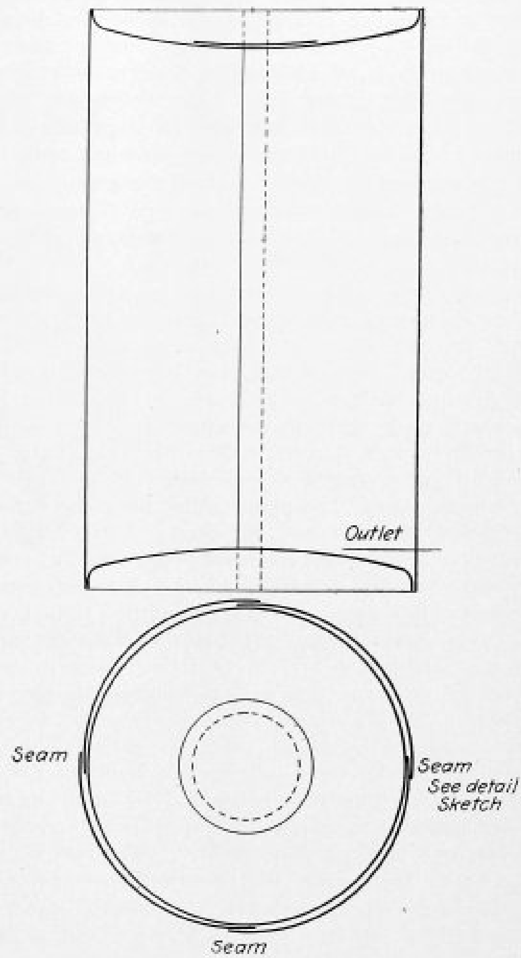


Fig. 2

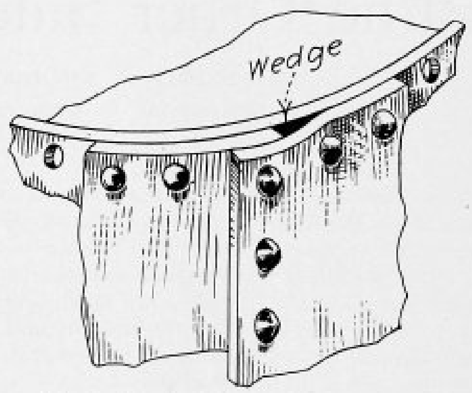


Fig. 3.—Detail of Seam Shown in Fig. 2

For difficult work canvas strips treated with boiled oil and red lead may be inserted in the seams, but some shops contrive to turn out creditable work without such aid. Sal ammoniac painted over the laps before riveting, and well brushed in some while before and after calking, will usually (given time and good work) insure a seam tight against standing liquid. If the finished tank can be kept in the open for a few days full of water, it generally takes up the weeps by rusting up. The virtues of "taking up in salt water" are well known and perhaps too much relied upon by the "black squad" whose business is concerned with ships.

Design is another factor with regard to tight work. The face side of the sheet from the punch must come together at the seam, and some care is necessary in laying out the job to render this certain. Further than this, the actual methods of making up have considerable influence upon the finished job. The following instance serves to emphasize this and also to show the relative difference in method between boiler shop and tank work.

For the purpose of storing fuel oil for engine use 600-gallon circular tanks were called for. The customer, realizing that the fluid itself was a preservative, declined to entertain the expense of galvanizing.

The tanks were to be 7 feet 6 inches high and 4 feet 5 inches diameter, with dished concave flanged heads. Beyond the fact that the tanks were to be 3/16 inch thick, the actual construction was left to the makers.

The first lot ordered were made by a regular boiler shop, which made them up as shown in Fig. 1, in three belts for body with stamped ends. The seam holes were marked off and punched at one long and one short lap of each body plate. The plates rolled up and other short edge marked through and punched. After assembling the belts the corresponding blank edges of the circular seams were marked through, taken apart and punched. Corners of plates were of necessity smithed to tuck under in the usual way. After the body was riveted up the heads were driven in and the existing holes in end of body served as templet to punch flange of heads. This construction follows closely the procedure for a vertical boiler.

Now these tanks were extremely difficult to get tight under test. Punching holes singly did not give fair holes; with small-sized rivets and with the scant amount of edge for calking it meant endless tinkering to get a tight job; in fact, when first tested there was leakage practically everywhere. The test, it must be stated, was merely that the job should be tight when full of water.

When another similar set of tanks came along the job was let to a tank maker at a much lower price. In fact, the boiler firm increased their former price, as in view of past experience they were entitled to do, making the difference in price considerable. The tank maker's design is shown in Fig. 2, and no trouble whatever was experienced under test.

All the sheets were holed by a multiple punch at all edges in the flat before rolling up. The body plates were rolled to templet for curvature. The body was then riveted up. Heads were dished with large wood mallets and edges rolled or spun up on a large jenny cold, the tank shop having no stamping plant. No smithing was done to any of the sheets. The heads were driven home and the existing holes at end of body were used as templets to punch flange of heads. To fill the gap left at the intersection of the longitudinal seams, head wedges were used and calked on edge (Fig. 3). It is probable that Fig. 2 is the stiffer job because of the four longitudinal seams extending full length of tank. It is quite obvious that Fig. 2 is the cheaper construction, and, as results proved also, the better tank. Such a construction would scarcely suggest itself to a boiler maker and would certainly be inadmissible for boiler work, hence the design of Fig. 1.

The two designs * could scarcely be bettered as illustrating the divergence between boiler and tank work; each trade meets its own problem in its own way.

Design is, after all, fitness for a destined end. Provided this is obtained in the most economical manner, he would be a rash man to quote recognized authorities to condemn a design successful in practice where the rules laid down were formulated for another purpose and for entirely different circumstances altogether.

* Needless to say, both shops would have used the same design for a smaller job where a single plate would be sufficient for the body of tank. Sheets 170 inches by 90 inches are unusual stock (although a maker's list shows 3/16 sheets 180 inches by 90 inches), leading to the necessity in both instances to make up the body in sections and incidentally to this article.

The Other Side of Boiler Inspection

Personality of the Inspector—Punctuality in Keeping Appointments—A Case of Overcoming Unusual Difficulties

BY J. P. MORRISON

It is generally conceded that a boiler inspector should know how to design, construct, install and operate a steam boiler properly, although there is a difference of opinion as to how that knowledge must have been obtained.

The fact that a mechanic applies for such a position is, of course, evidence that he is interested in that kind of work, but often the interest extends no further than obtaining a livelihood, and there is not that desire to serve his employer, whether an individual, corporation or the public, by accommodating those with whom he comes in contact in a business way, within the limits of the law and safety.

The personality of the inspector is of great importance, second only to mechanical knowledge, and has been likened to the attractive paper and string placed around the new pair of shoes we purchase. However, in many cases that virtue might better be compared with the soles of the shoes, as the personality of an inspector may be the means of having the owner of a boiler of questionable safety discontinue its service or make suitable repairs before it could logically be condemned as unsafe.

Closely associated with personality is the desire to keep appointments, which in the work of inspecting boilers is imperative, in order to discourage the idea that the inspector is a necessary evil which must be tolerated, now becoming so usual, particularly when the inspection is made by authority of law. The inspector who fails to keep his appointments is in a class with the engineer who, failing to prepare a boiler, thinks the inspector should remove the manhole plates, ashes and soot.

The possession of a ready wit and ability to form an accurate opinion quickly are as necessary in boiler inspection as in law or medicine. A desire to take advantage of the opportunities met and a liberal allowance of "horse-sense" must be as much a part of the inspector's outfit as is the hammer, test gage and carbide light. No doubt some inspectors have been more or less successful without many of the qualities mentioned, but so are there some who pose as boiler inspectors who do not use overalls when making internal inspections, but you "can't fool all of the people all of the time."

When the inspector appears at the shop to examine the material which is to enter into the construction of a boiler, giving it the "once over," as it were, or when the "twice over" is given the reaming of rivet holes and other work of construction, or, yet again, when the "third degree" in the form of a 150 percent hydrostatic test is applied to the completed boiler, there may be those who wonder why kindly Providence did not place them in such a position of authority, without realizing that but one corner of a polygon has been observed, and that the work of inspecting boilers carries responsibilities undreamed of by those who have never engaged in the work.

Of course, the inspector must arrange, or have arranged for him, his work in advance and know how best to reach each plant in order to eliminate useless traveling. Occasionally an unexpected call for an inspection causes a change in plans, which should of course be made without inconvenience to other boiler users, and often requires diplomacy of no mean sort.

A case of this kind arose recently when the owner of a sawmill in the lumber district of a neighboring State wired for an inspector, as he desired information as to needed repairs to one of his boilers. The trip would necessitate an all-night train ride and depended upon connections with other roads as to whether part of the next day would be spent upon the road, with like conditions governing the return trip.

The inspections which had been arranged for the following day could be taken care of by the other members of the force, but not so with the work of the second day, thus making it necessary for the trip to be completed in one day. An examination of the railroad time folders disclosed no way of reaching the destination before noon of the following day, with no opportunity of completing the round trip within the allotted time, but the State map showed a short line belonging to a logging company, leading from the main line of the railroad to be traveled, to the vicinity of the lumber mill, and if connections could be made with the log road undoubtedly the trip could be made without unnecessary loss of time.

Union depot and city ticket officials could give no positive information, but offered encouragement, so the night trip was commenced on a ticket to a point from which the going could be continued in the direction indicated to be the best, depending upon information yet to be obtained.

The railroad and Pullman conductors could give no information, so the night ride was completed, as begun, with no definite knowledge as to the route to be followed, but the encouraging advice was obtained by wiring ahead, when the breakfast stop was made, that the train on the logging road did not leave until after the trunk line train arrived. A quick decision to chance the log road was made, and a long chance it proved to be when upon arrival at the junction it was learned that the logging train did indeed not leave until after the through train arrived, possibly from force of habit, as its coming and going appeared to be uninfluenced by anything else, but its point of departure was two miles distance.——"Impossible to hold the train over 10 minutes," was the reply to an inquiry over the 'phone, and no conveyance at hand.

On account of swampy roads, driving to the sawmill some 20 miles away was out of the question, but in surveying the range of possibilities, a small railroad motor car was encountered and pressed into service. The operator of the motor car was well informed regarding lumber industries in the district, and was able to overtake the logging train, but imparted the discouraging information that the sawmill which the inspector was seeking could not be reached from the end of the logging road on account of swamp lands, and offered advice as to how best to reach the plant overland.

A planter plowing cotton along the roadside proved a solution of the difficulty, as he knew the exact location of the sawmill, about nine miles away, the path which led to it, and offered the use of his team, a horse and mule, providing the inspector could ride horseback. A trip through a dense forest upon the back of an undersized mule would hardly be made for pleasure under the most favorable circumstances, but when an inspector's outfit, packed in the usual grip and weighing about 35 pounds, as well as the anxiety to win out against the odds encountered, is added to an abstinence from horseback riding for several years, a regret that the usual routes of travel were not followed, even at a sacrifice of time, could not be dissipated.

However, the last lap of the first part of the journey was made without mishap, although there were times when it seemed probable the trip would be terminated before the sawmill was reached, particularly when the mule, hunter style, nimbly "took" the logs obstructing the path.

The inspection of the boiler was made, repairs prescribed, and by using a logging locomotive the noon-day train, by which with ordinary traveling the plant would have been reached, was taken to a city containing the repair shops doing work in the lumber district.

The conditions found and the remedies necessary were outlined to the boiler makers, so that men, tools and material were on their way to the plant the following morning, at which time the inspector, after spending another night in the Pullman, was reaching home, with a big day's work before him and a feeling of satisfaction that those who had prepared their boilers for his inspection that day would not be disappointed, although the results of riding nine miles on an Arkansas mule were retained for several days.

Dangerous Boiler Heads

Attention is being drawn forcibly to the danger lurking in the heads of steam boilers. It is realized that formulæ used in designing such heads give insufficient thicknesses. And an important point overlooked is that in the process of flanging a disk of metal in order to produce a flanged head, the head is thinned in the bend of the flange at the very point where fracture is most likely to occur.

The writer recently had occasion to examine the head of a steam boiler that had exploded violently. The head was made of material ½ inch thick, but it was only 7/16 inch thick at the point of fracture. In this case the process of flanging the head had reduced its thickness, and consequently diminished its strength 12½ percent.

Another point often overlooked is that there is continually going on a small but perceptible inward and outward movement of the head in rhythm with the pulsations of the engine; and while the amount of this movement is slight, it occurs a considerable number of times per minute, a great number of times per day, and in the course of eight or ten years the repetitions are sufficient to weaken the plate seriously in the bend of the flange.

It is advisable, therefore, that manufacturers shall be certain that their boiler heads are constructed of material that is amply thick. And it is important that inspectors examine with more or less suspicion, and with very great care, all boilers coming under their charge. They should remove carefully all dirt and scale on the inner surface of the head in the turn of the flange, and then with a strong light and a good magnifying glass look carefully to see whether the plate has not started to crack.—*Monthly Bulletin of the Fidelity and Casualty Company of New York.*

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later that the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

A very favorable report regarding progress in the States on the Pacific Coast of the campaign for the adoption of the standard boiler code compiled by the American Society of Mechanical Engineers has recently been issued by Mr. Thomas E. Durban, chairman of the American Uniform Boiler Law Society. A conference in Salt Lake City with the executive committee of the American Uniform Law Association disclosed the fact that boiler code legislation was outside the province of the Uniform Law Association, as they have the power only to seek to recodify existing laws. So far as the American Uniform Law Association is concerned, therefore, the American Uniform Boiler Law Society can expect to receive no support from them for the promulgation of a uniform boiler code.

In California, however, the prospects for the immediate adoption of the boiler code are very bright. The Commissioner of Public Safety in that State has the power to put the boiler code in operation and it is expected that very shortly the new part of the code will be adopted absolutely, while Part II of the code, which relates to old boilers, will be slightly modified and rulings on Part II will be changed from time to time by the Commissioner of Public Safety so that ultimately the A. S. M. E. Code will be in operation in its entirety. It is expected that the code will be made operative in California on January 1, 1917.

In Oregon five efforts have been made through the legislature to pass a boiler code, but each time for special reasons, political or otherwise, the effort has been defeated. However, the matter has been thoroughly thrashed out and the atmosphere cleared, so that through the efforts of the Commissioner of Labor of the State it is very probable that the next legislature will put the power of adopting a boiler code in the hands of the State Labor Bureau, and if this takes place the A. S. M. E. Code will undoubtedly become the standard boiler code in Oregon.

In the State of Washington, the cities of Seattle, Spokane and Tacoma all have boiler laws, but while boilers under the Seattle laws will pass in Tacoma and Spokane, the Tacoma and Spokane specifications will not fully satisfy the Seattle inspectors. The State authorities are thoroughly alive to the necessity of a standard boiler law throughout the State and in general the public officials, boiler manufacturers and others interested are in sympathy with the movement, and it is believed that there will be no trouble in having the A. S. M. E. Code adopted in Washington when the legislature meets again.

In Minnesota there will be no opportunity to take up the matter of the adoption of a boiler code until the next legislature meets in 1917. A thorough campaign has been laid out, however, for bringing the matter up in this State at the proper time, and, unless some unforeseen complications should develop before the next legislature meets, the committee which has the matter in charge feels very confident that the A. S. M. E. Code will ultimately be adopted in the State of Minnesota.

Apart from the work of the American Uniform Boiler Law Society, the State of Connecticut has acquired a new boiler inspection law by the passage of an act at the last session of its legislature, which repealed certain sections of the general statutes of the State. The new law gives the Governor authority to appoint a "suitable person" in each congressional district to inspect boilers; no mention is made, however, of the standard that shall prevail for the safe construction of the boilers. The A. S. M. E. code should be enforced for this purpose.

From the foregoing it is evident that the outlook on the Pacific Coast and in Minnesota is very bright for the adoption of the A. S. M. E. Code. It is especially encouraging to note that no serious objections to this movement have been raised, and those who are in positions of influence in these States almost without exception are heartily in favor of the movement, and will use their influence to bring about the adoption of the A. S. M. E. Code. This favorable report from the Pacific Coast should do much to stimulate those who are working along similar lines in the East and South, and no opportunity should be lost to make the adoption of this Code as widespread as possible at the next sessions of all State legislatures.

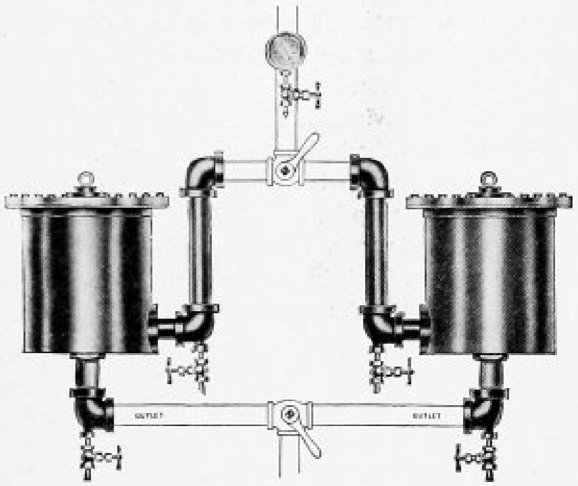
Engineering Specialties for Boiler Making

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

What Oleite Does

"Deoleizer" is the trade name of an instrument for the complete removal of oil from emulsion. It is manufactured and sold by William Andrews, Inc., 120 Liberty street, New York. To de-ole-ize means to de-oil-ize, or take out oil. The material which does this is sold under the trade mark of "Oleite."

Oleite is a discovery, not an invention. The original investigators were endeavoring to perfect a roofing material having certain desirable qualities. In running down the line of experiment they accidentally discovered that at a certain stage of the manufacture the material developed a singular natural affinity for oil, an affinity analogous to that of cement for water. Following up this discovery it was found that Oleite would remove 99.99994 percent of all the oil from an emulsion. So complete was this purification, it is claimed, that it required the delicate ether test to detect the residue, which is equal to about one drop in one and a half barrels of water. The application of Oleite, therefore, in the treatment of condensed returns, whether from heating systems or surface condensers, was at once undertaken and has been followed up with remarkable results.



"Deoleizer"

Although the apparent action of Oleite is that of a filter, its real action in no way resembles the ordinary mechanical straining implied in the term filter. Oleite is a calcined mineral substance granulated to a uniform grade, and in appearance much resembles old-fashioned black gunpowder. The voids are large and if sand or charcoal were used there would be no perceptible effect on the emulsion. Oleite, on the contrary, acts by a remarkable and thus far unexplainable attraction for, and entanglement of, the emulsified particles of oil. It is claimed that it seizes upon every minute atom within reach and, once seized, it never lets go. In time the Oleite is found to coagulate the oil in its voids until the whole mass becomes a sort of jelly. It can be forced to part with the oil only by burning it off. The Oleite itself does not materially suffer by the operation and can therefore be recovered and used a number of times before losing its efficiency.

The action of the Deoleizer is supplementary to the action of the ordinary oil extractor. The latter is set in the flow of the exhaust steam. The former takes the oily returns after condensation and reduces them to a distilled water of limpid clearness and perfect purity in which there is not a measurable trace of oil. This last fractional percent of oil is the elusive one, hard to catch but cumulative in its damage if it gets into the boiler.

The "Simplate" Valve—Its Construction and Operation

The Chicago Pneumatic Tool Company, Chicago, Ill., has placed on the market a new design of flat plate air compressor valve known as the "Simplate" valve, for which many advantages are claimed. Its chief advantages are that it is simple; that its plates are independent in action; that each plate has its individual springs; that the tension of the spring on the inlet and discharge valves differs according to the density of the air handled; and, lastly, that it is applicable to all positions and conditions.

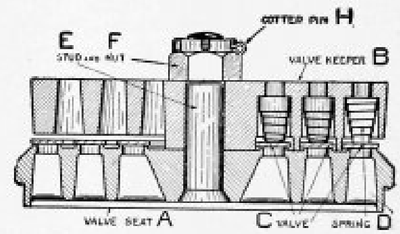


Fig. 1.—Discharge Valve

Fig. 1 shows a discharge valve. The valve seat *A*, cast from a special composition, has circular ports. It is machined so that the raised portion of the seat, or the points on which the plates rest, forming the joint, is very narrow, thus reducing the unbalanced area to a minimum. The keeper *B* is of the same material, and is provided with suitable ports for the free passage of air through it. It also furnishes the guides for the valve plates, and affords as well satisfactory pockets for the valve springs. The valves *C* are concentric steel plates of uniform section, with a separate and independent plate over each port. Each plate is independently governed by its own springs, hence the action or opening of each valve is entirely independent of the other. Should one of the plates open, the one next to it does not necessarily need to move, unless the speed conditions should demand it. The springs *D* are of the volute type. The parts making up a complete valve are

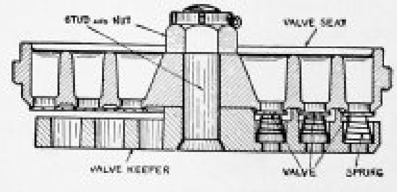


Fig. 2.—Inlet Valve

assembled and held together by the nickel steel stud *E* and castle nut *F*, and when this nut is securely tightened in place it is firmly held so by cotter pin *H*.

Fig. 2 shows the inlet valve, the construction of which is very similar to that of the discharge valve. It differs only in the following respects: The valve stud enters through the keeper instead of through the seat, as does the discharge; the keeper is thinner, and the springs are of lighter tension. On account of the difference in the thickness of these valves, they cannot be reversed; that is, the inlet cannot be put in where the discharge should be, nor the discharge where the inlet belongs—a precautionary measure deemed to be highly necessary. The spring tension on the inlet valves is made very light, so as to get the full benefit of the varied opening of the different plates when the piston speed is changed. For instance, with an inlet valve of the size here shown, the spring tension is so calibrated that the outer plate opens with a pressure of but ¼ ounce per square inch, and one ounce will open the intermediate plate, while it requires 2½ ounces to open the inner one. This illustrates the true meaning of the varied opening.

The Cochrane Recorder for Measuring the Flow Over Weirs

With any type of weir or orifice the rate of flow is dependent upon the head, and once the law of the weir or orifice is known, may be calculated directly therefrom. For most purposes of measurement, however, mere knowledge of the rate of flow at a given instant is not sufficient, but continuous or total results are wanted. This has led to the development of various types of flow recorders, one of the most recent of which is illustrated herewith.

The apparatus includes a float which moves vertically in response to changes in head. With weirs or orifices where there is a free surface of the liquid on the up-stream side, this float rests directly on the surface, whereas with Pitot tubes and Venturi tubes it ordinarily rests upon the surface of mercury in one of the legs of a U-tube, the two ends of which are subject to the differential pressure due to the Venturi or Pitot tube.

If the motion of the float is employed directly to actuate the recording device, so that the action of the recording pen is directly as the motion of the float, or in proportion to it, a record of rate of flow can be obtained, but the divisions on the chart are not in general equal for equal increments in rate of flow. It is therefore necessary to incorporate some kind of translating or modifying mechanism between the motion of the float and the motion of the recording pen. This translating mechanism is ordinarily a cam. Besides taking account of the law of flow over the weir, the translating mechanism must also provide the proper ratio between float movement and pen movement. In the design of recorders for use with V-notch and rectangular weirs it is customary, therefore, to make the total length of the cam much greater than the movement of the float, using a multiplying gearing between the float and the cam.

In the flow recorder herein described the cam is laid out as a spiral on a flat circular plate, and the multiplying mechanism consists of a small drum mounted upon the spindle of the cam, and having wrapped about it a thin metal cable, which is attached to the float spindle, a counterweight on another cable serving to keep the first cable taut. The spiral groove is cut into the surface of the disk, and is so arranged that the part of the cam corresponding to the low heads is near the center of the disk, and the part corresponding to high heads is near the periphery of the disk, whereby the angle between a tangent to the cam at any point and a tangent at the same point to a circle concentric with the disk is kept small, due to the fact that what would otherwise be the steeper part of the cam is at the greater radius. To accommodate the recorder for use with weirs of different heights it is only necessary to substitute cable drums of the proper respective diameters. One cam serves for all weirs, having the same law connecting head and flow.

The chart being driven uniformly by a clock, the pen not only records the rate of flow at each instant, but the

Recording Meter for Measuring Flow of Boiler Feed Water

area under the pen trace is proportional to the total flow for any elapsed period. In other words, the user of this recorder is supplied not only with a history of the rate of flow, as for instance the rate at which his boilers have been fed throughout the day, but may also obtain by the use of an ordinary engine planimeter the total amount of water which has been fed to the boilers, and by comparing this quantity with the amount of coal used, may determine the total and average evaporation for the day. Many users, however, desire to obtain the total flow directly, without the use of a planimeter, and for this purpose an integrating attachment has been added. To meet a third requirement, a visible pointer moving along a large scale with open divisions has been added, making it possible to read the rate of flow from a distance.

The clock and recorder parts are supported from brackets on a cast-iron base, which is attached to the back-plate of the case, the latter being built of heavy plate throughout, with a flanged bottom of heavier material than the sides. The door is flanged, is carried on three hinges, and is held closed by three-way draw-in bolts operated from a single lock. Felt gaskets around the door and on both sides of the plate-glass windows prevent the entrance of dust.

The Cochrane flow recorder, while originally designed for use with V-notch weirs, may be used with rectangular weirs or submerged orifices. It is manufactured by the Harrison Safety Boiler Works, Philadelphia, Pa., and is regularly supplied in connection with the Cochrane V-notch meters and metering heaters manufactured by this company.

CURRENT NEWS ITEMS

Business for Boiler Makers Improving

The demand for steam power equipment throughout the Middle West continues active, although the prices quoted on boilers are, on the whole, too low for profitable business. Boiler makers in Louisville, Ky., are figuring on a lot of new work. The boiler and tank situation continues to improve in Cincinnati and better business was reported during the month from boiler makers around New York, where a number of orders have been received from abroad.

While the demand from Ohio tank shops for plates is fairly active, plate mills are not crowded and fairly prompt deliveries can be secured. The Kinnicott Company, of Chicago, recently placed orders for a thousand tons of steel plates for building oil storage tanks for the Santa Fe Railroad.

Orders for Locomotives

The Erie Railroad has placed orders for 33 locomotives during September, 18 of which will be built by the American Locomotive Company, 10 by the Baldwin Locomotive Works and 5 by the Lima Locomotive Corporation.

In all, about 135 locomotives were ordered from American builders during two weeks in September, all of which are for domestic buyers with the exception of 25. Inquiries are now out for approximately 100 other locomotives.

The Norfolk & Western is in the market for 30 Mallet locomotives, the Illinois Central for 50 Mikado type locomotives, the Chicago & Northwestern has ordered 45 of various types from the American Locomotive Company, the Chicago, St. Paul, Minneapolis & Omaha has ordered 10 and the Madrid, Saragossa & Alicante Railway, of Spain, has ordered 25 from the same company. The Baldwin Locomotive Works has received an order for 13 from the Texas & Pacific and 6 from the Utah Copper Company. The Servian Government has also ordered 15 Prairie type locomotives from the American Locomotive Company. The American Railway Company, of Porto Rico, has ordered 3 Consolidation type of locomotives from the American Locomotive Company.

Railway Equipment Orders Increasing

Greater activity in the market for railway equipment has been manifest during the last month than has been evident at any other time during the past year. It is estimated that rail orders amount to over 400,000 tons for delivery in 1916, and, as many other large contracts are under negotiations, this total will be increased very materially. Many of the railroads are placing large orders for cars, and this has resulted in inquiries for thousands of tons of steel plates, shapes and bars. The market for boiler tubes has shown marked improvement and the prices of both iron and steel tubes have advanced materially. Japanese interests have recently put out an inquiry for a thousand tons of boiler tubes for early delivery to the Far East. Inquiries have also been received in New York from Italy for boiler plates and boiler furnaces.

Boiler Shop Additions and Improvements

The Pittsburgh Boiler & Tank Company, Pittsburgh, Pa., according to reports, has acquired an interest in the Carroll-Porter Boiler Works Company, Wellesville, Ohio, and will increase the capacity of that plant.

The Milwaukee Reliance Boiler Works, Milwaukee, Wis., has purchased patents on a metal and glass store fixture and has organized a new company which will manufacture this device at its boiler works in Milwaukee.

The American Locomotive Company is building an addition to its oxy-acetylene generating plant at its Brooks Works, Dunkirk, N. Y.

Raymond F. Smith, 210 Lyon street, Grand Rapids, Mich., is the head of a new company which has been organized for the fabrication of structural steel. This company will soon be in the market for punches, drill presses, cold saws and pneumatic tools, together with electrical equipment for motor drive throughout the plant.

Rumors are current to the effect that the Pennsylvania Railroad Company will remove its repair shops from Columbus, Ohio., to Cincinnati, Ohio.

The Illinois Central Railroad is to build a new round house at Cherokee, Iowa, at a cost of about $52,000.

The Harmon Boiler Equipment Company, Milwaukee, has been organized with a capital stock of $15,000.

The Cleveland Punch & Shear Works Company, Cleveland, Ohio, has let contracts for extending the buildings of its plant in order to double its present capacity on account of the increased demand for small tools.

One of the most important of recent additions to the Pittsfield, Mass., works of the General Electric Company is a new modern tank shop. The building has a floor space of 39,200 square feet. An important feature of the shop is the riveting pit, where two hydraulic riveting machines are installed, having individual oil forges for heating rivets.

PERSONAL

Fred Bayer has been appointed master boiler maker on the Pennsylvania Railroad, with headquarters at Columbus, Ohio.

B. C. Tracy has been appointed supervisor of electric welding of the Baltimore & Ohio Railroad, with headquarters at Baltimore, Md.

OBITUARY

William Middlehurst, a well-known boiler maker, died recently at his home in Swissvale, Pa., aged sixty-one years. Mr. Middlehurst served his time in the boiler making trade with Messrs. Dickenson Company, of Sunderland, England. He came to this country about thirty years ago and was a member of the Amalgamated Society of Boiler Makers and Shipbuilders of England and the Brotherhood of Boiler makers and Iron Shipbuilders of America.

BOOK REVIEW

Business Administration. By Edward D. Jones. Size, 5 by 7½ inches. Pages, 275. New York, 1914: The Engineering Magazine Company. Price, $2.

By a study of the older professions of war, statecraft and science, Professor Jones has sought to establish the scientific principles of the newer profession of the administration of maufacturing and operating companies. From the data compiled in this study definite primary principles of administration have been analyzed. The administrator is considered as a leader of men more than as a trustee of properties. No special doctrine or practice of management is advanced, but the treatment of the subject tends to bring administration to the high plane occupied by the older professions and serves to stimulate and direct the ideas of those who have made this profession their life-work.

Letters from Practical Boiler Makers

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

Inexpert Criticism

Here are two excerpts which I culled from *The Nation's Business,* published by the Chamber of Commerce of the United States. I submit this principally because I believe it was not written by a technical man. The writer of the article "criticises" the Seamen's Act:

"On American boilers hydrostatic pressure must be applied once a year. This causes serious delay and great expense. The operation racks the boilers and pipes, which take weeks to get in proper condition, after each yearly test. This is not required by any other nation except in Canada, unless a boiler has been weakened in some way."

If this test always "racks the boilers and pipes" it must be *some test,* as we say in slang.

Also here is something I have never seen before on fusible plugs. Heretofore I had thought that fusible plugs were regarded in a more kindly light. They are sometimes a nuisance, in that they melt and must be replaced; but in spite of that bother they are invariably replaced by another plug, which is again liable to melt. Here is what the excerpt says:

"Fusible plugs are unnecessary for safety and changing them every six months causes great delay to the ship. They are not used by any other nation, and there are no more explosions on foreign ships than on ours."

Believing that further comment is unnecessary, I am,

New York. N. G. Near.

Shop Kinks

The different methods for construction of an ellipse, as shown in The Boiler Maker, are interesting and instructive. Fig. 1 shows a method of laying out an oval,

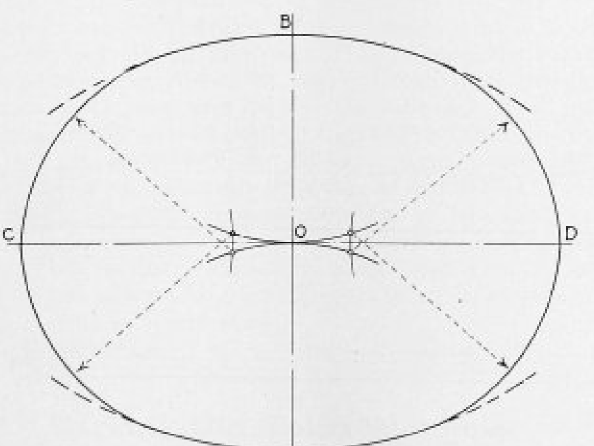


Fig. 1

such as used for handholes and manholes in boilers. On *AB* set off the minor axis; on *CD* set off the major axis. From *A,* with radius *AB,* strike an arc as shown, strike the same radius from *B.* Set dividers to *AO,* strike arcs as shown from *A* and *B*; strike the same radius from *C* and *D* with the same radius and from the intersection on arcs, as shown, strike arcs from *C* and *D,* intersecting the major arcs, and the oval is completed.

Figs. 2 and 3 show an extension socket, as used for drilling in the interior of boiler shells and fireboxes. It is very simple in construction and saves a great deal of time, in the majority of cases doing away with the necessity of blocking up. The small pipe is made to slide inside of the large pipe and can be adjusted to different lengths. Holes are spaced 1 inch apart, using a 3/8-inch bolt for

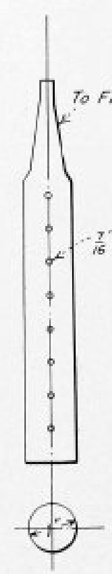


Fig. 2

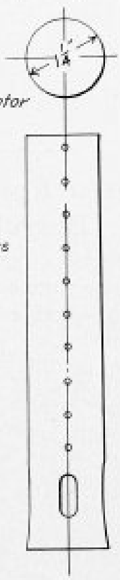


Fig. 3

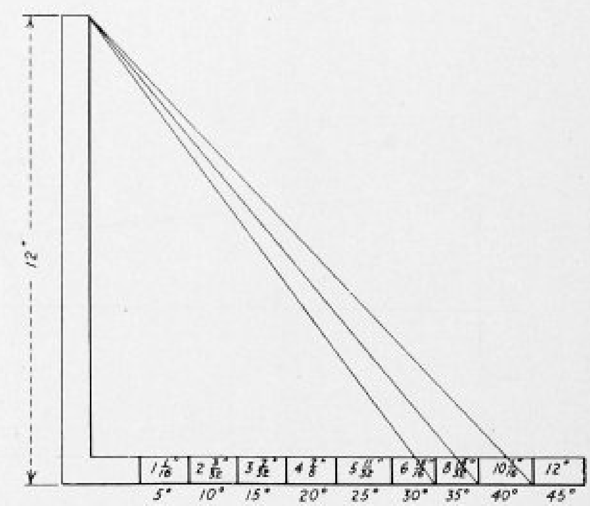


Fig. 4

securing the two pipes at the length required, the slotted end on Fig. 3 has a drill socket welded in for holding drills. I have drilled holes up to 1½ inches diameter with this device.

Fig. 4 will be found useful in any shop for setting off angles when a protractor is not handy. Mark off 12 inches on both legs of square, and this gives 45 degrees, then the other distances from the heel of the square give the different angles as shown.

Lorain, Ohio. Joseph Smith.

"And So On"

I have before me this statement in plain-as-day print. It seems to me I have seen similar statements before, just as absurd, and no doubt other engineers have also:

"Various estimates have been made of the loss of fuel due to the presence of scale in the boiler, the lowest of which is as follows:

For 1/16 inch..................	15 percent
For ¼ inch..................	50 percent
For ½ inch..................	120 percent

and so on."

The thing that "gets" me is the "and so on." Can there possibly be a loss greater than a total loss? After a loss of 100 percent is reached, what then?

Burn up a pile of coal in the open air and I can conceive that the loss is 100 percent, but where can a loss of 120 percent exist—and so on?

New York. N. G. Near.

To Lay Out a Round Tank or Boiler Barrel Sheet

When the heads of a round tank are ordered flanged, or when applying a barrel sheet to a ring that has been turned up, as a mud ring for upright boiler, or a connecting ring for locomotive smoke-box, the following rule may prove a great help in laying out the barrel sheet:

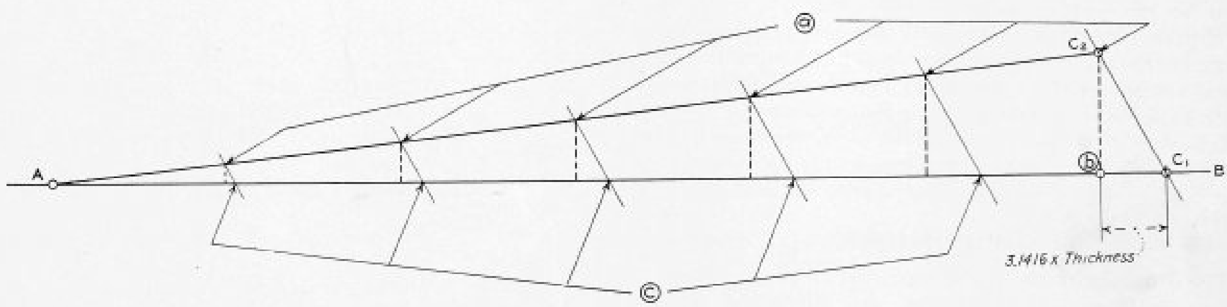


Fig. 1

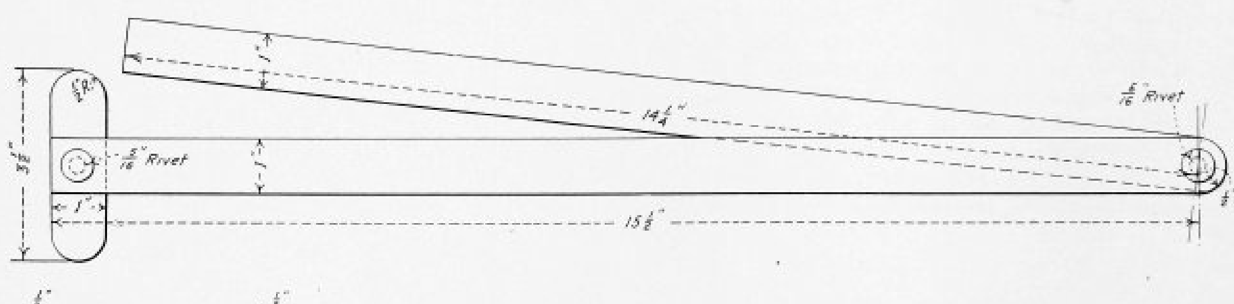


Fig. 2

A thin strip of steel, such as a blank tape, is put on the flange or ring over the lines of the holes, and by the rule given the take-up of the rolling, as it is called by most boiler makers, is overcome. The center of the material of the finished barrel sheet is exactly one thickness more in diameter than the surface or outside diameter of the head or ring to which it is applied, and as the circumference or distance around increases in proportion to the diameter, then, when the diameter increases one thickness of the material, the circumference must increase 3.1416 times one thickness of the material.

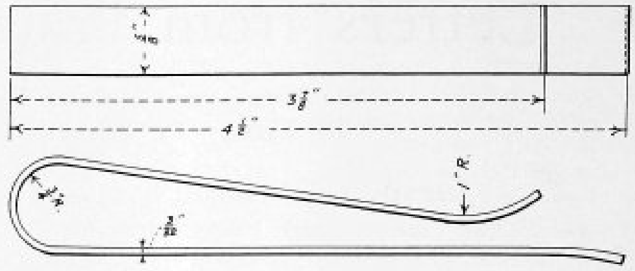


Fig. 3.—Spring Steel Clip

We now come to the job of laying out a barrel sheet. Get a blank tape as thin as the steel tape lines used by layerouts. The heads having been flanged, draw a flange line on the flange by using a gage from the flat side. Put the tape around the head; and to make it easy to understand, I will say cut the tape so the ends will just touch each other when drawn tight around the head. Then the strip of steel will be equal in length to the circumference of the head on the outside. Now as your sheet has thickness to be considered, as stated before, this thickness must be multiplied by 3.1416, and this, added to the length of the strip, gives the length required to make the barrel sheet fit where the strip of steel has been taken from.

Now mark a line on one edge of the flat sheet, from which the barrel is to be made, a distance from the edge equal to the desired lap, and suppose the line *A-B*, Fig. 1, should be this rivet line on the barrel sheet. The distance *A* to *B* represents the length of the tape when brought down upon *A-B*, and from *b* to *C* 1 shows the take-up allowed, or 3.1416 times the thickness of the barrel sheet. Now if the tape would be made fast at the end *A*, or the first hole at the left end of the line *A-B*, and the right end swung away to a short distance, or to point $C\,2$ in the sketch, a line drawn through $C\,2$ and $C\,1$ would form a triangle, and by drawing a line parallel to $C\,1$-$C\,2$ from each point indicated by (a) to each point indicated by (C) the same proportional part of each line would be laid off at each of the respective points, because a series of like triangles has been made.

When the holes are already marked in the head they are transferred on the tape, and they would then be the same as the points (a), Fig. 1, and by completing each separate triangle or by drawing the diagonal lines we automatically lay off the proper proportion of the line A-B to bring each hole to its proper place in the rivet line, the points indicated by (C), Fig. 1.

Now we go to Fig. 2, which is the tool with which we make these diagonal lines. By studying this sketch any layerout can see how it is made. It is a folding bevel square, and to apply it simply means to open it out like a pocket knife. Let the blade come upon the points $C\,1$ and $C\,2$, while the handle rests against the edge nearest to you, and slide it along from one point to another until all the holes have been located on the line A-B with the bevel square.

The spring steel clip shown in Fig. 3 is used to fasten the tape on the sheet. As the tape is never cut, as stated before, it reaches past each end of the sheet, and is there fastened by applying this clip. Pencil marks are made instead of cutting the tape. When holes are not spaced equally this rule works out every hole to perfection, and when making smoke-box sheets for locomotives this method is a great improvement over old methods, as holes are often unequally spaced on account of dodging cylinder holes, etc.

Clips to fit over heavy rings can be made on the same lines as the light one shown in Fig. 3. To mark the rest of the sheet should be easy enough. As I wished only to introduce this method of overcoming the take-up, I will not continue to lay out the whole sheet.

When one sheet in a boiler or tank has to fit outside of another barrel sheet, the neutral diameters are one thickness apart on each side, or the difference of the neutral diameter of an inside and of an outside sheet is twice the thickness of the material. Then if both sheets are flat, and it is required to lay out an outside sheet, put the tape on the line of rivet holes on the flat inside sheet, and with the same method explained by Fig. 1 (with the exception of taking twice the thickness times 3.1416 from $C\,1$ to point b), an outside sheet can be laid out, or if the method is reversed, an inside sheet can be laid out from an outside sheet or the holes in a head or ring can be diminished in space taken from a flat sheet, already laid out. Once understood, this rule will be a help to anyone who works on round work.

Columbus, Ohio. PHIL. NESSER.

Marking Out Boiler Manholes

A previous contribution of mine under the above caption appeared in the issue of January, 1912. The solution was originated by me, but had obvious limitations.

The construction then given is again repeated here for convenience, as Fig. 1. $A\ B$ and $C\ D$ are the minor and major axes of the required oval. With B as center and $B\ A$ as radius an arc is struck; this is again repeated with A as center. With C as center and $B\ A$ as radius cut $C\ D$ in F. Join $F\ B$ and bisect at right angles, producing bisection line to cut $C\ D$ at K. With K as center and $K\ C$ as radius, the arc produced will close the figure.

The limiting conditions are readily apparent if the minor axis be relatively short; the arcs having the ends of minor axis as centers and its length as radius will cut the major axis short of its length, the figure being thus impossible to construct.

It was previously pointed out that the best proportions were 2 : 3, or, say, 10 inches by 15 inches, when its shape

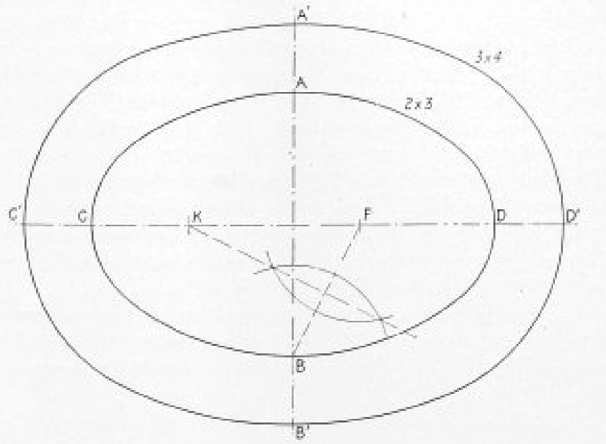


Fig. 1

is nearly true elliptical form. In the proportions of 5 : 8 or 3 : 4 the oval made is less good.

Needless to say, any oval drawn with circular arcs must be inferior in appearance to an actual ellipse. The feature of the actual mathematical curve is the fact that for a given length of circumference the area contained is the greatest possible. Still the construction of an actual ellipse is tedious and little understood in the ordinary

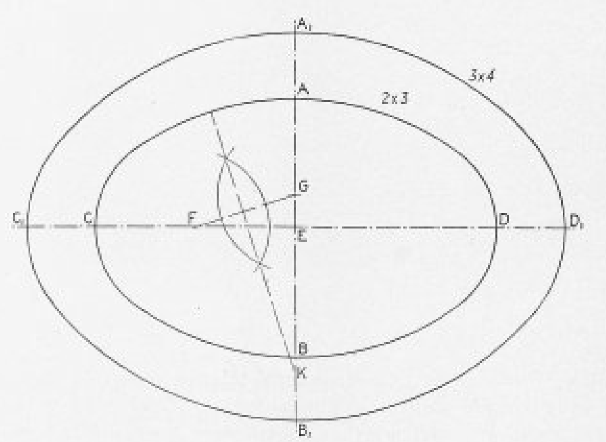


Fig. 2

shop. For the methods of its setting out any good textbook may be consulted.

Where elliptical trepanning tools are absent or where the desired oval is outside the range possible to the existing tools, the method of circular arcs will continue in use. Either default of geometrical knowledge or easier marking out will continue the practice.

It is a rather curious but well-known fact that subsequent to any tussle with a refractory problem, and invariably after a satisfactory solution is made, other methods of solving the same knotty point come along in a casual manner. In consequence of this, two other solutions passed over to me by a mathematical friend are here presented. Both of these solutions are free from the limitations of the former construction as given in Fig. 1; they both vary the arcs in proportion to the major and minor axes. In the case, however, of a very long oval, any shape made by circular arcs is less happy than a true ellipse, while in manhole proportions the results are sufficiently near.

CONSTRUCTION OF FIG. 2

A B and *C D* are minor and major axes. On *A B* set out a length *A G* from choice which must be less than *A E*. Set out this same length from *C* along major axis as *C F*. Join *F G*. Bisect *F G* at right angles, producing bisection line to cut minor axis or its prolongation at *K*. *K* and *F* are the centers of the required arcs. *F C* and *K A* are the required radii, respectively.

In Fig. 1 the radius of one arc is fixed by the length of the minor axis. In Fig. 2 the radius of the smaller arc is an arbitrary length dependent upon personal selection. Hence the shape formed in this second construction may be varied by altering the length *A G*.

In the following construction, Fig. 3, the radius of either arc is determined by the construction. It is slightly more elaborate, but eliminates the personal element.

CONSTRUCTION OF FIG. 3

A B and *C D* are minor and major axes. With center *C* and radius *C E* describe an arc; with center *E* and radius *E C* describe an arc cutting the former in point *G*. In

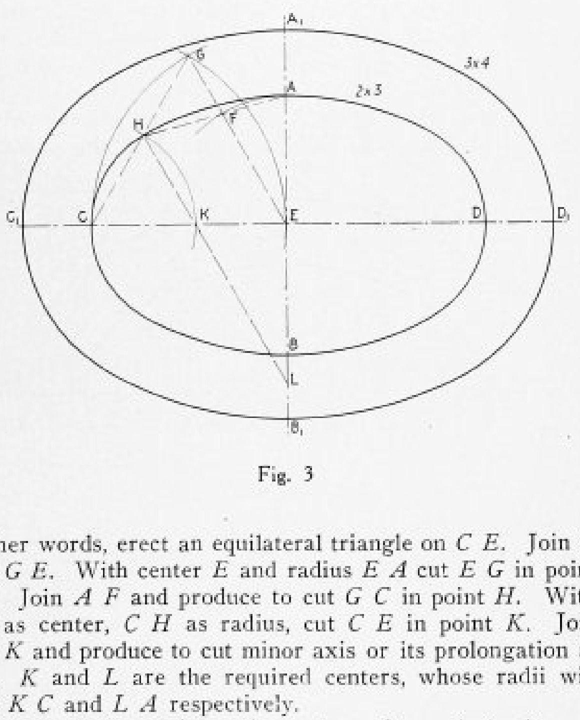


Fig. 3

other words, erect an equilateral triangle on *C E*. Join *G C*, *G E*. With center *E* and radius *E A* cut *E G* in point *F*. Join *A F* and produce to cut *G C* in point *H*. With *C* as center, *C H* as radius, cut *C E* in point *K*. Join *H K* and produce to cut minor axis or its prolongation at *L*. *K* and *L* are the required centers, whose radii will be *K C* and *L A* respectively.

Since the line joining the centers of two circles in contact also passes through the point where they touch, the point *H* is the actual contact point of the circular arcs. This fact enables the marker out to finish the line at the exact point of intersection.

The construction of Fig. 3 is really less elaborate than it seems. If once followed out, or, better still, actually made, it will be found quite simple. In any of the constructions careful work is assumed, while in use any layer-out setting out a manhole opening of usual proportions will be pleased with the exactitude with which the circles touch. The results seem remarkable when first tried and are a considerable improvement over any guess and try determination.

London, England. A. L. HAAS.

An Elementary Talk on Boilers

If you had a row of boilers set up in a room and they could talk, they would answer the question by saying, "We are evaporators of water," and each boiler would tell you, quite likely, that it could do the work better than any of the other boilers there, and each one would believe it.

The entire idea of a boiler is to turn water into steam, and all the various styles of watertube or Scotch boilers or any other kind of boilers are designed to do this work of making steam as cheaply as possible.

If you built a coal fire in a cook stove with a hod of coal, you would set free from the coal a certain amount of energy in the shape of heat. Suppose you took two tin pans and you put one of them upside down on the stove, and you put the second one on it, putting in it, say, a quart of water, and noted the time you put it on and found that in one hour the water had all boiled away, or evaporated; then suppose you had the same fire conditions and you took the upside down pan away and let the other pan down on to the top of the stove. You would find, if you put another quart of water in the pan, it would boil away in much less than an hour—say, in a quarter of an hour. It will be easy to understand that you are getting more out of your coal in evaporating the water under the second conditions, as you are taking less time to do the work of evaporation.

In the first case just as much heat was given out in a quarter of an hour as in the second case, but the heat was not as directly applied to the water, but was radiated to the air through the upside down pan and not directly applied to the water. The bottom of the pan would represent what is called the heating surface if in a boiler, and in both cases it is the same area, but in the first case it is not as "effectually applied," as the "highbrows" would say.

Every boiler designer is after effective heating surface. Every heated object tries to give up its heat to surrounding objects until they all become of the same temperature, or as it is sometimes put, "Nature tries to establish an equilibrium." If you take two pieces of metal, one heated to 100 degrees and the other to 150 degrees, and put them into a square box in which the air is 70 degrees, the temperature in the box would become higher and the temperature of the two metals would change until a uniform temperature was established in the metals and in the air in the box.

It takes some time for heat to act. If you had a 4-inch bar heated red hot and you pushed it into a 5-inch tube which was surrounded with water, you would have to let the red hot bar stay in the 5-inch tube for some time if you wanted to heat the surrounding water. If you just pushed the bar through the tube it would not transmit much heat to the water. It is evident that if you have heating surface you must have heat to make it of value, and in boilers the heat comes, usually, from coal, sometimes from oil fuel, but we will consider coal fuel only.

The next thing after the heating surface to be figured out is the "grate surface," as on it must be spread the coal which generates the heat. Long series of experiments coupled with careful tabulation of results has resulted in certain rules and proportions being laid down which can be used to determine just how much heating surface is needed to evaporate a given amount of water and what amount of grate surface under certain conditions will be needed for the heating surface. Such information can be obtained from any number of text-books which a young boiler maker can buy which will guide him in designing a boiler.

But no matter how well a boiler is designed, if it is not well made with properly driven rivets, tight seams, etc., it is a source of endless trouble and loss. Therefore every young boiler maker should be impressed with the fact that there is no part of his work which can be neglected without endangering lives. This is a serious thought for anybody learning the trade of boiler making.

I have heard from some of my boiler maker friends that they fear that the trade will disappear by the introduction of the internal combustion engine. This fear is entirely groundless and boiler making will be going on centuries from now. It is quite possible to believe that fewer boilers may be used in some directions as giving power to prime movers, but the wants of the world, in the way of steam, will constantly increase.

But I do believe that greater skill will be required in both the design and actual production of the boilers than heretofore, and this latter means that boiler makers must know their trade better in the future than in the past.

New London, Conn. W. D. Forbes.

Low Water Boiler Explosion

The effects of a boiler explosion which took place recently on board a pumping boat belonging to the Diamond Coal Company on the Monongahela River at Courtney, Pa., are shown in Figs. 1 and 2. The force of the explosion sank the boat and the boiler was blown fully 100 feet in the air and about 30 feet from the river bank, where it landed across one of the heavy steel rails of the railroad closely by, breaking the ties and fastening itself on the rail in such a way that all traffic was stopped to get the obstruction removed. It was necessary to remove the entire section of rail, but so firmly was the rail enveloped that it was impossible to extract the rail, and the ends were cut off.

Pittsburgh, Pa. Flex Ible.

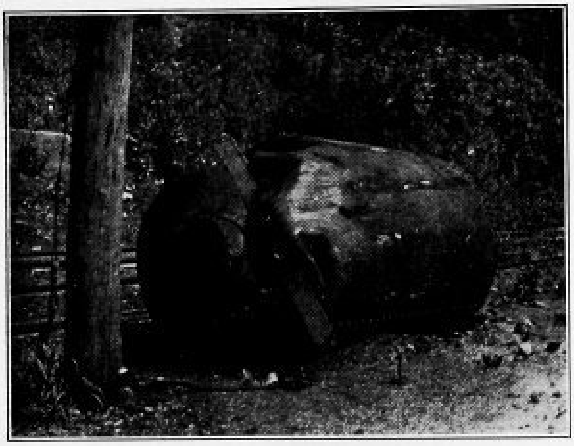


Fig. 1

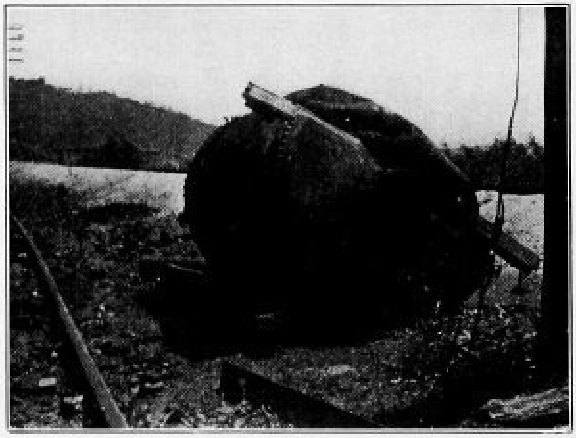


Fig. 2

Care of Locomotive Boilers

In these days of long hauls, increased tonnage and high speed, the locomotive boiler is a very important item in railroad economy. There is no part of the locomotive which requires more careful and painstaking care than the boiler, and each one from the engineer to the cinder-pit man should contribute his share towards keeping it in a serviceable condition and in the highest state of efficiency, which can only be accomplished by the hearty co-operation of all concerned with the handling and operation of the locomotive.

Let us take a locomotive just out of the shop which received general repairs, with a full set of flues, the boiler given a hydrostatic test and then given a steam or fire test, and all steam leaks taken up and pronounced absolutely tight. The engine is then given a trial trip to ascertain if the front end appliances, ash pan and grates have been properly applied and adjusted. In order to avoid engine failures, due to being improperly drafted or having some defect develop in the newly applied front end rigging and grates, an inspection should be made after each trip and a report made on a regular form showing the condition. Any defects reported should be repaired immediately. Whenever an engineer reports steam pipes leaking, engine not steaming or burns her coal at door, examine the flues first to make sure that they are clean, as invariably the above conditions are due to stopped-up flues.

The cleaning of flues is a very important factor in locomotive performance, as stopped-up flues cause a poor steaming engine and cause flues to leak, especially in superheated locomotives, as you will find in most every case. A honeycomb gathers on the unit ends. If this is not removed it may break off and lodge in among the units and stop up the flue. No locomotive should be allowed to go into service with any flues stopped up. The cleaning of flues should be done before the boiler maker enters the firebox, so he can check the work and see that it has been done properly.

The prevention of engine failures due to leaky flues does not rest entirely with the round-house boiler maker, regardless of the fact that they are compelled to assume the responsibility in most instances. One may take a locomotive with practically a new set of flues, and by the improper use of the injector cause most of the flues to leak. This can be demonstrated after the fire has been drawn and the locomotive placed in the round-house with a perfectly dry set of flues, then start the injector and watch the results caused by the change of temperature in water around the flues. The fireman and engineer should be very careful when injecting water in the boiler that a bright fire is maintained and fire door kept closed while the injector is on. If the flues are all opened in good condition and there is no mud on the flue sheet there is no reason for a failure due to flues leaking. Yet there are cases where tonnage is reduced or trains set out, and on making an inspection of the flues they are found to be in good condition, but loose in the flue hole, which is prima facie evidence of the improper use of the injector.

It is a common practice to fill the boiler at terminals while the blower is on and the fire door standing wide open, in order to eliminate the black smoke. Whenever it becomes necessary to fill the boiler while standing at a station or on the siding, a bright fire should be maintained.

After the cause and effect of the inequalities of temperature in the boiler is thoroughly understood by the engineman and hostlers, it should not be difficult for them to fully appreciate the damage done to flues and firebox sheets by the injecting of water at a temperature of about two hundred degrees lower than the water in the boiler, with the blower on and the door open. The sudden contraction of the flues on account of the difference of their thickness as compared with the flue sheet causes leaky flues. This is also caused by the sediment that lodges between the flues and flue sheet.

The successful maintenance of the locomotive boiler in service is summed up in just one word—"co-operation"; first, by the foreman and mechanic turning out a perfect job; second, the careful inspection and work of the roundhouse organization in keeping boilers tight and free from mud and scale; third, in the careful handling by the enginemen. The best care and workmanship will be of no avail, however, if the boiler does not receive intelligent treatment while in service.

The washing of the boiler is another important factor in locomotive performance. The boiler should have all steam blown off until all pressure is off, then let the water out, removing all washout plugs and leaving the whistle or other openings at the steam dome open for at least one hour. This gives the boiler a chance to cool naturally. Then start to wash the crown sheet from the washout holes in the back head; then wash the door sheet around the door hole. Then cross wash the crown sheet from the washout holes in the wagon top or roof sheet, using a straight nozzle for the crown sheet and a bent nozzle for washing down the side sheet. Then wash the flues and barrel of the boiler from the washout holes in the first course above the flues, using straight and bent nozzles. Wash down thoroughly; then wash from the bottom hole in the first course, using a bent nozzle, washing towards the back flue sheet until thoroughly clean. Then wash the legs of the boiler, starting from the back and washing towards the front, using a straight nozzle in the corner holes and a bent nozzle in the back and sides, also using wires to ascertain if any mud is lodged in among the staybolts. The washout plugs should be examined to see that none of the threads on plugs or washout holes is stripped. Plugs should be applied with graphite and valve oil made into a thin paste to enable the plugs to be removed easily on wash days.

The engineer and fireman should carefully examine the firebox sheets and flues as soon as they take charge of the locomotive, reporting any leaks or defects to the roundhouse foreman, and if any defects are found they should be repaired before the engine goes into service. If found in good condition and acceptable, with intelligent treatment, there should be no engine failures on account of the flues leaking.

J. L. Didier.

Tension in Rivets

When a rivet is driven it is usually hammered to such an extent that when hammering ceases it really is in tension. Generally, though, rivets are driven hot, in which case it is the contraction on cooling which creates the tensile stress. Nevertheless, hot or cold, the object of the riveter is to make the rivet so tight that it will be in tension.

In boiler discussions we sometimes hear and read about the effect of this tension in creating greater joint efficiency because of the fact that the boiler sheet ends are squeezed tightly together, friction is established, and therefore a considerable force would be necessary to pull the sheets apart, due to the friction alone. This is certainly true, and joint efficiency is therefore often higher than the computed figure. But reliance cannot be placed upon the amount of the compressive force through the rivet, and the effect is therefore invariably neglected in computations.

The compressive feature has another slight advantage that I have never seen discussed in connection with lap-riveted joints. In lap-riveted joints the rivets are subject to a slight tensile stress, as well as a shearing and bending stress. But there is no real increase in tension in the rivet unless the tensile stress due to the tension from the boiler plates becomes "greater" than the tension in the rivet that was there initially, as above explained.

To make the thing clear, I have drawn Figs. 1 and 2. In Fig. 1 I show a common riveted joint with tension

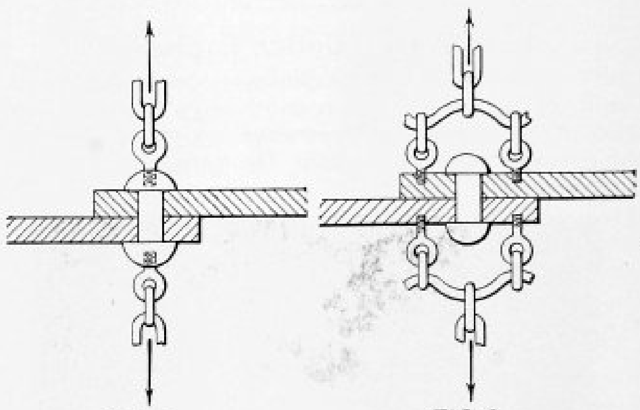


FIG. 1 FIG. 2

screws placed in each end of the rivet, and with forces acting in opposite directions, as indicated by the arrows. In such case the tension in the rivet will be "increased" because the force is additional to the tension already on the rivet. Such a case, so far as I know, does not occur in practice. I show it merely for illustration.

Fig. 2, however, is a different case, and is similar, in a way, to lap-joint practice. But here the tension in the rivet "does not" increase until the force is great enough to relieve the pressure betwen the plates. This pressure was caused, as I have already stated, by the tension already in the rivet.

The best way I know of to prove this point to your own satisfaction is to take two blocks of wood and fasten them together with a rubber band or bands. Fasten them so that the bands will be in tension, which condition will then be similar to the riveted plate. Then, without touching the rubber, endeavor to pull the blocks of wood apart. You will be unable to do so until the force you exert will be greater than the tension already in the rubber bands.

To prove the case illustrated in Fig. 1, take hold of the rubber band itself while in tension and attempt to stretch it some more. You will feel it "give" immediately.

Therefore, I conclude, it sometimes may happen that in lap-riveted joints the tension in the rivets does not increase at all. It all depends upon the tension already in them due to the driving and initial cooling. In fact, I cannot see why this might not take care of the bending stresses in the rivets to some extent.

As for boilers that are butt-riveted, these arguments do not apply, for the rivets are never in tension there, which is by all means the best practice.

New York. N. G. Near.

Selected Boiler Patents

Compiled by

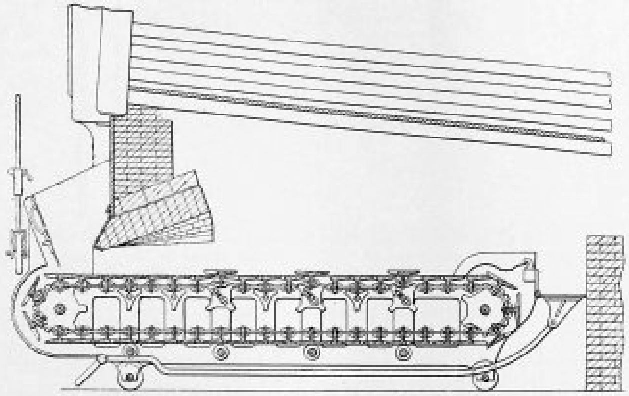
DELBERT H. DECKER, ESQ., Patent Attorney,

Millerton, N. Y.

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

1,146,198. GRATE-BAR FOR CHAIN-GRATE STOKERS. BARTHOLOMEW J. MORRISON, OF NEW YORK, N. Y., ASSIGNOR TO EDWARD R. DUNHAM, OF NEW YORK, N. Y.

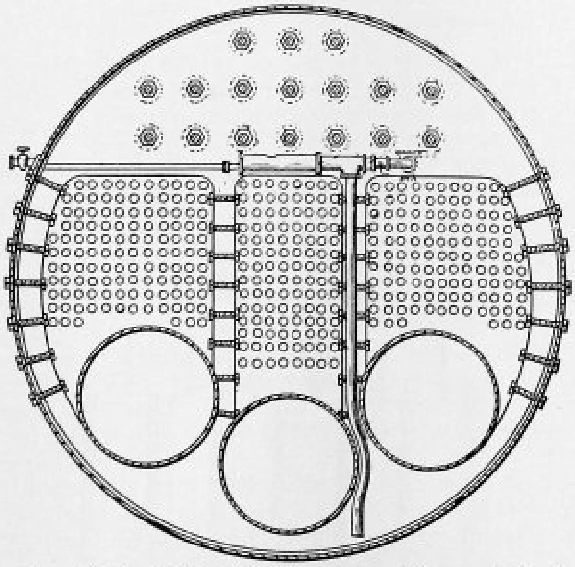
Claim 1.—In a chain grate stoker, a grate bar comprising a plurality of sections detachably secured to each other, projections extending from the outer ends of the sections, said projections interlocking with the



chains and serving as suspending means for the grate bar, and said sections when detached from each other while in their inverted position being adapted to be swung transversely of the chains out of engagement therewith. Six claims.

1,146,213. BOILER WATER-CIRCULATING DEVICE. HENRY THURSDON, OF KINGSTON, ONT., CANADA.

Claim 1.—The combination with a boiler of a water circulating device located below the normal water level of the said boiler, comprising a cylinder having an outlet orifice located in the top thereof, a pipe connected at one end to the said cylinder, a stuffing box in the said pipe, a gland adapted to make threaded engagement therewith, a feed pipe



adapted to slidably fit the said stuffing box and form with the inner periphery of the first said pipe, an annular space, a suction pipe designed to be attached to the lower side of the first said pipe adjacent to the said stuffing box, such suction pipe extending downwardly to the bottom of the said boiler and means for removing the scum from the water, as and for the purpose specified. Four claims.

1,144,461. BOILER-FLUE CLEANER. JOHAN W. CARLSON, OF CLALLAM BAY, WASHINGTON.

Claim 1.—A cleaner head comprising a body member, a plurality of resilient shanks secured to the body and diverging away from each other toward their free ends, the free ends of the shanks having cutters, and a taper pin engaged between the basal portions of the shanks for separating the shanks when it is driven inwardly. Two claims.

1,144,995. STEAM BOILER. JACOB H. BODIGER, OF NEW YORK, N. Y.

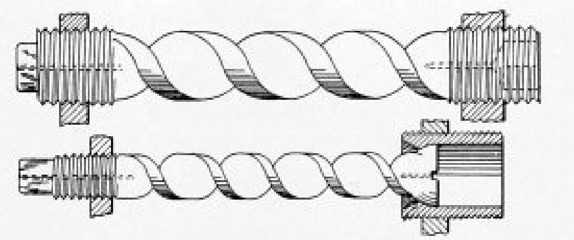
Claim 1.—A boiler comprising a main boiler, an auxiliary tank located above said main boiler, a water inlet pipe communicating with the lower end of said main boiler and auxiliary tank, and a steam outlet pipe communicating with the upper ends of said main boiler and auxiliary tank adapted to equalize the pressure therein, and valves located in said pipes. Four claims.

1,144,553. BOILER-FLUE-CLEANER SYSTEM. FREDERICK W. LINAKER, OF DUBOIS, PA., ASSIGNOR TO THE VULCAN SOOT CLEANER COMPANY OF PITTSBURGH, PA., OF DUBOIS, PA., A CORPORATION OF NEW JERSEY.

Claim 1.—In a boiler tube cleaner system, the combination with an inclined bank of tubes, and a relatively long baffle in back of said tubes, of a relatively short baffle at the lower end of the bank of tubes spaced from the longer baffle to form a heat protected zone between the baffle, and a fluid distributing pipe rotatably mounted in said heat protected zone for projecting fluid onto said tubes for cleaning the same. Four claims.

1,146,481. FIRE-BOX STAYBOLT FOR LOCOMOTIVE AND OTHER BOILERS. ETHAN I. DODDS, OF CENTRAL VALLEY, N. Y., ASSIGNOR TO KERNER MANUFACTURING COMPANY, OF PITTSBURGH, PA., A CORPORATION OF PENNSYLVANIA.

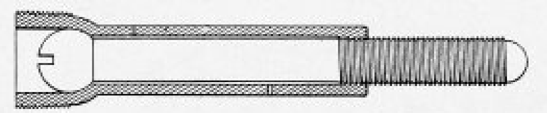
Claim 1.—A staybolt having a body portion of greater width than thickness, the parallel faces of the body portion at one point being paral-



lel to the similar faces of the body portion at another point of the body and intermediate portions of the parallel faces being at an angle thereto, and securing means on the ends of said bolt. Three claims.

1,146,482. STAYBOLT. ETHAN I. DODDS, OF ZELIENOPLE, PA., ASSIGNOR TO KERNER MANUFACTURING COMPANY, OF PITTSBURGH, PA., A CORPORATION OF PENNSYLVANIA.

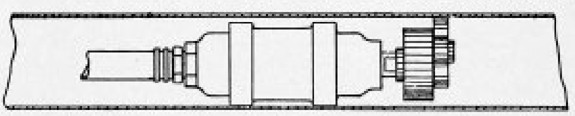
Claim 1.—A staybolt having internal and external body portions separated from each other through a portion of their length, but connected to



each other at the ends thereof, the connection at one end comprising a ball and socket, the external body portion being twisted about the axis of the bolt. Three claims.

1,147,230. TUBE CLEANER. WILLIAM D. FULLER, OF SPRINGFIELD, OHIO, ASSIGNOR TO THE LAGONDA MANUFACTURING COMPANY, OF SPRINGFIELD, OHIO, A CORPORATION OF OHIO.

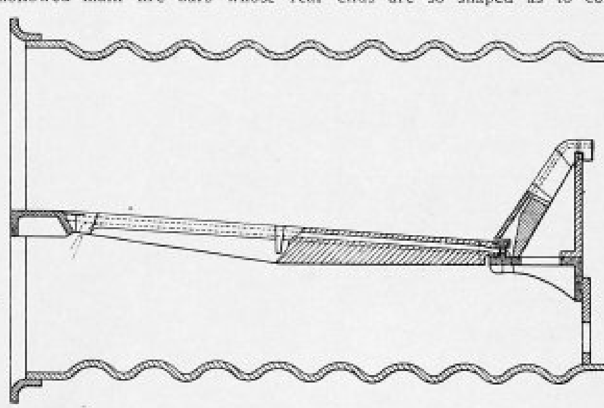
Claim 2.—In a tube cleaner, a rotary body having a single transversely extending arm in front of said body pivoted at one end thereto and a tool or tools in front of said arm pivoted to the free end thereof, said



tool or tools being proportioned and said arm free to swing said tool or tools in position to turn upon their pivot across the longitudinal axis of said body, substantially as described Seven claims.

1,147,605. FURNACE FIRE-GRATE. JAMES CAREW, OF LIVERPOOL, ENGLAND.

Claim 1.—In a fire-grate, the combination of a rest having affixed to it a vertical web with lateral flange, spaced ribs and stop bar, hollowed main fire bars whose rear ends are so shaped as to come



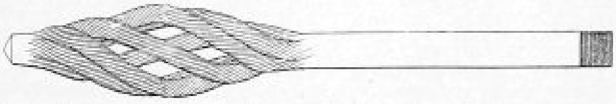
against the web between the rest and the flange, hollow sloping fire bars at the back of the main bars whose lower ends are so shaped as to rest on the flange and come against the web between it and the stop bar, and ports in the web to connect the conduits in the main bars with those in the sloping bars. Four claims.

1,146,108. FURNACE. GEORGE W. WILSON, OF BEAUMONT, TEXAS.

Claim 1.—A furnace consisting of a chamber, a transverse partition separating the chamber into upper and lower compartments, said partition having a plurality of air passageways therethrough, a plurality of pipe sections supporting said partition, said sections being connected together and forming a continuous fluid passageway therethrough, a fuel inlet arranged to discharge into the upper compartment, a section of the wall of the lower compartment being formed of open brick work to permit the free passage of air therethrough, and shutters controlling the passageway of air through said open brick work. Three claims.

1,147,824. FLUE CLEANER. SOLOMON A. SOULE, OF FRANCES, WASHINGTON.

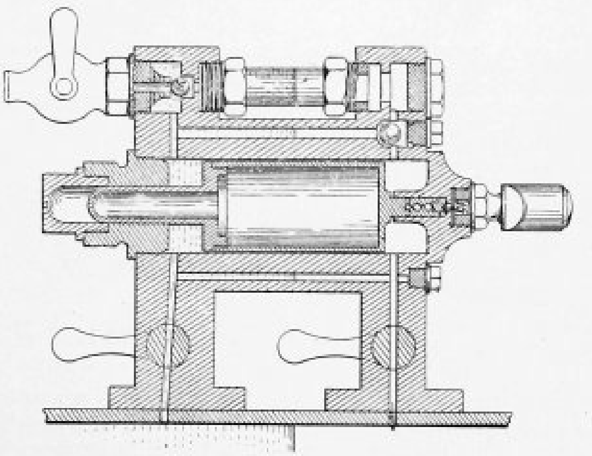
Claim 1.—A flue cleaner comprising wire cable sections secured together to provide a shank and tip, each section comprising a plurality of



strands twisted tightly together, and the sections having outwardly bowed portions between the shank and tip. Two claims.

1,147,835. LOW-WATER ALARM FOR STEAM BOILERS AND THE LIKE. ROBERT WOOD, OF NEW YORK, N. Y., ASSIGNOR TO THE NATHAN MANUFACTURING COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

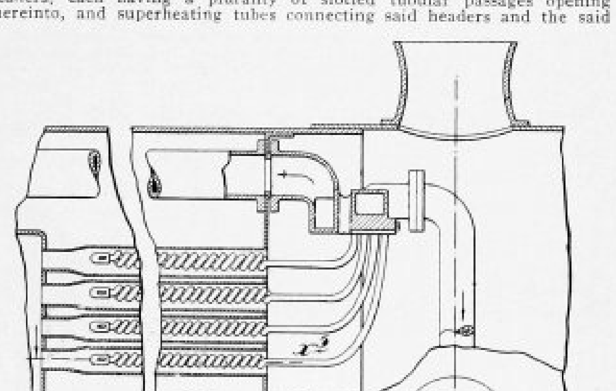
Claim 1.—In a low-water alarm for steam boilers and the like, a casing inclosing a float chamber and having an alarm supply opening provided with an internal valve seat, a float operating in the float chamber, and a valve device controlling the opening and including an



extension operating in said opening and having a valve movable into and out of co-action with the seat, said extension having a passage provided with an outlet port that opens into said opening in advance of the valve seat and also having an inlet port that is located in the opening when the valve is initially unseated to permit leakage past the valve, said inlet port being movable out of the opening to allow a free flow through the passage and past the valve seat. Five claims.

1,147,815. LOCOMOTIVE SUPERHEATER. GEORGE B. RAIT, OF MINNEAPOLIS, MINN., ASSIGNOR TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

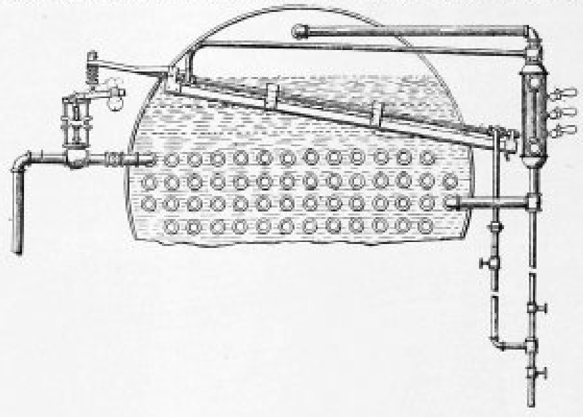
Claim 2.—A superheater comprising wet steam and superheated steam headers, each having a plurality of slotted tubular passages opening thereinto, and superheating tubes connecting said headers and the said



tubes, at their ends, having sleeve-like heads axially nested together in rows within said tubular seats with the connected ends of said tubes passed through the slots thereof, and clamping plugs screwed into the ends of said tubular seats and holding the heads of the said tubes detachably but rigidly together with steam-tight joints. Nine claims.

1,148,483. METHOD OF FEEDING WATER TO BOILERS. ROGER W. ANDREWS, OF LOMBARD, ILL., ASSIGNOR TO ERIE PUMP & EQUIPMENT COMPANY, OF ERIE, PA., A CORPORATION OF PENNSYLVANIA.

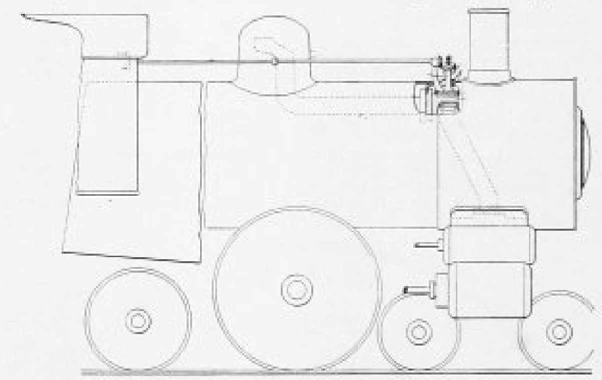
Claim 1.—A method of feeding water to boilers consisting in causing the inflow to be continuous at all times and to exceed the outflow when the outflow is decreasing, to substantially equal the outflow when the out-



flow is normal, and to be less than the outflow when the outflow is increasing, and in causing the inflow to become equal to the outflow when the outflow above normal is excessive or long continued. Nine claims.

1,145,757. LOCOMOTIVE ENGINE CUT-OUT VALVE. SAMUEL AUSTIN DUGAN, OF GALVESTON, TEXAS.

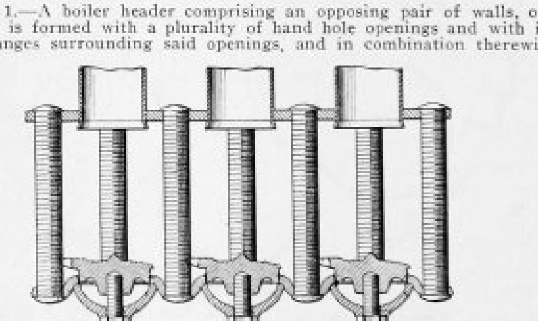
Claim 1.—In a locomotive, the combination of driving engines, a boiler, a horizontally-disposed dry steam pipe, a smoke-box into which the pipe extends, branches in the smoke-box and leading from the pipe to the



engines, a Y-coupling uniting the branches with the dry steam pipe, and valves in the Y-coupling for opening and closing the supply of steam to the branches. Five claims.

1,148,544. BOILER CONSTRUCTION. WILLIAM F. SELLERS, OF EDGEMOOR, DEL., ASSIGNOR TO EDGEMOOR IRON COMPANY, OF EDGEMOORE, DEL., A CORPORATION OF DELAWARE.

Claim 1.—A boiler header comprising an opposing pair of walls, one of which is formed with a plurality of hand hole openings and with internal flanges surrounding said openings, and in combination therewith



staybolts connecting said walls and secured to the wall in which the hand holes are formed between the latter, and hand hole covers comprising tapered plug portions which enter and jam in said hand hole openings from the interior of the header. Two claims.

1,150,952. SUPERHEATER. CHARLES D. MOSHER, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—A steam boiler having a single combustion chamber extending from one side of the setting to the other, a central steam drum, two water drums, one on each side of the combustion chamber, banks of inclined tubes connecting the steam drum and the water drums, said banks being divided into two groups to afford a chamber between the groups, superheaters comprising headers having transverse partitions therein to form a succession of chambers, U-tubes connected to said headers and extending therefrom into the chamber between each group of tubes and disposed substantially parallel with the axes of the drums, and a valved pipe for admitting water to the superheaters when the latter are to be used as part of the circulating system of the boiler. Two claims.

THE BOILER MAKER

NOVEMBER, 1915

What are You Doing for Your Apprentices?

The Advantages and Necessity of Training Boiler Maker Apprentices —Systems Adopted in Railroad Shops—The Apprentice Instructor

BY R. J. HETTENBAUGH*

Every railroad in the country to-day is striving to reach perfection—economy and safety being the watchwords. Perfection is a big word and cannot stand on a weak foundation. One of the principal strongholds of this foundation is the apprentice system.

What are you doing for your apprentices? Are you allowing them to drift through their time learning only what their fellow mechanics are inclined to show them, or are you educating them up to the standard for which you are striving? A number of the larger railroads have organized apprentice systems in their shops, by which means they are training and educating their apprentices to be thorough and efficient mechanics. It is one of these thoroughly organized systems of which I am writing.

Apprentice System in Railroad Shops

The apprentice system consists of a school and a shop instructor where a large number of apprentices are employed, and in smaller shops one man covers both shop and school. Every apprentice, regardless of the trade he may be learning, is required to spend four hours each week in the school room, for which he is allowed full time according to his rate in the shops.

Before an apprentice can enter the shop he must pass an examination that requires a grammar school education in order to enable him to pass. This keeps out the rougher element that would get in if no examination were required. In addition, he must pass a physical and visual examination. Every apprentice is employed with the understanding that if at the end of six months he hasn't proved satisfactory to the company he is to be dismissed from the service.

It is the duty of the shop instructor to show the boys the best and quickest methods of setting up their work on the machine, the proper way to grind their tools and how to get the highest possible efficiency out of their machines. By this system the boy becomes confident early in his time and he is able to handle better classes of work. Moreover, he is not held down to the rougher classes, which do not require much thought, and consequently you do not have that common expression among apprentices, "I am not getting a show." It will be surprising what a large percent of the output of the machine shop will depend on the apprentices; thus the shop instructor cannot be considered as an extra expense to the company.

In the classroom every boy, regardless of the trade he is learning, is given the same preparatory course in drawing and mathematics. After this he is ready to follow out his course covering his own trade. As machinists and boiler makers cover a large percent of the apprentices, I will give an outline of their studies.

The machinist is first given a chart from which he learns every part of the locomotive. He is then given a series of problems on pulleys and belting, measurements of solids, leverage, steam gages, hydraulic jacks, laying out gears (which includes both mathematics and drawing). At this period he is about ready for floor work, and is given a regular course in setting valves, and is taught from a quarter-sized model with all parts adjustable how to make changes, so that when he takes a job with the machinist in the shop he figures the changes and compares them with the machinist's, instead of the machinist spending half of his valuable time explaining how they are made.

If the boy is a good scholar and has this work all done before his time is completed, he is given lessons on lubricator injectors, and is taught the fundamental principles of the air brake. The air brake is not taught extensively in the classroom, but it is a study that is not discouraged, if a boy undertakes it.

Boiler Maker Apprentice Course

The boiler maker apprentice is given a special drawing course and a series of lessons on shearing strength of rivets, tensile strength of boilers and a complete course in laying out sheet metal, both by projection and triangulation. This is a big study, and takes up most of the boy's time in school, as they must lay out all classes of boilers. In addition to classroom work, each boy is required to work from 25 to 50 problems each month at home, all of which pertain to shop work.

This system is not laid out as a standard to be used at all times, but we are improving our methods and widening out courses, both in the shop and school room, whenever the opportunity presents itself, and every effort is being extended to make more efficient mechanics out of our apprentices. About 15 percent of our apprentices in the last several years are holding positions as foremen and draftsmen with the company, and the 60 percent are still in the service.

This shows for itself what the apprentice system is doing. The apprentice is no longer required to go elsewhere and finish his trade before he can obtain a job in the shop where he serves his time. After a boy has completed his four years under the apprentice system the company is profiting by holding him in the service.

* Apprentice instructor, Cleveland, Cincinnati, Chicago & St. Louis Railway Company, Mt. Carmel, Ill.

There are lots of positions at the top that are waiting for the good men to fill them, and every apprentice has the same opportunity to reach them, and there is nothing else which puts confidence and ambition in a boy, necessary to hold these jobs, like an apprentice organization.

There have been a great many attempts made at organizing night schools for the apprentices, but these schools are seldom a success. They hold together until the novelty is worn off; then the attendance begins to lag and the school finally breaks up. The spirit of these institutions is all right, but they lack compulsion that is necessary to bring boys at this age to time.

The apprentice system is by no means in its infancy, as the one of which I am writing is eight years old. I do not think it will be long until every railroad will see the advantage of the apprentice system, and duly equip their shops with such a system.

Noise and Its Relation to Accidents

If a representative body of workmen were asked which one of the five senses is most valuable from a safety standpoint, it is certain that they would decide unanimously in favor of sight. It is almost as certain that hearing would be ranked next in importance. It is self-evident that a man who cannot see dangerous conditions is likely to be injured, and it is equally evident that one who cannot hear warning signals is also in danger of accident, whether his disability is due to defective hearing or to loud noises in and about the workplace. There are many men at work to-day who are partially or totally devoid of the sense of hearing, but who are nevertheless able to perform their duties without being subjected to any special hazard in consequence of their infirmity, simply because their environment and work have no special dangers. If these same men were employed in a shop where good hearing were essential to safety the chances of injury would be greatly increased.

Fatigue has a notable influence in causing accidents, and anything that will tend to reduce or increase fatigue among workers should therefore receive consideration. Noise, for example, should have a prominent place in the list of items accredited with the production of fatigue. Loud noises, even though produced for only a short time, irritate the average person; and if they are continued all day, and every day, they may have a serious effect on the nervous system, and become a potent factor in causing fatigue.

There are no statistics available to show just what part noise plays in causing fatigue, or what percentage of accidents may fairly be attributed to it. It is possible, however, to get a better idea of the connection between noise and accidents by studying the conditions that obtain in many factories and shops wherein the safety of the men often depends on their observance of warning sounds. There are hundreds of operations performed in our industrial plants every day that demand the sounding of a warning for the men to "stand clear." For example, it may be necessary to transport a ladle of molten metal, or a billet of hot steel, or some other heavy load, from one section of a shop to another by means of an overhead crane. If the shop contains a large number of noisy machines—pneumatic hammers and riveters, for example—it is hardly to be expected that the men in the path of the crane will always hear the warning bell or the sounds made by the approaching crane. A low-hanging load, or a break of any part of the crane apparatus, is then likely to injure the men on the floor. The primary cause of such an accident would be carelessness in carrying the load too close to the floor, or lack of care in the inspection of the crane apparatus; but the fact that the workmen could not hear the warning signal should be classed as a contributory cause.

The older employees in a noisy shop become more or less accustomed to the noise, and often can readily detect any new or unusual sound. New men are likely to be confused by the constant loud noise and the strangeness of their environment, and are less likely to note warning sounds. When the din in a shop is so great that a workman must shout into his companions' ears in order to be heard, it must needs be a sound very much out of the ordinary to draw his attention to danger and keep him out of harm's way.

It is often necessary, in a shop, for several employees to co-operate in moving or completing a particular piece of work, and under the guidance of a competent and careful foreman the men can do the work efficiently and in safety, if the conditions in the plant are normal and favorable. A serious accident may easily occur, however, if the noise in the shop should prevent one or more of the men from hearing an order from the foreman, or cause them to misunderstand the order at a critical stage. In such a case the noise would be responsible for the breakdown in the co-operative effort of the men, because in a quiet shop the whole operation could have been completed without friction or accident.

The whirr of wheels and gears, and the clang of hammers and hiss of steam, are the burden of the song of our industrial plants. It is unfortunate that our ears are not attuned to the song now, and that they cannot very well be so attuned in the future. The problem of noise-suppression in factories is receiving more and more attention from machine and tool manufacturers. For some time we have had the silent chain-drive, and noiseless gears and pinions have also been introduced. In other ways, too, a tendency is observable toward suppressing unnecessary noises, and deadening or softening those that are unavoidable. Much can be accomplished in this direction by designing the machines correctly, by providing heavy, solid foundations and suitable shields and guards, and by substituting less resonant material than steel for certain parts of machines.

The management that makes a systematic effort to suppress noise will have fewer orders misunderstood and therefore more orders properly executed, and will also increase the safety of the workmen by an amount which is none the less real and important even though it is indefinite and hard to measure.—*The Travelers Standard.*

If you have to "fish" a bolt into place be sure the nut goes on hand free before you do the fishing.

You will find more right and left workmen telling about their ability in that direction than you will see at work.

Many a job is made a bad one because the boiler maker thinks it is too near knocking off time to make a good one.

Every boss has a list of the men who are the last to be laid off.

Why? Because the men on that list pay him better.

Try to get on that list.

It is a great mistake if the boss is not willing to pay a first-class boiler maker more than an ordinary workman. It may make some men growl if he does, but it encourages most men to try to do more and better work, and by doing so get a raise in wages.

Uniform Cost Systems

Where and How the Direct Labor Percentage Plan Fails

BY WILLIAM M. KENNEDY *

It is hardly conceivable, after giving due consideration to a uniform cost system, that the direct labor percentage plan can be considered as the best means to provide comparable results, enabling executives to check the efficiency of performance from period to period. The inconsistent results obtained will be described in following paragraphs and a brief reference will be made to a system that will give accurate results in a boiler shop.

If simplicity is the method sought, seeking may cease at the direct labor percentage plan, but it is far from accurate; especially so in a boiler shop where the variety of operations prevents simplified accounting from giving trustworthy results.

During a business depression the above referred to method shows high overhead charges, automatically increasing the cost of product; and as estimates are based on direct labor, direct material plus the existing ratio of overhead to direct labor, proposal for work would be at an advance at the very time work should be taken, even at cost, to keep the organization intact.

Relation of Overhead Charges to Output

Yearly overhead charges are practically constant, regardless of the volume of work; if a plant shuts down for a period, certain of the expenditures which go to make up overhead continue as an expense. Under these conditions there is no direct labor to apportion the overhead to; this expense is properly chargeable to profit and loss, due to maintaining the plant, which is idle.

If the idle plant now gets sufficient orders to work at its capacity, the amount of overhead is at a minimum; but the previous idle time while closed must be taken care of—as by this method all overhead expenses must be proportioned to direct labor, it would not be logical to charge this amount to the first period after beginning work, so it would probably be carried under a suspense account and a portion assigned each period.

Now, instead of showing profits, with the plant working full time, this extra burden has the tendency to misrepresent cost, giving the impression that at the price for which work is being done you are not really making the profits you anticipated. Competition must be met, consequently prices cannot be increased to make the desired profits.

A plant working fifty percent capacity would give the same results of overhead distribution as the plant closed for a period, then working at full volume. At every stage of a plant's capacity the cost of production—which will, of course, include overhead—varies; the cost of the unit of output fluctuating with the amount of work being done.

"The effect *in the costs* of lowering the wage rate of a man is also to reduce the amount of establishment charges which gets allocated to the job by the system of percentages. If this represented anything like the facts, it would not be so bad; but, unfortunately, the highest probability exists that by substituting a poorly paid man for a good man on any particular job the true proportion of charges would be actually increased. He would take longer, for one thing, yet as his longer time occupied is counterbalanced by a smaller total of wages, the percentage would not be increased. Again, he would probably absorb more of the foreman's attention, but this would not show in the accounts. In short, the result of the change would really be to increase the cost of the works—the works cost—but the apparent effect would be to reduce it, because the prime cost might be reduced and the burden of charges which were before allocated to that job would fall on other jobs with which it has nothing to do." (Page 30, "The Proper Distribution of Expense Burden," by A. Hamilton Church, the Engineering Magazine Company.)

Piece work, bonus, or premium systems of any description have the tendency to reduce the direct labor cost of production, some method of payment of this kind being in vogue in all successful plants. It would be desirable to have all work done on some profit-sharing basis, provided the prices were fixed right. Few plants have reached this high state of efficiency; having done so their system of cost accounting will be capable of greater refinement than can be possible by the percentage plan.

Profit-sharing systems pay a workman from 20 to 80 percent over day's pay, according to the efficiency of the man, this being considered a fair compensation for the extra effort and co-operation. Consider this form of payment and the effects on overhead if a man's earnings are increased 50 percent, that much greater burden is assigned to his direct labor. Time saved is money saved, yet by assigning a certain percentage to direct labor this fact of time saved is ignored.

By increasing output the employee has as his inducement the extra compensation; the greatest portion of the employer's saving is in the machine time—but the system fails to show this.

Relation of Production to Cost

In the *Iron Age* of July 1, 1915, a report of a meeting of the American Society of Mechanical Engineers discusses the relation of production to cost. This article will prove of interest to any cost accountant. Prevailing methods are discussed by men of management. Each of the systems is capable of greater refinement than possible by the direct labor percentage plan, yet all have failed to fill the requirements. At the conclusion a motion was passed for the appointment of a committee to investigate the subject of cost systems for industrial establishments.

Mr. H. L. Gantt, author of "Work, Wages and Profit," *Engineering Magazine*, 1911, contributed a paper, "Relation Between Production and Costs—The Fallacy of All Expense, However Large, Being Carried by the Output, However Small—New Theory of Expense Distribution." The following is an idea obtained from his paper: In any manufacturing business it is found to be more economical to purchase certain articles than to attempt to manufacture them. Certain other items (when using the direct labor percentage method of accounting) can be made cheaper when the shop is busy than it is possible to buy them; but when work begins to fall off the overhead increases and the cost of manufacture of the article in question rises in proportion, until it is found to be more economical to purchase the article. This results in more

* Quarterman Shipfitter, League Island Navy Yard, Philadelphia, Pa.

work being taken from your plant, with the consequent increasing overhead for the remaining work; it can reach such a stage that it would be more economical to buy everything. When this stage is reached, in the natural event of happenings, the shop must be closed.

An excellent reason that machines should carry an hourly burden, idle or in use, is illustrated in the foregoing paragraph; the idle time goes into profit and loss or maintenance of idle equipment. Then we shall be on firm ground, knowing the cost of idle equipment. The cost of producing an article remains the same, idle or busy; overhead charges assigned are not increased in dull times and decreased in busy times, estimates are based on constant production costs, enabling the management with precision to add the cost of marketing the product.

Having the idle time record serves as an impartial monitor; during dull times it is a constant reminder of how badly work is needed, since from the profit of work being produced, the idle time must be paid. Obtaining work to reduce the idle time is naturally suggestive, but at what price can new work be profitably taken? The answer is, at a figure considerably below that which would, under usual circumstances, produce dividends, as every hour of idle time which is turned into productive time is, in turn, changed into profit.

When business is dull the price of a product is low—i. e., we cannot get a price for our product that includes a profit, and the question of how low a price the product can be sold at is of vital importance; to determine the cost of a product, then, becomes essential, and this determination is only of value when correct. The percentage on wages method, as can be seen, fails, and as Mr. Church says, "It is, as usually employed, a 'handy,' or, in other words, a rough and ready method."

Methods proposed by Mr. Church, in his book previously quoted, also in "Production Factors in Works Management," for the accurate distribution of general expense are capable of a refinement seldom attempted; still, the need of such a system is daily demonstrated. This system modified is, to my knowledge, being now installed in a number of plants where the varied operations are not exceeded in any manufacturing business. The principle of "Organization by Production Factors" is shown graphically by Fig. 1.

Executives are beginning to realize that as an aid to management the cost accountant is indispensable, that by presenting costs under a logical set of account numbers, each having a separate and distinct meaning, costs will be presented in such a way as to give us a more comprehensive understanding of our business.

PROTECTION AFFORDED BY THE PRODUCTION FACTOR METHOD

The up-to-date cost accountant will reveal useless space and machinery and show by idle time of some production centers that their necessity is imaginary. It is the tendency in all works, when a rush of orders is received, for the foreman to agitate the purchase of new equipment, when in reality the present equipment is equal to the output; but when new machines are recommended from such a source, the management has no way to know that the machines are not urgently needed. The production center method affords a protection when this question arises; the idle time record of machines will clearly demonstrate the necessity for additional equipment. It will usually be found on investigation that a rearrangement and some slight changes will meet the demand for additional output.

Shop men and foremen usually want their shops loaded with new equipment, but from the cost accountant's point of view this spells disaster, as the plant account is increased to meet, probably, an imaginary increase in work. It will be found, as shown by the accountant's point of view, that it is better to increase efficiency of present equipment instead of the quantity. This can be done by separating planning from production, knowing your shop's output, enabling completion of work to be determined for weeks ahead, scheduling work ahead for machines, planning and looking ahead.

Fig. 2 is a "form of expense curves" which gives a graphical description of the items that make up the "overhead expense," by Naval Constructor W. B. Ferguson.

What composes overhead expense? This seems to be more a matter of local judgment, when it should be recorded, ironclad instructions. No two similar plants are comparable unless the items which go to make indirect are identical. It is supposed, of course, that the major items are similarly charged—i. e., rent, interest, depreciation, supervision, organization expense, etc. The items usually left to someone's judgment are drafting, special dies or patterns, tests or experiments, planning or technical advice; it seems that the proper way to charge any of these items, which are made specially for a job, would be as direct labor; standard patterns, drawings, jigs, tools, etc., would be charged as indirect expense. The tendency, then, is to make the special or non-standard work carry a higher burden by charging as direct labor some of the

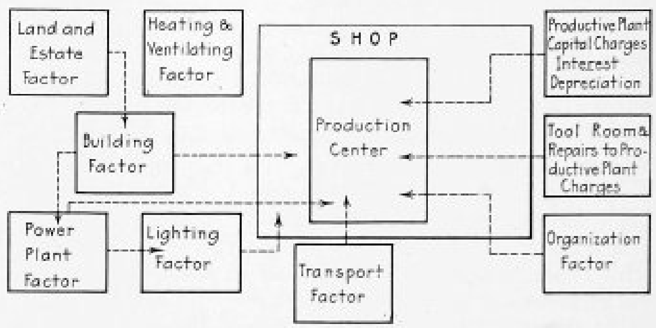


Fig. 1.—Graphical Representation of Organization by Production Factors

items which go to make overhead on standard work. As all direct labor carries a burden, this indirect labor, which under the cited circumstances becomes direct labor, would be carrying a double burden; therefore, charges of this kind would not be charged with an overhead percentage.

To provide suitable forms is a process of trial and error; a plant without these forms will be ably assisted by referring to "Factory Organization and Administration," by H. Diemer, M. E. The author illustrates the uses of many forms; from among them will be found a number applicable to any business. To readily check estimates, it will be found that by estimating by operations, it will permit checking to be done as work progresses. By "operation" is meant some definite act, as punch, shear, drill, roll, rivet, calk, etc.

Orders to the shop should be issued from the "planning section," and thus issued can be confined to definite operations. From such orders properly issued, amount of work ahead is predetermined, date of completion of work can be set with precision, status of work at any date is known, and the actual cost by operations plotted by curves on cross section paper will provide invaluable estimating data. A set of the "operation" curves completed semi-annually will tell by the rising or falling of curves if efficiency is being maintained. "Estimating the Cost of Work," by Naval Constructor W. B. Ferguson, gives an excellent illustration of the practical use of these curves.

The form for material should have vertical columns to show drawing number, item number, amount of raw material, number of finished pieces, name of finished piece, pattern or die number, material source, progress of item in state of manufacture from shop to shop, unit cost and total cost of items. Read in a horizontal line, the history of each item appears. Material sheet is made out by drawing room, if drawing is being prepared by them, otherwise by the "planning section." There should also be a form from which foreman could request material inadvertently left off sheet when being made out, this "material request" to have inserted shop order and purpose for which intended material is to be used.

"In efficiency plants work time is reckoned not by minutes, but by hundredths of the hour. A decimal clock is started when the whistle blows, workmen take their time from it. The clock is set in motion by the timekeeper each morning. It regulates duplicate clocks in every department by means of which the workmen can compare the time consumed in each operation with the 'standard' time indicated on instruction cards. The clock is but one detail of scientific management, yet it illustrates the refinements which are made to eliminate chances for error and make the records accurate." (From "How Scientific Management is Applied," by The System Company, A. W. Shaw & Co.)

The fifth form, "providing for the final assembly of costs of materials, costs of direct labor and the overhead expense," is strictly a function of the accounting division.

The boss notices the careful man.

When you leave washers, nuts, bolts and wrenches in a boiler you cost the boss money and lessen his profit and your own chances of better wages.

You cannot put an inch rivet through two one-inch holes that are offset. It is better to ream the holes out and use a larger rivet.

When you order fittings and are not sure what the commercial name of the fitting is, make a sketch and put the figures on same.

Compressed Air Costs and Savings in Railroad Shops

BY THOMAS F. CRAWFORD

Twenty years ago, when pneumatic tools were in their infancy, the installation of an air compressor did not demand the careful study which is now required, because the wonderful saving in time effected by the substitution of air tools for hand tools overshadowed all other costs.

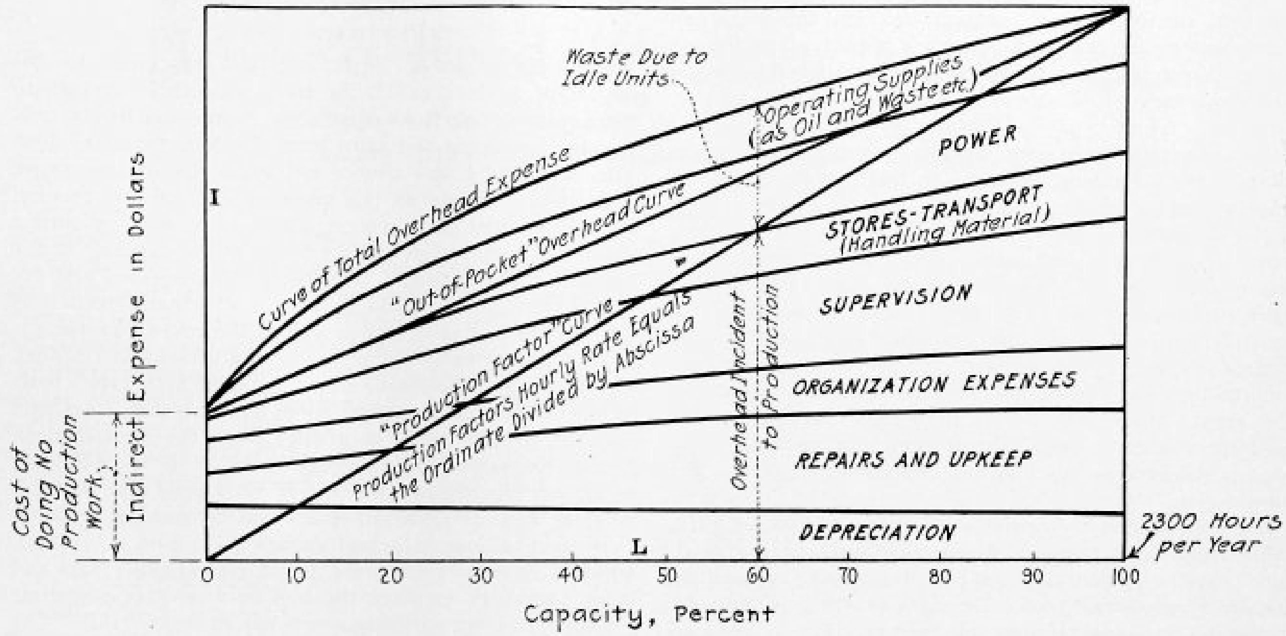


Fig. 2.—Expense Curves

To-day, however, instead of a luxury to be found in only the best and most progressive shops compressed air is used in every conceivable plant from the two-stall roundhouse on some isolated branch line to the 40-pit main shop at division headquarters.

RAPID COMPRESSED AIR DEVELOPMENT

A careful study of the growth of the compressed air system in the average shop reveals the fact that the original system has been gradually extended by additions, owing to the many and varied uses to which the high pressure air medium has been applied. The original single-stage, 200- or 300-cubic foot compressor has been replaced by a cross-compound machine of 1,500 cubic feet capacity; and it in turn has now been supplemented by still more modern and economical compressors with capacities ranging from 3,000 to 5,000 cubic feet of free air per minute. Steel cars have revolutionized shop practice, and to-day the repair tracks are demanding from 500 to 3,000 cubic feet of air, where 15 years ago all work was done by hand. This phenomenal development in many cases has bewildered the mechanical department to such an extent that, in spite of the best practice in air-compressor construction and installation, enormous losses are daily incurred through improper piping and the lack of study devoted to the very important subject of air distribution.

PROVIDE PROPER PIPING

The false economy of using the old piping as the system is extended is eating up hundreds of dollars every day in the boiler room and on the switchboard. It is a well-known fact that the cost of air varies as the pressure varies; in other words, it costs more to compress a cubic foot of air to a pressure of 100 pounds than to 90 pounds. Consequently any arrangement of piping which will tend to reduce the initial pressure at the compressor will save money. Assume, for example, that a shop is piped for a certain size compressor and with the increased requirements the management finds it necessary to purchase a machine of double the capacity. Then, as is often the case, owing to the cost of the machine rigid economy is enforced as to further expenditures, with the result that the important question of piping is neglected. The old piping is considered good enough and only the necessary extensions to the car tracks or other important points are made. No engineering study of the subject has been made and the money saved at one end is going up the stack at the other.

This can readily be seen when a few facts concerning compressed air are considered. In the first place, loss of pressure due to friction in pipe lines increases very rapidly as the diameter of the pipe decreases. The pressure loss when transmitting 500 cubic feet of air per minute through 1,000 feet of 3½-inch pipe amounts to 1.39 pounds, with an initial pressure of 100 pounds per square inch, while if the pipe size is cut down to 3 inches the loss of pressure jumps to 3.08 pounds. Globe valves and fittings such as tees and elbows add greatly to the frictional loss and great care should be given to their application. It will, therefore, be seen that it does not require many poor conditions to build up an unnecessary load on the compressor.

Let us consider a compressor with a capacity of 3,000 cubic feet of free air per minute operating during a 10-hour day at approximately 100 pounds pressure and assume that by some rearrangement or replacement of piping the frictional transmission load on this machine is reduced 10 pounds. What will the saving be? Under ordinary or even good railroad shop operating conditions it will amount to nearly $3 per day, which, in a year of 300 days, would be $900. This represents the interest on an investment of from $10,000 to $15,000, which would go a long way in providing new piping and would pay for considerable engineering study.

Another phase of the subject which offers possibilities for considerable saving is the after-cooling and reheating of the air, particularly where the moisture is excessive and the weather conditions such that long exposed lines are greatly affected. This, however, is a refinement and may be left for investigation after the greater faults are corrected. It is mentioned here simply for the purpose of showing the extent of the field that is awaiting attention.

Leakage

Pipe and hose leakage presents another source of loss which, while appearing small, amounts to many dollars annually in railroad operation. Few master mechanics or shop superintendents realize what a leak signifies in dollars and cents. They know it amounts to something and that it should not exist, but their attention is taken up by things which are of more immediate importance as far as their daily duties are concerned. But when it is realized that for every leak amounting to 1/64 inch in diameter on a 100-pounds pressure line there is a loss of 1.2 cents per day, while for a leak amounting to only 1/16 inch there is the enormous loss of 19.35 cents per day, the subject of leaks assumes some importance. Add up all the leaks from New York to Chicago, for instance, on one of our trunk-line railroads, and it will be found that there is quite a sum of money that is simply vanishing into the air.

In the ordinary railroad shop installation having a capacity of from 1,000 to 5,000 cubic feet of free air per minute it is fair to assume that it is costing from 2.5 cents to 3 cents per day of 10 hours for every cubic foot of air per minute that is compressed, while in smaller plants, where single-stage compressors and other old types of machines are used, the cost may be much higher. This is particularly true in roundhouses and small shops using tubular boilers without feed water heaters. With these costs as a basis, another field of economy still greater than those already considered becomes evident. It is the operation and care of pneumatic tools.

Pneumatic Tools

Even ten years ago little attention was given to this important subject, and if the tools were lucky enough to get any attention it was probably from some handy man passing out drills and taps from the tool room window. The continuous and almost universal use of pneumatic tools to-day brings up the question not only of repairs, but of economy of operation. Instead of waiting until a motor or hammer is broken down before tagging it for the tool room it should be periodically inspected and repaired, and there should be kept a systematic record of the condition of each tool as well as the cost of its upkeep.

The air consumption of each tool should be studied. No up-to-date shop can afford to keep antiquated tools of obsolete design operating on its floor when it is realized that the cost of air is so great. Even the most modern four-piston air motor consumes from 50 to 60 cubic feet of air per minute, and when it is considered that through wear or lack of attention it is often consuming 70 or 80 cubic feet, a loss in actual dollars and cents is evident, which will, many times over, pay for the repair parts and labor necessary to place the tool in first-class operating conditon, or even purchase a new one to replace it.

Pneumatic Tool Power Consumption

In order to emphasize the importance of maintenance, attention is called to the fact that on a full-load basis for equal periods the cost of the compressed air required to operate an ordinary 35-pound pneumatic drill used for such work as staybolt tapping, etc., is from two and one-half to three times as great as the cost of electricity to drive an 18-inch engine lathe.

The standard four-piston type air motor has a crank speed varying from 2,000 to 2,500 revolutions per minute, but as this is geared down at the spindle to a speed suitable for the class of work on which it is to be used the casual observer does not realize the amount of action taking place inside the metal casing. However, it is readily seen that with these little air pistons operating at such high speeds it does not require a great amount of false adjustment or wear to soon result in a large increase in air consumption. With the actual cost of air known, and knowing the cost of the various repair parts, such as pistons, bushings, valves, etc., it is an easy matter to determine the economic high and low limits for every tool and to establish a system by which repairs are made on a basis of air consumption tests, rather than under present practice.

The apparatus necessary for testing air consumption and power developed, covering both pneumatic motors and hammers, is inexpensive and can be operated if desired by a second- or third-year apprentice. Data can be kept in such shape that every tool will have its record on file covering both the tests made and the parts replaced. With such a system in operation, if an air motor, the card record of which shows a normal air consumption of 50 cubic feet per minute is sent in for test and is found to have a consumption of 60 cubic feet per minute, on a basis of three cents per day for each cubic foot per minute it is wasting 30 cents per day, or $9 per month of 30 days. It will not require much calculating to show that regardless of the service which this tool may be giving it should go to the repair bench.

The same idea applies to the various types of hammers, all of which are at times eating up many times their worth when to outward appearances they are in first-class condition. With a hammer, however, the waste is not so great, as it is held in the hand in such a manner that the operator becomes extremely sensitive to its operation and can often tell from "the feel" that it is taking too much air. However, the average shopman has never had impressed upon him the great cost of compressed air and his education in the matter by the methods now utilized in safety promotion work would undoubtedly result in eliminating many wastes.—*Railway Age Gazette.*

How to Read Working Drawings

Meaning of the Lines and Symbols Used in Making Working Drawings—Arrangement of the Drawings

BY FRED WEST

The boiler maker makes constant use of working drawings. These drawings consist of certain views of constructions that he is to make; sometimes they represent what he wants some one else to make for him.

Working drawings form a language that is universal, because mechanics of all nations who use drawings can readily read the same drawings. The knowing of how to read working drawings, like the reading of English, is such a practical and useful accomplishment that every mechanic should learn it. We will give in this first article what is known as the *alphabet* of the subject. It will be found by the reader that the subject is much easier to learn than any of the written languages.

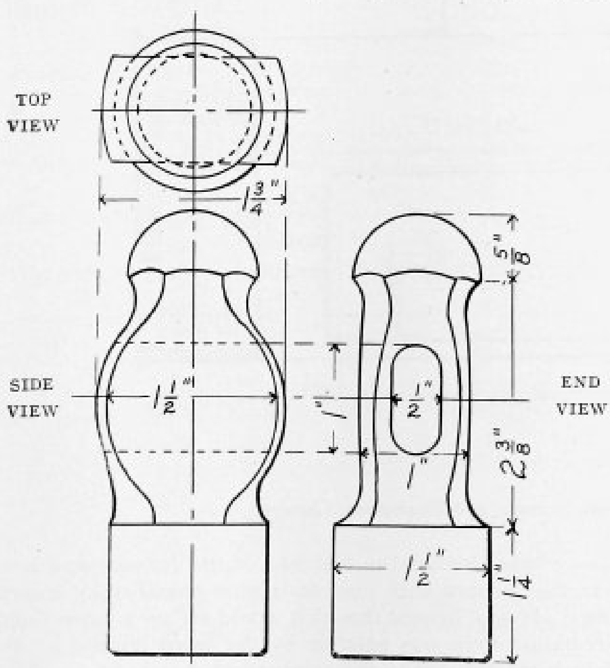


Fig. 1.—Working Drawing of a 1½-Pound Hand Hammer

A working drawing is a picture of an object made with lines so as to show separate views for each side or face of the object. This drawing is entirely different in appearance from a photograph or similar picture of the object, because the photograph can show three or more sides of an object in the single view. Also the photograph has the shadows and the surface as it actually appears to the eye. But, of course, the photograph can be made only of an object that is in actual existence, while most mechanical drawings are made of mental creations that are not yet built.

The working drawing, on the other hand, consists of one or more views as would be made by placing the object on the paper and marking around it.

The reading of mechanical drawings is entirely different from the work of making them. The making is done by the draftsman. The reader does not need to be a draftsman, but the more he knows about how mechanical drawings are planned and made, the better reader he will be.

The method is illustrated by the working drawing shown

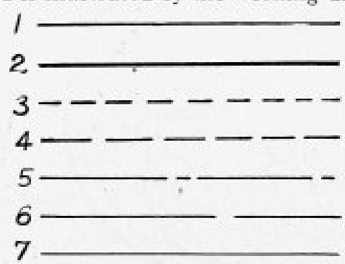


Fig. 2.—The Seven Kinds of Lines Used in Making Mechanical Drawings

in Fig. 1 of a 1½-pound hand hammer. If the hammer stands on the paper so that its outline can be marked off around it, the view called the *top* view will be made. Then, by looking square at the side of the hammer, the outline, which is called a *side view* or *elevation,* will be made. Finally, the hammer may be set on edge and the *end* view made.

From a close inspection of the working drawing in Fig. 1, it will be seen that several kinds of lines are used. Then if we speak of the alphabet of working drawings, or the "*A-B-C*" of it, we mean by the "*A*" the different kinds of lines used; by the "*B*" the arrangement of the different views on the paper in respect to each other, and by the "*C*" the method of marking the sizes of the various parts on the views.

First, as to the seven kinds of lines used, these are shown in Fig. 2, and they have the following meanings:

No. 1 is called the *medium full line,* which is used for the visible outline of the views.

No. 2 is the *heavy full line* which is used for shade lines, usually on the right-hand and lower sides of the views and for the border lines around some drawings.

No. 3 is the *dot line* used for hidden outlines. It is made of the same weight as either No. 1 or No. 2, depending upon which it replaces. It will be observed that the top and the bottom of the eye of the hammer are shown by dotted lines in the top view.

No. 4 is the *short dash line* used to connect the same points shown in different views.

No. 5 is used for *center lines* and *section lines*, and consists of a long dash followed by a short one.

No. 6 is the *dimension line*, made up of long dashes.

No. 7 is the *light weight solid line* used for cross hatching.

Examples of these lines not used in Fig. 1 will be shown later.

The several views that make up the mechanical drawing are arranged on the drawing paper according to a certain system. This requires that one view, such as that of the front or side of the object, be taken as the leading view, and that each other view be located next to the side of the leading view that it represents. Thus in Fig. 1 the top view is placed above the front view; the bottom view, if one should be needed, would be placed below the front view; the right-hand view of the end is located at the right, and the left-hand view would be at the left.

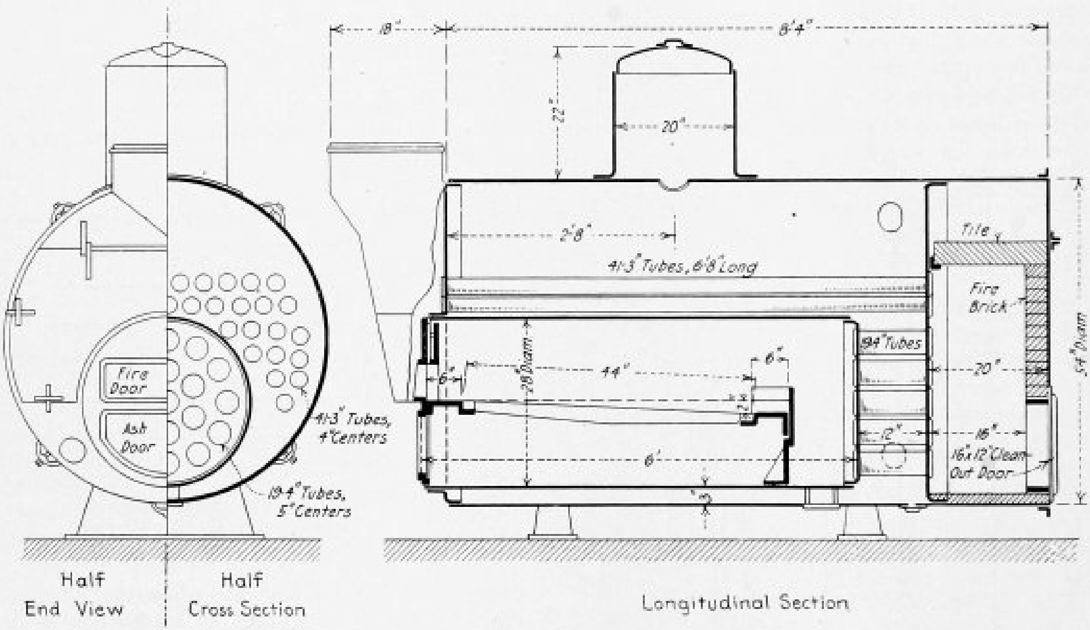
The changing of the size of the views to get a standard size of drawing is called "making the drawing to scale." This is done for convenience. Usually it would not be convenient to make the drawings the full size of the object. Hence the drawing is made to scale, such as half-size, quarter-size, etc. The scale should be marked on the drawing. Sometimes more than one scale is used on the same drawing, each view being marked with its own scale. This is the case where the object is extra long and narrow, and where some small parts must be drawn large in order to show fully their construction.

Boiler shop drawings showing the applications of the *"A-B-C"* system as explained in this article will be published in later issues.

Improved Type of Marine Boiler

The type of marine boiler shown in the illustration was designed to obtain better circulation, thereby increasing the amount of steam produced, or, in other words, the commercial horsepower, as compared with a boiler the same size but of the usual design.

The change made which was to accomplish this was to



Dry Back Marine Boiler, with Tubes Between Furnace and Combustion Chamber

In addition to the placing of the views in this way, the edge of each view next to the central view represents the front edge of the object. The idea of this arrangement can be understood by supposing that all the views are hinged together. Then, suppose the central view to be lifted up, allowing the other views to swing down and form the shape of a box with the central view as the top. A view of each face of the object which fills the box will now be correctly shown on each side or end of the box.

All the dimensions necessary to make the object should be marked on the different lines of the drawing. The figures should be the actual lengths. The size of the views, however, may be either larger or smaller than those of the real object. Referring to Fig. 1, it will be seen that the dimensions are written so as to read right side up when the lines are horizontal. The drawing should be turned ninety degrees to the right to bring the vertical lines in the proper position for reading the dimensions.

place a tube sheet in the rear end of the furnace and connect the furnace with the combustion chamber by 4-inch tubes. It was figured that this would set up a more rapid circulation than was possible by the usual method of attaching the furnace to the combustion chamber.

The test made was short and simply to determine what the boiler would do under unfavorable conditions. The shell was not insulated, the feed water very low in temperature and the coal as poor a grade of slack as could be imagined. It was figured that if the boiler would give the rated capacity under the most adverse conditions, it would be safe to assume that the performance under better conditions would be highly satisfactory. As the test was to determine the capacity of the boiler, or how closely the actual horsepower would agree with the designed horsepower, only such data were taken as would be of use in figuring the commercial horsepower, and these data were recorded with the greatest of care.

The boiler was set up in the shop, the stack projecting through the roof. During the test it was aimed to keep the pressure as near 100 pounds gage as possible, the safety valve being set for that pressure. The steam generated by the boiler did not perform any useful work, but was allowed to pass out through the boiler stop-valve into a pipe line placed alongside the smokestack and into the atmosphere. The feed water was carefully weighed by means of a barrel placed on a scale; from this barrel the water was allowed to run into a tank placed alongside the boiler. From this tank the feed water was picked up by an injector operated by steam from the test boiler and fed into the boiler. A thermometer was placed in this tank and the temperature of the feed water recorded every five minutes during the test.

On starting the test the height of the water in the boiler was marked by tying a string on the water gage glass; the test was stopped with the water at exactly the same level as in starting. The condition at the start of the test was carefully noted and the test was stopped with the fire in the same condition that it was in starting, as nearly as could be judged. Natural draft was used, the stack being 40 feet high and 18 inches in diameter.

SUMMARY OF TEST

Duration of test	1 hr. 34 m. 35 s.
Grate surface	8 5/9 square feet
Heating Surface:	
Furnace crown	21 square feet
19 4-inch tubes 12 inches long	18.62 square feet
41 3-inch tubes 6 feet 8 inches long	199.52 square feet
Back tube sheet (effective)	3.65 square feet
Total heating surface	242.79 square feet
Ratio H. S. ÷ G. S.	28.39
Average steam pressure by gage	95.05 pounds
Average steam pressure, absolute	109.75 pounds
Average temperature of feed water	45 degrees F.
Total water fed to boiler during test	1,845 pounds
Total water fed to boiler per hour	1,165 pounds
Quality of steam, percent	97
Water evaporated per hour, corrected for quality	1,130 pounds

$$\text{Factor of evaporation, } \frac{(H - t + 32)}{966.1} = 1.212.$$

Where H = total heat of steam at 109.75 pounds absolute = 1,183.9.

t = average temperature of feed = 45 degrees F.

Water evaporated from and at 212 degrees F. = 1,130 × 1.212 = 1,369.56 pounds.

The evaporation of 34.5 pounds of water from and at 212 degrees F. is considered equal to one boiler horsepower by the Committee of Boiler Tests of the American Society of Mechanical Engineers. Hence the horsepower developed equals

$$\frac{1,369.56}{34.5} = 39.7.$$

The builders had rated this boiler at 30 horsepower. Hence the percentage of rated capacity actually developed was

$$\frac{39.7 \times 100}{30} = 132\ 1/3 \text{ percent,}$$

or 32 1/3 percent above its rating.

As the builder in rating this boiler had used the standards of heating surface and grate surface which would ordinarily have been used for the usual type of marine boiler, and had never obtained such a high percentage above the designed rating, the excess was atributed to the only point of difference between the two types, namely, the 4-inch tubes connecting the furnace with the combustion chamber.

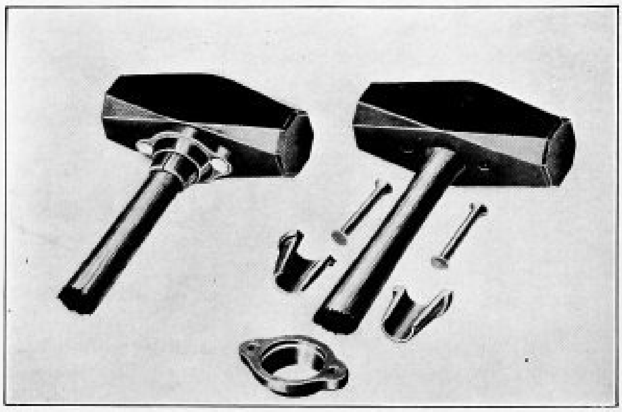
St. Louis, Mo. ARTHUR C. MEYERS.

Safety Lock for Sledge Hammer

BY FRANK C. PERKINS

A simple safety device attached to the handle of a sledge hammer to keep the head of the sledge from flying off and possibly injuring a workman is shown in the accompanying illustration. The device consists of three steel castings. One is a circular flanged casting, the hole of which is slightly tapered. Into this ring fits two taper or wedge castings with a shoulder on one end. This lock is easily adjusted to any sledge hammer.

There are two holes drilled in the head of the sledge to conform to the holes in the circular casting. The two taper castings are then fitted to the handle close to the head of the sledge, the ring casting is then slipped over the wedge or taper castings and connected to the head of the sledge by two rivets. When the lock is in place and riveted to the head of the sledge it is impossible for head of sledge to fly off, for the more force exercised by the head in a flying movement, the tighter the lock clamps to the handle of the sledge; therefore if the wedges come out of the handle and the handle is carelessly fitted in the head, with this lock in place the head cannot fly off.



Details of Safety Locks for Sledge Hammer

The sledge may break in two pieces at the eye but the lock will hold them together. The handle may break, as it often does, inside the eye of the sledge, but the head cannot fly off. It is claimed that this lock has been tried and tested under the most severe conditions and has always proved to be absolutely safe.

About Boilers

BY DR. LEONARD KEENE HIRSHBERG

Continuous and automatic analysis of the products of combustion will indicate the method of stoking that produces the best results. As is well known, the carbon in coal is never completely burned in carbonic acid gas. It is very often changed only into carbon monoxide. Even the carbon dioxide that is formed often prevents complete combustion, if it comes in contact with overheated coal. It then forms carbon monoxide as it passes through the flues and chimney.

A pound of dry carbon coal burned entirely to carbonic acid gas yields 14,600 B. T. U. of heat. The same weight of coal burned, as is the usual rule, only to carbon monoxide gives but 4,450 units of heat.

Consequently, if there is a low percentage of carbonic acid gas—carbon monoxide—in the flue gases and other exit vapors, a vast amount of heat is lost. A test of the escaping gases soon tells what is the case.

A recording instrument, which automatically registers the amount of CO or CO_2 each hour will thus indicate whether a boiler is obtaining its money's worth of heat.

There are two factors to be considered in estimating the carbonic acid gas contents of the waste gases: the percentage of carbon monoxide and the heat of the gases at the stack. As carbon monoxide is a heat absorber, it is obvious that it would be of little avail to produce a set of conditions which, while it secured a large amount of carbon dioxide, had a tendency at the same time to encourage the presence of carbon monoxide. The admission of air in the first place will prevent the initial formation of carbon monoxide.

The chance of changing carbon dioxide back to carbon monoxide is a remote one as long as the percentage of carbon dioxide is, on the recording instrument, not more than fourteen or fifteen percent, and the formation of carbon monoxide under those conditions is most likely due to a low velocity of the gases in the furnace at a high temperature. This encourages contact of particles of carbon dioxide with highly heated carbon.

A high temperature at the stack is caused either by conditions unfavorable to complete combustion of the fuel and the gases given off by it immediately over the grate, or too high a draft pressure. The result in the previous instance is to be seen on the records; in the latter case it is advisable to take into consideration the temperature of the exit gases in addition to carbon dioxide percentage.

If an engineer could, by the use of a carbon dioxide recorder, increase the percentage of carbon dioxide in the exit gases from 5 to 14 percent, it would effect a saving in coal of 21½ percent. If, also, he succeeded in reducing the temperature at the stack of 100 degrees, the saving would amount to 24 percent.

Boiler Feed Piping*

Arrangement of the Internal and External Feed Piping

Boiler feed piping for the purpose of the present discussion may be considered to include everything from the feed heater to the discharge end inside the boiler. Because the feed line naturally divides itself into two parts, that inside and that without the boiler, with the point of division where the pipe enters the boiler shell, and also because these two portions of the feed piping perform somewhat different functions, and have somewhat different requirements, we will divide the discussion of them in the same manner.

Internal Feed Arrangement

The purpose of an internal feed pipe, or an internal feed device of any sort, is to raise the temperature of the entering feed water as nearly as possible to that of the contents of the boiler before discharging it, and secondly to direct the flow of the discharged water so that it will assist and not retard the natural circulation due to convection currents in the boiler. In addition to discharging the feed in the direction of the natural circulation, it is also necessary to prevent the entering water from striking directly on heated shell plates or tubes, and particularly must this be avoided in the neighborhood of joints. Careful choice of layout for an internal feeding device may even do more than this, for it is quite possible to so direct the flow of the entering water, and to so control its temperature at the moment of discharge as to very greatly modify the deposition of scale and sediment, and in this way assist in the maintenance of a clean internal heating surface.

Years ago it was a common practice to feed boilers at the bottom. Sometimes this was accomplished through the agency of a mud drum into which the feed was introduced, while in other cases the feed connection was through the blow-off. Trouble was experienced because the water so introduced was of necessity colder than the water already in the boiler, even when a heater was used. The temperature difference, running anywhere from 50 or 60 degrees to 100 degrees F., depends on the pressures carried and the efficiency of the feed heater. Of course much greater differences could be obtained if high-pressure boilers were fed with cold water, a condition frequently found even to-day.

The feed introduced in this way at the bottom of the boiler, colder than the water already inside, is of course always *denser* than the boiler water. Hence it cannot rise with the natural circulation until it becomes heated to such a temperature that its diminished density makes it rise. It follows, then, that the feed must spread out on the lowest part of the boiler surface, displacing the hotter and lighter water, until it has taken up enough heat from the metal of the boiler to rise naturally and take its place in the circulation. The metal of the boiler is certain to become appreciably cooled by this enforced heating of cold water, and it will cool rapidly, because the *rate* of heat transfer from the hot metal to the cold water depends on the temperature difference, and will be greater the colder the water. The cooling is also assisted by the fact that it takes much more heat to raise the temperature of a pound of water 1 degree than is given up by the cooling of a pound of steel through a like temperature range. Moreover, since the heating is so rapid, by far the greater portion of the heat given to the cold feed must come from the store of heat *already* in the metal, and not from the heat being transferred *through* the metal from without. Therefore, a cooling of the boiler metal through a considerable range at each entrance of fresh, cool feed water is to be anticipated.

It is perhaps well to consider the magnitude of the mechanical stresses which may be involved when a structure like a boiler shell is locally cooled. Some years ago this subject was considered in *The Locomotive* (March, 1893) and calculations were made for the case of a steel boiler, working at 100 pounds, into which feed water at 100 degrees F. was introduced. It was shown that under such conditions the plate would experience a drop in temperature of some 200 degrees F. and also that if the plate could be conceived of as held rigidly at the edges by the unchilled portions of the boiler, stresses of 37,700 pounds per square inch might be developed in the chilled portions of the boiler plate. This stress is great enough to seriously damage the plate, or indeed to rupture girth seams, but it is unlikely that so great a stress is produced, because the

* From *The Locomotive* of the Hartford Steam Boiler Inspection and Insurance Company.

cooled portion of the plate is not held at its edges by an absolutely rigid structure, but is part of a shell which is elastic and yields under the pull of the cooled portion. Calculations which took account of this sort of action in the chilled boiler plate led to the conclusion that stresses of the order of 8,000 to 10,000 pounds per square inch might be expected to occur in the particular boiler considered. This, of course, would be in addition to the pressure stress which a working boiler is always called upon to carry. It is, therefore, easy to see that a boiler plate, when stressed by the admission of cold feed water, must bear stresses quite too close to the elastic limit of the material for safety, and indeed cracks, ruptures, leaking joints—any or all of these defects—are absolutely certain to follow the continued discharge of cold water directly on the shell of a high-pressure boiler, and they frequently occur in a surprisingly short space of time.

The most familiar means for avoiding trouble of this nature is some form of internal feeding device which shall provide a means for raising the temperature of the entering water to boiler temperature before it is discharged and allowed to mingle with the boiler contents. In general, two methods are available for accomplishing this, the internal feed pipe and the method of spray or steam space feeding.

The internal feed pipe consists of a length of piping disposed near the water line of a boiler, and of such length that the feed may be heated in traversing it very nearly to the boiler temperature. The discharge is then so located, depending on the type of boiler, as to direct the water flow away from joints and the shell, and so far as possible along the path of the natural circulation.

The various forms of steam space feed depend on breaking up the incoming water into a spray or thin sheet so as to expose as large a surface as may be to contact with the steam. The effect is to condense enough of the steam to raise the water to boiler temperature while falling to the surface of the water already in the boiler. One form of this device used largely abroad, where boiler forms are such as to render it practicable, consists of a series of trays so disposed in the steam space that the entering water flows over them in thin sheets and is heated by contact with the steam, at the same time depositing much, if not all, of its scale, forming solids on the trays. The objection to such an arrangement in the boilers in common use in this country is that so much of the available room above the water line would be taken up by the device that the boiler would be almost inaccessible for inspection, and, indeed, this is a serious objection to many forms of steam space feed. Another objection is that under some conditions of loading, and especially in a boiler of restricted steam room, the introduction of a spray feed has a tendency to increase the moisture content of the steam. This objection has been much overrated, and many times a top feed would work well in boilers where the operator fears to introduce it because he expects a large increase in the moisture carried by the steam.

The exact design of an internal feed pipe must vary with the type of boiler. In the familiar horizontal return tubular type the best practice is to carry the pipe through the front head at the side and just above the top row of tubes. The pipe then extends back toward the rear head for about two-thirds or perhaps three-fourths of the tube length, running parallel to the tubes. At this point its direction is changed through 90 degrees by an elbow, and the pipe is carried across the boiler to a point near the opposite side, where it terminates in an open elbow, which is arranged to look down. The pipe should be rigidly supported by straps from the braces, so that there can be no chance of its rubbing on the tubes or plate when it pulsates under the intermittent action of the pump. If rubbing should occur, a very rapid corrosive action is to be expected at the point of contact. The cause, often wrongly attributed to friction alone, is to be found in the displacement of rust or scale at each pulsation of the feed pipe, so that fresh metal is constantly exposed to the corrosive action of the boiler water, so that a rapid attack is to be expected even from waters not otherwise especially corrosive.

In a vertical tubular boiler the internal feed pipe, when present, is usually fitted to discharge just below the water-line, near the center of the tube nest. This arrangement, while in most cases quite satisfactory, has been the cause of trouble in at least one case, from the repeated contraction and expansion of the tubes directly exposed to the impingement of the entering water. This may perhaps be due to the fact that in this type of vessel it is not very easy to arrange an internal pipe long enough to serve as efficiently as does its counterpart in the horizontal tubular boiler. However, with the feed heated to a reasonable degree by some of the many forms of feed water heaters, no trouble need ordinarily be anticipated. In very small vertical boilers it is usual to introduce the feed water at a point near the bottom of the water leg, although this practice is not to be commended.

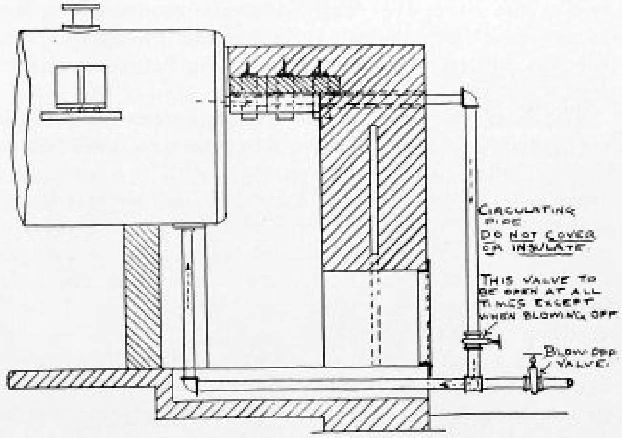


Fig. 1.—Sketch of Circulating Pipe

In locomotive type boilers, wherever the construction makes it possible, an internal feed pipe of the type described for horizontal tubular boilers should be used. When this is not possible, the feed should be introduced in the barrel as far from the firebox as is feasible.

Where feed pipes pass through boiler shells or heads, we have found the best construction to consist of a boiler bushing of either brass or steel, threaded tightly into the head or shell plate, and with an internal thread into which the outside portion of the feed pipe may be screwed on the outer end while the internal pipe is screwed into the inner end. The bushing should be long enough to permit both these connections to be made to the full depth of thread required by standard pipe fittings of the diameter used, without the ends of the two portions of the feed pipe binding on each other inside the bushing before the joints are tight.

Two general considerations should always receive attention before a layout for an internal feeding device is approved. First, it is imperative that the internal piping be arranged so as to remain full of water, for should it become in part steam bound, a water hammer is to be expected when the water flow is again established. Secondly, the piping should be so placed as to be readily accessible for cleaning and repair, as the internal portion of a feed line is subject to incrustation or choking from scale, and when partially filled with such a deposit it may not be able to supply feed fast enough to meet the conditions of maximum steam demand without permitting the water level in the boiler to become dangerously low. A choked feed pipe is especially dangerous in a plant where it is the practice to feed up the boilers as much as they will stand without priming, and then let the level gradually lower to the lowest safe limit on peak loads, so that the fireman need not contend with the added effort of heating incoming feed water when called upon for the greatest flow of steam. Under these conditions, and they are quite too common, if the feed pipe is not free and the pumps in good order trouble is very apt to be experienced in getting the waterline back to a safe point if for any reason the excessive draft of steam should last a little longer than is usual, or if the fireman should be a little careless and let his water go too long before starting to feed up again.

The best material for internal feed pipes must be left for individual conditions to determine to some extent. On the other hand, it is true that, with few exceptions, brass is to be preferred. Brass pipe will outlast iron in boilers fed with very pure soft water, carrying some organic matter, and will have a life at least as long as iron in the great majority of boilers. More important, perhaps, even than the question of durability is the great freedom of brass pipe from choking. This is due both to the fact that no rust scale forms and to the great difficulty which ordinary scale matter seems to experience in attaching itself to this material. This greater freedom from scale deposits has at times been questioned, but the record of long experience seems to justify the statement. The gain in safety from a clean feed pipe is greater than might be expected, for in addition to the greater area of an unchoked pipe, there is the very greatly lessened friction of the smooth internal surface. The choking of feed pipes is particularly troublesome in some parts of the country where boilers must be operated on waters carrying large amounts of scale matter, and we have frequently observed cases where the pipe was so nearly closed off by deposits of hard scale as to make it a matter of wonder how the boiler could possibly have been operated so long without replacing or cleaning the pipe.

One reason why the practice of feeding through the blow-off has persisted so long in some regions, in spite of all recommendations to the contrary, is that this practice protects the blow-off pipe. When a very large amount of scale matter is deposited by the feed water there is a tendency for sediment and scale to form in the blow-off pipe, and when this sediment becomes hardened and attached to the metal, overheating follows, since the blow-off passes through about the hottest part of the boiler setting, where it receives the direct impact of the hot blast from over the bridge wall. When there is a constant flow of feed water through this pipe, the sediment is kept well stirred up and has much less chance to settle and bake on with disastrous results. We cannot see, however, why this fact, true though it undoubtedly is, should be made an excuse for preserving the blow-off at the expense of the boiler itself. It is a very simple matter to arrange a circulating pipe as shown in Fig. 1 which will accomplish all that the feed water can do in the way of keeping the blow-off free and at the same time will permit feeding the boiler in the safer matter through a proper internal feed pipe. The action of the circulating pipe is so simple that it is hardly necessary to comment on it; a glance will show that the vertical part of the connection, since it is outside of the setting and not covered, will radiate heat to the atmosphere fast enough to cool the column of water contained in it. This cooled water, as it is denser than the boiler water in the proportion of their difference in temperature, will flow down into the blow-off pipe, there to be again heated by the impact of the hot gases, and thus as it rises again to the boiler a flow will be established which will be rapid and will be maintained automatically as long as the boiler is under steam. Experience shows that such an arrangement will effectively overcome the scaling and overheating of the blow-off at least as well, if not better, than the flow of the entering feed. It will be seen from the sketch that a valve is fitted in this vertical pipe near the tee where it joins the blow-off line. This valve should be open at all times except when the boiler is being blown down, and it should be manipulated in a regular routine with the blow-off valves, so that the operatives will acquire the habit of first closing the circulating valve, then blowing down in the usual way, and finally, when the blow-off is again secured, open the circulating valve. The importance of such a routine in preventing lapses of memory in the performance of duties of this sort may best be appreciated if one will attempt to tie one's shoes in the opposite order from that to which he is unconsciously accustomed and see what a degree of mental effort is required to accomplish it.

In watertube boilers the same principle should be applied as in firetube boilers. The feed should not be introduced through mud drums or directly on the heating surface, but some form of internal feed pipe adapted to the design of the boiler, and which will be accessible, heat the feed water properly, direct its flow away from the heating surface and in line with the natural circulation current should be provided. This will usually be most easily accomplished by feeding in an upper or stream drum. Many excellent devices to do this have been designed by the various builders of watertube boilers, and many attempts have been made to combine with the feed heating device some arrangement which will arrest and hold the sediment deposited by the entering feed when heated. There is only one objection to these devices, and that is that in the smaller drums usually associated with this type of boiler construction it is rather difficult to so design an effective water heating device which can at the same time act as a scale catcher without seriously obstructing the spaces which must be visited by the inspector, and therefore rendering difficult the detection of incipient defects.

A single case exists where it is permissible, and indeed advisable, to feed boilers through the blow-off connection. Where boilers are operated at low-pressure for steam heating and are fed with the condensed water returned from the radiating surface, then, since the temperature differences are not great, both the circulation in the system and the return of the condensate will be facilitated by feeding through the blow-off. This subject was discussed in *The Locomotive* for January, 1913, and suitable arrangements and precautions for such an installation were described at that time.

External Feed Piping

External feed piping should be laid out so as to secure the most reliable supply of feed water for each boiler which is possible. It should also secure for each boiler a feed supply which is as nearly as maybe independent of conditions in each boiler.

To this end it is best to employ extra heavy brass pipe for the entire feed system from the heater to the boilers because of the greater freedom of brass pipes from choking and so stopping the water flow, as well as because of its longer life under the corrosive action of hot water.

The layout of the external feed line should be such as to secure a direct short connection to each boiler, with all portions of the piping accessible and in plain sight, to facilitate inspection and repair. With the exception of a stop valve, and in some cases a relief valve near the pump, all valves should be located in the separate branches, keeping the main line free. All feed lines are best fitted with tees or crosses instead of elbows, where a change in direction is necessary, the unused openings of which should be plugged so that the runs may be cleaned with the least possible loss of time. To further facilitate the quick repair of either the main line or its branches, either flanged or screwed unions should be used with reasonable freedom, so that a portion of the piping may be removed without any very general dismantling of the system. Provision should be made for the necessary expansion, and care should be also taken to see that the piping is anchored securely against the pulsating effect of a reciprocating feed pump.

Each branch to a boiler should be fitted with a swing check to prevent the flow of water back into the line from the boiler, and also with at least one stop valve, gate preferred, for regulating the water flow to that boiler, located between the check and the boiler. When two or more boilers are fed from the same feed line, it is best to provide two stop valves, one on either side of the check valve, so that the branch pipe or the check for any boiler may be overhauled without interfering with the operation of the unit.

The location of the stop valve used for regulation of the feed to a boiler is a matter for some consideration. In the first place its location will be determined by the level from which the water tender or the fireman is to work. In plants where the water glasses are high up on vertical or other high boilers, so that a gallery is provided for the supervision of the gage glasses and gage cocks, then it is probably best to locate the feed valves so that they may also be operated from the same gallery, and the water tender may then get at all of his valves and gages with the least loss of time and effort.

What Becomes of the Steam Boilers?

BY F. WEBSTER

What becomes of all the pins is an old question. Where, oh where, have all the steam boilers gone is another.

An industry as active as that of boiler making turns out an immense amount of product each year. It is easy to account for the loss of about one million horsepower of steam boilers that have disappeared during the past year. Bluntly speaking, they have gone to find McGinty and are at the bottom of the sea. Yes, "War is hell!"—for steam boilers as well as for humanity.

An inspection of the reports issued by casualty companies and the government shows that each year over five hundred boilers blow up. It is supposed that all of these that go up come down again, and thus there are a mighty lot of carcasses to take care of.

The cutting up of old boilers gathered from all kinds of service is quite an industry. The cutting is done both by hand and by power chisels and by the gas flame. The scrap is used for making steel castings, car wheel centers, forgings, building and repairing certain kinds of machinery, making sidewalks, floors for bridges, culverts, targets, shields for furnaces and the like.

A Row of Old Boilers—Relics of a Steam-Heating Plant—Now Ready for the Melting Pot

The accompanying photograph shows a row of old-style locomotive type boilers, the kind once so commonly used in the mining region. These boilers were gathered from various sources and used to form the "plant" for holding down the franchise for steam heating a city. A few years in this service showed the futility of their effort, except as to the aforesaid "holding down of the franchise" job, and they have been discarded for boilers of modern design located in a new plant.

Since the photograph was taken about two months ago these boilers have been cut to pieces and sent to a score of industries, from which they will come in due time as new products for the service of mankind.

Boilers that are old,
Like boilers that are "busted,"
Can be exchanged for gold—
Though never to be trusted.

Spiral Riveted Pipe

Layout of Pattern for Heavy Plate—Allowances for Seams

BY C. B. LINSTROM

For a great many years spiral seam pipe has been employed for various kinds of pipe lines, as, for example, in water lines, irrigation and dredging work, for pulp and flour mills and other mills where pipe conveyors are required. On account of the formation of the seam, which is wound spirally around the pipe, as in Fig. 1, a greater resistance to bursting and collapsing pressures is secured than with pipes having circumferential seams. In fact, the seam is the strongest part of the pipe.

In the making of spiral pipe, strips of sheet metal are cut to the required dimensions first, and then run through machines especially designed for such work, and which draw and shape the strips of sheet metal to the proper form. The best results in riveting the seams are secured by the compression method, which forms the rivet heads and upsets its shank in one operation.

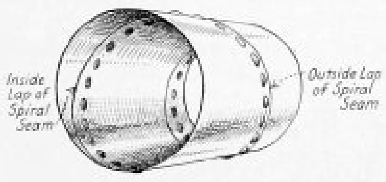


Fig. 1.—Arrangement of Spiral Seams

In Fig. 2 is shown a spiral riveted pipe of No. 16 gage metal, which was tested to a pressure of 650 pounds per square inch before it bulged out in any part. After the test the seam was in good shape, but the metal between seams bulged out considerably. Pipes of this description also withstand a great collapsing pressure, such as is met with under earth-fills. Manufacturers make such pipe of different metal thickness, ranging from No. 16 gage to ¼ inch thickness and of various lengths.

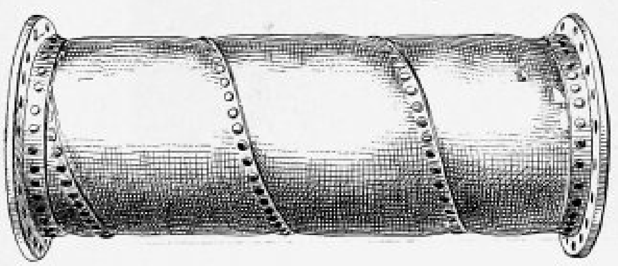


Fig. 2.—Spiral Riveted Pipe after Test for Bursting Pressure

An important matter to look after when installing steel pipe is to protect as well as possible the lasting quality of the metal against the action of corroding and other destructive elements. There are two processes employed in coating the surface of pipe, namely, galvanizing and asphalt coating. By the galvanizing process the surface of the pipe, both inside and outside, is covered with a heavy coat of zinc; several operations are required in this work and also special apparatus for doing it. Sometimes galvanized sheets are used instead of black iron or steel sheets to offset the operations of galvanizing the pipes after they are formed. Engineers and corporations, however, are usually specific and insist upon the pipes being galvanized after they are formed, because in the operation of forming galvanized sheets the zinc coating cracks and peels off, thus leaving the metal exposed to corroding elements.

Galvanizing is done by what is termed the hot process, the first step consisting in cleaning the pipe from all dirt and grease in a pickling bath of acids. It is then removed from the acid bath and thoroughly washed in a water bath to remove the acid. Then it is dried and afterwards submerged into a kettle of molten spelter or zinc, in which it remains until the pipe has reached the temperature of the spelter and taken on a good coat of zinc.

Asphalt coating, as the term signifies, consists of applying a coating of asphaltum, which is a mineral rubber. The coating is done after the pipe has been formed, thoroughly cleaned and dried. It is then immersed into a bath of mineral rubber which is kept at a temperature of 400 degrees. It is redipped until the pipe has taken on a good coating both inside and outside. Asphaltum withstands the uneven temperatures of hot and cold weather without any trouble, and it is proof against alkali and other earth substances. The life of steel pipe covered in this way is dependent upon the thickness of coating. It has been found that if the coating is properly applied that for underground work it will last a great length of time.

Pipe Development and Allowances for Seam

The principle of development in this problem involves the construction of a helix the pitch of which is equal to one complete turn of the seam around the pipe. The pitch of the helix and diameter of the pipe govern the angle of the joint with respect to its axis. Its angularity is a factor in figuring its strength or efficiency as compared with the solid plate. The strength of seams of this kind may be calculated as explained for the diagonal seams given in October's issue of The Boiler Maker.

Construction of Plan and Elevation

The development of the pipe pattern without considering the plate thickness, as is done when light gages are used, is a simple matter. But with heavy plate the metal thickness must be duly considered, as it is a factor in the making of the correct development of the pattern.

In Fig. 1 is shown a section of a pipe having one and a half turns and Fig. 3 illustrates the development of its helical seam along the neutral layer of the metal. In Fig. 1 can be noted the position of the inside and outside lap of the seam, and it may be understood that when a section of the pipe is looked at through a plane at right angles to the axis of the pipe, the section on the outside lap is larger in diameter than a section through the inside. Fig. 3 shows this condition clearly in the plan view, which is slightly exaggerated to bring out this point. The radius r is for the neutral radius of the outside and r' for the inside. Lay off the center lines x-x and y-y, then the pitch of the helical seam for one complete turn around the pipe. Locate on x-x at some convenient point the center for drawing the two circles in the plan. Divide the circle in the plan into any number of equal spaces, also divide the pitch into the same number, in this case sixteen.

To develop the helixes draw lines from points 1, 2, 3 and 4, and 1′, 2′, 3′, 4′, etc., from the plan to the elevation parallel with the line x-x. Then from the points on the pitch draw corresponding horizontal lines intersecting as at a, b, c, d, etc. Connect points a-a, b-b, c-c, etc., with solid lines and then draw the dotted lines from *a* to *b*, *b* to *c*, *c* to *d*, etc. While this is not exactly essential, yet if done it will give a better idea of how to lay off the construction lines when developing the pattern.

Next find the true length of one solid line, as *d-d* and one dotted as *c-d*, by constructing triangles as shown to the right of the elevation at *d'*-4-4 and *c'*-3-4. The heights

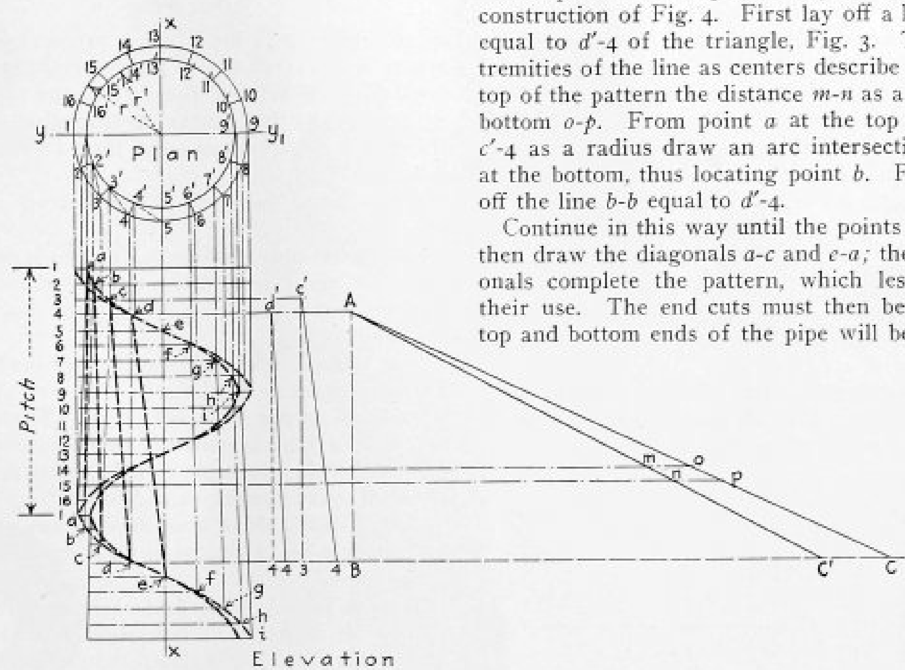


Fig. 3

of the triangles are equal respectively to the vertical distance between points *d-d* and *c-d*. Their bases are taken from the plan and are equal to 4-4' and 3-4'. The diagonals of each triangle as *d'*-4 and *c'*-4 are the true lengths of the lines *d-d* and *c-d*.

Also find the length of the spaces for laying off the distances between points *a-b*, *c-d*, *d-e*, etc., on the inside and for the outside edges of the seam. This may be done by finding first the length of the spiral for one complete turn on the inside and outside lap of the seam. Note the two triangles to the right of the elevation at *ABC'* and *ABC*, Fig. 3. The length *BC'* is equal to the circumference of the inside neutral layer of the pipe, which is represented by the small circle in the plan view. The height *AB* is equal to the pitch, the hypotenuse *AC'* is the true length of the inside helix. Line *BC* is equal to the circumference of the large circle and *AC* is the length of the outside helix. By projecting the vertical distance between any two points on the pitch to these lines as at *m-n* and *o-p*, determines the length of spaces.

Layout of Pattern

The pattern development may be understood from the construction of Fig. 4. First lay off a line *a-a*, section *A*, equal to *d'*-4 of the triangle, Fig. 3. Then with the extremities of the line as centers describe arcs, using for the top of the pattern the distance *m-n* as a radius and for the bottom *o-p*. From point *a* at the top and with the line *c'*-4 as a radius draw an arc intersecting the one drawn at the bottom, thus locating point *b*. From this point lay off the line *b-b* equal to *d'*-4.

Continue in this way until the points *e* have been fixed, then draw the diagonals *a-c* and *e-a*; then with these diagonals complete the pattern, which lessens the work by their use. The end cuts must then be made so that the top and bottom ends of the pipe will be parallel. This is done by making the point *x* from *c* equal to one-fourth the distance *c-e*, *y* equal to one-half of *a-a* and *z* equal to three-fourths of *e-e*, as shown.

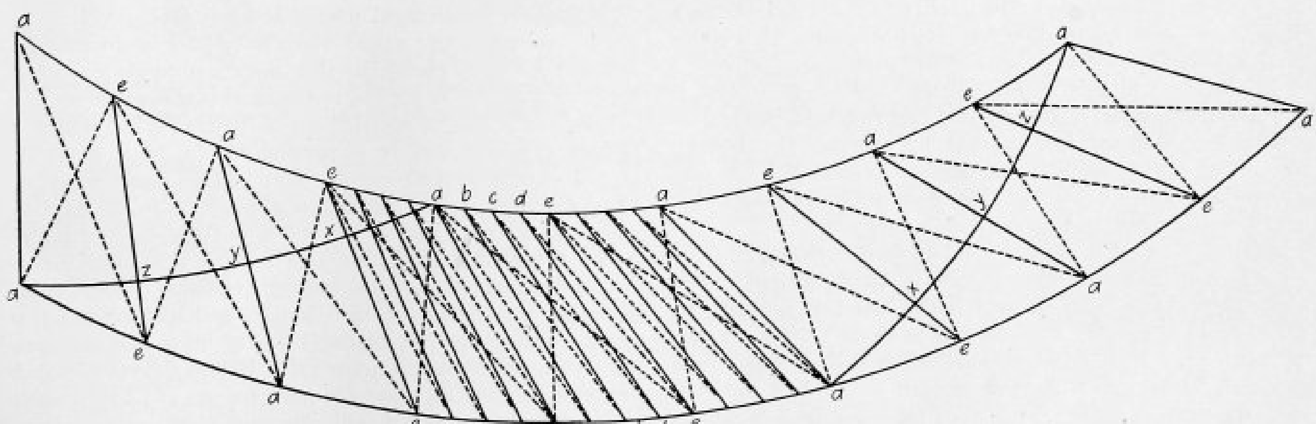


Fig. 4.—Pattern

There is a lot more skill required in firing a boiler than there is in opening the drain cock on an engine and handling the throttle valve, but judging by the difference in pay of the men who handle the jobs nobody seems to think so, and considerable more damage results from a boiler letting go than a cylinder head blowing out.

Force must always be considered in connection with time. An ounce moving a foot a minute lighting on your hand will not do you any harm; yet if the ounce is moving 1,000 feet a minute it would take your hand with it.

John and the Blower

Overcoming Troubles with the Shop Blast for Heating Rivets

BY JAMES F. HOBART

"What's the reason, Mr. Hobart, that our shop blower makes such hard weather of furnishing blast for the forges, rivet heaters and some of the plate heaters? The belt is strained tight as it can run, you can hear it slip and squeal when all the air discharge openings are working, and there is sometimes so little force at the fires that it is hard to make welds on large work. Can you tell me what the trouble is, or what it is likely to be?"

"What kind of a blower is it, John. A plain centrifugal 'fan blower' or is it one of the positive gear-wheel type where the air is brought in among the teeth of two gears and squeezed out into the discharge pipe when the gears mesh into each other?"

"Oh, it's one of the fan blowers, all right; just a plain, everyday affair, something as shown by Fig. 1, which shows just how this fan is arranged in our shop."

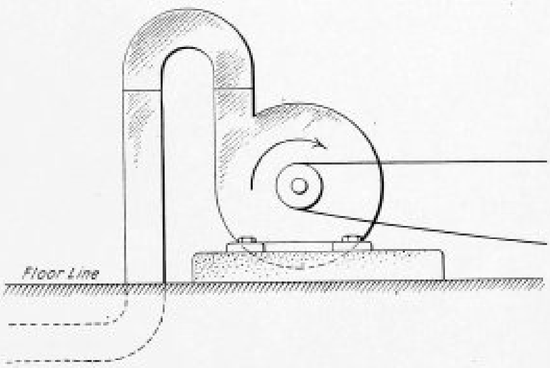


Fig. 1.—Blower in John's Shop

"What is that inverted syphon for in the discharge pipe?"

"You can 'search me,' Mr. Hobart. All I know about it is that 'There 'tis, Father,' as the boy said. All I know is that it is there."

"How big a pipe is it, John?"

"About 8 inches, as closely as I can measure it."

"Well, John, the loss caused by forcing air through those two elbows is about the same as is caused by 70 feet of straight pipe. The three elbows shown in the engraving cause a loss equal to that of 100 feet of pipe."

"What would that loss amount to in our shop?"

"That depends upon the velocity at which the air travels through the pipe. If the velocity be 600 feet per minute, or 10 feet per second, the loss will be about 1/25 ounce per square inch. But if the velocity of the air in the 8-inch pipe should be 1,200 feet per minute, or 20 feet per second, then the loss per 100 feet of pipe will be 1/5 ounce, and at a velocity of 4,200 feet per minute the loss per 100 feet of pipe would be 2.45 ounces per square inch—almost as much as a forge fire uses. So, John, you see it pays to use large pipes and low velocities of flow. There should never be any more pressure or velocity than will supply the fires in good shape. Anything above this is just dead loss."

"Mr. Hobart, how much air pressure is necessary, anyway, to operate a forge fire in good shape? I hear them saying that in a new shop just being set up the blower specifications call for a blast pressure of 8 ounces per square inch.. Isn't that a pretty good pressure? I should think it would blow all the coal off the tuyre-iron."

"Yes, John; that's more pressure than is needed at the fire, and I don't believe more than 4 ounces of blast ever gets there."

"Then what becomes of the rest of it—the other 4 ounces?"

"Just remember, John, that there's a fine blast gate in each pipe, right next to the tuyre, and there is where the pressure is reduced, when it is not cut down by pipe bends, crooks and turns."

"Say, what's the use of such high-pressure at the fan if it is not used at the forge?"

"It is of no use whatever, John. The only excuse for maintaining that pressure is to make sure that the fire gets all the blast it needs and that your fire has plenty of air when every opening is wide open."

"Say, I should think it would take lots of power to drive the blower when 4 ounces of blast pressure is kept on top all the time."

"It does take a good deal of power, John, but not as much as it looks to at first sight. A blower takes less power when the pipe is closed than when the pipe is wide open——"

"Why, how can that be? I should think that with the discharge pipe closed and the fan trying to drive air out when it can't, would take a whole lot of power more than when the air can get out as fast as it wants to. Just look what it does to a pump when you choke down the delivery valve—makes everything strain and groan!"

"Look out, John; you are dealing with a centrifugal air pump when you deal with a fan blower, and the centrifugal water pump works under the same rules and regulations, and a centrifugal pump, be it handling 'wind' or water, consumes less power when the outlet is closed than when it is wide open, but this does not apply to other types of pumps. It applies to the centrifugal only."

"Say, if a fan is speeded up to deliver wind under 8 ounces pressure and is stopped down by blast gates to give 4 ounces pressure at the fire, is it any more saving of power than to run the fan at 4 ounces straight?"

"Certainly not, John. The cost will be greater the 8-ounce way. To deliver air at 4 ounces pressure from a No. 8 Sturtevant pressure blower requires 1,200 revolutions per minute of the ran runner, and consumes 4.5, 9 or 13.5 horsepower, accordingly as the blast gate be open one-third, two-thirds or open full. But to deliver air at 8 ounces pressure, the same fan must be run at 1,675 revolutions per minute. and it will consume 13.26, or 39 horsepower, according as the gate be open one-third, two-thirds or full."

"Why, then, it's cheaper to keep the pressure down as low as possible, isn't it? And if that is so, why do they specify 8-ounce pressure at the fan in the delivery pipe?"

"They specify the higher pressure, John, to protect their machinery against fool things, such as is shown by Fig. 1. The manufacturers of the blowers and the forges cannot prevent useless bends and elbows from being put into lines of pipe, and about the only way they can protect them-

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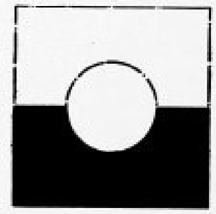
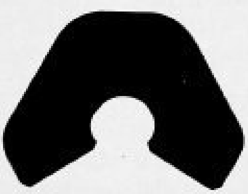
SIDE OF GEAR GUARD.



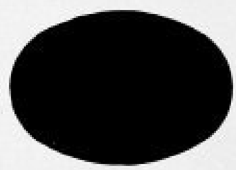
CULVERT SHIELD

DEVELOPMENT OF CONE SHEET.

SECTION OF HEMISPHERICAL TANK BOTTOM.



DEVELOPMENT OF SHEET FOR TAPERING BODY WITH OBLONG BOTTOM & ROUND TOP.



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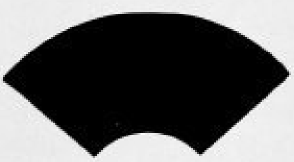
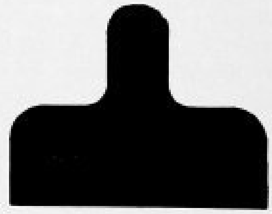
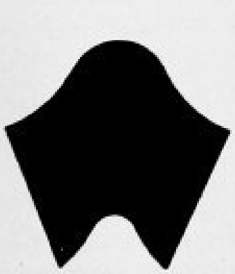


DEVELOPMENT OF CONE SHEET.



END OF CAR SEAT.



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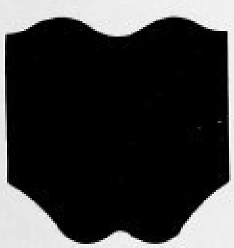
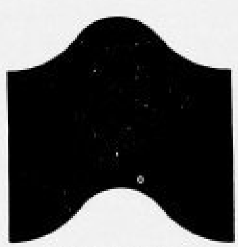


DEVELOPMENT OF SHEET FOR SLANTING TEE



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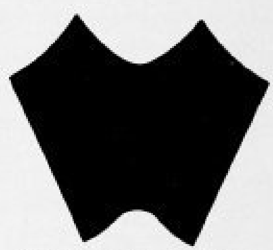

DEVELOPMENT OF TAPERING ARM OF Y-CONNECTION.

selves is to specify a pressure high enough to overcome all the obstacles liable to be put into a blower pipe. The pressure specified—8 ounces—carries a factor of safety, same as a boiler does. Why, you know that the boiler which is sent out as 'Good for 150 pounds working pressure' will stand up to 600 to 750 pounds per square inch if tested to destruction, according as the 'factor of safety' has been taken at 4 or 5. And the blower is specified to give 8 ounces of pressure in order to have a factor of safety of 2, to take care of fool piping, extra bends and too small pipe. That's what the fan pressure is 'jacked up' for."

"Well, Mr. Hobart, that's a new one to me. I supposed they just let the fan run at any convenient speed, and if they didn't have blast enough at the fire, they speeded the fan another hundred revolutions per minute."

"That's about the way they do it, John—where they run things 'hit or miss,' but they don't do things that way where they are looking for efficiency wherever possible. There they build the pipe lines to give just the necessary pressure and then run the fans to give only the velocity necessary to maintain the required pressure at the tuyre."

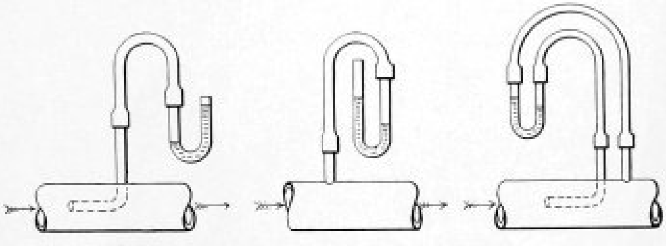

Fig. 2 Fig. 3 Fig. 4

"But how about this pressure and velocity business? If you increase the speed of the fan, don't you increase both the velocity and the pressure of the air delivered by the fan?"

"In a way, yes; but there is such a thing as increasing the pressure without affecting the velocity in the least."

"I don't see how that can be done?"

"It's this way, John; suppose the discharge pipe was entirely closed and an air pressure was maintained therein of 4 ounces per square inch. Increase the pressure to 8 ounces and the velocity has not changed, because there isn't any. See?"

"Yes, I see it that way. But suppose that the 8-inch pipe were closed except for a 1-inch opening in it. There must be a certain velocity of air in the 8-inch pipe to supply the air which passed through the 1-inch pipe. So, if the pressure be increased to 8 ounces, it surely will increase the air velocity some inside the 8-inch pipe, will it not?"

"Yes, John; it will increase the velocity of the air in a ratio corresponding to the areas of the 8-inch pipe and the 1-inch delivery pipe. The velocity of the air in the little 1-inch pipe fixes the quantity discharged, and so it does also in the 8-inch pipe, but if we use a velocity of 10 feet per second in the 1-inch pipe, there will be a discharge of 3.27 cubic feet of air per minute. But if we increase the velocity of the air to 20 feet per minute we have just doubled the volume of air discharged, which now amounts to 6.54 cubic feet per minute."

"So doubling the velocity doubles the discharge? That's so, of course, but how does it work out with the pressure? Does doubling the velocity or the pressure require double the power?"

"You may be sure it does, John, and then some more power too! We found in a preceding paragraph that doubling the pressure required about three times the power, but to double the velocity—well, that requires more figuring than you would care to wade through were it printed here, so you had better look that up in Kent, Wiesbeck, or in Halsey's Handbook for Machinists and Draftsmen."

"Say, Mr. Hobart, how do they measure the pressure and the velocity of air in pipes, anyway? I can see how the pressure could be measured with a draft gage, or with a small pressure gage, could one be found small enough to read in ounces per square inch, but how they measure the velocity—that gets me. How do they do it?"

Measuring Velocity and Pressure of Air in Pipes

"There are several ways, John, of measuring the velocity of air in a pipe. If the pipe be large enough, an instrument known as the manometer may be placed inside the pipe. There are a lot of dials on the instrument like those on a gas meter, and by reading the dials before and after the instrument has been running in the pipe for a certain length of time, the velocity of the air may be determined easily. There is a little propeller wheel on the instrument which is revolved by the air current in the pipe and the number of revolutions made by the propeller is recorded by the dials and corresponds to a certain number of revolutions per feet per second or minute of air velocity."

"But they can't measure the velocity in a small pipe with that instrument, so how do they work the trick with a 1-inch pipe?"

"John, they can use what is known as the 'Pitot tube.' This is a bit of glass or metal tube, with a sharp edge and with walls made as thin as possible. Fig. 2 shows one of these tubes in place inside an air pipe. As the Pitot tube can be made as small as necessary, it can be used inside of a 1-inch pipe or even in a much smaller one if desirable."

"Why, that's just a common draft gage. There's the rubber tube, the glass U-tube with water inside which is forced down in one leg and up in the other leg, according to the pressure of the air in the pipe."

"You're wrong, John. The tube shown by Fig. 2 is more than a draft gage. A draft gage is shown by Fig. 3, and you will notice that this tube stops just inside the air pipe, while in Fig. 2 the tube is turned at right angles and faces toward the direction of blast. You may also see that the water is driven up farther in the Pitot tube than in the plain gage, and that means that in Fig. 2 both velocity and pressure are forcing back the water in the U-tube, while in the draft gage, Fig. 3, the pressure alone is acting upon water in the U-tube."

"Oh, ho! I see it now. To find how much the velocity forces up the water in the U-tube, we can measure the distance between water surfaces in Figs. 2 and 3, and the difference will be the head of water due to the velocity of air in the pipe?"

"That's the idea, John; but there is no need of doing any measuring. Just connect both draft gage and Pitot tube with the same U-tube, as shown by Fig. 4, and no measuring will be necessary. You can read the water head due to the air velocity directly from the water levels in the U-tube."

"Why, how is that? Both tubes are connected to the U-tube and I don't see how it tells us anything."

"Look a little closer, John, and you will see that pressure is connected to either water level in the U-tube; therefore, there would be no raising of level in that tube from

(*Concluded on page 361.*)

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6,000 *copies of this issue were printed.*

NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later that the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

With a few exceptions, boiler manufacturers in the United States do not figure prominently in the business of exporting steam boilers to foreign countries. A market exists, however, in South America that, under present conditions, should prove a profitable field for development, especially for small and medium-size boilers. Hitherto this market has been supplied principally by boiler manufacturers in Great Britain and Germany. Only a few boiler shops have been established in South America, and the majority of the boilers in use have been imported. Now that Germany's trade with South America has been discontinued on account of the war, and England's greatly diminished, boiler manufacturers in the United States should seize the opportunity to become permanently established in this market, not only to meet the present needs of South American buyers, but also to take advantage of the future development of the steam power plant field which will follow as a natural result of the industrial expansion of South American countries.

At the present time, according to information published in the daily *Commerce Reports* issued by the Department of Commerce, the boilers used in Chile are usually of the Cornish, Galloway, Lancashire or Babcock & Wilcox type. The working pressure varies from 60 to 120 pounds per square inch. Office buildings, public buildings of various kinds, apartment houses and large residences are not equipped with boilers, but about 50 percent of the horsepower developed in Chile for industrial purposes is by steam. The imports of boilers into Chile for 1913 were mainly from Germany and Great Britain; the United States being third on the list, followed by France and Belgium.

In Argentina the market for boilers is limited by the fact that industrial production is as yet little developed. Small and medium-size boilers used largely for heating plants are made on a small scale at Buenos Aires. The industrial census, based on data collected in 1908, shows seven boiler shops in Argentina, all located in Buenos Aires, with a total annual output valued at only $110,000. Practically all of the boilers in use in this district are imported, the greater number in recent years being imported from Great Britain and Germany.

The market for boilers in the Rosario district in Argentina is out of all proportion to its size and population; a result, in the first place, of lack of industrial development. The boilers used in this district are chiefly for heating plants, sugar factories, sawmills, light and power plants and miscellaneous industries, which are, however, represented by only a few factories scattered over the district. For heating plants, and incidentally for small distilleries, an inexpensive vertical type of boiler, averaging about 6 horsepower, is used, the working pressure varying, as a rule, from 40 to 80 pounds per square inch.

The province of Tucuman has thirty sugar factories in which 150 boilers are installed. On an average the industry requires perhaps five new boilers a year. The size of the boilers varies from 2,000 to 5,000 square feet heating surface, the working pressure averaging about 100 pounds per square inch. For sawmills and the miscellaneous small industries of the district a medium boiler of about 20 to 100 horsepower, with a working pressure of 100 to 140 pounds per square inch, is required. Watertube boilers from 20 horsepower up are commonly used where this type is suitable. Single and double flue boilers are to be found where large steam capacity and steady pressure are required, but nearly all medium and large boilers are of the watertube type.

While the foregoing reports indicate only in a general way the present condition of the steam boiler market in South America, nevertheless they point to a distinct opportunity for United States manufacturers that should not be lost. A few American firms have already become well established in this trade, but the field is widely scattered and the class of power equipment varied so that, either individually or collectively, American boiler manufacturers should take up the development of this trade and exploit it fully.

Engineering Specialties for Boiler Making

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

A New Vacuum Pump

The modern power house equipment invariably includes a condenser plant, the efficiency of which depends upon the degree of vacuum within the condensing apparatus. For maintaining this vacuum, and for general service in other lines where a high degree of vacuum is desired, the Ingersoll-Rand Company, 11 Broadway, New York, has recently introduced a complete line of steam and power driven, duplex type, "Imperial" vacuum pumps.

In general design these machines follow that of the "Imperial" air compressors. The vacuum cylinders, as will be seen from Fig. 2, are somewhat different from those ordinarily met with. The intake valves are of the Corliss type, so placed in the cylinder head that the clearance is exceptionally low. This is a desirable feature, in that the air trapped in the clearance spaces at discharge pressure will not reach such a volume, upon being expanded to intake pressure, as to greatly limit the pressure reduction which may be obtained. The action of the valve is positive and quick and, its action being independent of the cylinder and intake pressures, the pressures within and without the cylinder are as nearly equal as possible.

The intake ports are large and direct, which, together with the water-jacketing of the valve, tend to cool the intake gases.

The discharge valves, which are of the "direct lift" poppet type, are placed in the bottom of the cylinder heads so that any entrained moisture or water is immediately discharged, a feature that makes for safety in handling moist or even saturated vapor. Clearance at the point of discharge has been reduced by making the valve partially fill the port in the cylinder head. The discharge passages are also water-jacketed.

The cylinders and cylinder heads are completely water-jacketed. The unusually low clearance in "Imperial" vacuum pumps has been obtained, not by dangerously close piston clearance, but by the correct design of the valves and valve ports. Owing to the extremely low clearance, the complete water-jacketing, the use of mechanically operated Corliss inlet valves and other refinements of design the manufacturer guarantees the easy maintenance of a vacuum of within one-half inch of barometer.

Lubrication is by the bath system, providing automatic flood lubrication yet retaining, by the removal of covers from the casing, all the points of accessibility of the open type of machine. When operating the fly-wheel is practically the only visible moving part, yet the entire mechanism is readily accessible while in motion.

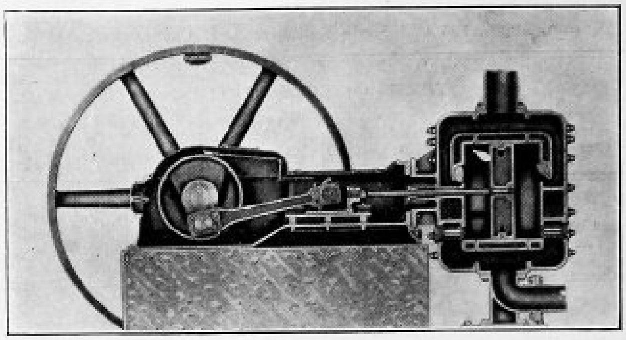


Fig. 2.—Sectional View of "Imperial" Vacuum Pump

In reality, a duplex machine such as this is two identical units of like capacity united by one common frame with cranks at 90 degrees. This makes it possible, should requirements fall temporarily below that for which the equipment was originally installed, to remove one connecting rod and the operation of one-half the machine discontinued, while the other half operates at its rated speed and hence its utmost efficiency, displacing, however, one-half the vapor the entire machine is capable of handling.

These machines are built in capacities from 795 to 7,048 cubic feet per minute, both for atmospheric and low-pressure (5 pounds) discharge.

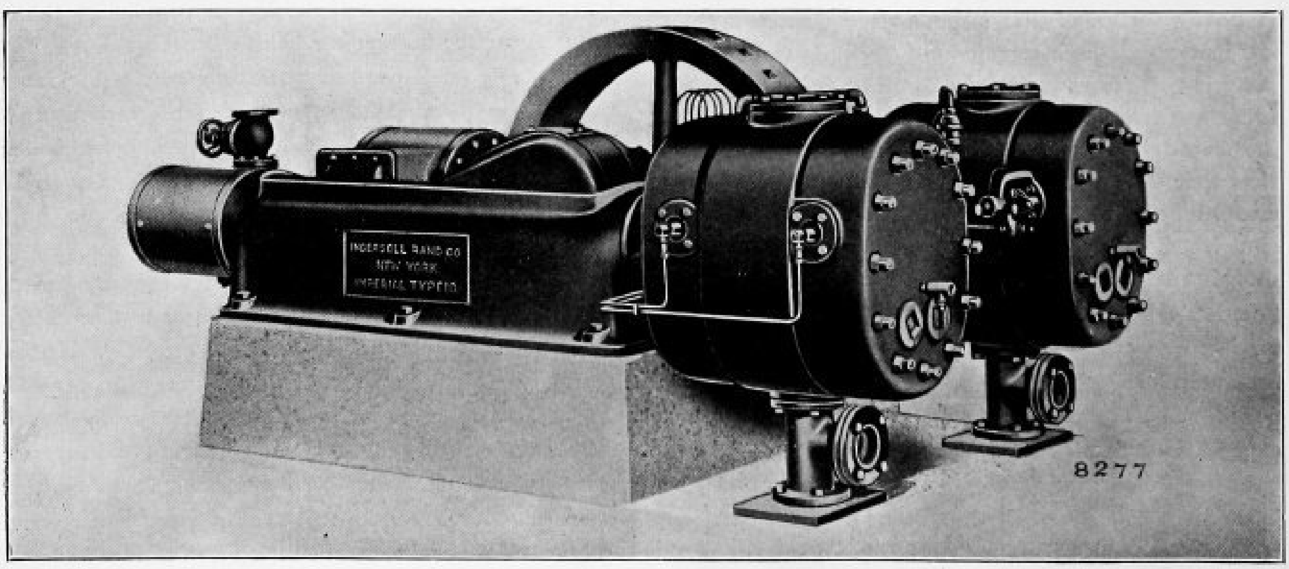


Fig. 1.—"Imperial" Vacuum Pump Built by the Ingersoll-Rand Company

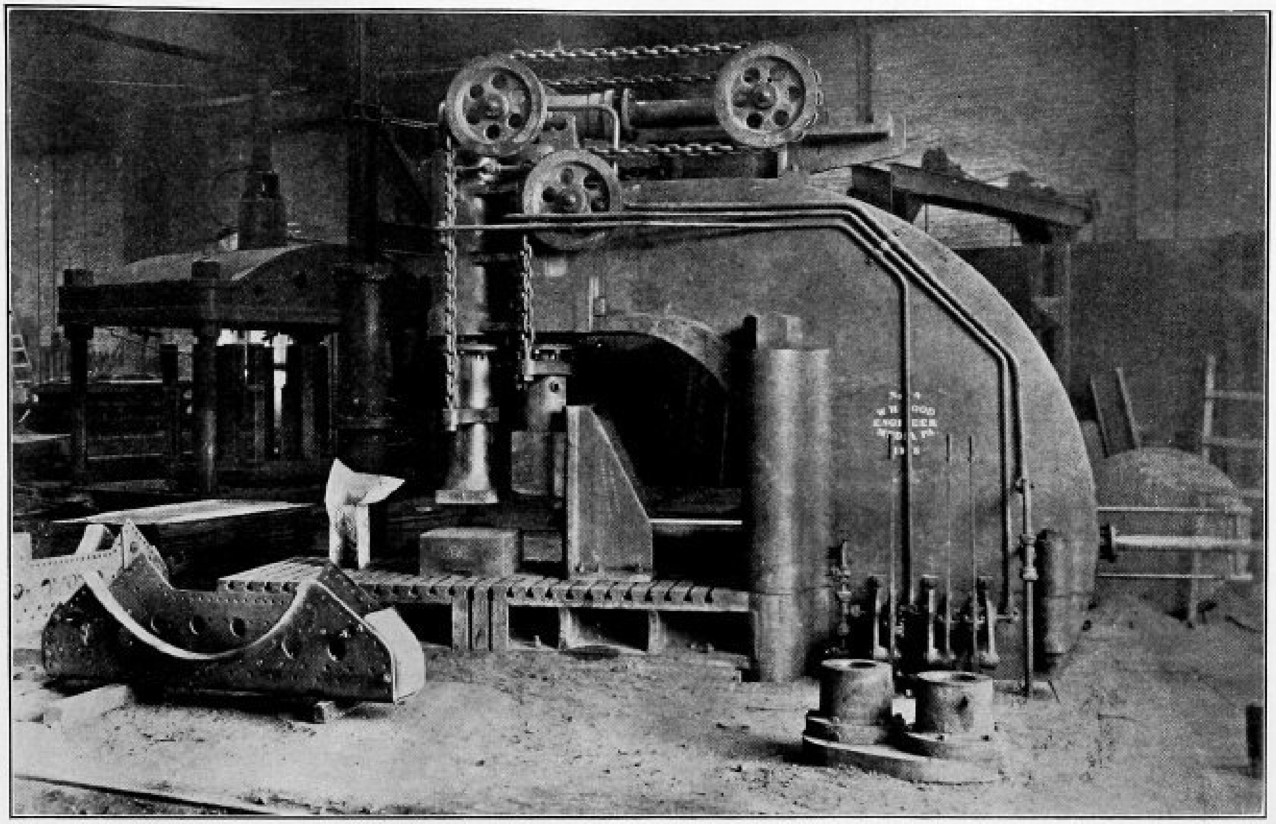


Fig. 1.—Universal Hydraulic Flanging Press of 150 Tons Capacity, Installed at the Casey-Hedges Boiler Shop in Chattanooga, Tenn.

Universal Hydraulic Flanging Press of 150 Tons Capacity

William H. Wood, president of the Wm. H. Wood Loco Fire Box & Tube Plate Company, Media, Pa., recently installed in the Casey-Hedges plant, Chattanooga, Tenn., the universal hydraulic flanging press illustrated in Fig. 1, which has a capacity of 150 tons and is designed to flange anything by section formers up to 20 feet in diameter. The photograph also shows a 550-ton four-column press which Mr. Wood installed in this plant several years ago. In front of the flanging machine is shown a piece of flanging for a watertube boiler. Fig. 2 also shows some of the flanging that has been done by similar machines for steam road rollers such as are built by the Kelly-Springfield Company. At the Casey-Hedges plant, which is one of the best equipped boiler making establishments in the South, there is also a Wood circular flanging press as well as the hydraulic lifting jib cranes, three hydraulic riveting machines with hydraulic towers, cranes and accumulators and pumps for working the hydraulic plant, all supplied by the William H. Wood Company.

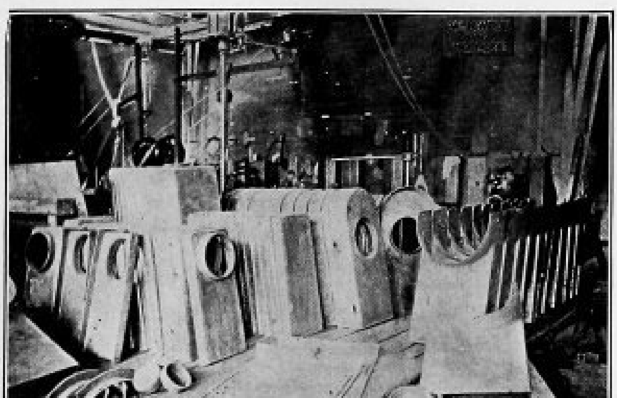
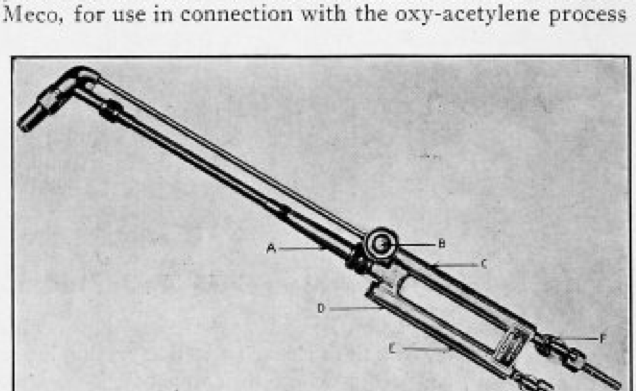


Fig. 2.—Throat and Door Sheets Flanged by Hydraulic Press

Meco Oxy-Acetylene Welding and Cutting Torch

The Modern Engineering Company, St. Louis, Mo., has placed on the market a torch known to the trade as the Meco, for use in connection with the oxy-acetylene process



Meco Oxy-Acetylene Torch

for cutting and welding metals. The torch is provided with a universal mixing chamber shown at *A*, which is made of bronze. It is said to produce an absolute neutral flame of over 6,300 deg. F., with a minimum consumption of gas. The mixing of the gases in this chamber is claimed to be so perfect that it is impossible for the gas to burn in the mixing chamber even when the largest tips are used. An automatic check valve system, *C D*, is provided which prevents either gas from flowing into the passage of the other, thus eliminating the possibility of injury to the operator by the gas burning back into the hose. The handle of the torch is cast in one piece of a special metal which is stronger than brass and lighter in weight than aluminum. A notable feature of the Meco torch is the simplicity with which the cutter is attached to the torch. Only two operations are required, namely, to remove the nut on the oxygen valve and the union nut on the gas conduit when the torch is ready to receive the cutter. The cutter is controlled by the needle valve *B*. The necessity for removing the hose connections at *F* is eliminated.

Flexible Plug for Rigid Staybolt

H. A. Lacerda, a foreman at the West Albany Shops of the New York Central Railroad, has patented a flexible plug which can be used with ordinary rigid staybolts in

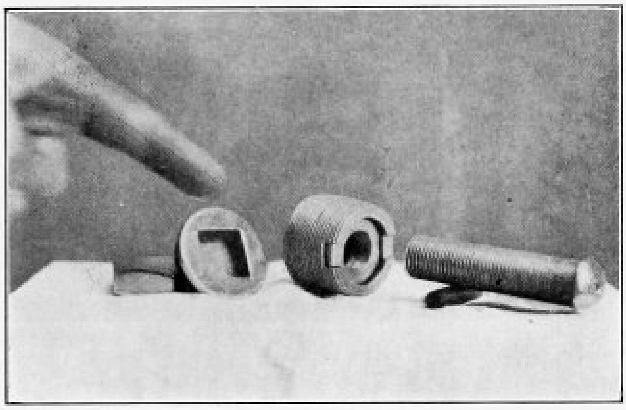


Fig. 1.—Parts of Flexible Plug

locomotive boilers, converting a rigid staybolt into a flexible bolt to overcome the contraction and expansion of the firebox sheets. The details of the flexible plug are clearly shown in the illustrations. It can be manufactured to

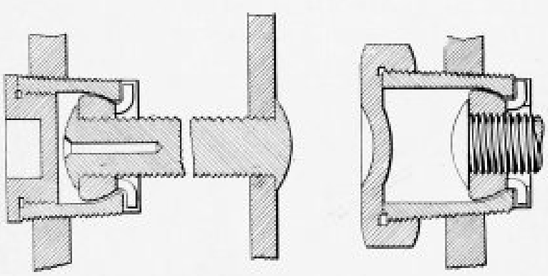


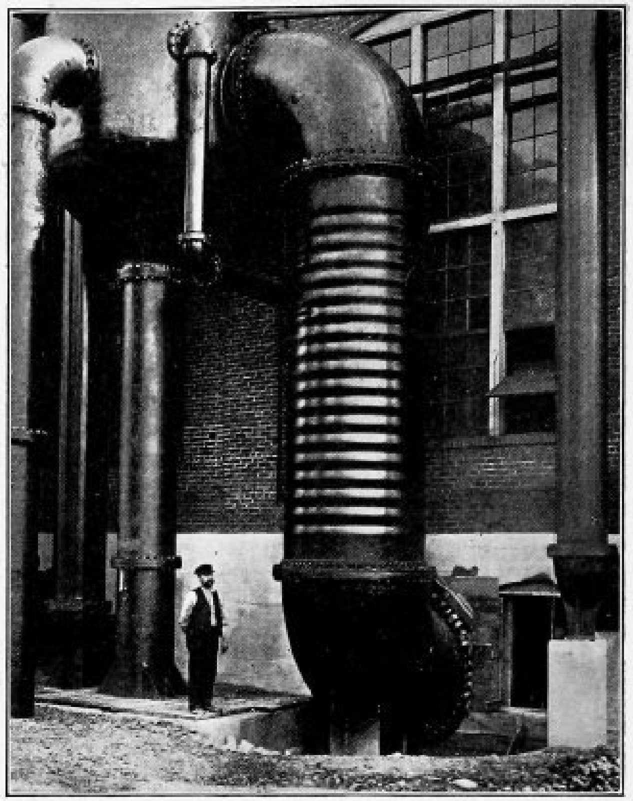
Fig. 2.—Sections Through Two Styles of Flexible Plugs

admit any size or length of rigid staybolt, and it can also be used in the place of a flush sleeve as well as a sling brace or in any part of a firebox where a flexible bolt is desired. An important advantage claimed for this arrangement is its simplicity and the cheapness of its manufacture.

Large Diameter Corrugated Exhaust Steam Pipe

The American Spiral Pipe Works, Chicago, Ill., has recently supplied to the Lucerne Power House, Indiana County, Pa., a 66-inch diameter lap-welded exhaust steam pipe for the exhaust steam lines to the condenser. The pipe has slight corrugations to provide additional stiffness in a vacuum service, thus giving a factor of safety much greater than the plain pipe. It is 66 inches diameter, made of steel ⅜ inch thick, with the corrugations on 8-inch centers about one-half inch deep. Seamless forged steel flanges are attached.

While corrugated pipes and flues have been used for



Lap-Welded, Corrugated, Exhaust Steam Pipe of 66 Inches Diameter

many years for internally-fired boilers sustaining the full boiler pressure on the outside of the flues, this adaptation of the slight corrugation in the large diameter lap-welded pipe for vacuum service is believed to be new. This enables the use of lighter pipe than the plain pipe wherever subjected to external pressure through vacuum service.

The corrugations are so slight that their resistance to the free passage of steam under vacuum is claimed to be practically negligible.

Papers of Interest to Boiler Makers to be Presented at the Annual Meeting of the American Society of Mechanical Engineers

Among the numerous papers which are to be read and discussed at the annual meeting of the American Society of Mechanical Engineers, to be held in New York, December 7 to 10, the following will be of special interest to boiler makers:

"Design of Firetube Boilers and Steam Drums." By F. W. Dean.

"Circulation in Horizontal Watertube Boilers." By Paul A. Bancel.

"Proportioning Chimneys on a Gas Basis." By A. L. Menzin.

"A Novel Method of Handling Boilers to Prevent Corrosion and Scale." By Allen H. Babcock.

It is a mighty poor boss who asks a foreman how long it will take him to do a job. If he does not know, he ought not to be the boss.

Letters from Practical Boiler Makers

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

Uniform Boiler Rules Versus the Foreman Boiler Maker

I have read John T. Lee's letter in the September issue of THE BOILER MAKER with much interest, because others have complained about the A. S. M. E. boiler code and the manner in which it was codified, in a very similar way and I therefore conclude that there is something wrong with it. The A. S. M. E. boiler code can be improved.

Next time the A. S. M. E. decide to consider changes in the code I would therefore suggest that Mr. Lee "lay for them" with as many good suggestions as possible.

In getting out the present code the committee had many things to consider, so I am told, which we ordinary mortals must believe. I am sure the committee did the best it could under the circumstances. We all know how difficult it is to come to an absolute agreement when everybody has different ideas. Well, that was the condition, perhaps, in many of the committee's meetings. The committee said it would consider anybody's ideas that seemed worth while, and I do not doubt but that Mr. Lee's ideas would have been worth while. Others who *did* make suggestions say that their ideas were ignored, but we must overlook that for the present and hope for better success next time.

If Mr. Lee cannot get the foreman boiler makers together, as he suggests, he could "go it alone" and I am sure he would be given a hearing. The united effort of a great many foremen, though, would doubtless be more effective. There is no question but that the A. S. M. E. would be pleased to co-operate with such a body of men.

In fact, an organization wouldn't be an absolute necessity. Foremen could just mail suggestions to Mr. Lee. Mr. Lee could appoint a committee of, say, five submitters to consider all suggestions, and those approved could be sent to the A. S. M. E. committee, etc. There are many ways to do it. The principal thing is—do it now.

New York. W. F. SCHAPHORST.

Applying Boiler Flues

The articles appearing in THE BOILER MAKER pertaining to the rolling of flues are very interesting, and as one reads them over it must be forcibly impressed upon many of us that there are men in our line of business who are honestly trying to help the other fellow and at the same time bringing the art of boiler making to a higher plane of perfection. As Mr. C. J. Mason says: "To learn any particular business we must get right into it; we can learn much from the columns of THE BOILER MAKER, but all the reading in the world can not take the place of 'Old Man Experience.'"

The apprentice of to-day is a lucky fellow, if he only knew it, for he has the advantage of modern machinery to help him over the hard places in the business, and, above all, the privilege of subscribing to THE BOILER MAKER, a privilege which was denied to us fellows that started in the business twenty-five years ago.

Regarding the installing of flues, many of us have different ideas and ways of doing this work; some roll them and some expand them with the prosser. From my own experience, either method is good, but, like other good things, they can be overdone.

To the experienced boiler maker there comes an undefinable, mysterious knowledge of when "enough is enough," and there are many, no doubt, who have stood alongside of a boiler when flues were being applied, and have heard the prosser still being driven in when he himself would have cried "Enough" a dozen strokes back. You can't blame the man with the gun; he doesn't know any better, for he has not been taught that a little common sense must be used along with the strong arm. But he should be taught so, if you are to get the service, not only out of the flues, but also out of the flue sheet, for to the careless prossering of flues can be ascribed the tendency of the top flange of flue sheet to assume the shape of the letter V after a few months of service.

Now, I should like to ask the opinion of some of our experts in the business as to the question, if it was considered good policy to file both ends of the flue after annealing, as they did years ago, why wouldn't it be so now? "Too expensive," you will say. "Too slow," says another. Very well, you apply your flues just as they come from the swaging machine. See that coating of scale on the safe end? What becomes of it when the flue is expanded? It doesn't vanish into the air; it is somewhere between the flue and the copper, and then you wonder why the flues leak after the second or third trip.

How many smooth up the flue holes with a file before applying the coppers? And how many apply their coppers without rolling the life out of them and also take care that they are flush with the firebox side of the sheet? A good deal of the flue failures are put down to bad water and unusual service conditions, but it is the honest belief of the writer that in the majority of cases it lies nearer home —and that is in the shop.

Lorain, Ohio. JOSEPH SMITH.

Punching Versus Drilling

Having read with great interest the articles in THE BOILER MAKER entitled "Punching versus Drilling," one in the July issue contributed by Mr. A. L. Hass, of London, England; the other in the August issue, by Mr. Glenn Lacey, I wish to make a few comments on the same. While I differ in some respects with the opinions expressed by the authors of these articles, still we cannot all look at the subject in the same light, and perhaps some of the readers of THE BOILER MAKER may get a few pointers by the time this discussion is ended. This is why I wish to make a few remarks on this very important subject.

Now, the facts as I see them are as follows: As every boiler maker knows, drilling is the best course to pursue on any make of boiler, and I would like to see it become a law to prohibit punched holes on all kinds of boilers. Take the contract shops, for instance; they punch all boiler plates, and in some shops they even punch the flue holes on some of their boilers, although not all of them, but especially boilers for drilling oil wells and stationary boilers for saw-mils, etc. Now, these contract shops would command a better price for their boilers if they were all drilled holes. It would take a little longer, however, to drill them than to punch them, and I am not aware at this writing of a machine that can drill a hole as quickly as you can punch the same, but the contract shops would probably fight this subject to a finish before they would give in, as they would say it takes too long to build a boiler when all the holes have to be drilled. If, therefore, all men or corporations who are fair-minded enough —I mean those that purchase the different types of boilers for their manufacturing plants throughout the country— would combine and refuse to accept a boiler that had punched holes in it, that would undoubtedly end the argument. This would be in line with the safety-first movement.

Now, these corporations would undoubtedly want to be shown the difference between drilling and punching, and it would not take a boiler maker long to make it clear to them that drilling is the safest way to construct a boiler; that is, after same is laid out. It takes a little longer to construct a boiler by drilling, but, when the boiler is completed you can look at same from all angles and point with pride to the boiler and exclaim, "All the holes were drilled in this boiler. The workmanship is excellent! This boiler is without a flaw of any kind." But you could not express such an opinion on a boiler in which all the holes were punched because, in punching holes, the punch has a tendency to pull the steel along with it to the edge of the holes. This weakens the plate to a certain extent, as we all know, and also opens up the grain in the plate. In punching the holes ⅜ inch smaller than the regular hole called for, then reaming the hole out to the regular size, we would get a much better hole than if we punched the hole to the regular size. This method would also ream out a good bit of the fracture in the plate caused by punching this small hole, and keep the cost down as well. While this is not as safe as the first method, perhaps it may be the next best course to pursue.

To eliminate punching the holes in the plate on the flat, roll the plate to regular diameter. We can keep the holes round by punching them small, or, as I said before, use a hydraulic riveting machine rigged up for this purpose. All that is required would be a punch and die, then assemble your shells together and ream out all the holes to the regular diameter.

The Cleveland Punch and Shear Works, of Cleveland, Ohio, advertised a punch in the June issue of THE BOILER MAKER that is capable of punching a 6¾ by 11¾-inch hole in 1¼-inch plate. Now, what must be the strain on a plate in using such a punch! I would not use such a punch on any kind of work in a boiler shop.

Regarding the acetylene burner or any other similar machines on the market, this method is a little slower, but you get a job done right, the plate does not get strained in burning the holes out. Mr. Haas states in his article that in structural steel yards the punched hole has been in many instances discarded, as it has proved cheaper and more expeditious to drill than to punch. It seems that old England has put one over on us in this country, according to his statement. Why can't we do the same in this country? Because the contractors for boilers, etc., all wish to make as much as possible out of their business, which is natural, but the manufacturers would not adopt the drilled holes because it takes too long to build a boiler.

There was another very good illustration on punched holes in the June issue, contributed by the Hartford Steam Boiler Inspection and Insurance Company. It shows the surface of the plate disturbed by punching holes, and another illustration shows a plate with a crack in it, which was being put in shape in the boiler shop. This company stated it would require a chemical and very careful microscopic examination of the material in the neighborhood of the fracture, which was why they withheld their opinion. Now, while that may be all well and good logic, the examination would help some, I admit, but, if I was working on a plate that behaved in that manner I would not have any of it put on a wheelbarrow. The company, no doubt, would replace this plate with another one after they had made a careful examination of the material near said fracture and arrived at the cause of failure. It surely would not be caused by neglect in assembling the same. I should think it would simmer down to one point, "poor material."

Now, while I expect a good bit of criticism on the points that I have touched on, that is what I wish to hear— opinions from men, far and near, on this subject. We may be able to learn something on this point before this discussion is closed.

Youngstown, Ohio. WILLIAM J. KELLY.

Specialization

I do not know of any boiler manufacturer who makes his own traveling cranes, his own engines, his own electric motors, his own typewriters, etc., because the manufacture of such things is rather complex. The first cost of the equipment for making these articles is great, and so the boiler manufacturer relies on somebody else to provide him with the necessities that are outside of his specialty.

In my way of thinking, boiler manufacturers should use their own boilers only, or some sheet metal tanks that are made along the same methods as boilers. I am not a believer in the "home-made" product as long as something better is obtainable. And it stands to reason that a specialist will do better and quicker work on his specialty than will a novice.

We frequently hear people say: "I don't see how they can make them for that money." They couldn't make them for that money unless they were made in large quantities, or, if the work is all hand work, unless the workers were adept specialists. The specialists' work, therefore, usually costs less. It is for these reasons that we live better than our ancestors did. We have better fitting and better made shoes, clothes, houses, boilers, engines, everything. We don't work so many hours per day. We have more pleasure. If it weren't for this specialization, if every family had continued to make its own necessities and nothing else, as in the centuries ago, we would still be what they were then.

And, again, we frequently have friends confidentially whisper in our ears: "Common ——— is just as good as the ——— made by ——— & Co." It may be that in rare cases a substitute not made expressly for a certain purpose is better than an article made by specialists for that purpose, but I doubt it. Give me the specialists' product every time. The specialist has studied his field much more thoroughly than you or I, and therefore knows what to do and how to do it. He is bound to give you something better than you can make for yourself unless you yourself also become a real specialist in his line.

New York. N. G. NEAR.

Definitions

3.1416: These figures are often called the "magic number." They represent the ratio between the circumference of a circle and its diameter; that is, if you divide the circumference of a circle by its diameter you can only get the above figures. The decimal point may change and the decimals can be carried out any number of places, and this is necessary for some finer calculations.

If the circumference of the circle is known, its diameter can be obtained by dividing it by 3.1416. If the diameter of the circle is known and the circumference is wanted, multiply the diameter by 3.1416. If the area of the circle is needed multiply one-half the diameter, or the radius, by itself (this is called squaring), and this result by 3.1416.

Conversely, if the area of the circle is known, the radius is obtained by extracting the square root of the area divided by 3.1416.

If the cubical contents of a sphere is wanted, it is obtained by multiplying the circumference by its diameter, and this result by 3.1416.

In mathematics these figures are represented by a Greek letter π, which is pronounced pie. Its use saves a great repetition of figures.

B. T. U.: These letters stand for British thermal units. A British thermal unit is the amount of heat required to raise 1 pound of distilled water 1 deg. F. when the water is at a temperature of 39 deg. F.

At 39 deg. F., or about that, water is at its greatest density. Water has a curious action of becoming denser up to this point of temperature, and it then begins to expand and keeps on doing so until it congeals or freezes at 32 deg. F. This phenomenon keeps the plumbers busy and happy house owners and their tenants miserable.

A cubic foot of water weighs 62.425 pounds at 39 deg. temperature.

A gallon of water weighs 8.3356 pounds at 62 deg. F., and contains 231 cubic inches. The Imperial or British gallon weighs 10 pounds and contains 277.274 cubic inches at 62 deg. F.

Fahrenheit, who lived at Dantzic, Prussia, mixed salt and ice together and produced what he thought the lowest possible temperature, and took this for his zero. He took for the other, or upper, end of his thermometer the boiling point of water at sea level, and he divided this distance into 212 parts or degrees. The French system of noting temperatures is based on dividing the distance between the point on the thermometer where water freezes and where it boils into 100 divisions or degrees. This system is used by electricians and is much more convenient than the Fahrenheit system and will undoubtedly become sooner or later universally used.

New London, Conn. W. D. Forbes.

Pacific Type of Locomotive Boilers with Superheat Tubes

In reading over the September issue of The Boiler Maker I note there are several letters referring to the importance of fuel economy in locomotives on railroads. I take the opportunity of replying from an engineering standpoint that there is no practical way of accomplishing this without increasing the firebox and combustion chamber heating surfaces, as is the case in my complete corrugated plans. For illustration, I may state that plans have been made for the Pacific type of locomotive boilers by one of the locomotive building companies on my plans, and that the heating surface in this type of boiler has been increased 54 square feet, as follows:

In the Wood boilers the total firebox and combustion chamber heating surface is 272 square feet. In the regular type of boiler the total heating surface is 218 square feet. The number of stays in the Wood boiler is 1,058. The number of stays in the regular boiler is 1,787. The reduction of stays in the Wood boiler is on account of the extra strength given to the firebox by the corrugation, which shows a reduction of 729 stays.

It will be noted that this extra firebox surface is clear gain, as the fire grate areas in both boilers are the same. In order to illustrate the gain, it will be remembered that a few years back the Master Mechanics' Association Committee came to the conclusion that the firebox heating surface was equal to ten to one of the tube surface. This was verified by the spectacular boiler test at Coatesville, Pa., and it had also been previously set forth in my circulars on locomotive boilers in 1908.

It is clear from the above explanation that there would be considerable saving in fuel; the amount of saving would be just as well left to the judgment of your readers to compute from the explanation given.

William H. Wood,
Mechanical and Constructing Engineer.

Media, Pa.

A World Boiler Law

Now that the A. S. M. E. has laboriously worked up a good boiler code, it stands to reason that every State in the Union should adopt that code or something very nearly like it.

It might be all right for a State to say, "No, we will be even more strict with our boilers," and go ahead and forbid lap seam boilers, require higher factors of safety, etc. In any event, the A. S. M. E. code should be the "standard" upon which all State codes should be built.

Heretofore each State has had a sort of code of its own, and nearly all codes were different, which is a foolish and wasteful method indeed. It is illogical. It is much better to have *one good* boiler law than a dozen not so good. The old Golden Rule, for example, is considered by many of our best thinkers to be a better law than the thousands of volumes of State laws combined.

To carry the idea a step farther, is there any good reason why a *world boiler law* should not be established? Boilers are subject to about the same kind of stress and the same kind of troubles all over the world—at the North Pole, the South Pole, Hong Kong or Keokuk. Good design in one place is usually considered good design in another, as far as boilers are concerned.

Let us therefore make the A. S. M. E. code the *starter* for that world law.

New York. N. G. Near.

Why Can't Practical Men Land Teaching Positions

A chief draftsman confided to me not long ago that he had taken an examination in the city of New York to teach mechanical drawing in night school. But he failed to pass the examination because he did not understand the questions and he was not allowed to inquire as to their real meaning. Terms used by theorists and little used by practical men were very conspicuous. Simplicity, such as the practical man always craves, was absent. And so he failed.

The only way this man could have passed the examination would have been to read a text-book through, learn all the terms and names applied to the various tricks of the trade, remember them, and then he would have "passed."

Rather strange, isn't it, that a man can handle several dozen men in a large sure-enough drafting room in practical life but is found incompetent to teach it? This man looks over applicants from first-class schools and colleges nearly every day and turns them down because they are not well enough versed in actual drafting room practice. He has "mechanical engineering graduates" under him. These men who are turned away have been taught by book-learned teachers who couldn't hold a *real* job, yet land the teaching positions because they know the "fancier" names of things.

For example, most of us can go through a park and name the various trees as pine, elm, oak, box elder, maple, etc., yet, on attempting to pass an examination for a position to teach these names to youngsters we would find ourselves confronted with names that are "Greek" to us. A practical botanist can't "get through" any more than can a practical draftsman and designer, but when it comes to doing the *actual work*, who is invariably sought? The theoretical man? No, guess again. You know the answer.

There is no good reason, so far as I can see, why everything must always be named and why the names must always be memorized. Why, for instance, should a practical man know what is meant by "the third quadrant"? Why not put a man in charge of the examinations who can explain the meaning of the queries?

Any natural artist can make a painting or drawing without knowing words for expression, and a seasoned draftsman can draw, project, enlarge, reduce, etc., without knowing the "high-falutin'" names of each operation.

It therefore appears to me that the above examination was rather unfair to the highly practical man.

New York. N. G. NEAR.

The Organization of Contract Shop Foremen

In a previous article I suggested that the contract foremen, layerouts and inspectors get together and organize for the purpose of assisting the cause already put under way by the A. S. M. E. committee, viz., "the uniform boiler rules," and incidentally for other reasons educationally and socially, which are obvious.

The question will naturally arise as to the advantage of another association of this kind. While it is true that there is an organization of master boiler makers, it is also true that the contract shop men are very poorly represented by it. The reasons for this are many:

First, contract shop men are at a disadvantage when it comes to attending the annual convention, in so far as the transportation is concerned. The railroad foreman is allowed a pass to wherever the convention may be, while the contract shop man has to foot the bill himself, simply because the boiler manufacturers cannot see any advantage gained from an educational point of view by sending their foremen and layerouts to these conventions.

Second, when one attends the present Master Boiler Makers' Convention, he hears nothing mentioned of that part of the craft which is outside of railroad work. It is purely a railroad organization, which is all well and good; but the contract shop men have no place in their ranks, and therefore should have a society of their own.

Third, if the contract shop foremen and layerouts, through organized efforts, would give the maximum amount of attention and study to the existing boiler rules and their assistance to the A. S. M. E. committee on boiler rules, in an effort to revise them and make a perfect set of rules, this feature alone would entitle us to commendation and admiration from the boiler manufacturers, and I feel sure that we would get their moral and financial assistance to help make an organization that would be far-reaching and of much mutual help, educationally and socially.

Fourth, never have the contract shop men received the right amount of attention through the pages of this magazine (THE BOILER MAKER). Everything, or nearly everything, is pertaining to locomotive boilers. The fault does not lie with the editor of this magazine, I am sure. If the contributions would come as they should, and which they shall when an organization is formed, the publishers would be glad to do all in their power to give us the reading matter we require; but it is plain they cannot do this unless they find out what we want, and they cannot find out what we want until we tell them by suggestions and contributions. In this way we could help ourselves to a greater extent by helping THE BOILER MAKER to become a bigger and better magazine; in fact, we look upon it as our official organ. Where the circulation of the magazine now is only about five thousand, I venture to say that within three months after an organization is formed and on a firm footing the circulation would be doubled.

Let me hear what others—the contract shop foremen, layerouts and boiler inspectors—think of this suggestion. The subject is of vital interest to all, and once the thing is launched it cannot help being a great success.

Dayton, Ohio. J. T. LEE.

Correction of Layout of Elbow

A study of the layout of an elbow as described by Mr. E. Eaton on page 315 of the October issue of THE BOILER MAKER will show that it would be impossible to get two of such pieces as he shows in his Fig. 2 together. So, for the benefit of those who are interested in laying out, and in order that they may not be misled, I will endeavor to make plain in the accompanying drawings the correct method of laying out a taper course elbow.

I will use Mr. Eaton's measurements as far as the diameter and length of elbow are concerned, but on the developed pattern I will measure the circumference where it belongs. Compare the two patterns and note the difference.

To prove how far wrong the first method is, and that the way I describe is correct, have a model turned up out of wood in conformity with the measurements shown in Fig. 3. Lay out on paper a pattern as shown in Fig. 2, cut it out and wrap it around the model. Note that the model is constructed to suit the neutral diameter and the paper pattern is laid out to suit the neutral circumference. When the paper pattern is wrapped around the model, it should make a perfect fit, the miters of both the paper pattern and the model corresponding.

It will be noted that in my diagram, Fig. 1, I have disregarded the taper required to make one end enter the other, but I am taking care of that detail in the development of the pattern. Also I am showing two methods of finding the lengths of the ordinates to obtain the miter in the pattern of the elbow. The way shown in Fig. 1 is the longest way and is most generally used, while the other, shown in Fig. *A*-1, is a simpler method and is not widely used because it is not very widely known.

A camber, or versed sine, is required in the pattern of a taper course elbow, and a simple method of determining the camber is explained in an article which will follow this. Just remember that the rules as shown and described for determining the camber are applicable to the elbow, only be careful to use the points for your circumference and for drawing the camber as I have shown in Fig. 2, as the points between the miters on the centerline of the elbow are the only ones that are correct. When other points are used, as in Mr. Eaton's drawings, it will be readily seen that the elbow is not a true circle at the centerline—the very place that all practical layerouts work from. When Mr. Eaton's pattern is laid out and rolled up, the miters are not on a plane, but will resemble an angle saddle pipe.

I trust that the foregoing will be clear to all and, along with my sketches, may be of benefit to many.

Dayton, Ohio. J. T. LEE.

Injurious Effects of Hydrostatic Tests on Boilers

Referring to the article on page 326 of the October issue of The Boiler Maker, under the head of "Inexpert Criticism" and signed N. G. Near, the writer has for a great many years had more or less to do with marine boiler construction, and in my opinion the yearly test by hydrostatic pressure is an abomination and is often injurious to the boiler and fittings.

Take some of the modern liners with boilers built for a working pressure of 225 pounds. These boilers have to stand a hydrostatic pressure once each year of 338 pounds to the square inch. Some experts do not hesitate to say that the strain that the boiler is then subjected to is more injurious to it than the entire year's service between tests, to say nothing of the great damage done to the various joints of steam and water connections, and starting leaks in calking, etc.

Many joints in steam pipe connections give out shortly after the hydrostatic test has been applied, which causes lots of inconvenience, to say the least. It is the opinion of some men who have given the matter careful consideration that the hydrostatic test applied to large high-pressure boilers of the Scotch type, made of very heavy plates, comes very close to being positively injurious to the plate.

The head of the Steamboat Inspection Service is not in sympathy with the yearly hydrostatic test, according to the writer's understanding. In my opinion it does not prove very much to have a boiler stand the required hydrostatic test. I have often seen boilers that passed the test all right which had many plates badly worn and corroded, dangerously thin, especially in the water legs of the various types of firebox boilers used for marine purposes.

In conclusion I wish to state that in my opinion the yearly hydrostatic test is doing considerable injury to various types of marine boilers, and is very little, if any, benefit as a precautionary measure.

Oswego, N. Y. Robert Joy.

Look over every tool you take out on a job to be sure it is in good order. When you are five miles from a grindstone it costs money to go to it to grind a tool.

John and the Blower

(Continued from page 352.)

the air pressure—in fact, the pressure head, as in Fig. 2, gets subtracted from the velocity pressure head (Fig. 3) and nothing but velocity head shows in the U-tube in Fig. 4. See it now?"

"Yes, sir-ee. And that's some stunt, too. Why, I know what bothers Mr. Rider now. He was taking the draft vacuum in the shop boiler stack the other day, and he had a U-tube set up outside the stack and some of that coiled wire hose for connection between the U-tube and the smoke flue. He would place the end of the coiled wire tube in various parts of the smoke flue and take readings on the draft gage, and I noticed that the readings taken in the same place were much different at some times than at others. I see where he got the different readings now. That coiled wire tube was rather stiff, and sometimes it hung right down straight in the flue, while at other times it coiled up a bit at the end and stood nearly 90 degrees from the vertical. And sometimes the opening of the tube pointed one way and sometimes another. When the end of the tube happened to point toward the draft—against the current—then he got a high reading in the U-tube, but when the tube trailed with the current, then there was a sort of injector action which reduced the water height in the U-tube and gave a lesser reading. Then, when the end of the coiled wire tube chanced to stand exactly at right angles to the flow of gases in the stack, then the pressure, negative pressure, partial vacuum was alone recorded upon the U-tube and was the correct reading, while the other readings were more and less respectively than this, the correct reading. Say, I will look out for the direction of the tube opening if I ever have to test for pressure or for draft. I won't get caught that way."

"It is very important, in using both Pitot tubes and ordinary draft gages, to have the opening point in the right direction, and unless you do so there is very little accuracy in the readings and the test becomes practically worthless."

"Mr. Hobart, there's one thing I don't understand, and that is: After a reading has been taken with the U-tube in Fig. 4, how do you work out the velocity in feet per second of the air in the pipe?"

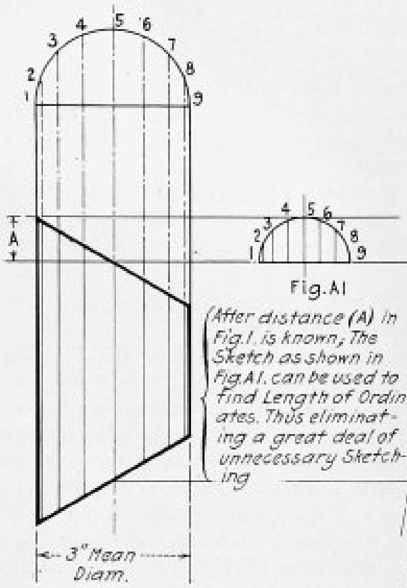


Fig. 1

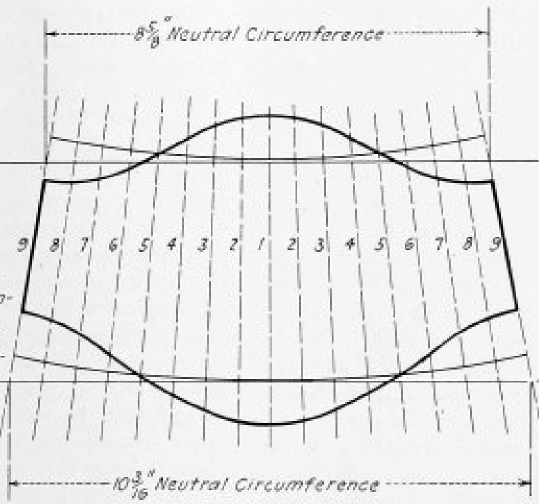


Fig. 2

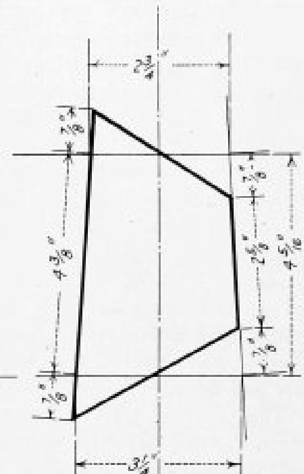


Fig. 3

"There are formulæ given in various text and hand books for this, John, and there is not room here for that business, so you had best look it up in one of your books. If it is not in yours, the boss will loan you one which does have it. Then you can see all the various formulas used and just how they are worked, but for general use in the shop it is not necessary to figure just how much velocity a given number of inches of water stands for. Just use the results comparatively and you will find out all that is necessary regarding the velocity of air in various pipes."

"Can I test out the air at the blower and at the forge blast gate and find out what I need know without working the formulæ you mention?"

"To be sure you can. Just let the velocity results stay in 'inches of water' and it will be exactly as good for your purpose as 'feet per second' and much easier determined. You can get a clue to the relative velocity head by testing the air in the 1-inch pipe and in the 8-inch one. Should the velocity in the 1-inch pipe chance to be 64 feet per second, or minute, then the velocity on the 8-inch pipe should be 1 foot per the same time unit."

"Say, how is that made out? I don't see where 64 comes from."

"John, the areas of pipes are to each other as the squares of their diameters, are they not?"

"Yes, sir; that's what the books say about it."

"Then here you have it: The square of 1 is 1, and the square of 8 is 64. Therefore, the velocity in the two pipes will be as 1 : 64, and it must be 64 times as fast in the small as in the large pipe, so there you are."

"Say, why can't I test a forge which works well and then test the air at one which does not give satisfaction?"

"That's what, John. Try that stunt and you will at once determine the velocity and pressure of air which works well at the forge, and then you can use means to bring the other air pipes to work likewise. Working thus, you don't care a rap about the formula for finding velocity of air in pipes from its velocity head in water, for you know how much pressure should show in the U-tube to insure a good blast at the tuyere. And in the poorly working forge, when you find high-pressure and little velocity, you will be apt to look after the air passages in the forge to see if they are obstructed in any way, by dirt, clinker or lead or babbitt metal. I have seen the air passages nearly closed by soft metals which have been melted and spilled in the forge and run down through the tuyere and clogged the air passages. And, John?"

"Yes, sir; what is it, Mr. Hobart?"

"When you get your 'velocity pressure gage' all rigged up, don't forget to take readings on each side of the inverted siphon, Fig. 1, and you will then see what effect a couple of elbows have on pressure and volume of air."

PERSONAL

John A. Stevens, consulting engineer and chairman of the Committee on Boiler Rules of the American Society of Mechanical Engineers, has removed his offices from 107 Merrimack street to the Sun building, 8 Merrimack street, Lowell, Mass.

W. H. S. Bateman, for many years the Philadelphia representative of the Champion Rivet Company, Cleveland, Ohio, and the Parkesburg Iron Company, Parkesburg, Pa., has been appointed Eastern sales agent of the Canton Sheet Steel Company, Canton, Ohio, with offices in New York and Philadelphia. J. G. Esslinger, formerly with the Youngstown Sheet & Tube Company, will have charge of the New York office and Joseph R. Wetherald will have charge of the Philadelphia office.

H. A. Varney, general sales manager of the National Boiler Washing Company, Chicago, has resigned to become manager of the railroad department of the Smith-Totman Company, with offices in the Peoples Gas building, Chicago.

GENERAL NEWS ITEMS

Master Boiler Makers' Convention

The tenth annual convention of the Master Boiler Makers' Association will be held at the Hollenden Hotel, Cleveland, Ohio, May 23 to 26, 1916

Boiler Shops Damaged by Fire

The roundhouse and shops of the Chicago, Milwaukee and St. Paul Railway Company, in Malden, Wash., were destroyed by fire recently.

The boiler shops, foundry and blacksmith shop of the MacKinnon Boiler Company, Bay City, Mich., were destroyed by fire on October 12, entailing a loss of about $50,000.

$36,000,000 in Orders

In the issues of the *Railway Age Gazette* for the last two weeks in October, there were reported orders for new locomotives having a total value of approximately $8,000,000; for passenger cars, $240,000; for freight cars, nearly $20,000,000, and for rails, $8,000,000, making a total of $36,000,000 in contracts for rails and new equipment awarded by the railways of the United States in the short space of two weeks. Records kept by the *Railway Age Gazette* show that the orders for locomotives for domestic service only this year to October 29 totaled 1,005, as compared with 848 reported at the end of October, 1914; that the domestic orders for freight cars totaled 71,398, as compared with 67,820 up to October 30 last year, and that for the first time in 1915 orders for locomotives and freight cars passed those of 1914 for a like number of weeks. These reports form a reliable barometer of conditions in the railway supply trade field.

Endorsement of the A. S. M. E. Boiler Code by the National Electric Light Association

An important co-operative movement in the introduction of the Boiler Code into legislative channels in the various States is the recognition given at a recent meeting of the National Electric Light Association in approving the action of the American Uniform Boiler Law Society in its work of securing the general adoption of the Boiler Code recently formulated by a committee of the American Society of Mechanical Engineers. The National Electric Light Association has appointed John Hunter, member of the council of A. S. M. E., as its representative to serve on the executive committee of the American Uniform Boiler Law Society.

New Edition of the A. S. M. E. Boiler Code

A second edition of the Boiler Code which contains a comprehensive index to the volume, has been issued. The index is divided into two parts, one a general index to the complete rules and the other containing sectional indexes to the parts referring to New Installations of Power Boilers, New Installations of Heating Boilers, and Existing Installations. Copies of the new edition can be obtained from the American Society of Mechanical Engineers, 29 West Thirty-ninth street, New York.

Selected Boiler Patents

Compiled by

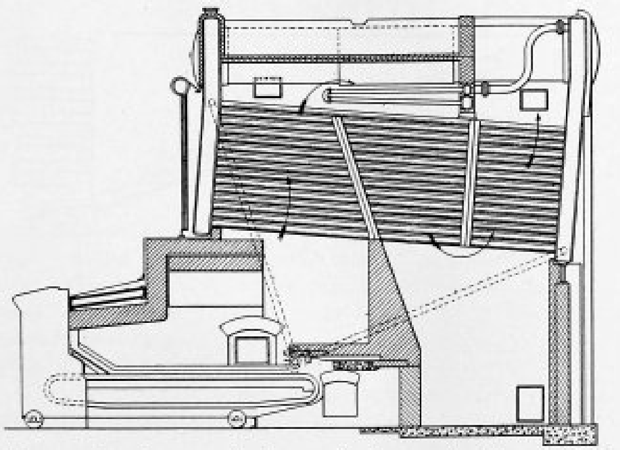
DELBERT H. DECKER, ESQ., Patent Attorney,

Millerton, N. Y.

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

1,148,543. BOILER WATER-BACK. WILLIAM F. SELLERS, OF EDGEMOOR, DEL., ASSIGNOR TO EDGE MOOR IRON COMPANY, OF EDGEMOOR, DEL., A CORPORATION OF DELAWARE.

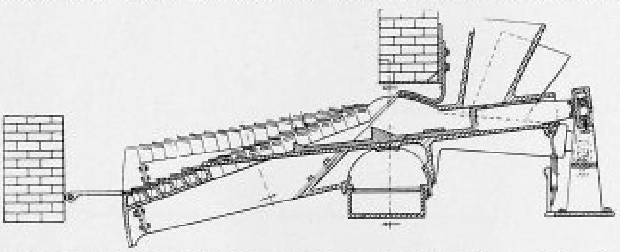
Claim 1.—The combination with a boiler proper, its housing and furnace chamber, of a water-back projecting into and removable from the furnace chamber through an outer wall of the boiler housing and formed



with two channels communicating at the inner end of the water-back, and pipes detachably connected to the outer end of the water-back externally of the boiler housing and connecting one of said channels to the boiler proper at one point and the other channel to the boiler proper at another point. Seven claims.

1,148,625. UNDERFEED FURNACE. ROBERT SANFORD RILEY, OF PROVIDENCE, R. I.

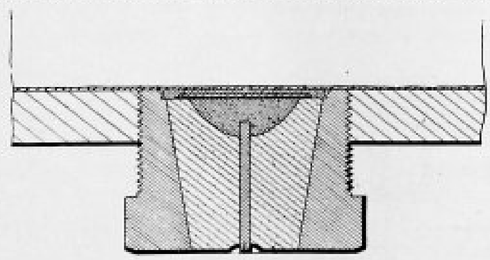
Claim 1.—In a furnace, a fuel burning retort consisting of a bottom impervious to the passage of air and side walls at each side of said bottom, said walls being mounted with capability for upward and down-



ward movement at one end, means for constantly feeding fuel into the retort at one end thereof, and means for giving the defined movement to said walls to effect a gradual progression of fuel and refuse through and from the retort. Thirty-five claims.

1,150,647. FUSIBLE SAFETY-PLUG FOR BOILERS. ALLEN D. TOWNE, OF KIRKSVILLE, MO.

Claim 1.—In a fusible plug for boilers, a body portion, a fusible alloy carried thereby, an explosive charge carried by said fusible alloy at the



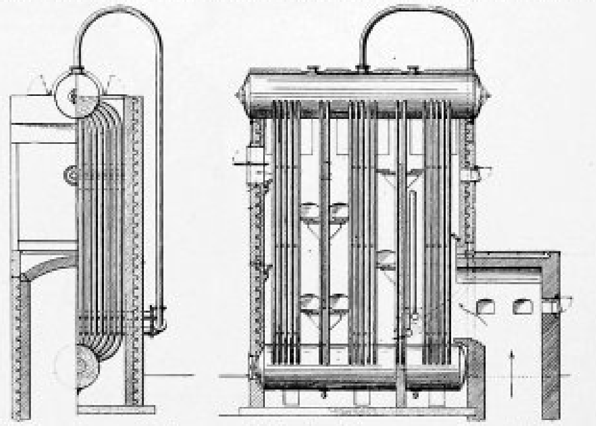
upper part thereof, and a conductor having one end disposed in said explosive charge and the other end projecting through the bottom of the fusible alloy member. Four claims.

1,148,075. STEAM GENERATOR FEED APPARATUS AND APPERTAINING MECHANISM. THOMAS F. BUDGE, OF MALAD CITY, IDAHO.

Claim 1.—In an apparatus of the character described, the combination with a boiler, of a chamber having a way for conducting fluid in a predetermined path therethrough and adapted to deliver liquid by gravity from said chamber to said boiler, a conduit for conducting fluid to said way of said chamber from a lower lever than the same, means for preventing back flow of fluid in the said way of said chamber, means for conducting steam to said chamber, and valve mechanism for permitting passage of steam through said last-mentioned means when the water in said boiler has a low level, but stopping said delivery when the same has attained a high level, substantially as and for the purpose set forth. Four claims.

1,150,913. WATERTUBE BOILER. EDWARD H. WELLS, OF MONTCLAIR, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

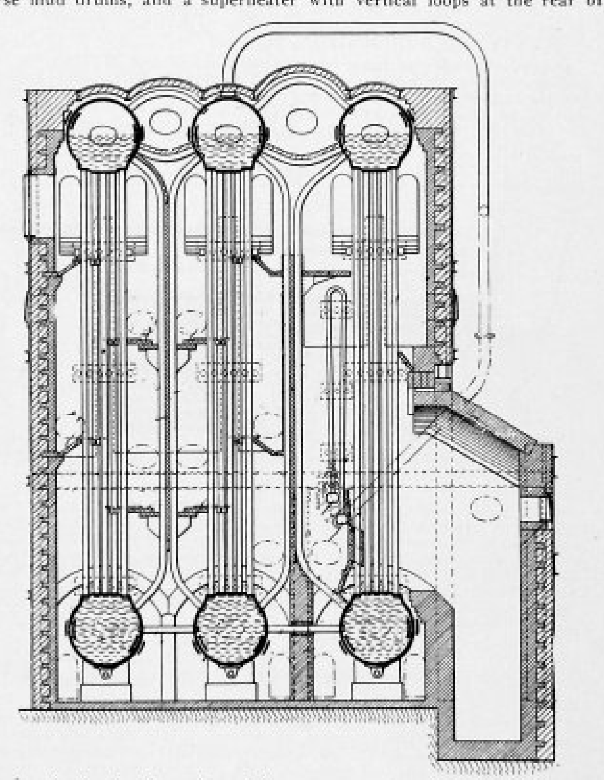
Claim 1.—A boiler having a single longitudinal steam and water drum and a single longitudinal mud drum, watertubes arranged in separated banks in planes at right angles to the longitudinal axes of the drums



and connecting said drums, said banks being separated sufficiently to allow entrance between them, vertical baffles between the banks and water tubes separated from the banks and supporting said baffles, said supporting tubes being expanded into the drums. Seven claims.

1,150,944. SUPERHEATER BOILER. DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—A watertube boiler having a plurality of transverse steam and water drums connected by banks of tubes to corresponding transverse mud drums, and a superheater with vertical loops at the rear of



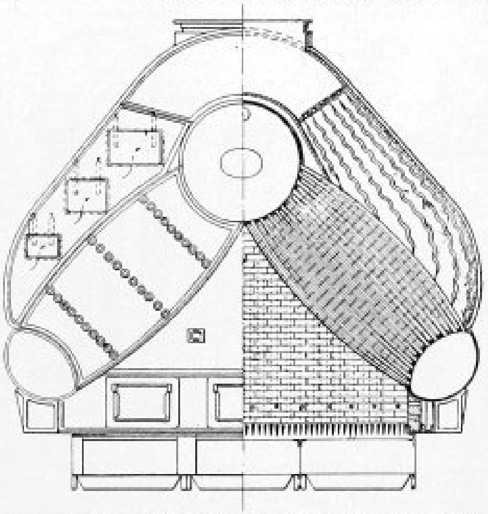
the first bank of tubes, there being a protected space back of the first bank of tubes, and transverse boxes into which said tubes are expanded, said boxes being in proximity to the lower part of the first bank and within said protected space. Eleven claims.

1,148,846. BOILER FLUE-CLEANER SYSTEM. FREDERICK W. LINAKER, OF DUBOIS, PA., ASSIGNOR TO THE VULCAN SOOT CLEANER COMPANY, OF PITTSBURG, PA., A CORPORATION OF PENNSYLVANIA.

Claim 1.—In a boiler flue cleaner system, the combination with an inclined baffle and a bank of inclined boiler tubes, of a fluid distributing pipe adapted to discharge cleaning fluid in streams within the spaces between said tubes, said pipe being transversely disposed within the boiler, setting back of said baffle out of the destructive heat zone of the fire chamber of said boiler, curved nozzles projecting from said pipe and adapted to be projected over the edge of said baffle, and means for rotating said pipe to project said nozzles beyond the baffle and for returning the nozzles to rest position in back of the baffle. Nine claims.

1,150,951. STEAM BOILER. CHARLES D. MOSHER, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

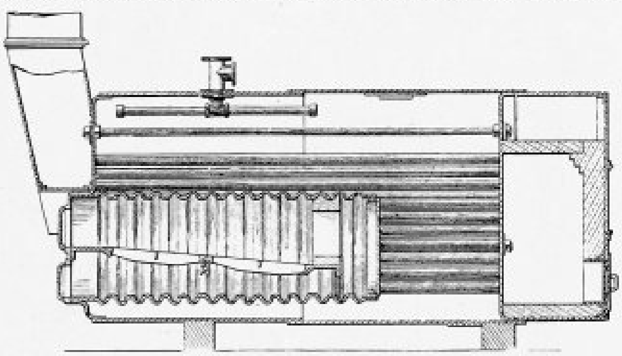
Claim.—The combination with a boiler and casing of an integral air heater located in the up-take and composed of metal sheets secured to end plates so as to form between them in alternation passages communicating with the combustion chamber and the stack and passages



through corresponding openings in the end plates communicating with the atmosphere and the combustion chamber, heat radiating webs secured to the rear wall of the combustion chamber and disposed in the passages between the air heater and the combustion chamber, the sheets being spaced to distribute equally the hot gases from the combustion chamber, and adjustable dampers to control the flow of hot gases through the passages therefor.

1,151,127. BOILER FURNACE. CHARLES H. SCHROEDER, OF BURLINGTON, IA., ASSIGNOR TO MURRAY IRON WORKS COMPANY, OF BURLINGTON, IOWA.

Claim.—A boiler furnace comprising a cylindrical shell having front and rear heads, an inner shell disposed within the boiler shell above the bottom thereof and extending rearwardly more than half way through said boiler shell, said furnace shell provided at its rear end with a head and provided at its front end with doors, a bridge wall within said



furnace shell co-operating with the rear head of the latter to form a chamber, a grate within said furnace chamber, a rear smoke chamber having walls of masonry behind the rear head of the boiler shell and provided with a cleaning door, a forward smoke-box, flues connecting the rear chamber of the furnace chamber with the rear smoke chamber, flues connecting the rear smoke chamber with the forward smoke-box, and a shell inclosing the walls of the rear smoke chamber and forming an extension of the boiler shell.

1,152,423. TUBE CLEANER. FREDERICK W. LINAKER, OF DUBOIS, PA., ASSIGNOR TO THE VULCAN SOOT CLEANER COMPANY, OF PITTSBURGH, PA., A CORPORATION OF NEW JERSEY.

Claim 1.—In a tube cleaner, the combination with a vertical water-tube boiler having spaced rows of vertical tubes, of a revoluble fluid distributing pipe mounted in the boiler setting and extending transversely of the boiler between two adjacent rows of tubes thereof and provided with discharge nozzles, said pipe shiftable longitudinally to space the nozzles thereof in line with different spaces between the rows of boiler tubes whereby each nozzle projects fluid into different spaces. Twenty claims.

1,148,342. RELIEF DAMPER FOR LOCOMOTIVES. JOHN P. STAATS, OF WILMINGTON, DEL.

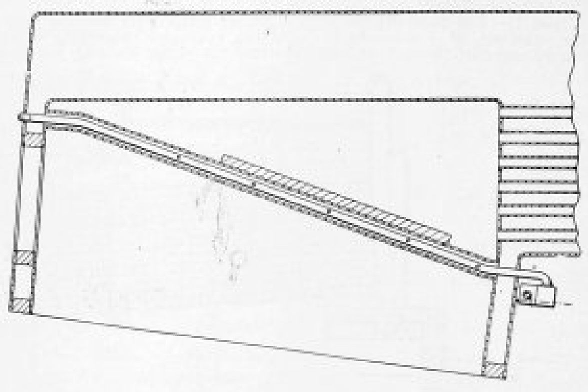
Claim 1.—The combination of a boiler having a smoke box; an exhaust nozzle communicating with the smoke box; a stack, also communicating with the said box, the shell of the smoke box having an opening therein; a frame surrounding said opening, the upper portion of the frame projecting on the outside of the shell and the lower portion of the frame extending on the inside of the shell; and a damper pivoted to the frame and arranged to open when the draft in the smoke box exceeds a given limit. Four claims.

1,145,757. LOCOMOTIVE ENGINE CUT-OUT VALVE. SAMUEL AUSTIN DUGAN, OF GALVESTON, TEXAS.

Claim 1.—In a locomotive, the combination of driving engines, a boiler, a horizontally-disposed dry steam pipe, a smoke-box into which the pipe extends, branches in the smoke-box and leading from the pipe to the engines, a Y-coupling uniting the branches with the dry steam pipe, and valves in the Y-coupling for opening and closing the supply of steam to the branches. Five claims.

1,151,893. FEED-WATER HEATER. FRANK MANKOWSKY, OF CHICAGO, ILL.

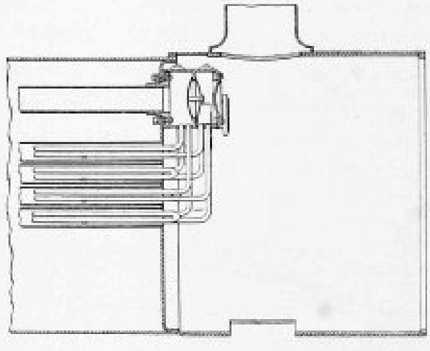
Claim 1.—The combination with a locomotive fire-box having water legs and arch tubes connecting the same, of feed-water pipes extending lengthwise through said tubes and discharging thereinto, and a dis-



tributing chamber mounted on the outside of the fire-box and having a water inlet, said chamber having partitions whereby it is divided into a plurality of compartments, to which the aforesaid pipes are connected, respectively. Two claims.

1,152,839. LOCOMOTIVE SUPERHEATER. JOHN PRIMROSE, OF NEW YORK, N. Y.

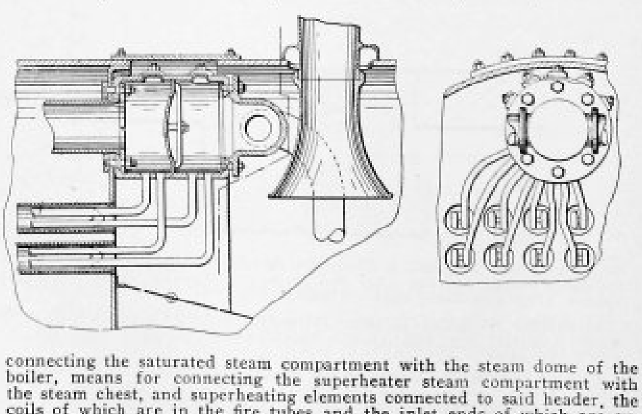
Claim 1.—The combination with a boiler having a plurality of fire-tubes arranged one above another in substantially the same vertical plane, of a header provided with steam chambers, and superheater units arranged



in the fire-tubes and having upwardly projecting end portions which are expanded into said chambers, the end portions of the upper units being located substantially behind the end portions of the lower units, and any of said units adapted to be removed from the boiler independently of the others. Ten claims.

1,151,934. LOCOMOTIVE SUPERHEATER. ERNEST H. FOSTER, OF NEW YORK, N. Y.

Claim 1.—A boiler provided with fire tubes, in combination with a superheater comprising a cylindrical or drum header having a saturated steam compartment and a superheated steam compartment, means for



connecting the saturated steam compartment with the steam dome of the boiler, means for connecting the superheater steam compartment with the steam chest, and superheating elements connected to said header, the coils of which are in the fire tubes and the inlet ends of which are expanded into said saturated steam compartment and the other ends of which are expanded into the superheated steam compartment. Eleven claims.

THE BOILER MAKER

DECEMBER, 1915

Useful Boiler Shop Kinks

Adjustable Templates for Laying Out Smokebox Fronts and Crown Bar Braces

BY C. E. LESTER

It is a well-known fact among those concerned that a really round smokebox is the exception rather than the rule, especially after engines are in service any length of time. In fact, in several years inspecting at locomotive manufacturing plants, the writer has found as many ½-inch or more out of round as there were that were true.

This means that a smokebox layed out to a true circle with the trammels is very liable not to be a good fit.

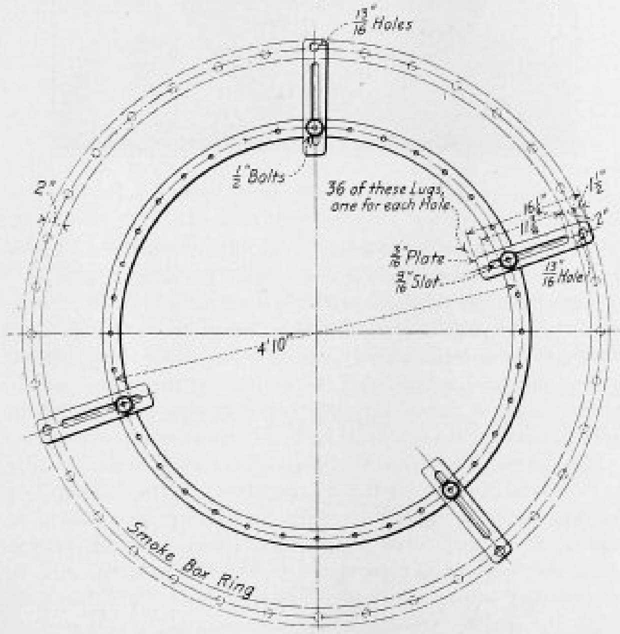


Fig. 1.—Adjustable Template for Laying Out Smokebox Fronts

Frequently it is necessary to drill holes from 1 inch to 1½ inches diameter to take a ¾-inch bolt in order to get the front on, or to drill one hole at the top of the front—then hang it up and mark off the remainder of the holes. This is, of course, a laborious and expensive operation, and is entirely uncalled for.

The jig, or adjustable template, illustrated, was designed expressly for the purpose of laying off smokebox fronts to true dimensions, irrespective of the irregularity of the smokebox ring; that is, all fronts within its range. All that is necessary is to hang the jig to the smokebox ring with about four or five bolts and tighten up the nuts securely so that the jig will be retained in a fixed position, and then adjust the different straps to cover each bolt hole in the ring and bolt each one securely in position. The whole ring can be dimensioned and the results marked off on the front in twenty minutes with accuracy and ease and little expense.

In hanging the jig have the straps on the outside so that, when placing on the front for marking off, the straps will lie flat on the front. The dimensions and number of straps shown were used to conform most closely to several classes of fronts for which it was desired.

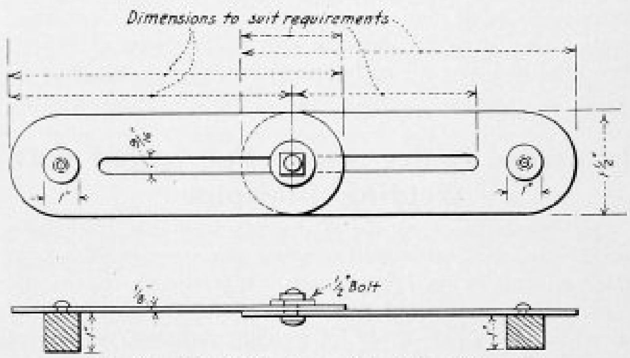


Fig. 2.—Adjustable Crown Bar Brace Template

In shops where boilers range from the little old "footboard" of about 48 inches diameter to the Mallet of 100 inches, it is, of course, essential that jigs of different diameters be made. A range of 20 or 22 inches is about large enough for convenience, so that three rings are about all that any shop might require.

Adjustable Crown Bar Brace Jig

The second illustration is of an adjustable crown bar brace jig or template. Any one who has crawled in and out over a set of crown bars times without number, getting the length and setting crown bar braces without a good measuring gage, knows what a tedious back- and bone-breaking job it is. With two of these gages (a long one and a short one) and a clean planed pine board about 24 inches by 18 inches, the length of an entire set of crown-bar braces can be taken in a couple of hours without even leaving the crown sheet.

First a hole 1 1/32-inch diameter is drilled at the bottom center of the board about 1 inch from the edge to accommodate the peg on one end of the gage. (It is assumed that 1-inch brace bolts are to be used.) The pegs in the gage can, of course, be made several different sizes and changed as required.

The board and a short gage for the side holes and a long one for the middle ones are taken inside the boiler.

Commencing at the back end and numbering each brace consecutively, the lengths are taken with the gages. These are then passed out to the helper in the shell, who inserts one peg in the hole on the board, takes a pencil and scribes around the other peg and places the brace number inside the scribed circle. This operation is repeated for each brace until the entire set is located; for a large set more than one board may be necessary or both sides of the board may be used. If the braces are the old-style forged brace, the board and gages are turned over to the blacksmith, who takes his lengths from them and forges the braces to the proper length. If strap braces are used the boiler maker transfers the dimensions to the straps and sends them to the drill press or punch for finishing.

Washing Out Boiler Flues

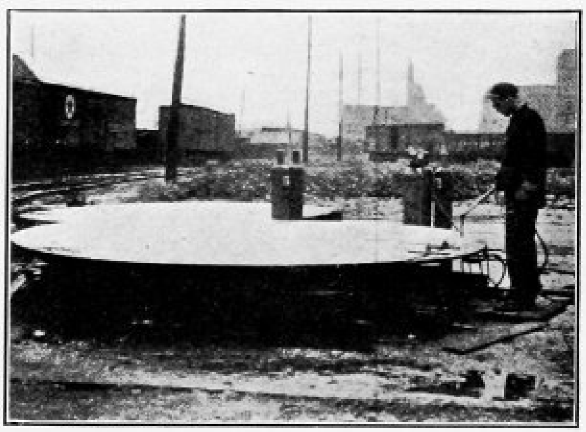
The following stunt is not claimed as original, but the writer never saw or tried it before, and has thought it might prove of aid to some one who has had similar troubles:

An engine was received at the shop where the flues were not to be removed, but required cleaning out, as about 100 of them were plugged solidly. The usual method of blowing with air and boring with an augur was tried, but without much success, and it appeared for a time that it was a case of let them go or remove the flues.

As a last resort a ½-inch pipe was coupled up to the boiler washing waterline and washing was tried. The results were more than satisfactory, as about 75 flues were washed out perfectly clean in less than two hours, where two men had worked without success for five hours.

Immense Boiler Sheets Fabricated with Welding Blowpipe

An interesting example of the oxy-acetylene blowpipe's utility for general manufacturing purposes is shown in the accompanying photograph, reproduced from the *Acetylene Journal*, of two large steel tube sheets for a marine type boiler, made by welding together two plates



Large 1-Inch Tube Sheet for Scotch Boiler, Welded by Oxy-Acetylene Torch

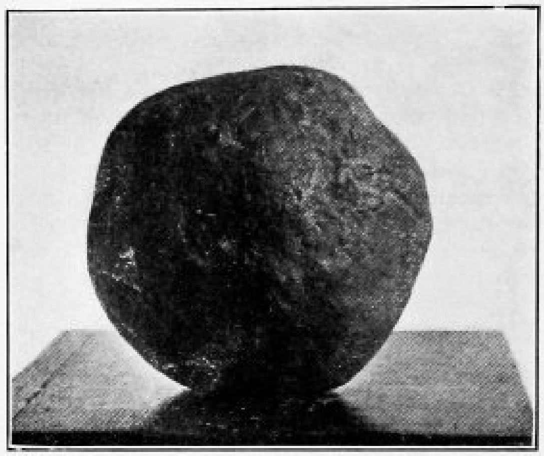
of heavy 1-inch rolled steel. It was essential that the finished sheets be 151 inches in diameter, and, as the largest plates rolled are stated to be but 142 inches in width, it was necessary in this instance to provide a satisfactory means of joining on an additional 9-inch strip of metal. The blow-torch filled this need.

There were two factors which entered to make this job difficult: That the circles were of such large size, hence awkward to handle; and in the welding it was essential that the added strip be held in the same plane.

Each plate required about 6 feet 2 inches of lineal weld, and, as both sheets were flanged when assembled, the line of weld meets a certain strain. Also 3½-inch tube holes were drilled in the completed sheets, some through the weld itself. This would likewise put the weld under test.

"Grease Balls" in Boilers

The accompanying illustration shows an interesting and somewhat unusual deposit taken from a boiler. When feed water enters a hot boiler the carbonates of lime and magnesia that the feed contains are precipitated from solution, and if the circulation in the boiler is not too active, the precipitated matter often floats on or near the surface



Grease Ball Taken from Boiler

of the water for a time in light flocculent particles. If oil or grease is also present in the boiler, the floating carbonates are likely to combine with the organic part of it, forming a sort of soap, having lime and magnesia as a basis instead of the usual soda or potash. The soap thus formed is insoluble and sticky, and the motion of the water sometimes causes it to collect into solid masses varying from mere pellets up to spherical balls of considerable size.

The "grease ball" that is shown above was formed in this way, and is about 3 inches in diameter. When "soap" of this kind comes in contact with the boiler, it is likely to adhere to it and form a non-conducting coating, which keeps the water away from the metal and so gives rise to overheating of the plates or tubes, which are then likely to bulge or collapse.—*The Travelers Standard.*

"Practice makes perfect" in tool making as well as elsewhere.

It is a good idea to keep away from the booz-y-torium and the picture shows for a couple of weeks and buy a new pair of shoes. Winter is coming on.

It is better to look out yourself if you are going to throw a lot of tools off a staging, than to holler "Look out" to someone else after you have done the chucking.

Be man enough to tell the foreman about it if you have injured or broken a tool. Don't tell him the staybolt tap "just fell apart in my hand." He won't believe you.

Marine Steam Boilers*

Recent Developments in Fire Tube and Watertube Marine Boilers

BY CHAS. F. BAILEY †

During the last decade there has been a considerable development and improvement in marine boilers, both of the Scotch type and of the watertube type.

No radically new principles have been adopted in practice, although several notably conspicuous new inventions have been made which may develop in the future. Among these should be mentioned the Bone surface-combustion experiments, the mercury boiler, invented by Mr. W. L. R. Emmet, the Talbot high-pressure boiler, which has been used in small units with much success, and the Bettington powdered coal boiler.

The efficiency of marine boilers has been generally improved, due to the following causes: A more careful study of conditions governing combustion in the boiler and means for quick analysis of the products of combustion and for observing the variation of temperatures throughout the path of the gases; the study of heat transfer, in which is involved the volume of the combustion chamber, baffling of the gases, and arrangement of passages for same, tube spacing, disposition of the heating surfaces, circulation of the water, liberation of the steam, cleaning of the heating surfaces, both on the fire side and on the water side. Steam pressures cannot be said to have generally increased excepting in some particular instances.

In addition to the foregoing, there should be mentioned the revival of interest in superheated steam, which bids fair to largely increase and which promises considerable gain in overall efficiency. Oil burning has developed to a high degree of perfection both with steam and air atomization, and notably with mechanical spraying. The study of corrosion has occupied considerable attention.

Improved workmanship is recognized as an important factor in ultimate boiler efficiency, and along with this may be noted the advance in shop facilities for working the materials and tools for more accurately and rapidly machining the finished parts. This has led to the standardizing of many details which have been most carefully designed for assembly, or replacement, durability, reduction in weight, improvement in appearance and facility of manipulation.

The use of oxy-acetylene flame for cutting materials, the use of electric welding, especially for repairs, and the extensive adoption of pneumatic tools, have had a material effect in improving the quality of boiler work and reducing the cost of construction and upkeep.

The increase in size of marine boiler installations is one of the most striking recent advances, and along with this increase is to be noted some decrease in heating surface per horsepower, which is largely due to reduced steam consumption of the propelling machinery and partly due to a higher boiler efficiency and dependability. In naval work the use of oil only, or oil and coal combined, has reduced the heating surface to a more marked degree. Boiler installations of over 100,000 horsepower per ship are now made, whereas ten years ago powers of 20,000 to 30,000 horsepower per ship were about the maximum.

Scotch Boilers

The changes during the past decade in the Scotch type of boiler and other firetube boilers have been less than in most forms of watertube boilers.

We note simplification in design due to the modern rolling-mill facilities for supplying larger plates, thus reducing the number of seams. It is usual now to construct single-end Scotch boilers up to 12 feet in length and nearly 18 feet in diameter with no middle circumferential seam and with only one seam across the back head. Separate

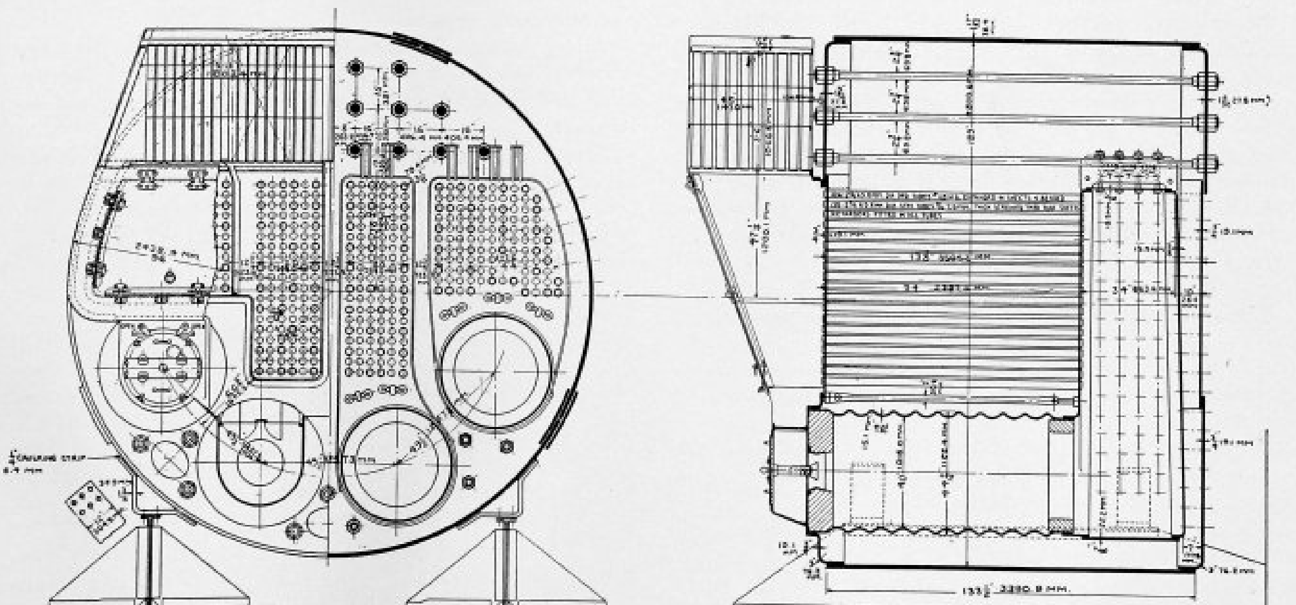


Fig. 1.—Scotch Boiler and Air Heater Box, for S. S. *Topila,* Fitted for Burning Fuel Oil with Forced Draft

* From a paper read before the International Engineering Congress, San Francisco, Cal., September, 1915.

† Chief Engineer, Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

combustion chambers are usually fitted in single-end boilers and also in double-end boilers in connection with forced draft. With natural draft or assisted draft, in double-end boilers, it is not unusual to connect the corresponding furnaces in opposite ends of the boiler to straight through combustion chambers; this considerably reduces the length and weight and simplifies the construction. When such combustion chambers are fitted, fire-brick walls are sometimes built up in the middle between the furnaces.

The combustion chambers for double-end boilers are usually tied to the bottom of the boilers to prevent working when steaming, although with single-end boilers it is not essential to tie the chambers down.

The lower wrapper plates of the combustion chambers are sometimes made in one plate of greater thickness at the bottom part where unsupported by stays, thus saving the side riveted laps.

The question of material of boiler tubes is one on which there is a considerable difference of opinion. The best charcoal iron tubes and seamless drawn steel tubes seem under favorable conditions to give equally satisfactory results. The use of Serve tubes in Scotch boilers has practically been discontinued. With watertube boilers it is common to use seamless drawn steel tubes.

It is now usual to fit the back ends of the corrugated furnaces either of the horse-collar type, the straight type or of some form of flanged type which permits of the furnaces being renewed at a minimum expense.

It is not uncommon to fit Scotch boilers of very large dimensions. The boilers of the steamship *Aquitania* are 17 feet 8 inches mean diameter by 22 feet mean length.

Some owners take precautions to prevent air drafts from circulating at the bottoms of their boilers, and lag the bottoms with asbestos or magnesia blankets or pads which are easily removed for examinaion. This is an excellent practice, promoting economy in operation and upkeep.

The ordinary plate saddle or support is largely used for Scotch boilers in conjunction with fore and aft chocks. A form of Scotch boiler support which is frequently adopted by American builders is illustrated in Fig. 1. These supports consist of heavy bent steel lug plates riveted to the lower shell of the boiler, each lug being fitted with a 1/4 inch calking plate adjacent to the shell. These plates can be hydraulically riveted when the shell riveting is being done. Girders are fitted in the ship, as indicated in Fig. 1, to which the lug plates are bolted. Provision is made at one end of the boiler for expansion. Similar supports are also common for Yarrow boilers. All boiler supports should provide the greatest facility possible for care of the lower parts of the boiler. It may be noted that the heating surface per cubic foot volume of boilers has not altered materially, but the tendency is to allow more steam space, which gives better access for cleaning and care.

WATERTUBE BOILERS

The recent developments in the design and construction of marine watertube boilers have been much more pronounced than in Scotch boilers. Many of the early errors in design have been eliminated, so that high efficiencies are now common, both in naval and merchant work.

The requirements demanding the best material and workmanship have been recognized, and now many of the watertube boilers are examples of the finest product of skilled designers and workmen and modern machinery and methods. In this connection it is interesting to refer to the early influence of Mr. A. F. Yarrow, who, in 1891,* pointed out that only the best materials and workmanship should be employed in boiler work.

* Paper on Construction of Boilers Adapted to Forced Draft, Institution of Naval Architects, 1891.

Boilers of the Babcock & Wilcox, Niclausse, Belleville and Yarrow types have all retained their essential features for the last ten or fifteen years. Many of the other so-called express types of boilers have been merging towards a more or less composite design in which the objectionable features have been largely eliminated.

Boilers which a few years ago were fitted with tubes having extreme bends are now made with these tubes of gradual bends, and in some cases the tubes are straight with the exception of the lower ends entering the water drums. The upper ends of the tubes are now usually submerged and arranged to facilitate cleaning and inspection; air pockets are generally avoided, as it has been found corrosion is active at these points. The straight-tube type of boiler, represented by the Yarrow, fits the rows of tubes next to the fire with slight bends to allow for expansion. Steam drums are of larger diameter in the three-drum, or express type of boiler, than in the Babcock & Wilson or the Niclausse boiler, due to structural reasons, accessibility, and to provide a good volume of water.

The water pockets at the lower ends of the tubes are approaching the circular section and in some cases the oval or D-drum has been replaced by the circular drum.

Due to these improvements, resulting in great reliability and increased durability, the heating surface for naval work, especially where oil fuel is used, has been notably reduced.

The watertube boiler has been adopted for practically all naval vessels, excepting auxiliaries such as colliers, where Scotch boilers are used in some cases.

The German navy uses the Schulz or Schulz-Thornycroft boiler nearly exclusively for all sizes of vessels. Other navies are using two or more types of boilers, principally as follows:

England—Babcock & Wilcox and Yarrow for large vessels. Yarrow and White Forster for smaller vessels and destroyers.

France—Belleville, Niclausse and Guyot Du Temple for large vessels; Normand and Lagrafel d'Allest, Du Temple Guyot and White Forster for small vessels and destroyers.

Italy—Belleville, Niclausse, Blechynden, Babcock & Wilcox and Yarrow for large vessels; Thornycroft for small vessels.

Japan—Yarrow, Belleville, Niclausse, Miyabara and Babcock & Wilcox for large vessels; Miyabara and Yarrow for small vessels.

United States—Babcock & Wilcox and Yarrow for large vessels; Babcock & Wilcox, Yarrow, Normand, Thornycroft and White Forster for intermediate vessels and destroyers.

Thus it is seen that a wide range in type of boiler is still being allowed by naval authorities. The requirements in boiler installation which appeal to one nation as most essential appear differently to another; and doubtless properly so, as the broadest view of ultimate efficiency should be taken, into which enter a consideration of the home facilities for building, replacing or repairing in the most expeditious manner. Thus the fine shops in Great Britain and the United States for expeditiously building the Babcock & Wilcox boiler and the corresponding facilities in France for constructing the Niclausse boiler and the absence of such special works in Japan, may influence the Japanese Admiralty in adopting in a home-built vessel the Miyabara boiler or some other type which may be constructed with the shop facilities at hand.

It is to be noted that the sizes of watertube boiler units have greatly increased. The efficiency of the large units is higher than that of the small units, especially with oil firing.

In installations of the small tube boilers for large powers it is usual, in English and American practice, to provide considerably more heating surface than with the installations of Babcock & Wilcox boilers. In making comparisons between boilers on the basis of heating surface this point should be borne in mind.

WATERTUBE BOILERS IN MERCHANT VESSELS

In considering the installation of watertube boilers in trans-ocean or coasting merchant vessels, the question of proper facilities for cleaning the boilers during long voyages must be kept in mind. Many boilers which show high efficiency under shop tests may fail under the severe conditions of service in merchant shipping, where long voyages are made, changing weather conditions are encountered and the quality of coal is sometimes inferior. The operation of merchant vessels is often attended with limited time in port for overhauling, repairs and cleaning. Some large installations of watertube boilers have been made in merchant work which have not given the satisfactory service anticipated, owing to the lack of facilities for properly cleaning the fires, sweeping the heating surfaces, regulating the air to the furnaces, and ventilating the stokeholds. Such installations do much to retard the introduction of watertube boilers in the merchant marine. The Babcock & Wilcox boiler has probably been installed in a greater number of mercantile vessels than any other type of watertube boiler, and its success has been largely due to the characteristics outlined by the late Rear-Admiral George W. Melville,* formerly Engineer-in-Chief, U. S. Navy, in an article in which he says:

"From my study of the subject, I have reached the conclusion that the thoroughly satisfactory watertube boiler should possess, among others, the following characteristics:

"Reasonable lightness, with scantlings sufficient to promise reasonable longevity;

"An adequate amount of water, so that failure of the feed supply or any inattention thereto would not immediately cause trouble;

"Accessibility for cleaning and repairs on both water and fire sides;

"Straight tubes, with no screw joints in the fire, but the simple expanded joints so well tested out for years;

"No cast metal, either iron or steel, subjected to pressure;

"Ability to raise steam quickly;

"High economy of evaporation;

"Economy of space;

"Interchangeability of parts, and, as far as possible, the use of regular commercial sizes so that repair material could be procured anywhere;

"The ability to stand severe forcing without injury;

"The ability to stand abuse—that is, to be of rugged construction and not so delicate as to require skilled mechanics to run it;

"Safety against disastrous explosion, meaning that only the part of the boiler which gave way would be damaged."

Higher efficiencies can often be obtained with well-designed watertube boilers than with Scotch boilers, principally owing to the fact that the furnace is large, its form may be nearly ideal for thorough combustion before the gases enter the tubes; whereas in Scotch boilers the furnaces are contracted and low and the combustion space is completely surrounded by the cooler boiler surfaces.

Experience in the merchant vessels *Creole, Matsonia, Adeline Smith* and several others, each operated by different owners and fitted with Babcock & Wilcox boilers, indicates that with a reasonably intelligent engineering staff boilers of this type are thoroughly reliable and can be operated at a lower cost of maintenance and are more flexible, and probably more efficient, than ordinary Scotch boilers. In the *Adeline Smith*, fitted with four boilers, there has never been a delay of any kind for cleaning or minor repairs; one of these boilers can be cooled sufficiently to work in within an hour or two, and steam raised again in forty-five minutes.

The writer is informed in regard to the six Babcock & Wilcox boilers and three single-end Scotch boilers installed in the steamer *Matsonia*, and using oil fuel, that very little cleaning of the watertube boilers is necessary and that it is not required to mechanically clean the tubes oftener than once in two or three months. No signs of corrosion have appeared. The zinc plates are renewed approximately each six months. A half keg of Renown compound is also used per trip of 2,000 miles. It is not found necessary to have higher grade men in the fire room to operate these boilers than those ordinarily operating Scotch boilers. Feed-water regulators are desirable and the Hough patent feed check valve is considered a necessity where reciprocating feed pumps are used.

The Matson Navigation Company's purpose in installing a combination of Scotch boilers and Babcock & Wilcox boilers in this vessel was that they might have Scotch boilers for winch work in port, owing to the larger steam space. They find, however, that a number of steam schooners fitted with only two Babcock & Wilcox boilers have no boiler troubles, even though using them constantly in port for donkey boiler service.

The saving in weight and space which may be effected with watertube boilers over that required for Scotch boilers is great, as shown by Admiral Melville in his paper.

THE NICLAUSSE BOILER

This well-known boiler, which has been largely adopted by the French navy and others, has retained the essential principles of its unique construction, but recent improvements have resulted in a very high efficiency.

These improvements, some of which have been in use a considerable time, include the following:

Constructing the headers of solid drawn pressed steel of larger rectangular section.

Making the tubes solid drawn with swellings to form the cones and lanterns.

The adoption of a system of forced circulation and feed distribution to the lower tubes which are nearest the furnace, which also includes arrangements for purifying the feed.

All of these points are described in a paper by Mr. Niclausse * and records are given of a test by naval officers of the boiler as proposed for the new French battleship *Béarn*.

WHITE FORSTER BOILER

As is well known, the distinctive features of this boiler are the adoption of a uniform curvature of all of the tubes in any particular boiler and the arrangement of the tubes in the steam and water drums so as to permit any particular tube to be removed and replaced through the steam drum without disturbing other tubes in the boiler.

The spare tubes may be carried of the longer lengths and cut to any desired length.

This boiler is now constructed either with D-shaped water drums or circular water drums. Fig. 2 shows the latest type of the White Forster boiler as built in the United States by the Babcock & Wilcox Company, which embodies the circular water drums.

Owing to the large radius of curvature of the tubes,

* "The Development of the Marine Boiler in the Last Quarter Century." *Engineering Magazine*, January, 1912.

* Paper read before the Mechanical Engineers at Paris, July 8, 1914, and published in *Engineering*, July 17, 1914.

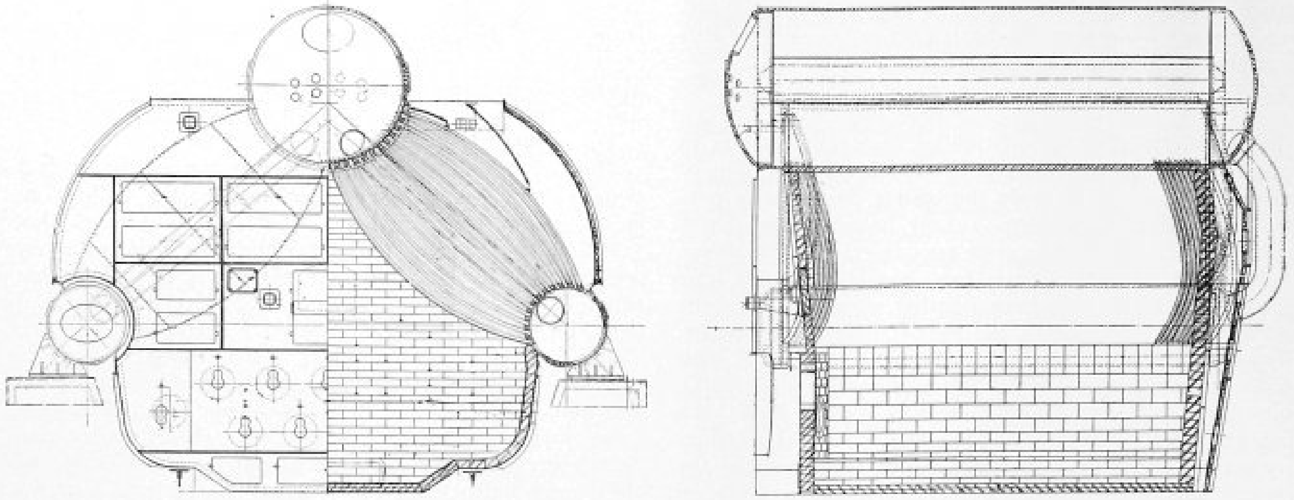


Fig. 2.—White Forster Watertube Boiler, Built by the Babcock & Wilcox Company

they are easily cleaned, both internally and externally, and the stresses due to expansion are minimized.

This boiler is capable of developing a very high efficiency and it can also be severely forced without injury.

NORMAND BOILERS

The Normand boiler has long been considered one of the most efficient and best designed boilers of the express watertube type. The Normand firm, owing to the early inventive ability and resourcefulness of M. Normand in France, has been particularly successful in the construction of torpedo boats and destroyers fitted with high-power machinery.

Fig. 3 shows a boiler of the Normand type as constructed by the Bath Iron Works for torpedo boat destroyers. This company has met with singular success in the development of this boiler for U. S. destroyers. The dry weight of the boiler as shown by Fig. 3, complete with all mountings, oil burners and tuyéres, but not including the uptake, amounts to 11.2 pounds per square foot of heating surface and the weight of water in steaming condition amounts to 2 pounds per square foot of heating surface. The combustion chamber space can be made as large as desired.

Attention is called to the steam dome, provision for baffling the steam before entering the dome, and the arrangement of the tubes so as to baffle the gases and give them a long passage across the heating surface.

The boiler has been forced to extremely high capacities in naval installations in various countries. M. Normand was one of the first engineers to point out the ill effect of the admittance of feed in such a manner as to interrupt

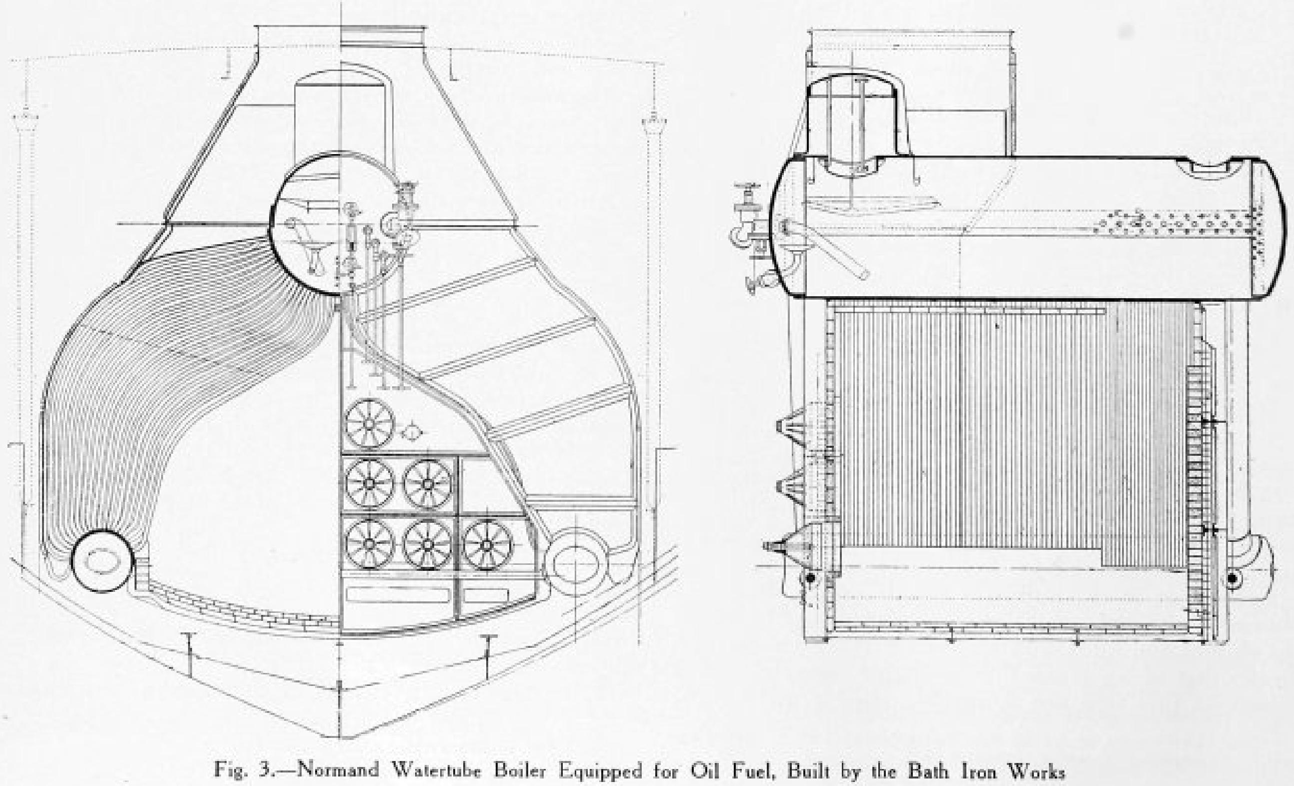


Fig. 3.—Normand Watertube Boiler Equipped for Oil Fuel, Built by the Bath Iron Works

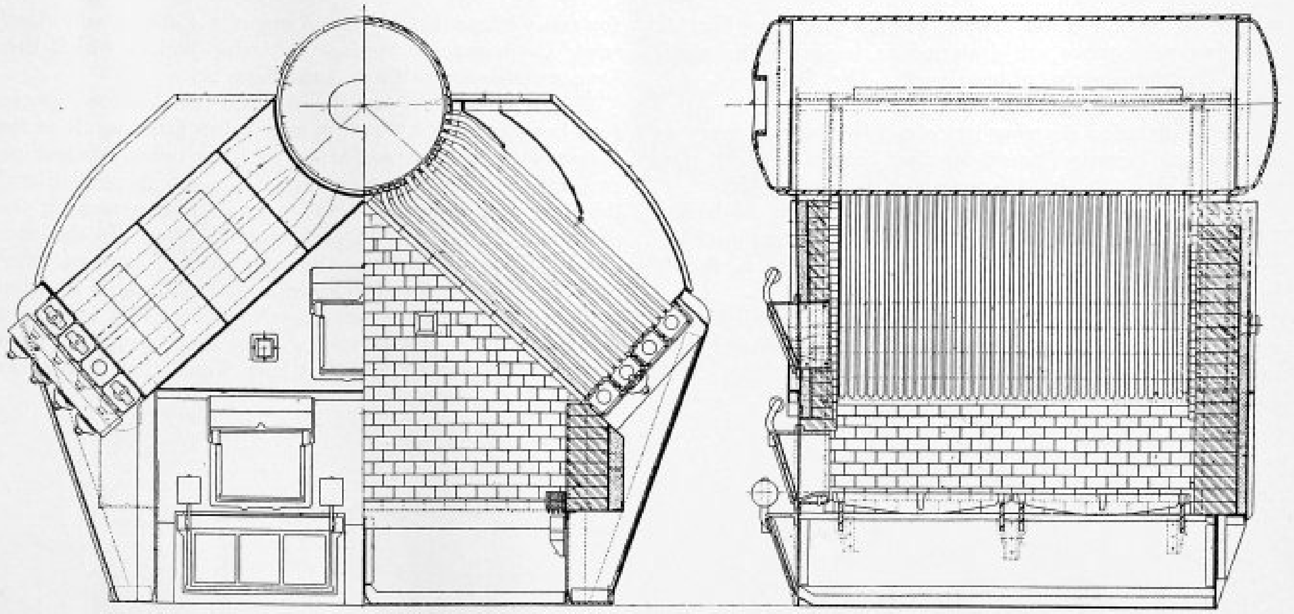


Fig. 4.—Box Type Watertube Boiler, Built by the Babcock & Wilcox Company

the proper circulation in watertube boilers and to show the inefficiency resulting from such methods of feeding.

The Box Type of Boiler

The box type of boiler, built by the Babcock & Wilcox Company, is shown in Fig. 4. This boiler embodies an ingenious arrangement of steel headers. These headers take the place of the usual water drums in the A type of boiler, and it should be noted that they may be of either the straight box or corrugated form, running either longitudinally or crosswise of the bank of tubes; this allows great flexibility in regard to size of boiler. These headers are of the regular type incorporated in the Babcock & Wilcox boiler. The boiler is particularly accessible for cleaning and examination of the interior surfaces of the tubes; and if space is allowed in the vessel, any individual tube may be examined and cleaned from either end, and any tube may be renewed without interfering with other tubes.

Drum Type of Boiler

The Babcock & Wilcox drum type of boiler is shown in Fig. 5, which represents these boilers as recently installed in the steamers *Great Northern* and *Northern Pacific*. The boiler is fired from the water-drum side, which gives an efficient furnace arrangement and is well adapted for either coal or oil burning. The baffling is across the tubes and is of the well-known and efficient Babcock & Wilcox type. The boilers illustrated were fitted with Schütte & Koerting fuel oil burners.

Thornycroft Boilers

The latest form of Thornycroft boiler is constructed with tubes which are straight excepting at the lower ends where they enter the cylindrical water drums. The curvatures of the tubes are limited to only two or three radii, which simplifies the spares. This design enables each tube to be examined internally by placing a light at the lower end; it also allows flexibility for expansion. The tubes are easily cleaned internally and are so disposed in cross section as to be accessible for external sweeping. The cylindrical water pockets are the most economical in weight and cost of construction. It is feasible to make the water pockets of welded or solid drawn construction, which obviates the dangers of leaky seams in case cold feed is ad-

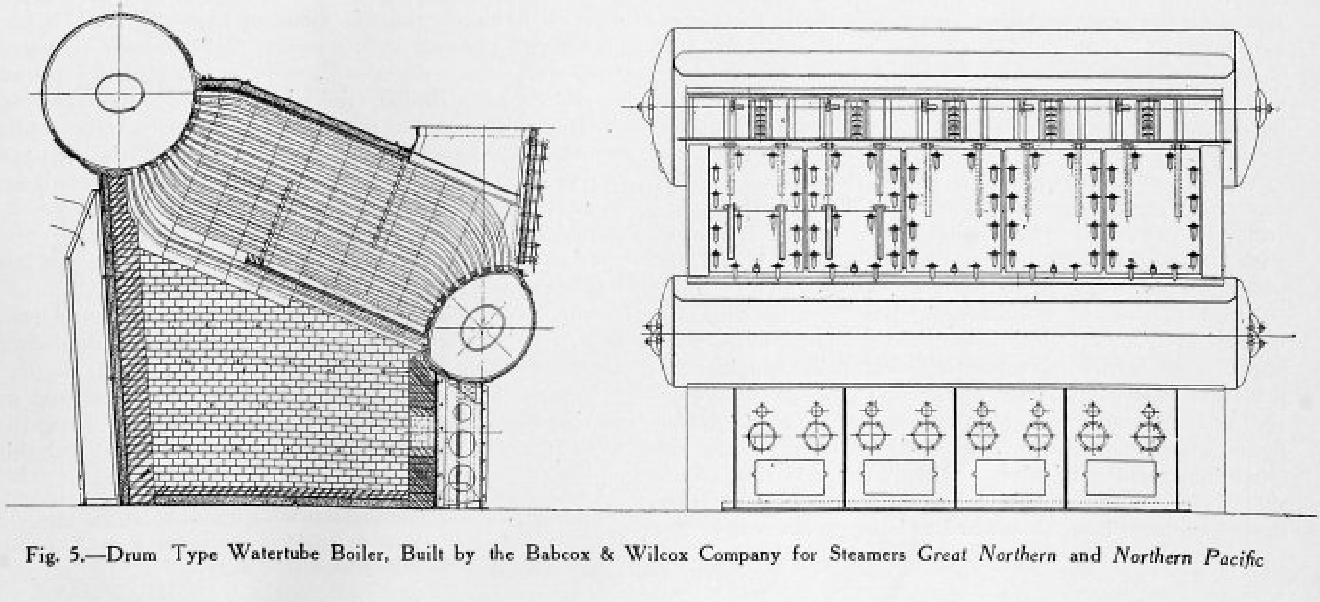


Fig. 5.—Drum Type Watertube Boiler, Built by the Babcox & Wilcox Company for Steamers *Great Northern* and *Northern Pacific*

mitted to the bottom drums as indicated in Fig. 6. The downtake tubes are designed to facilitate the minimum fluctuations in water level. The boiler is well adapted for the installation of superheaters.

The combustion chamber space can be made as large as desired, and usually for oil-burning boilers is about 0.09 to 0.12 cubic foot per square foot of heating surface.

Fig. 6 shows the Thornycroft latest design of boiler. When superheaters are installed they are arranged between the boiler casing and the generator tubes, as shown in Fig. 6.

Messrs. Thornycroft & Co., Ltd., have supplied their system of oil fuel apparatus for numerous naval and mercantile vessels throughout Europe and America. Such installations, which have been made or are now being made, amount to over 2,000,000 horsepower.

Sir John I. Thornycroft is a particularly noted contributor to the original investigations and developments which are resulting in the modern efficiency watertube boiler.

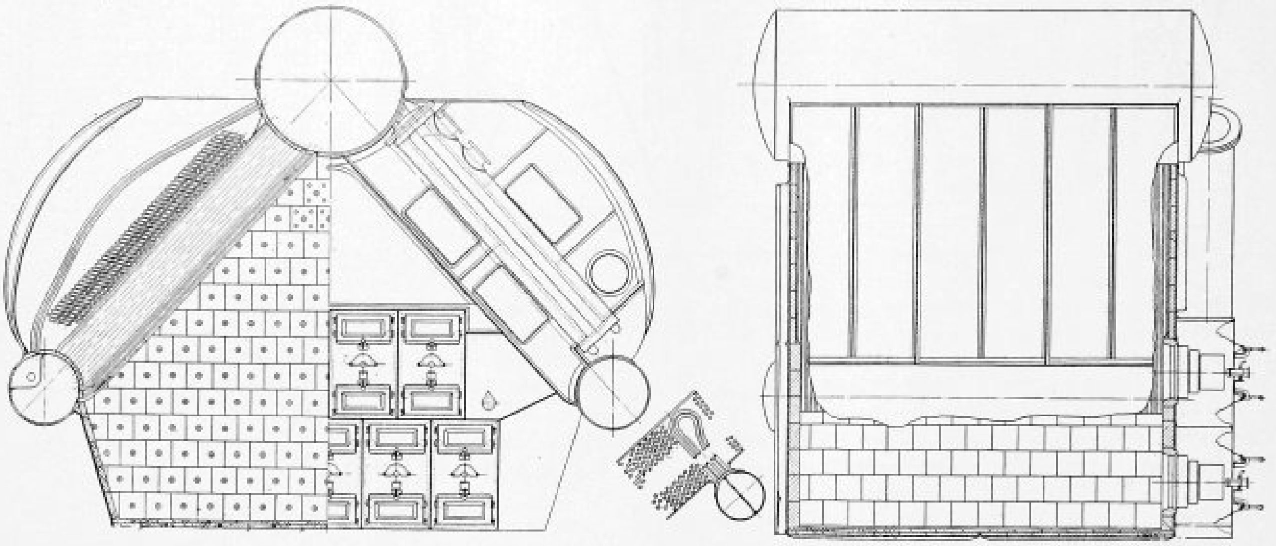


Fig. 6.—Thornycroft Watertube Boiler, Fitted with Feed Heater and Superheater

Yarrow Boilers

The Yarrow boiler has been largely adopted by the British and by other admiralties for destroyers, intermediate vessels and the largest types of battleships and battle cruisers. This was one of the boilers selected by the British admiralty after an exhaustive report by its committee in 1902.

These boilers are sometimes fitted of the double-end type and arranged for oil burning in conjunction with coal burning, which provides a large overload factor quickly available.

The general construction of the Yarrow boiler is well known. Fig. 7 represents the boiler fitted with superheaters, and shows the boiler as now usually fitted with angle-iron baffles and longitudinal feed division plates, as recommended by Messrs. Yarrow.

The high class of work done by the Yarrow Company, both in design and construction, and the large number of experiments which have been conducted in studying the principles of correct boiler construction, theory of operation and efficient working, have placed the Yarrow boiler in an enviable position as regards efficiency, endurance and other important particulars. One of the cuts shows outside down-comers, but Mr. Harold Yarrow states that these have now been abandoned as being unnecessary.

Messrs. Yarrow state that the forty-two boilers built for the Chilean battleships *Almirante Latorre* and *Almirante Cochrane* are the last battleship boilers which they have constructed without superheaters.

These boilers are arranged with the Yarrow special feed-heating device which is now being fitted in all of the boilers built by Messrs. Yarrow for destroyers, battleships, cruisers and other war vessels. In these boilers* the cold feed enters the lower drums and passes up the outside rows of tubes in each water pocket. In the case of the Chilean battleships the four outside rows of tubes were used for the feed to ascend. A longitudinal division plate is fitted in the steam drum to deflect this feed as it enters the drum and prevent it from short circuiting back to the water pockets, as it has been found that such short circuiting has a tendency to cause excessive stresses in the water pockets and seams. The boiler is fitted with angle-iron baffles, as indicated in Fig. 7. These consist of ordinary angle irons laid in the spaces between certain of the outside rows of tubes in order to more uniformly distribute the gases and it has been found that these considerably increase the efficiency of the boiler.

Two trials, each of twelve hours' duration, were run on one of the Chilean boilers when burning fuel oil only. One trial was made with the feed entering both water pockets and ascending the outside tubes, on which trial, with oil having a calorific value of 19,000 B. T. U.'s per pound and running at low power, 16.81 pounds of water from and at 212 degrees F. were evaporated per pound of oil; during a similar trial with the feed water entering the steam drum the corresponding evaporation fell to 15.83 pounds. The uptake temperature in the first trial was 312 degrees F., and in the latter trial this temperature rose to 423 degrees F. These trials indicate the advantage obtained by this system of feeding.† An interesting discussion of the heat analysis in connection with these trials has been contributed by Mr. Donald W. Rennie.‡

The Yarrow boiler has been most extensively adopted in a large number of navies, the total installations since 1905 amounting to well over 4,000,000 horsepower.

Messrs. Yarrow feel that the future development of marine boilers for naval vessels will be largely along the lines of increasing the rapidity of circulation and that this

* "The Yarrow Boiler." *Engineering*, Vol. XCV, page 681, 1913.

† Harold E. Yarrow, Institution of Naval Architects, March, 1912.

‡ "The Heat Analysis of an Oil-Fired Watertube Boiler." Donald W. Rennie, *The Engineer*, Vol. XCVII, 1914.

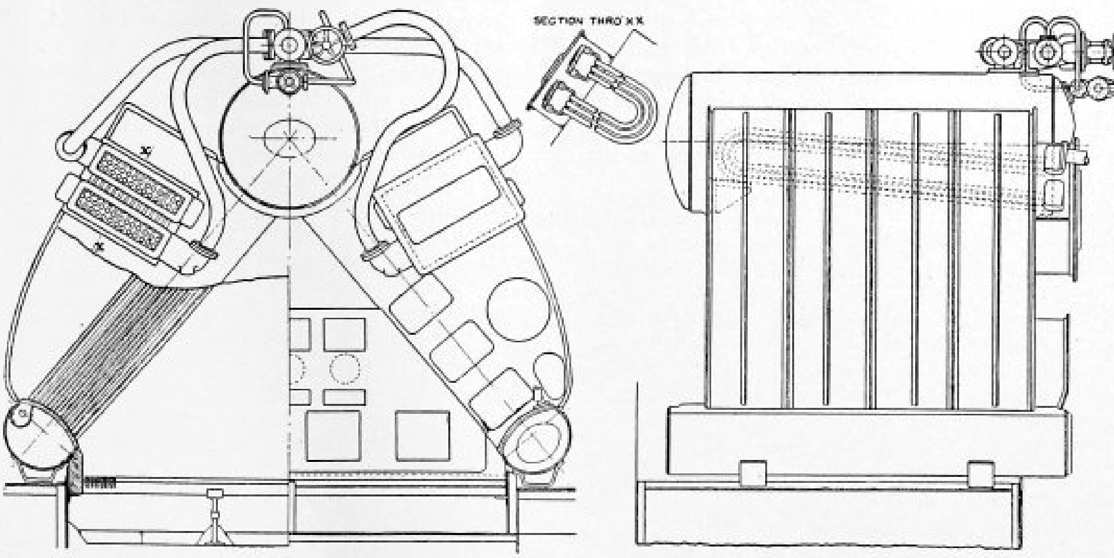


Fig. 7.—Yarrow Watertube Boiler with Superheater, for H. M. S. *Yarmouth*

will require tubes placed at a considerable angle to the horizontal. Liberal combustion space for the burning of oil fuel will also be required, since all boilers of this class should be capable of being forced to the highest extent without detriment whenever emergency conditions require.

Attention is called to the very high rates of combustion which may be obtained in the Yarrow boiler.

The Yarrow boiler is to be noted for the following points, emphasized by Messrs. Yarrow & Co.:

1. The simplicity of design embodying straight tubes, excepting those adjacent to the furnace, which are slightly bent for taking up expansion. This facilitates inspection and cleaning of both fire side and water side of the tubes.

2. The rapid circulation due to the inclination of the tubes and regardless of the rolling of the ship in a seaway, which is especially important with high rates of evaporation now required in war ships. As is well known, intense circulation increases the efficiency of the boiler, and, in addition, it tends to clear the tubes of dirt or sediment, and therefore facilitates operation with less frequent cleaning.

3. Accessibility, freedom from numerous joints, together with the embodiment of the best designs, materials and workmanship, reduce the time required for repairs to a minimum. These qualities of the boiler also facilitate rapidity of raising steam, which has been especially emphasized during the last few months.

Babcock & Wilcox Marine Boiler

This boiler has been installed in both small and large powers in a great number and variety of vessels. It is one of the boilers selected by the British Admiralty after the report by its boiler committee in 1902. The company has large shops in the United States and Scotland equipped with the best special machines and tools, and they also have works in France and Germany.

The dry weight of the boiler when built for 250 to 295 pounds working pressure is about 20 pounds per square

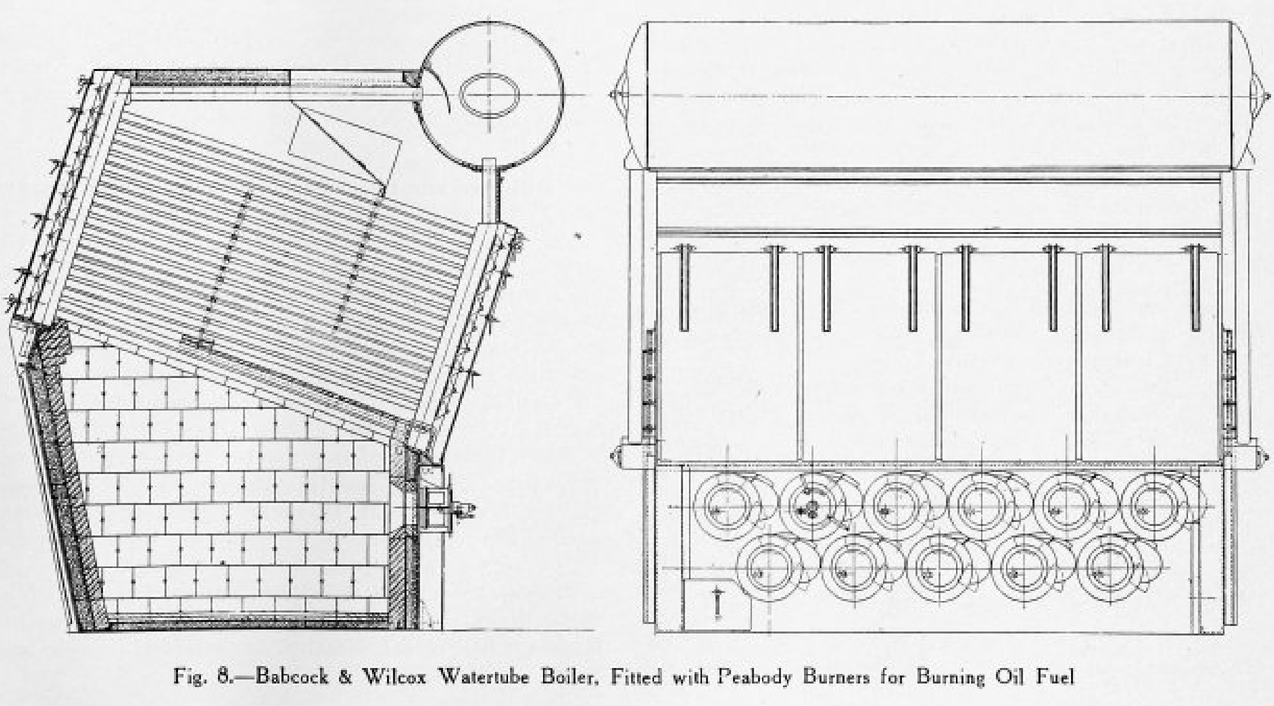


Fig. 8.—Babcock & Wilcox Watertube Boiler, Fitted with Peabody Burners for Burning Oil Fuel

foot of heating surface, as compared with 40 to 50 pounds per square foot for Scotch boilers for 180 pounds pressure. The water in such Scotch boilers varies from 17 to 20 pounds per square foot of heating surface. In large Babcock & Wilcox boilers arranged for oil firing and fitted with 2-inch tubes, No. 10 B.W.G. in thickness, the dry weight is below 16 pounds per square foot of heating surface.

The water in the boiler amounts to 3 to 5 pounds per square foot of heating surface.

The American coal-burning boiler is constructed with the tubes placed at 15 degrees inclination to the horizontal and with forged steel side water pockets below the tubes, which form excellent furnace sides for coal firing and efficient heating surface. In the English type of this boiler for coal burning the grates of adjacent boilers sometimes extend to a common division wall between the boilers, with cleaning space provided at the side doors above this division wall; this permits a considerable increase in the grate area, which is an advantage for long, high-powered runs where cleaning fires is an important condition.

The American type of boiler, built for oil fuel, is also fitted with side brickwork and without side water boxes below the tubes. The lower rows of tubes immediately above the furnace for oil burning are usually inclined 18 degrees from the horizontal, while the tubes above these are inclined 15 degrees. This is shown in Fig 8.

The fire side of the boiler can be cleaned efficiently while under steam, as the cleaning doors are arranged on the side. The tubes, being straight and accessible from either end, are easily inspected and renewed. The Southern Pacific Company find that in their steamer *Creole* they can blow down a boiler, renew a tube and again get up steam in about two hours.

Admiral Melville's requirement that no cast metal subjected to pressure should be employed in a watertube boiler has been fully met. The tools for working and forming the pressure parts of these boilers are such as to preserve the best qualities of the materials used, so that a high factor of safety is maintained.

Repeated authentic tests show that steam can be raised from water of 100 degrees F. to a pressure of 200 pounds per square inch within fifteen minutes without injuring the boiler.

The efficiency of the boiler with oil fuel rises as high as 80 percent under test conditions; with coal fuel the corresponding efficiency is about 75 percent. These efficiencies, of course, are with low rates of combustion, but the efficiency is well maintained with high rates of firing, as will be noted by reference to the tests of the *Arkansas* and *Wyoming* boilers with coal and oil fuel.* The boiler has been tested to extremely high rates of combustion, corresponding to 70 pounds of coal per square foot of grate surface per hour, and such tests have been run without injury.

The space occupied by the Babcock & Wilcox boiler is small as compared with Scotch boilers and satisfactory as compared with other watertube boilers.

The parts of the boiler are made interchangeable, and although many are special, still the items subject to the greatest deterioration are of commercial sizes which can be readily procured.

The form of furnace is well adapted to complete combustion before the gases enter the tubes; the vertical baffles direct the gases three times at right angles across the tubes; and since the tubes are staggered, the gases are brought into intimate contact with the heating surface.

* "Test of Babcock & Wilcox Boilers for U. S. Battleships *Wyoming* and *Arkansas*," *Journal of A. S. N. E.*, Nov., 1910, Vol. XXII; May, 1911, Vol. XXIII.

The circulation in the boiler is rapid and efficient and at the same time the steam surface is liberal and the quality of the steam is remarkably dry. The feed enters a large drum and descends through the nipples and front headers, from which it passes into the tubes; mixed steam and water fill the back headers and pass through the return tubes entering the steam and water drum back of the baffle plate; the steam passes around the ends of the baffle into the steam space. Tests of the *Wyoming* boiler showed that when evaporating 14¾ pounds of water per square foot of heating surface, from and at 212 degrees F., the steam was 99.57 percent dry.

The boiler is of rugged construction and experience shows that it can be efficiently operated by the regular firemen found in service. The furnaces being all of one height is a great advantage and much favored by the firemen, as it is easier to work the fires in such furnaces than to work the high side fires of four-furnace Scotch boilers.

In regard to durability, it may be said that these boilers have been in operation in several steamships for periods of from eight to fourteen years with only minor expenses for repairs and are still in good condition. To cite an example, the steamship *Creole* had ten Babcock & Wilcox boilers installed in 1907 containing 28,500 square foot of heating surface, 4,350 square feet of superheating surface and 783 square feet of grate surface. The trip is usually made operating only seven of the boilers. The pressure part of the boilers, with the exception of a few superheater tubes, do not show any appreciable deterioration. This condition is attributed to the fact that the boiler water has been kept fresh.

Experience shows that these boilers can be kept clean as easily as Scotch boilers. Boiler cleaning in the *Creole* is all performed by the crew. The owners have sometimes employed outside labor to clean the internal parts of Scotch boilers in other vessels of their line.

The expense for upkeep of these boilers has been very much less than the corresponding expense of upkeep of Scotch boilers in sister vessels. The deterioration of the boilers in use is less than that of the boilers which are not in use. The casings are still in good condition and less expense has been entailed in maintaining these casings than has been expended in repairs to the ordinary galvanized iron covering over the lagging used on the Scotch boilers of sister vessels.

Much along the same line might be said for this boiler in naval vessels, but in such work the watertube boiler is a necessity and the grade of men to operate and care for them is higher than in merchant vessels.

One Hundred and Fifty-Ton Hydraulic Riveter Installed at the Lake Erie Boiler Works

The Lake Erie Boiler Works, Buffalo, N. Y., has installed in its plant at Perry and Chicago streets a 150-ton hydraulic riveter having a 12-foot 6-inch gap to operate under a working pressure of 2,000 pounds per square inch. The riveter has a solid cast steel frame weighing 40,000 pounds. It was built by R. D. Wood & Co., Philadelphia, and will be used in the construction of large marine boilers.

The company now has a number of boilers under construction for the Fore River Shipbuilding Corporation, Quincy, Mass. Mr. R. M. Fotheringham is general manager of the company.

PERSONAL.—Charles Beard, of Aurora, Ill., has accepted the position of foreman boiler maker of the International Railways of Central America, at Guatemala City, Guatemala, Central America.

A Flanging Job—Lost Time in the Shop

Forming a Curved Riveting Flange on Pipe—Where Time is Lost in Shop Operations—The Remedy

BY JAMES FRANCIS

"Henry, I want a riveting flange on the end of a 5-inch pipe flanged to fit an opening in the bottom of a 60-inch round tank, the pipe to lead off level and at right angles to the tank and so connected as to drain the tank completely. Can you make it up for me?"

"Expect I can, Mr. Francis, as soon as I get the idea of just what you want. If I get you right, you want a pipe *D*, flanged to the tank *C* as shown in the small sketch in Fig. 1?"

"Yes, Henry, that is the idea exactly. It will be about as shown by Fig. 1, with the point *A* at the bottom of the tank."

"Say, Mr. Francis, it would be better to cut out the flange from a piece of shell steel, then cut a piece of 5-inch pipe to the proper angle and join the two pieces by an oxy-acetylene weld; and there you are, with the job done almost as soon as it is commenced."

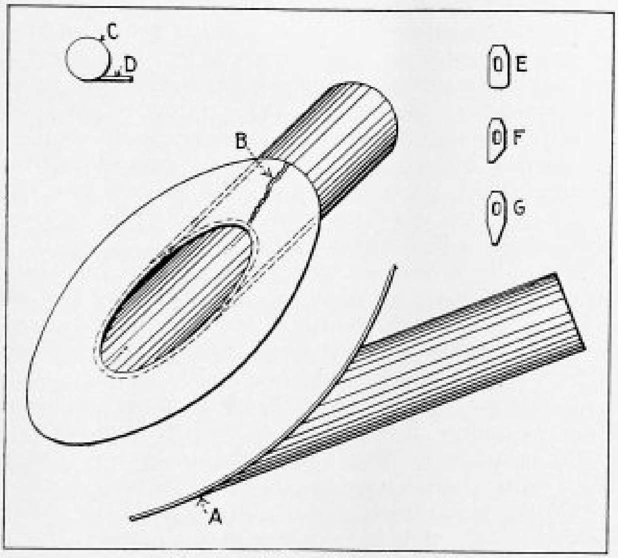


Fig. 1.—A Good Flanging Job

"Yes, Henry, you can do it that way and get a right good job, too, but I want this one made all in one piece. Just take a piece of 5-inch pipe and flange out one end as shown by the picture."

"That's a mighty bad thing to flange without some kind of form to welt it down to."

"Oh, I think you can do it all right, Henry, just as soon as you really look at it and not stand up there thinking you are scared of this little job."

"I am not scared of any job, Mr. Francis, but I like to see just how I am going to climb out before I jump in."

"That's a pretty good plan, Henry. Now, with this job, how would it do to take a welding heat on the pipe, push it over the horn of the anvil and let the helper whale it with a maul? You can keep raising up the far end of the pipe as he batters it down to the anvil horn. At *A*, and half-way 'round the flange, a common anvil with sharp sides and good top will do for working the flange up on: but for the other half of the flange, around *B*, there must be something sharp to reach in close to the pipe in a very acute angle directly at *B*. One way of doing the trick is to hunt up a form 60 inches in diameter and fit the flange up against it, using tools for driving the steel down to the form and working the half flange from *B* bottom side up, from which the half *A* was worked."

"But what kind of a tool can we find around the shop which will serve to drive the flange down flat at *B*? It will be nothing but a thin edge, and I don't know of any tool like that around here."

"Two or three heavy cold chisels are all the tools that you will need, Henry. You will have to forge and grind the chisels to fit the work. One can be almost flat on the business end, as shown by sketch *E*; another one should be made a little slimmer, as at *F*, while the third tool may be as shown by sketch *G*, almost as used for cutting. But it will be noted that all three of these tools have the working corner rounded off so it will not cut or mark the junction of flange and pipe."

"How are we going to do the work with these handled cold chisels?"

"Why, welt down the end of the pipe as detailed above, then turn the heel of the flange at *B* as well as you can by just hammering it back, until you get material enough flanged out to make as wide a flange as necessary. Then turn the flange over and drive it down upon the edge of the 60-inch form, using the tools for that purpose, as shown by sketches *E*, *F* and *G*."

"I don't see, Mr. Francis, how we are going to keep the shape of the flange, and it looks as though some parts would go over too wide while other parts would be too narrow."

"Never mind how wide they are, Henry. Just hammer out enough of the pipe to make the width of flange required—2 inches at the narrowest part—then trim off the parts which are too wide, and there you are."

"I've got you, Mr. Francis, and it works all right. Here is the flanged pipe, just like Fig. 1, but I had some trouble with the flange at the heel, for it split right open at *B*, in spite of all I could do."

"Never mind, Henry; that is where the weld in the pipe happens to come. It should have been turned around so as to come at *A*; then, there not being so much bending to the flange there, it would not have split. But I can put a little oxy-acetylene weld in the flange at *B* so that you never could tell that it has been split at all."

"That's good, Mr. Francis. I tried to get the pipe weld around to the toe of the flange at *A*, and I looked the pipe over half-a-dozen times; but to save me I could not tell where the old weld was, so it happened to come at *B*."

"It's a right good job, nevertheless, Henry, and you needn't be ashamed of it."

"It did come out pretty well, Mr. Francis—better than I expected when we began work on it, and it didn't take long to do the job, either."

"What's the time on the job, Henry?"

"One hour and twenty minutes, Mr. Francis, for one smith and one helper."

"That's not bad, Henry. Wish you could do as well all through the shop."

"Why, Mr. Francis! What's the reason we don't? I thought things were running pretty smoothly all through the shop. What is it you refer to?"

"They run too smoothly, Henry—that's just where the trouble is. Your men work along so smoothly and easily that the shop is a model for smoothness; but it hurts the output a good deal, and it is time, right now, that you and I had a talk which will bring a decided change for the better."

"But, Mr. Francis, I don't understand what you are calling me for. Will you tell me plainly?"

"Henry, I surely will. You are a good foreman of a good shop, but you have got to make some changes, right away quick, which will make you a better foreman of a much better shop."

"I don't get you, Mr. Francis. What it is you refer to?"

Lost Time in the Shop

"It's lost time, Henry. I have been noticing things pretty closely the past few weeks and have spent a good deal of time noting how various men did their work. They are good workmen—none better to be had—but, Henry, they have gotten so deeply into a rut that I don't believe we can pry them out without prying some of them out of the shop."

"Just what is the trouble, Mr. Francis? I don't get it yet."

"Well, Henry, here it is, right straight from the shoulder. Your men waste too much time getting ready to do something and waiting for each other. We will come right down to copper tacks and, for example, take the gang which is running the big hydrostatic flanger. They have just been setting up that machine to bend a 3-inch, 90-degree flange on two ends of a lot of sheets 36 inches by 42 inches for tanks. They used the forms we made for a 42-inch locomotive boiler front, the middle portion only being used, the top and bottom portions going idle."

"Yes, we do that often. Just set up any old form which is the right width, when we have only the ends of a sheet to flange; but, Mr. Francis, what was there wrong about that?"

"Nothing, Henry; that was O. K., but I happened through the shop just as they started on that job and I timed them and kept coming around occasionally to see how they did the work. And, Henry, I twice saw two of those five men working at the same time. On each of the other times when I came around, one man would be working while the other four were all looking at him—the old game of 'you keep still, while I stir.' Henry, they took two solid hours of time for changing those forms—counting from the time they began to take out the old forms until the new ones were set, ready for flanging a sheet."

"But, Mr. Francis, it usually takes about two hours' time to change the forms for a new job. What is there wrong about that?"

"Only everything, Henry. Two hours changing forms! Just see what that means! Four men and a foreman, five men in all, two hours each—that's a whole solid day of ten hours gone, and not a thing to show for it. And, then, there is the time the machine is idle. There's a sheet-heating furnace idle, too, two hours for that. The time of those machines is worth more than a dollar an hour, so there is a loss of two dollars' profit, beside the direct time of the men and the profit from their labor."

"But what can be done, Mr. Francis? The old forms have to be taken out, the new ones put in, then they have to be lined up, the bolts tightened, the set-up tested to see that there is the same and proper clearance all around between the two forms. All that takes a little time and we have to do it with the men who run the machine. There is nothing for them to do while the machine is being set up, and no other men to set up the machine if these men were at some other work while the setting up was being done."

"That's all right and proper, Henry, and there isn't a word to be said against it. But what I do kick about is that these men take two or three times as long as is necessary to do anything and everything. Why, several times during the setting up of that machine I saw one man screwing up bolt nuts with a big wrench, and each and every man of the other four stood stock still and watched the man with the wrench.

"And, Henry, that's just where the trouble is. There is no 'team-work' among your men or among the other gangs around the shop. If you ever saw a gun-crew go through their drill, or a boat crew on board ship, then you saw, carried to perfection, what we want, in a crude, rough way, in the shop, among your gangs of men. You never saw the sailor-boys stop to watch each other when drill was on. They, each and every one, was doing his work and trying to do it better and quicker than he ever did before—that's what team work is."

"Mr. Francis, I can't make gun crews or boat crews out of my men, so what am I going to do about it?"

"That, Henry, is right up to you. If you can't make your men work to advantage, so as to set up the flanging machine in a reasonable time, then you will have to stand aside and let someone else try it! It has got to be done, Henry, all through the shop. There is too much standing and looking to suit the conditions imposed by bad times, as at present; so you get busy and work out schemes and plans for lessening the time of doing things in the shop."

"I suppose it can be done, Mr. Francis—almost anything is possible—but, I'll be hanged if I can see now any way of getting better results. I don't know where to commence, what to do or what to do first."

"Henry, if I were in your place I would do a little hard thinking first of anything, and after that I might see a way to obtain results. The first thing in making repairs—and that is just what you are going to do now—is to determine exactly what the trouble is. The next thing is to study out a remedy, and then you can get busy and apply the remedy, it is to be hoped, with good results."

"I'm willing to do everything I can, Mr. Francis; but, as I said before, I don't seem to get hold of the proposition."

"Take a week before you do anything, Henry. This condition in the shop has not developed all at once. It is a slow growth and it will take a little time to straighten things out. But you just start with the first man you see when you go out of this office. See just what he is doing, how he does it, and then see if you can't find some way by means of which he can do the same thing in half the time and not work as hard as he is working now. Take each gang in the shop, study them in this way; then take each man of a gang and see what can be done to shorten the time he is consuming in doing his regular work."

"Say, Mr. Francis, isn't this some of the 'efficiency' business which they are getting into machine shops where they time men with stop watches?"

"Just about the same, Henry. I don't propose that you use the stop-watch in timing any of your men, but—here, Henry! Just watch this man, right now! That chap with the 30-inch Stillson wrench, right there on the 60-inch shell. See! He is screwing up the half-inch bolts you have slipped in to hold the shell until you drive the rivets!"

"I see him—that big husky with the Mother Hubbard overalls. He is a good man, but a little bit slow sometimes."

"Slow? Well, I should say so! And just see how he works. One-half inch bolts, and he is screwing them home with a 30-inch Stillson! And he puts the wrench on the nut so slowly and pulls just a quarter of a turn, then takes his time to advance the wrench another quarter of a revolution."

"Yes, he is rather slow with that job. He ought to have a 12-inch, solid-end wrench for that work."

"Yes, Henry, and why hasn't he got it? You are the man who is supposed to see that the necessary tools are at hand and used. Why are you not on your job? Why are not the tools at hand, and why are they not being used just right? And, Henry, just look five feet to the right of that nut-screwing, time-murderer. Isn't that a man—yes, two men—on the job with him?"

"Yes, there are two men there; they are waiting for Big Ben to get those nuts screwed home so they can cut that shell around a bit to receive the next section."

"More 'watchful waiting'—eh, Henry? And why are not those men fitted with some wrenches and some more bolts, too, that they might help Big Ben, instead of standing on one foot and holding the other up, while Big Ben kills time for the whole gang? Why is time wasted in this manner, Henry? Why are not those men shown how to do team work? How to work together so that while one holds the sheets, another slips in the drift pins and the third man enters a bolt and screws home the nut. Then, the other men, the drifts being driven, get busy with other bolts and wrenches, and the sheet is bolted in less time than formerly was required to get the first drift pin into the seam. That is team-work, and that, Henry, is what you, or some other foreman, has got to put into this shop, and to operate it there, from now out!"

"I'm sure willing to do all I can, Mr. Francis; and, now you speak of it, I can see that those men could work to better advantage than they are doing now. But the whole matter seems mighty strange to me, and I will have to study over it a whole lot."

"Of course you will, Henry, and so would anybody else who tried to wake up the men in this shop, and to make them work together with some idea of efficiency in view; and Henry—the first time you go past the tapping machine, just study things there a little bit, and see what you can conjure up about increasing the capacity of that machine. There is a fine, three-spindle nut-tapping machine; and if you go there right now you will probably find the operator with three days' work piled up around the machine waiting to be done."

"Yes, that machine is rushed all the time. I wish you would put in a faster machine, for it takes a long time to fill an order with that tool."

"And is it any wonder? Look at the manner in which that machine is operated. There are three tapping spindles, and three speeds for the machine to be run at. The operator is tapping ½-inch nuts, is he not? Yes, that's what he is running now."

"And isn't the machine running on its slowest speed? Yes, it's easier for the operator, that way. He don't have to put on and take off as many nuts. And, Henry, is there more than one tap in operation? That man is sitting there letting the machine run at slowest speed on one tap only, instead of cutting three threads at once at as high a speed (about three times as fast as at present) as the machine will stand."

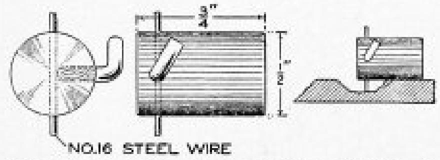
"Well, I swum! I didn't know I had a man in the shop who would do that. I'll fix him!"

"Hold on, Henry; no violence or sudden discharges. That man is in a rut; that's all that's the matter with him. And he is in the same rut that you and the shop are stuck in. You have got to get out, Henry—out of the rut or out of the shop—and I'd hate to see you do that, for I believe you can make good as soon as you get your eyes open a bit."

"I'll try to study out a scheme, Mr. Francis, and then I'll talk with you again. It may take dynamite to get 'em out of the rut, but I'll do it if I get blown out of the shop a-trying!"

Depth Gage to Measure Pits in Boiler Plates

In the inspection of boilers for conditions of sheets, the discovery of pitted portions is not uncommon. In reports of boiler conditions, the depths of such pits must be exactly recorded. In making many of these report sketches, one inspector makes use of a very handy pocket depth gage with which it is possible to ascertain quickly the depth of the sheet to which the metal has been corroded. The



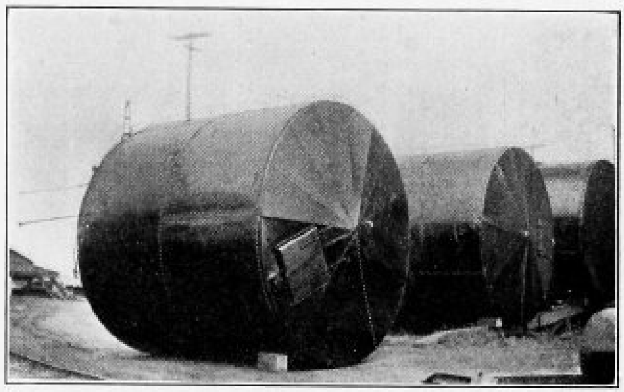
Depth Gage Made of Small Rod and Wire to Measure Pits in Boiler Plates

body of the gage is simply a piece of ½-inch round steel, about ¾ inch long. The thumb-screw and needle attachment are easily fitted in drilled holes. The illustration of the gage shows its application clearly.

Such measurements can be taken with a scale and a piece of wire, but wire is not always easy to find, and a scale cannot be used as a straightedge in many places. The gage is something easily carried in the pocket, and can be used in almost any place on a boiler where a sheet pit is liable to occur.—Contributed to *Popular Mechanics* by F. W. Bentley, Missouri Valley, Ia.

Tanks for Storage of Oil and Gasoline

Three large storage tanks were recently built at Decatur, Ill., for gasoline and oil. The gasoline storage tanks are riveted on hydraulic machines under a uniform pres-



Storage Tanks for Gasoline

sure. Afterward they are calked by air hammers, steel on steel, and made absolutely tight under pressure.

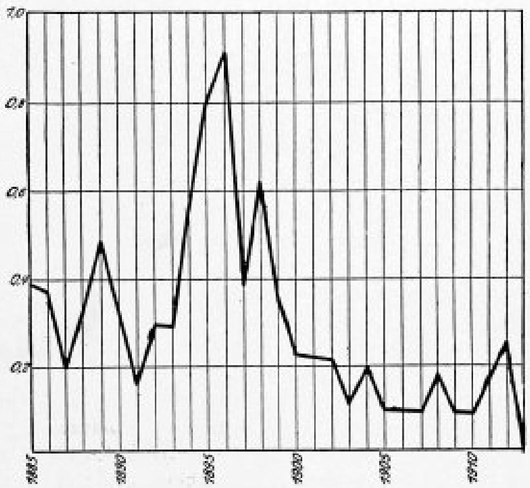
These riveted and welded tanks are built under the supervision of the National Board of Fire Underwriters. In the galvanized riveted tanks the lightest material used for gasoline storage is No. 10 in the shell and No. 7 in the heads. The tanks are galvanized by the hot process inside and out, after being made.

In the construction of galvanized welded tanks the lightest material used for gasoline storage is No. 16.

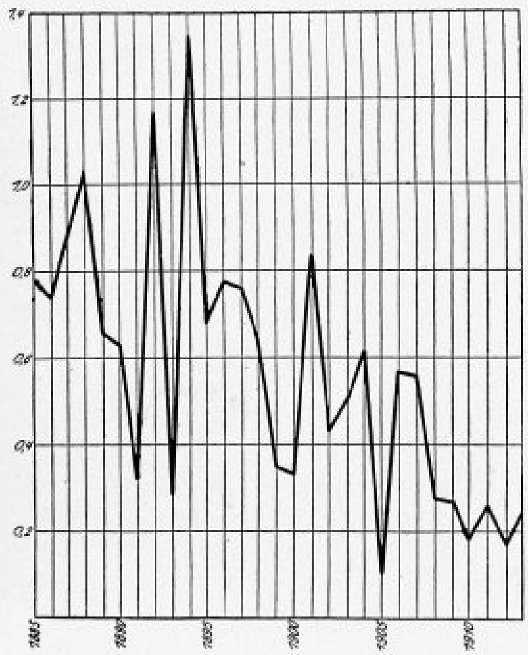
These welded tanks are built of basic, open-hearth steel and the joints are welded by the most improved process, insuring perfect gasoline tight tanks, and then are galvanized inside and out after being made. The tanks are finally protected on the outside by a coating of rustproof paint.

Increase in Safety of Boiler Operation in Prussia

In an article by B. Hilliger in a recent issue of the *Zeitschrift des Vereines Deutscher Ingenieure,* the author at-attempts to prove that the number of boiler accidents in



A



B

Fig. 1.—Explosions (per unit of 10,000 boilers) Caused by (A) Defects in Material and Workmanship, and (B) Defective Attendance

Prussia has decreased during the last few years. This article is reviewed in the September *Journal* of the American Society of Mechanical Engineers as follows:

The author divides all accidents into three groups—explosions, accidents which lead to the boiler being put out of operation, and various defects producing accidents. In the main, disturbances in operation are produced by one of the following four causes: *First,* defects in material and workmanship; *second,* piping, connections and auxiliary apparatus; *third,* attendance, and, *fourth,* operating conditions. He reports his data in the form of tables and curves, some of which are here reproduced. Fig. 1A shows the number of boiler explosions caused by imperfections in material and workmanship, referred, for purposes of comparisons in various years, to a unit of 10,000 boilers. The great jump in the number of boiler explosions between 1894 and 1897 is due to the fact that during that time a different definition of boiler explosion was used by the statistical office.

Under the class of explosions due to boiler piping, connections and auxiliary apparatus, are handled all accidents due to jammed or overloaded safety valves, clogged or incorrect manometers, or, finally, defective feed-water apparatus; also accidents due to the clogging of passages leading to the water gages and incorrect indication of water level by the gages. The curve shown indicates that the number of accidents reported as due to this cause is comparatively small and varies widely in different years, which, under these conditions, may be due to accidental causes.

The number of accidents due to lack of proper attendance appears to be comparatively large. Explosions in these cases are very often due to lack of water in the boiler, which can be traced to the carelessness of the fireman. Fig. 1B indicates the gradual falling off in the number of explosions. (The reasons for an unusual increase of explosions as shown by the curve for the periods 1894 to 1897 has been explained above.) In this connection, the author points out a curious phenomenon—namely, that statistics indicate that the number of accidents due to careless attendance on boilers has increased in the last few years, while the number of *explosions* due to this cause has decreased. Since the majority of accidents due to this cause are produced by low water level, it would appear that the boilers are being so built that they can better withstand trouble of this nature. Table 1 offers an opportunity of judging the tendencies in explosions and accidents in boiler plants by giving a comparison between what took place from 1885 and 1889, on one hand, and from 1909 to 1913 on the other. The same data are represented by curves in the original article.

TABLE 1.—COMPARATIVE DATA SHOWING THE VARIATION IN THE NUMBER OF BOILER ACCIDENTS IN THE LAST 18 YEARS

CAUSES.	Explosions to each 10,000 boilers in the period:		Accidents to each 10,000 boilers in the period:	
	1885-9	1909-13	1885-9	1909-13
Defects in material and workmanship	0.352	0.120	4.48	1.78
Defects in piping connections and auxiliary apparatus	0.246	0.069	2.04	1.84
Defective attendance	0.815	0.225	5.83	6.82
Defective operation	0.351	0.135	5.26	3,90

Why is it that we all like to use an S-shaped wrench instead of a straight one?

"Horse play" around a shop where there is moving machinery should relieve the boss from all responsibility. That it does not is one of the flaws in the labor compensation laws.

Get over the idea, Mr. Master Boiler Maker, that you can make better punch dies and other tools than you can buy. The man who tells you that is either fooling you or himself.

How to Read Working Drawings—II

Definitions of Geometrical Terms—Angles and the Protractor—The Circle, Ellipse, Helix and Spiral Curve

BY FRED WEST

While the English alphabet is a short and simple thing of 26 letters, yet we all know from experience that it cost us a wonderful effort to learn it. Many of us felt that the task would never have been completed had not old Mother Goose come to our assistance. She it was who showed us how to put life into those queer and meaningless characters or letters by saying: "'*A*' is for apple pie; '*B*' bit it; '*C*' cut it; '*D*' danced for it; '*E*' earned it; '*F*' fought for it; and '*G*' got it; '*Z*' stands for zither."

After we had learned the alphabet so that we could give the correct name of each of the 26 letters at sight,

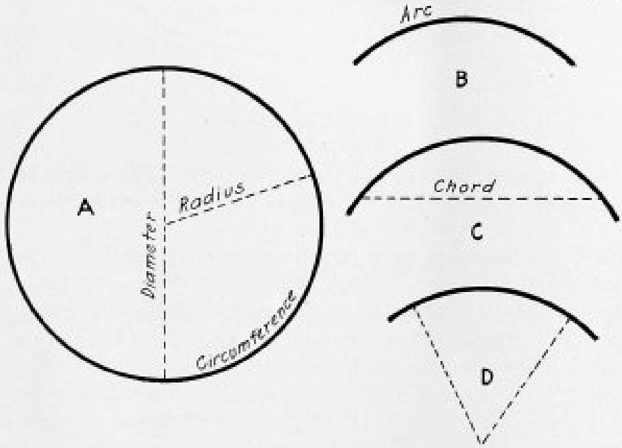


Fig. 3.—The Circle and Its Parts

either day or night, and we could "say the alphabet backwards" our heads felt like bursting from the internal stress of so great a load of information. Surely, we felt then that we knew as much at least as we did not know!

Did we not have the key to all knowledge? With the 26 letters in our possession we could learn every thing that was to be known. We have found that the English alphabet has been a source of pleasure and profit to us ever since learning it. We have also found out that to be of any advantage to us we must keep up a constant study of various sources of knowledge. So also is it with the mechanic who learns the alphabet of working drawings. He must begin to get information on a lot of practical things; otherwise he can not make use of this alphabet for pleasure and profit.

The "*A*" of the alphabet of working drawings was given in the first paper as the kinds of lines used. These were illustrated as solid lines made either light or heavy, broken lines made up of short and medium-length dashes, and broken lines, combining extra-long dashes with very short ones.

The illustration gave examples of these lines all as straight lines. One important point for the reader to learn now is that working drawings are made up of curved lines very largely, and that most of these curves are parts of circles. The names of the different terms used in connection with circles are given in connection with Fig. 3.

Circles

The complete circle is shown at *A*, and its curved line is called the *circumference*. Any straight line drawn across the circle and through the middle point, or *center*, is known as the *diameter*. Half the diameter, or a straight line from the center to the circumference, is the *radius;* the plural of radius is *radii*. The radius is the length to which the dividers or compasses would be set to draw the circumference.

The fact should be memorized that the length of the circumference of any circle is equal to the length of its diameter multiplied by 3.1416. Thus, suppose that the diameter of a boiler is 4 feet; what is its circumference, or girth?

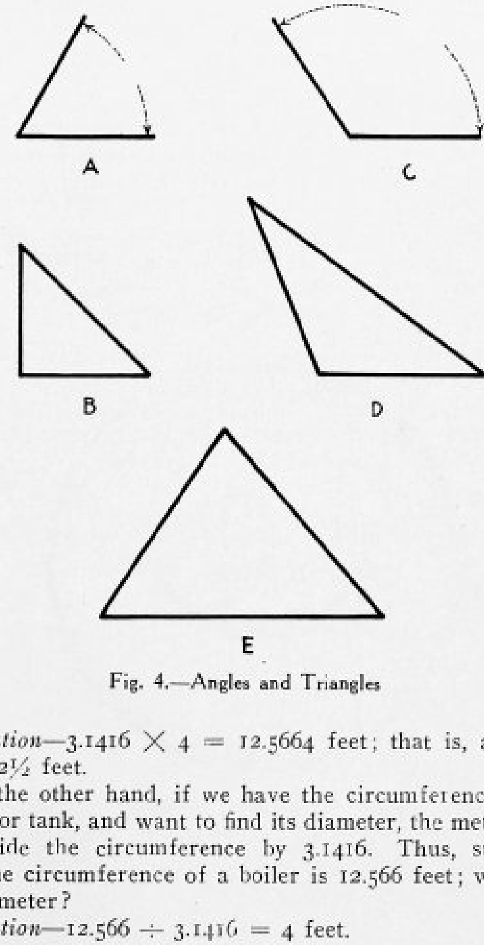


Fig. 4.—Angles and Triangles

Solution—$3.1416 \times 4 = 12.5664$ feet; that is, a little over $12\frac{1}{2}$ feet.

On the other hand, if we have the circumference of a boiler or tank, and want to find its diameter, the method is to divide the circumference by 3.1416. Thus, suppose that the circumference of a boiler is 12.566 feet; what is its diameter?

Solution—$12.566 \div 3.1416 = 4$ feet.

Any part of a circumference is called an *arc*, as shown at *B* in Fig. 3. A line drawn to the extremities or ends of an arc, as at *C*, is called a *chord*. The surface included between the arc and its chord is a *segment*, and that formed by an arc and two radii, as at *D*, is a *sector* Both of these terms are used in connection with drawings of boiler heads.

Angles

Another feature of working drawings relating to circular work is the subject of *angles*. To understand such drawings the reader must know what circular measurements are, and be familiar with the unit used in making them.

An angle is the opening between two lines that meet or intersect, as at *A* in Fig. 4. The size of the angle is stated in *degrees, minutes* and *seconds.*

If one line is square with the other, as at *B*, on the common measuring instrument, called a *square,* then the angle is 90 degrees. This is usually written 90°; that is, a small circle is written over the number to indicate degrees. A complete circle, as *A* in Fig. 3, has four angles

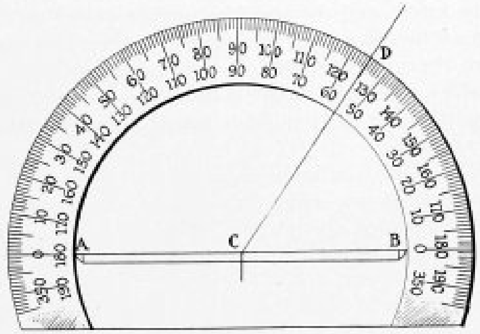


Fig. 5.—The Protractor

of 90 degrees each, making 360 degrees in all. A half of a circle contains 180 degrees, and an eighth of it has 45 degrees. If we divide a circle into six equal parts, as is done when making the common bolt head or nut, each side will include 60 degrees.

The half of 45 degrees is 22½ degrees, or 22° and 30′, as generally written. The mark over the 30 is read *minutes.* There are 60 minutes in a degree, and hence ½° equals 30′. As there are 60 seconds in a minute of angu-

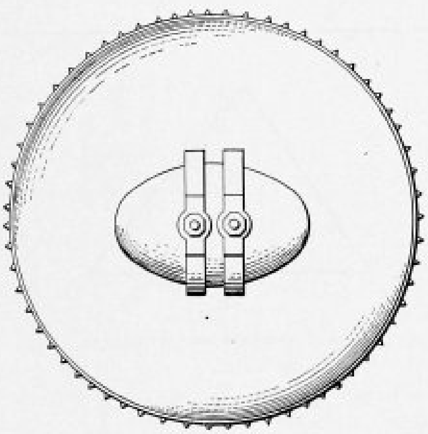


Fig. 6.—Elliptical Manhole

lar measure, a half minute is written 30″, which is read 30 seconds.

The angle of 22½° is that used for dividing a circle into 16 equal parts or arcs.

THE PROTRACTOR

The instrument used for measuring angles is called a *protractor.* One form of protractor is shown in Fig. 5. It consists of a half ring graduated on the edge into 180 equal spaces, or degrees. Sometimes it is possible to mark half degrees, but the protractor must be quite large for this.

To use the protractor, place its straight edge, *A B*, along one line of the angle with the center notch, *C*, at the point, or *vortex,* of the angle. Then where the other line, *C D*, of the angle crosses the graduated ring will indicate the size of the angle. In Fig. 5 the angle laid out is 55 degrees at the right of *C* and 125 degrees at the left.

Besides naming angles by stating their size in degrees, minutes and seconds, they are also given the names in working drawings as *right angles, obtuse angles* and *acute angles.* Thus, in Fig. 4, the angle *B* of 90 degrees is a right angle; the angle *C*, which is greater than 90 degrees, is obtuse; and the angle *A*, less than 90 degrees, is an acute angle.

In Fig. 4 is also shown the three-sided figures *B*, *D* and

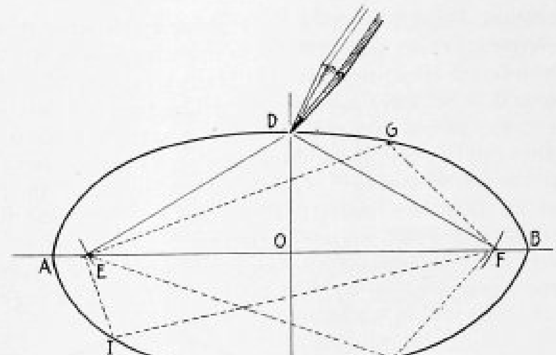


Fig. 7.—The Ellipse

E so frequently used in working drawings. These figures are known as *triangles,* and they may have a great many forms, as will be explained later.

A frequent use is made of other curves than the circle on working drawings. Thus, there is the *ellipse,* the *helix* and the *spiral.* Hence the reader should also know something of these curves.

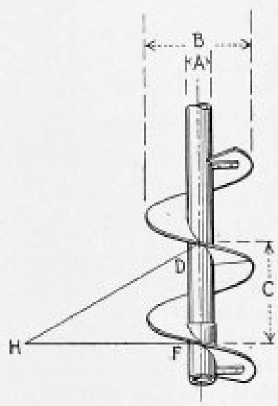


Fig. 8.—The Helix

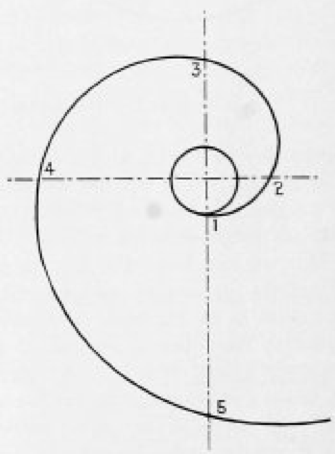


Fig. 9.—The Spiral

THE ELLIPSE

The ellipse may be considered as a circle flattened on two sides. It is the curve frequently used to form the openings for manholes, smokestacks, and the like. (See Fig. 6.)

The ellipse will be best understood when one knows how it is made or drawn. There are several methods, but that in Fig. 7 will serve the reader of drawings. First draw two lines at right angles to each other, as *AB* and *OD*, and make these of the lengths required for the manhole. Then set the dividers to half of *AB*, as *AO* or *BO*, and, with one point placed at the end *C* of the short diameter, mark off arcs *E* and *F* on the long diameter *AB*. Locate pins at the points *E* and *F* and fasten to them a thread of such a length that when a pencil point is held at *D* on the end of the short diameter, the thread will just reach from *E* to *D* and from *D* to *F*. Now pass the pencil along when held tightly against the thread, and the ellipse will be drawn. The dotted lines to *G, H, I,* etc., show various positions of the thread and pencil point.

There are other ways used by the draftsman to make ellipses, but the one described is sufficient for the reader of working drawings to use.

THE HELIX

The helix is the curve so commonly used on drawings of screw threads, conveyors for feeding coal into boiler furnaces, twisted metal strips placed in fire tubes, and many other constructions used in connection with boiler making.

A helix is shown in Fig. 8. The terms used in reading helical curves are as follows: *Inside diameter* (*A*), meaning the size of the cylinder around which the helix is wound; the *outside diameter* (*B*), which is the distance across the helix, or the size of the tube that would enclose it; the *lead* (*C*) of the helix, which is the distance the curve advances along the cylinder for one turn; then there is the *angle* (*D*) of the helix. This angle is the one formed by the lines representing the lead of the helix and its slope, and which is laid out as follows:

At right angles to the center line make a line *FH* equal in length to the circumference of the cylinder. As previously explained above, this length is that of a circle and is equal to 3.1416 times the diameter of the cylinder. Then from the upper end *D* of the lead draw the sloping line *DH*, and thus form the angle *D* of the helix. A sheet of paper cut like *DFH* and wrapped around the cylinder will form by *HD* the helix line.

THE SPIRAL CURVE

The spiral curve is one made after the manner shown in Fig. 9. The helix is sometimes called a spiral, but improperly so. The spiral is the curve formed by flat coiled springs, and it is also similar to the curve along the edge of a leather belt when rolled up.

As seen in the figure, a circle is drawn and divided into any convenient number of equal arcs. Through each division a radius is drawn and extended. Then on each radius a certain distance is laid off, beginning with No. 1. Usually the increase of distances corresponds with the increase of the angles. Thus, radius No. 2 is twice the length of No. 1; radius No. 3 is three times No. 1, etc.

WORKING DRAWING OF RIVETING HAMMER

The working drawing of a riveting hammer is shown in Fig. 10, which illustrates the use of circles, ellipses and the helix. This drawing is called a *longitudinal section* because it is taken lengthwise through the center of the tool. The various straight lines that are at an angle to each other are joined by one or more circular arcs. Such examples are seen at *A, B, C,* etc. Half an ellipse *D* forms the curve of the grip. The spring *E* has the form of a helix. This spring holds the air valve *F* closed, except when pressed down by the lever *G* while the riveter is operating.

The cross section lines show the different metals and parts making up the riveter, and it is assumed that the reader has enough knowledge of shop tools to know that all the parts are round when but one view is shown.

The air pressure causes the steel piston *H* to move rapidly back and forth in the cylinder *I*, and to strike the rivet set *J* with considerable force. The rivet set is held in its socket by a clasp spring *K*, and the steel valve *L*, with its seat *M*, automatically regulates the flow of the air into and out of the cylinder.

The riveter consists of two large main parts—the handle and the barrel screwed together. The small parts are fitted in various ways, as shown. The air hose is attached at *N*. The end of the rivet set at *O* is held firmly against the hot rivet when operating. The handle is drop forged from nickel or chrome-nickel steel, and the reader should know something not only of drop forgings, but of steel castings, malleable castings, and the other structural metals used in boiler outfittings. The description of these metals will be given in later articles.

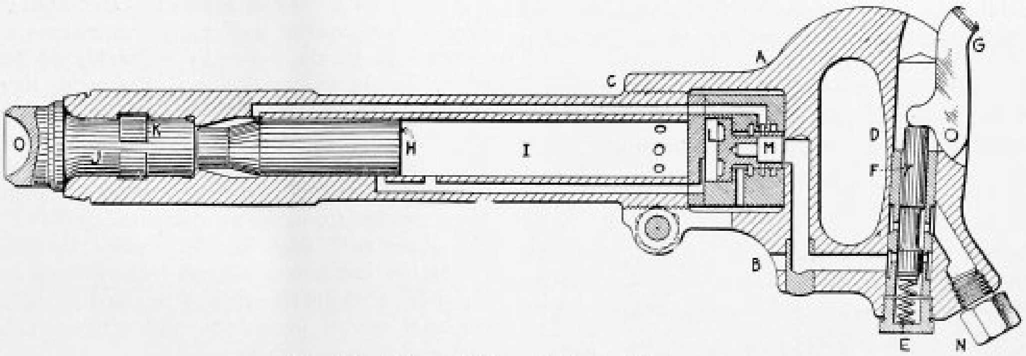


Fig. 10.—Sectional View of Riveting Hammer

Welding Short Boiler Tubes Saves Heavy Contract Penalty

It is in emergency cases, where money and time factors are at stake, that the oxy-acetylene blowpipe demonstrates its value as a utility tool. A case of this sort is described in a recent issue of the *Acetylene Journal,* and is pictured in the accompanying view, showing operators at work welding twelve hundred 2¼-inch boiler tubes, which, through an error, had been cut 2 feet too short.

Welding of Extra 2-Foot Lengths on 1,200 2¼-Inch Boiler Tubes Cut Too Short at the Mill, Thus Saving Large Contract Penalty and Considerable Time

This work was done at the plant of the Casey-Hedges Company, Chattanooga, Tenn., for the T. C. I. & R. R. Company, and was a rush contract job let on a heavy bonus and penalty basis.

Following the discovery of the error it was found impossible to obtain sufficient tubing of the proper length to fill the contract under three weeks' time. The boiler tubes were intended to be used in the construction of condensers for a benzol plant, and without being installed in reasonable time meant a large loss to the contractors.

The T. C. I. & R. R. Company is an extensive user of the oxy-acetylene process, and by putting three oxy-acetylene operators at work was able to deliver the welded tubes in plenty of time under the contract.

It was estimated that previous to the actual welding the cost would average about twenty cents per tube, excluding traveling and other expenses necessitated by the limited time in which to do the work. The final figures showed that the total expenses would come to about this amount. Following are the details of the welding work:

Oxygen, 1,200 feet, 1¾c	$21.00
Acetylene, 750 feet, 2c	15.00
Carbide, 150 pounds, 4c	6.00
Labor, 126 hours, and overtime	64.50
Labor, 60 hours, 32c	19.20
Filler, 100 pounds, 8c	8.00
Total	$133.70

It will be noted that compressed acetylene was used. This was necessary because a generator ordered did not arrive in Chattanooga until the work was partially completed, compressed gas being used in the interim. The above figures would signify that under ordinary conditions this sized boiler tube can be welded for ten cents each, or less.

The tubes were welded on cold mandrels turned down to 1/32 inch under size and hammered while hot, thus increasing the tensile strength, eliminating the possibility of leaks developing, and permitting slight reinforcement without increasing the size of pipe so as to interfere in passing through reamed holes in tube sheets. There was only 1/32-inch play, and every pipe had to pass entirely through the tube sheets, already built into the condensers.

It is stated that the cost of welding the tubes by the roller process would be about 30 cents each, showing a very substantial saving effected by oxy-acetylene. The welded tubes were later tested under high-pressure and showed no signs of weakness. The contractors were highly pleased with the work, through the large savings made and efficiency of the welded joints.

It is a poor time to oil a shears or a drill press after it has run hot or stuck. A little oil often is better than a deluge once a month.

We know weepy tubes and joints when a boiler test is made will generally take up, but most inspectors would rather have all tight first.

A big boiler works used to advertise, "We use no drifts in our shop." When it went out of business the auctioneer offered five tons of drifts for sale in one lot.

To-day quality, deliveries and prices are the argument that a good salesman uses in selling his goods. There are a few old-style drummers who still try to sell goods with cigars, whiskey and the power to call the boss by his first name.

Present Practice in Use of Oxy-Acetylene and Oxy-Hydrogen Flames for Welding and Cutting Metals

Preesnt practice in the use of the oxy-acetylene and oxy-hydrogen flame for welding and cutting formed the subject of a paper presented by H. R. Swartley, Jr., before the recent International Engineering Congress, under the title "High Temperature Flames in Metal Working." Mr. Swartley reviews the accomplishment of the process in the metal-working industries, in part as follows:

STRENGTH OF THE WELD

The strength of the joint produced by autogenous welding has been a fruitful source of discussion in the application of the process, and many contentions have been advanced as to the necessity of welds of highest tensile strength. It was early found that welds having a breaking strength equivalent to that of the metal itself could be produced, but the sacrifice of elongation and reduction of area materially lessened the apparent value of such welds.

Present practice is directed toward securing a weld of good tensile strength, as compared with the strength of the plate, with high ductility, since thereby the service conditions are better fulfilled. The growth in understanding of such requirements has resulted in the production of methods which, combined with proper apparatus, may uniformly produce these results.

DEVELOPMENT IN WELDING TORCHES

European practice covers the use of the low-pressure acetylene generator and injector type of blowpipe almost exclusively, the independent-pressure type of torch having shown little development, despite its well-known economy of operation. The introduction of the process, however, in this country was accompanied by the development of the medium-pressure, positive-mixture torch, utilizing both gases under independent pressure, assuring thereby stability and quality of the flame, heretofore not produced by the injector form of construction.

The trend of development in welding torches shows a progressive adoption by the rapidly increasing number of manufacturers in this country, of a construction which admits the gases under independent pressures. A review of exceptional performances, particularly of welding of heavy sections, covers a period coincident with the inception and exploitation of the medium-pressure form of torch with the accompanying successful acetylene generator producing that gas under pressure.

It is a prime requisite of operations carried out in the constantly multiplying instances of heavy metal section welding, that the work be carried on continuously, on account of possible failure due to shrinkage strains and similar causes. For operations of this character it will be noted that the medium-pressure positive-mixture form of blowpipe is almost invariably employed, due to its ability to withstand the high preheat temperatures to which it is subjected during the performance of the work and to the better combustion obtained.

Autogenously welded tube and pipe sections have formed important parts of foreign-constructed machinery. Welded sheet metal formations of exceedingly intricate character for many years puzzled the minds of American manufacturers, as to the method of production, until the application of autogenous welding provided a solution of the problem of duplication. It is interesting to note that there are now under construction in this country autogenously welded tubing, by mechanical operation, in quantities sufficient to compete with modern tube mills employing the lap-welding methods and with seamless drawn tubing.

The Boiler Maker

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5,800 *copies of this issue were printed.*

NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later that the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

During the five weeks beginning October 4 over 300 locomotives were ordered from American builders. The total number of locomotives ordered during the year up to the second week in November is estimated at 1,630, forty percent of which have been for export.

With the heavy buying of locomotives the demand for boiler tubes has also steadily increased and, together with the increased demand for merchant tubes, many of the tube manufacturers have sold their output for three or four months to come.

Similar reports come from the rivet manufacturers, and, in fact, the outlook for the entire supply field in the boiler-making industry has shown extraordinary improvement in the last few months, with every indication that the wave of prosperity will continue.

Up to the present time the A. S. M. E. Boiler Code has been adopted by the States of Ohio, Indiana, Pennsylvania, Wisconsin and California, and the cities of Detroit and Chicago. Although the code has been accepted by the authorities in these States, it has not yet been put in force in Pennsylvania, Wisconsin and California. The necessary action to make the code enforcible in these States, however, will be taken in the near future.

During the next year the legislatures of Georgia, Kentucky, Louisiana, Massachusetts, New York, Rhode Island, South Carolina, Virginia, and New Jersey, will meet, and the American Uniform Boiler-Law Society will concentrate its efforts in an endeavor to have these States adopt the A. S. M. E. Code. All boiler makers, manufacturers and engineers, who are in a position to influence legislation in the States mentioned, should co-operate with the representatives of the American Uniform Boiler-Law Society in conducting their campaign and getting the matter properly before the people.

Time lost in the shop is an item in manufacturing costs much larger than most of us realize. The insidious way in which this evil creeps into a shop organization is well illustrated in an article by Mr. Francis on another page in this issue. In this case the seat of the trouble was the fact that the workmen, while reliable and capable of doing an honest day's work, had unconsciously fallen so deeply into a rut that working hour after working hour was absolutely wasted and the output of the shop was far below its normal capacity and the cost of production far above what it should have been. How to overcome this waste is a subject which should receive careful consideration in every boiler shop.

Boiler makers who do not understand working drawings should read carefully the serial article on "How to Read Working Drawings," which began in our last issue. These articles were written expressly for the men who have not been taught the meaning of working drawings. They are intended to show what the various symbols and lines on a drawing mean, so that the work shown on the drawings can be carried out without further instructions. This information will be given in as clear and simple a manner as possible and, if any of our readers find statements in the articles which they do not thoroughly understand, we shall be glad to explain these points more fully.

Briefly, a working drawing is the medium by which the ideas and instructions of a draftsman, or designer, are transmitted to the mechanics and workmen in the shop, so that the individual parts of an object or article that is to be built, or manufactured, can be fashioned out of the raw material, finished and assembled in proper relation to each other. The working drawing tells what the object, or article, is; what it is to be made of; what the dimensions of every part are; what operations must be performed to finish each part, and, finally, how the various parts must be assembled to complete the object, or article. To be able to read a working drawing, therefore, is an absolute necessity for a competent mechanic, before he can be entrusted to carry out work on his own responsibility without the immediate supervision of a foreman or superintendent.

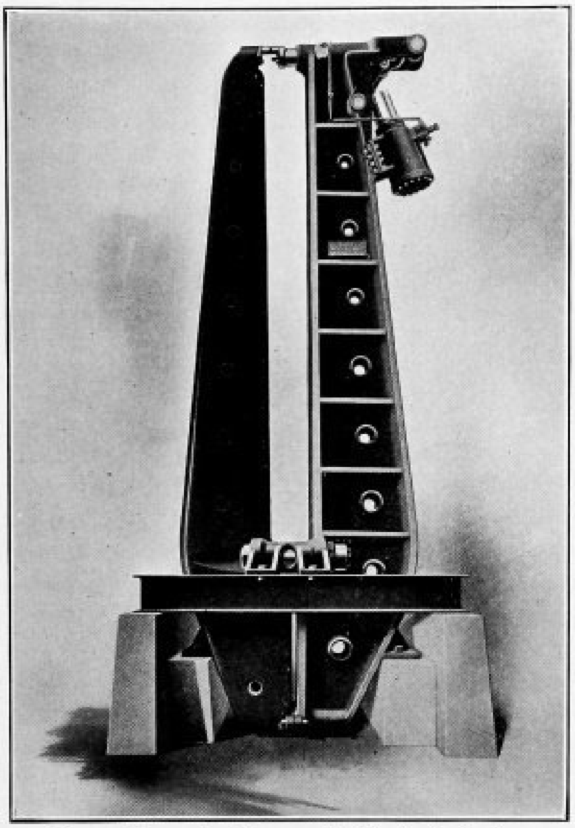
Engineering Specialties for Boiler Making

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

Large Pneumatic Riveter

Two of the largest pneumatic riveters ever constructed have just been built by the Hanna Engineering Works, Chicago, Ill. The machines have a reach of 21 feet and are capable of exerting a pressure of 100 tons on the rivet die at 100 pounds air pressure. Each machine weighs 40 tons.

In the Hanna type of riveter toggles, levers and guide links are combined to give the large opening of the toggle joint movement with its gradually increasing pressure until the desired pressure is reached, then a simple lever movement throughout a considerable space under approximately maximum pressure. This space is sufficient, so that there need be no uncertainty about the pressure applied on the rivet; and the machine once adjusted for a certain length of rivet and thickness of plate, will require no further adjustment for ordinary variations in length of rivets, size of holes, or thickness of plates.

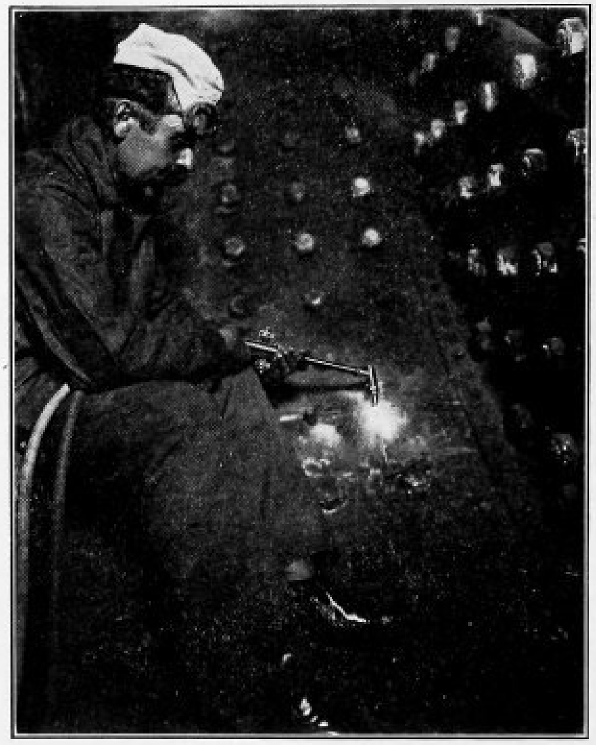


Hanna Pneumatic Riveter, with Reach of 21 Feet

The machines are furnished with cylinders having 22 inches of piston stroke with a relative travel of 5¾ inches of the rivet die. The toggle action takes place during the first half of piston travel, which represents approximately the first 4¾ inches of die travel. At this point the mechanism automatically changes into a simple lever action, without a critical point, thus producing the rated tonnage of the machine at the rivet die, practically uniform for the last 1 inch of die travel. By the use of a pressure regulating valve in the air supply line to the riveter, the pressure of air at the cylinder can be quickly changed to vary the pressure on the rivet dies to produce any tonnage the operator may deem advisable for any size of rivet he may wish to drive.

Savings Made by Oxy-Acetylene Cutting Torch

The wrapper sheets in three boilers on the steamship *H. M. Whitney*, of the Eastern Steamship Company, were cut out recently at Boston, Mass., by two men in six days of eight hours each by means of oxy-acetylene cutting torches. The superintendent of the company states that this work would ordinarily take nine boiler makers and helpers eighteen days if the job were done by hand. Nine men working eighteen days would make a total of 1,296 hours. On the other hand, two men working with a torch for six days at eight hours each equals ninety-six hours. Hence there is a total saving of 1,200 working hours on this job. Figuring the average wage of boiler maker and helper at 40 cents per hour, which is very low, there is a saving of $480 on this one job.



Cutting Out Wrapper Sheet in Boiler on Steamship *H. M. Whitney* with Imperial Oxy-Acetylene Torch

The oxy-acetylene cutting apparatus used in this case was supplied by the Imperial Brass Manufacturing Company, Chicago, Ill.

Something New in Steam Power Air Compressing

To provide a steam-driven air compressor which will operate satisfactorily with high pressures and superheat, as well as at more moderate pressures, there has been developed by the Ingersoll-Rand Company, New York, a

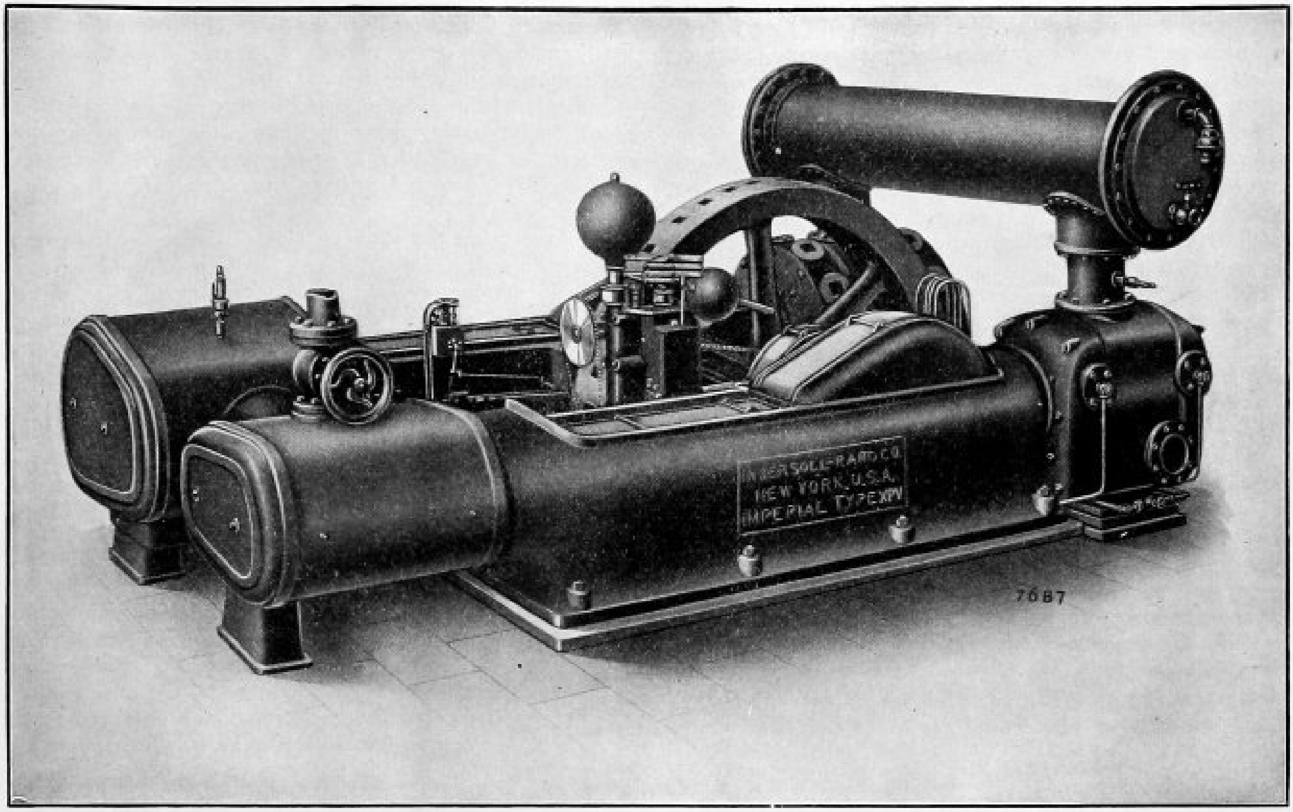


Fig. 1.—"Imperial" Duplex Air Compressor with Balanced Piston Steam Valve Gear

balanced piston steam valve gear. This has been incorporated in the design of the standard "Imperial" duplex air compressors.

The use of the balanced valve makes it possible to control the machine in the only really economical manner—by automatically varying the point of cut-off in the steam cylinders. This method of regulation maintains constant speed for changing steam pressures and at the same time varies the speed of operation to the demand for air. Steam is always admitted to the steam cylinder at full boiler pressure and without the wire drawing of a governor of the throttling type, which means, in short, that the machine automatically operates at its highest efficiency. It is pointed out that the higher the steam pressure the greater the relative increase in efficiency.

With the hand-adjusted cut-off valves, usually set at 5/8 or 3/4 stroke, the steam economy is admittedly poor, while with an automatic cut-off regulation the saving in actual steam consumption is the point most emphasized by the manufacturer.

This piston valve is a perfectly balanced valve of the telescopic type. The cut-off valves are right- and left-hand threaded to a cut-off valve stem. Steam admission is through the center of the valve, the steam then passing through the valve ports to the cylinder and then being exhausted by the ends of the valves. It is to be noted that this construction exposes the valve chest covers and steam packings to exhaust pressure only, proportionately reducing the liability of leakage. The design and even distribution of metal in the Imperial piston valve are claimed to preclude any possibility of warping and to result in a valve so balanced that friction is minimized and lubrication facilitated.

The steam ports are large and unusually direct, and special effort has been made by the manufacturer to reduce the condensation surfaces in the cylinders. Exceptionally complete insulation, the separation of live and exhaust steam passages, and the fact that the steam chest partially encircles the cylinder contribute to the steam economy. These points will be readily appreciated from the sectional illustration. The cylinder and receiver lagging is covered with a sheet iron casing, and that of the cylinder heads with neatly fitting case covers.

The unique steam receiver is a direct connection between high- and low-pressure steam chests. The low-pressure chest is proportioned to furnish additional ca-

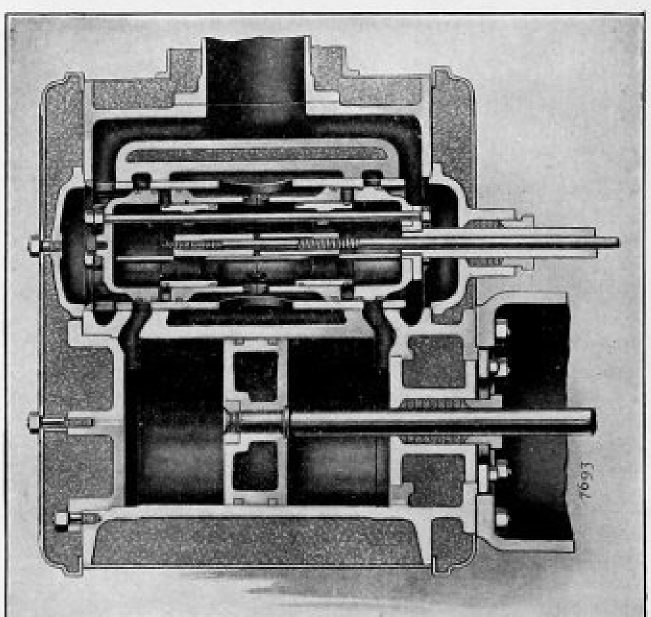


Fig. 2.—Section Through Cylinder and Valve

pacity and so located that the heat ordinarily lost by radiation is used in heating the cylinder and valve. A special expansion joint prevents any possibility of cylinder alinement being destroyed.

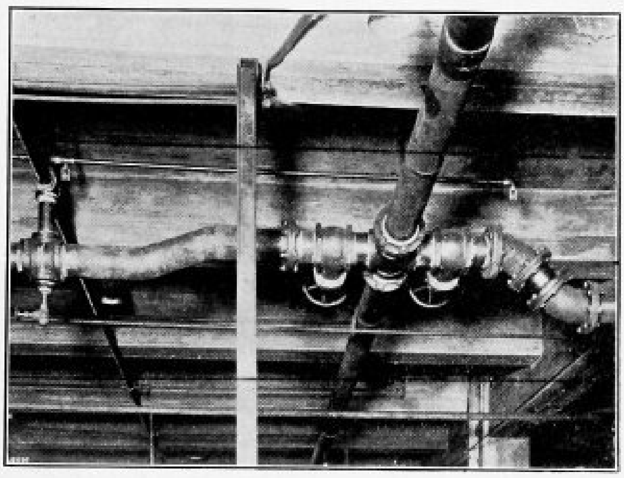
The governor is a speed and pressure regulator which varies the cut-off by automatically rotating the cut-off valve stem and changing the relative position of the cut-off valves. It is essentially a chain-driven, rotary oil pump, which acts against a weighted plunger. The variation in oil pressure, due to the changing speed of the compressor, or the varying air pressure through the movement of the plunger changes the cut-off point in the steam cylinders. This governor is claimed to be entirely automatic in operation and capable of maintaining exceptionally reliable, as well as close, regulation.

Lubrication of both air and steam cylinders and valves is provided for by force-feed oilers.

The other features of this new compressor, called by the maker "Imperial" type XPV, are those of the "Imperials" now in service; wholly enclosed main frames containing the reciprocating parts, automatic lubrication by the bath system and the standard Imperial completely water-jacketed air-compressing cylinders. This is built in capacities from 608 to 3,620 cubic feet per minute, and for discharge air pressures from 10 to 110 pounds per square inch.

A Novel Welded Pipe Connection

While most factories and metal-working shops are now fully aware of the usefulness of oxy-acetylene welding in ordinary repairs, it is a fact that a great deal of work which could be handled more economically and more efficiently by this process is oftentimes completely overlooked in favor of older and what are fast becoming obsolete methods. This was illustrated very forcibly by a recent sprinkler pipe installation handled in the Indianapolis plant of the Prest-O-Lite Company, Inc., one of the leading exponents of the oxy-acetylene welding process.



Pipe Offset Obtained by Welding and with Flanges

It became necessary to run branches from the 6-inch water main of the sprinkler system in this company's plant. On account of the fact that the main had been hung so close to the ceiling, offsets in the branches were required to clear the concrete girders and other piping already in place.

The usual procedure of employing ordinary screwed fittings was started until it was found that on one side a drop of 7½ inches was required, making the use of standard fittings with 6-inch pipe impossible. The connection was finally made by using regular 45-degree flanged elbows and nipples, giving the pipe a 12-inch drop.

The cost of the offset effected in this manner, including all of the necessary parts and labor for connecting the job, was $17.50. Had it been possible to make the offset with standard screwed fittings, the job would have cost $5.66.

The branch on the opposite side of the main, however, presented an altogether different problem. A downward offset of exactly 5¼ inches was necessary to clear pipes above and below the new line. Standard fittings, either flanged or screwed, could not be used and an estimate was obtained on the cost of bending the pipe for the required offset. It was found that this method would cost $18.60, including the bent pipe and labor for connecting. Furthermore, a considerable delay would have been occasioned waiting for the pipe to come from the mill.

The idea of employing oxy-acetylene welding was then suggested by one of the factory employes. A short section, cut at each end at the proper angle to give the offset desired, was welded into the line, at *a total cost of* $3.40, as compared with the cost of $17.50 for the flanged job and $18.60 estimate for the bent pipe.

The illustration shows the two methods of obtaining the offset, the one on the left by welding and the one on the right by using flanged fittings. It will be observed that the welded connection, in addition to its greater economy, also is very much neater in appearance and occupies comparatively little space. It is plain from the foregoing that the utmost possibilities of oxy-acetylene welding in plants, even where the process is familiarly known and extensively used, are not yet fully appreciated.

ESTABLISHING AND MAINTAINING BOILER ROOM ECONOMY is the title of a paper presented before the Ohio Society of Mechanical, Electrical and Steam Engineers, by George H. Gibson, developing the thesis that the most important requisites to further improvements of boiler plant economy are means of recording boiler performance; that is, of determining the number of pounds of water evaporated per pound of coal. Information obtained sporadically, as by means of short boiler tests, is not so suitable for this purpose as is information supplied continuously as by a feed-water meter. The relative values of different kinds of coal, the improvement in evaporation following cleaning of soot and scale off heating surfaces or the stopping up of air leaks, the relative merits of different methods of firing, are then readily demonstrated, and scientific management becomes easy and natural; that is, the ways and means of attaining a certain standard of performance having been demonstrated, the management is in a position to ask for good results continuously, in fact standard rules of operation; that is, directions as to methods of handling fires, regulation of draft, blowing of soot, banking of fires, carrying overloads, etc., can be written out, so that any man following instructions can obtain good results. The installation further arouses the pride of the engineer and makes it possible to reward skill or attention to duty—something that is ignored too often under ordinary conditions of power plant operation, with resulting loss in efficiency.

There is no other way so effective for telling a good fireman from a poor fireman. This pamphlet is being distributed by the Harrison Safety Boiler Works, Philadelphia, Pa., manufacturers of the Cochrane Open Feed Water Heaters, from whom copies may be obtained.

Letters from Practical Boiler Makers

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

Factor of Ignorance

"A new engineering term called the 'factor of ignorance' has been recently suggested in connection with the factor of safety of boilers. It is intended to allow for non-uniformity of strength in material and to deterioration resulting from abuse during the process of construction and for faults in workmanship. The term factor of safety, on the other hand, takes into consideration changes in load and the yield point of the material.

"The term 'factor of ignorance' is a good one which can be *safetly applied* to a good many things aside from engineering."

Isn't this a wee bit paradoxical? Can a "factor of ignorance" be "safely applied"? It sounds much like saying: "The man was safely killed."

New York. N. G. Near.

A Word of Advice to the "Youngsters"

I have been thinking for some time of writing you and thanking you for the many rough places which your worthy journal have helped me over. It has, in the past, been a very great consolation to me when up against a knotty problem to turn to the files of The Boiler Maker and invariably I found an article treating on the very subject which confronted me.

In this respect your up-to-date magazine reminds me of the poem (I am unable to give the author or speak the verse), the subject of which was, viz.: when you have a good thing, why not pass it along? This certainly appeals to me to be along the lines of brotherly love. I believe there are a great number of practical working boiler makers who, if they would take a little time to write up the many knotty problems which they have met with in their careers, and give in detail how they did the job, would give real assistance to the readers of The Boiler Maker.

In this respect I am reminded of being helped out very unexpectedly on a simple little job not long ago by a venerable old boiler maker who just happened to drop in to look around the shop where I was employed. It so happened I was renewing a few radial stays in a locomotive boiler at the time and, in lieu of having the proper tools at hand, was trying to install same with a short tap. The men, in tapping the holes, had driven the tap slightly out of line with the second sheet and, when it came to pulling the stay home, it would have required the power of a first-class mule team, although the holes were tapped plenty large.

At this stage of the game is where I made the acquaintance of Reinhold Betterman, who had with him a tool of his own invention for this very purpose. Mr. Beterman gave me a working demonstration of the tool along with some practical advice along the lines of boiler making and put in such a manner that I shall not forget it in the near future.

I will say right here I am comparatively young in the boiler-making business and, when I meet a horny-fisted, hard-headed boiler maker of the old school, then, boys, is when I am a mighty good listener, and I have always profited by letting his instructions soak in. When such writers as John Cook, Mr. Frances, Mr. Hobart and Mr. Harrison, of Pittsburgh, and scores of others who write for The Boiler Maker have anything to say it is for us youngsters to sit up and take heed.

Millwood, Pa. H. J. Donnelly.

Working of Old Flues

In the September Boiler Maker I saw an article on the working of old flues. In my opinion, this may be taken two ways; that is, retubing an old boiler with old flues or working old flues that have started leaking.

Most all the flues renewed in the railroad shops are old flues with a new tip about six or eight inches long welded on to them for the firebox end. Therefore, in the front end or smokebox you are working the old flue.

When I am ready to start working the smokebox end I cut some strips of soft iron just long enough to go once around the flue and about 1¼ inches wide. If there is not room enough to get one of these ferrules around the flue, cut off what it not needed and put what you can around the flue. After putting these ferrules around 15 or 20 flues I take a flue pin and pin the flues out, as this saves a lot of rolling, but care must be taken in pinning out these old flues, as they will crack very easily. After pinning out these 15 or 20 flues, if I use hand rolls, I roll them. Then proceed the same way until the job is finished. A boiler maker, after using hand rolls a while, can tell when a flue is rolled enough by driving the pin in until it sounds solid.

But if rolling the flues with machine rolls, I get all the ferrules in and all the flues pinned out before starting to roll. Anyone can tell after rolling a few flues when a flue is rolled enough by the pulling of the air motor.

On the working of old flues that have become leaky, such as round-house boiler makers run up against most every day, I use the following method: I have charge of the running work here nights, and I find that I have the best results with the prosser expander with the shoulder of the prosser ground off. If the prosser mark in the flue isn't very deep I use the live expander; that is, one with the shoulder or prosser on it. Or if the flue is not very thin and has got a ridge inside from the calking tools, I give them a light rolling, just enough to tighten them in the sheet.

Rolling an old flue too much weakens it very much and cuts the flue, causing the bead to break off flush with the sheet, and also enlarges the flue holes in the flue sheet.

Edgemont, So. Dak. C. H. Malet.

Constant Water Level in Boilers

In conducting tests and trials on boilers and stokers it is now common practice to maintain a constant water level to insure uniformity of conditions. With special cases as boiler tests such procedure appears logical to all engineers, but when it resolves itself into everyday operation little attention seems to be given to the important question of carrying the water at approximately a fixed point in the glass.

There are several good and sufficient reasons for advocating boiler feed-water control. Primarily among these is the fact that water injected into the boiler in large quantities now and then retards the circulation. Not only is the circulation retarded, but the flow of water is concentrated to the lower portions of the boiler. This results in unequal expansions, which are the direct causes of strains. In other words, improper feeding means shortening the life of the boiler.

The efficiency of the boiler is dependent upon the circulation; that is, the heat transfer will increase with an increase in circulation. If careless boiler feeding retards the circulation, the efficiency must likewise be retarded and lowered considerably. Steady feed-water level means a steadiness of steam generation. Sudden feeding means a sudden drop in the steam pressure which may cause the boiler to prime. The way in which a boiler is fed manifests itself in the operation of the furnace. If a boiler has a steady load and the water is suddenly injected, causing a wide fluctuation in the water level, the result would be a diminished temperature of the furnace gases. This condition may become so aggravated as to permit a large part of the volatile matter in the coal to escape unconsumed.

These reasons indicate that there is a relation between constant and uniform feeding and efficient operation.

Newark, N. J. H. A. C., Jr.

The Double Butt Strapped Riveted Joint

Much has been said and written on this subject and many rules have been set down to guide the designers, layerouts and foremen boiler makers; and yet when it comes to getting a clear and comprehensive explanation concerning this all-important question from the ones that are engaged most directly in the design, it is invariably found that it is not forthcoming.

This is especially true of boiler inspectors, representing their respective companies. The engineering or insurance company, whichever the case might be, will forward to the boiler manufacturer a set of specifications, with an order to build a boiler accordingly. They will specify a certain style joint, with the rivets spaced a certain distance apart; and regardless of the circumstances bearing on the case, they will insist that the pitch shown in their specifications be adhered to. Now everyone connected with the boiler business—designer, foreman, or layerout—knows that at times the circumstances will not permit, or at least they will cause a great deal of difficulty in order to get the specified pitch of rivets, owing to the distance from center to center of girth seam rivets. If the ring centers could be made to conform to the required pitch of rivets in the straight seam, all would be well and good. Take the matter up with the inspector, and he will tell you to follow the specifications, and refuses to assume any responsibility, even though an efficiency of joint with a percentage high enough to get the required working pressure could be obtained by varying slightly from the specifications.

All cuts and diagrams showing the different forms of butt joints as they appear in the books of rules of the different States having boiler laws either show only a portion of the joints or a joint that has the rivets spaced in such a way that it has equal spaces in the outer rows, at both ends. This is another thing that cannot always be accomplished, and although it matters not whether the spaces in the outer row at both ends are equal or not, I know there are a lot of men who would like to know the reasons why. I have heard several inspectors questioned on the subject. They all say it doesn't make any difference in the joint, but still they cannot tell you why.

For instance, in butt joints having alternate rivets omitted in the outer row, as shown in Fig. 1, a triple riveted double butt strap joint, having staggered rivets, and the outer row in single shear. We will assume that, in order to get the required pitch, it was necessary to divide the overall distance *a* into sixteen equal parts, and consequently distances *b* and *c* are unequal. If an unequal number of spaces had been used, *b* and *c* would be equal distances.

In quadruple riveted joints of the type shown in Fig. 1, in order to make the distances between the end rivets in the outer rows and the girth seam equal at both ends, a number of spaces that is equal to 1 minus any multiple of 4 must be used. Thus the number of spaces may be 11, 15, 19, 23, 27, 31, 35, 39 and so on.

If the distance *p*, Fig. 1, is an equal division, or 1/16 of the overall distance *a*, distance *c* is 25 percent more than the maximum pitch *p*, while distance *b* is only 75 percent of the maximum pitch *p*, and it would appear that the joint will be weak at the net section corresponding to the smaller pitch.

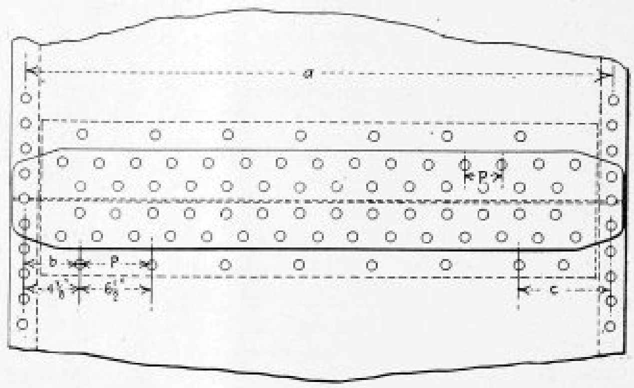


Fig. 1

Consider in this case that the rivets have a diameter of 13/16 inch and a pitch of 6.5 inches. The rivets in the outer row are in single shear. The distance between the end rivets and the girth seam *b* is $6.5 \times .75 = 4.875$ inches; the thickness of shell plate is ⅜ inch and the plate has a tensile strength of 60,000 pounds per square inch; the rivets have a shearing strength of 42,000 pounds per square inch in single shear. Then at the maximum pitch the efficiency of the net section is

$$\frac{6.5 - 13/16}{6.5} = .875 = 87.5 \text{ percent.}$$

At the short end pitch *b* of 4.875 inches, the efficiency of the net section is

$$\frac{4.875 - 13/16}{4.875} = .8333 = 83.33 \text{ percent.}$$

Since the efficiency of the net section at the 4⅞-inch pitch is least, it would seem as if rupture would occur at the line *b* instead of the line *p*. This is not the case, however, as rupture at *b* cannot take place without shearing some of the girth seams rivets. It is assumed that three of the girth seam rivets may be counted on to aid the net section *b*. The shearing resistance of the three girth seam rivets is $(13/16)^2 \times .7854 \times 3 \times 42{,}000 = 65{,}329$ pounds, nearly. The resistance of the net section *b* is $(4⅞ - 13/16) \times ⅜ \times 60{,}000 = 91{,}406.25$ pounds. The total resistance to rupture is 65,329 plus $91{,}406 = 156{,}735$ pounds.

The resistance of the solid plate the maximum pitch *p* is $6\frac{1}{2} \times ⅜ \times 60{,}000 = 146{,}250$ pounds. Hence at the line of pitch *b* the efficiency is

$$\frac{156{,}735}{146{,}250} = 1.072 = 107.2 \text{ percent.}$$

This shows that failure of the joint along the line between rivets at *b* is a very remote possibility.

D. VIDERS.

The Camber or Versed Sine

For the benefit of layerouts and estimators, in laying out or ordering plate for tapering courses, I propose to show a simple and time-saving method in determining the camber, or versed sine. There probably is not any one operation in laying out plate work that is done in as many different ways by different people as this. I have seen and tried a good many, but have yet to learn an easier one than the one I am about to explain. For those who are

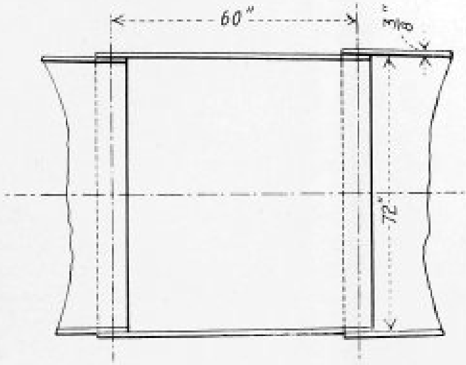


Fig. 1

just taking up laying out, I will illustrate the complete operation, in order that the beginners as well as the experienced layerouts can take advantage of it, if they choose.

I will take, for example, a 6-foot diameter pipe, plate ⅜ inch thick with 60-inch ring centers, as shown in Fig. 1. The first thing to be determined is the circumference. The mean diameter is 72 inches and the circumference of 72 inches is $72 \times 3.1416 = 226.195$ inches. Call it 226⅛ inches, which is near enough for all practical purposes. For the large end add 3¼ times the thickness of the plate, which in this case, the plate being ⅜ inch, is $3.25 \times .375 = 1.21875$ or 1¼ inches, and for the small end take off 3¼ times the thickness. Thus, we find the circumference of the large end to be 226⅛ + 1¼ = 227⅜, and the circumference of the small end = 226⅛ — 1¼ = 224⅞, and the difference between the two = 227⅜ — 224⅞ = 2½ inches, or 6½ × ⅜.

As the above essentials have to be determined in all cases before the layerout starts to work, it is just as well then to determine the camber mathematically, which will be necessary in order to simplify the whole operation in so far as the layout of the pattern is concerned. The camber can be determined in the following manner, and you will note that it is simply a problem in direct proportion and will take less time mathematically than it would geometrically.

We have found that 2½ inches is the difference between the circumference of the large and small ends. We know that the distance from center to center of rivets on the pipe is 60 inches. Then the camber is found by the following:

$$\frac{(6\frac{1}{2} \times \text{thickness of plate} \div 4) \times (\text{circumference of large end} \div 2)}{\text{Distance to center of rings}}$$

Converted, the formula becomes

$$\frac{\dfrac{2\frac{1}{2}}{4} \times \dfrac{227\frac{3}{8}}{2}}{60} = 1.184 \text{ or } \frac{\frac{5}{8} \times 113\ 11/16}{60} = 1.184.$$

The camber = 1 3/16 inch.

Now that the height of the camber or versed sine has been determined, the next thing is to lay it out on the plate, which we will do in the following manner: To the required lap, we will say 1½ inches, add the camber 1 3/16 inches, which equals 2 11/16 inches. From one edge of the plate measure in 2 11/16 inches and draw a line the full length of the plate; then, after allowing the usual amount of lap at one end, measure off the circumference for the large end (227⅜ inches), then divide this into eight equal parts.

On the center draw a line perpendicular to the base line, the full width of the sheet, in order that we can work from it on the small end of the course. On the center line add the camber 1 3/16 inches, measuring from the base line towards the edge of the plate, which will give the highest part of the curve. Then from either end point drop a square line down and mark off a distance equal to the height of the camber (1 3/16 inches) and divide it in four equal parts, because there are four equal parts on either side of the center line. Then with a straight-edge get the different points of the curve by holding one end of straight-edge at the height of camber, or point *V*, Fig. 2, and the other end at the division marks on the ends of plate, and where the straight-edge crosses the corresponding numbered division marks on the base line make a short mark.

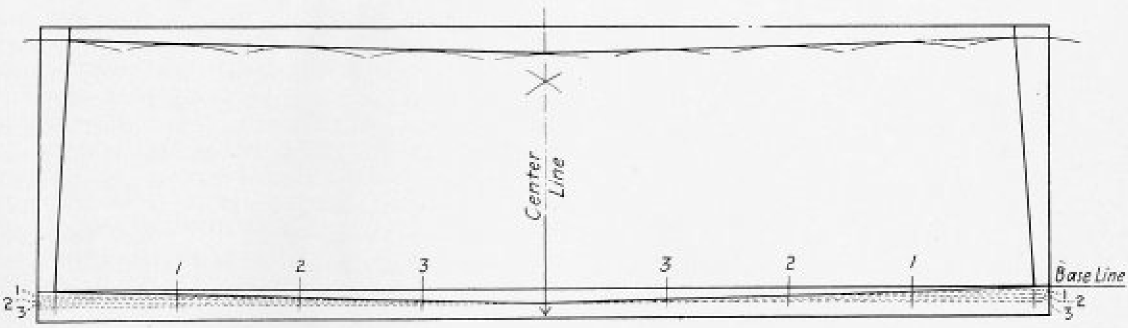


Fig. 2

All the foregoing is shown on Fig. 2. When all the points along the base line have been determined in this manner, trace the curve out by drawing lines between each mark found. Then by measuring around the curve, determine the correct circumference and divide the entire curve into eight equal parts and make a small center mark at each eighth. The only difficult operation of the whole layout is now completed, and it isn't really anything difficult, although it may appear so to the apprentice, but a little study and practice will familiarize one with all the little details in a very short time. So now for the rest of the operation, which is very simple, but as far as I know is not done in this way by many layerouts, although it is perfectly correct and safe.

On the center line, from the height of the curve, lay down 60 inches, the distance between ring centers, and set the trammel points to this measurement; then by using the different centers made around the curve, draw a corresponding number of arcs on the opposite side of the sheet. This done, trace the curve beginning at the center line and holding the straight edge on a tangent with each arc. The parallel curved lines are thus made. The latter curved line is the small end, of course, so all that remains to be done is to lay down the circumference 224⅞ inches, working from the center line in both directions, and then drawing the end lines for the straight seam.

D. VIDERS.

The Impossibility of a Perfect Boiler Code

We read complaints very frequently nowadays about the A. S. M. E. Boiler Code. It is charged by some that the committee which drafted the code is controlled by a sort of "ring," and that the committee is subservient to the interests of certain boiler manufacturers.

Whether or not these compaints are justifiable is not for me to say. I don't know, because I haven't had the opportunity to look at the problem from the same broad standpoint as has the committee.

Let us assume a simple case. Let us say that I hold all patent rights on the simple lap-seam joint. This joint has been used a great deal, and is still used, but it is falling into great disfavor because it is often dangerous, as we all know. I do my best to improve the joint, to make it perfectly safe, by so balancing the riveting, lap and plate thickness, that in my mind it "is better than any other joint."

In spite of my activities, though, the committee views the lap seam problem from a broad-gage standpoint. On account of past performances, and on account of the probability that those performances may be repeated in the future, the committee decides *against* such a joint.

Naturally, I feel myself to be a heavy loser, and I protest; but my protesting comes a little too late, for the code is already adopted, is recognized by legislature after legislature, and my chances for future recognition become slimmer and slimmer. Perhaps I should have *proved* to the committee, while the code was being drafted, that *some* lap seams, especially *my* lap seams, are O. K. The chances are that in such a case the wording would not have been so decisive against the lap seam.

When a thing once falls into disfavor it is not easy to bring it back into favor again. We are all liable to be somewhat superstitious, you know. The committee is not superhuman any more than we are, so the very best thing to do is to forgive the committee if it erred, and then work manfully with the committee in an endeavor to correct that error. And perhaps, after all, by turning the searchlight on ourselves we will find that we were very lax at the time the code was constructed and didn't offer any real aid. We just thought to ourselves, "Let the committee do the work. That's their business."

I am certain that had I been on that committee I would have done my utmost to make the code the *best* that could possibly be made. It is my belief that the committee *did* do its best. And I am also certain that even if I had been on the committee there would have been complaints afterwards, because, as I have endeavored to illustrate above, it is very, very difficult to please everybody.

New York. N. G. NEAR.

Jobs Carried Out With an Oxy-Acetylene Welder

About a year and a half ago I was working in a small railroad back shop in Western Kansas. They did not do much back-shop work there then, as they were not equipped to handle the big engines. The only engines they could handle were the small class engines such as were used in the yard for switch work and on the branch lines.

All engines brought in for repairs had O. G. fireboxes. One of these engines came in for repairs one day and I was sent up on it. The engine had got out of line and the right back driver had worn quite a hole in the connection where the wrapper sheet riveted to the shell. This place was worn nearly through the sheet and about three inches long.

After the wheels had been taken out I backed two rivets out that had become worn also; then I chipped the worn place out a little so the welding material would take hold better. The oxy-acetylene welding operator then brought his outfit on the job and welded this place over. After the welding operator had finished the job I chipped it off smooth and even with the other part of the sheet, reamed out and countersunk the two rivet holes and drove the rivets. Before this engine went out a test pressure of 200 pounds was applied, and this place never showed any water at all.

They also welded a flat spot on a trailer truck wheel on one of their large passenger engines. This job was done in the roundhouse without taking the engine out of service. They also cut broken staybolts out with the welding machine, saving the time it would take to set up and drill them out.

Although they have no welding machine here, they had one sent from one of the larger shops and had four mud-ring corner patches welded in one boiler and two mud-ring corner patches on another, and are getting two more patches ready on another boiler to be welded in; one on the left side sheet and one in the knuckle of the door sheet. All patches welded in here so far have given good results, not giving any trouble at all.

There have been several cracks in mudring corners welded over in the last month, with good results.

Edgemont, So. Dak. C. H. MALET.

Talks to Young Boiler Makers

In drifting about among boiler shops I have come to divide boiler makers into three classes. These classes have, of course, their various shadings.

The first is a very large one, not larger, however, than is to be found in other trades in proportion to those who are employed in it. It is made up of men who seem merely to go to work and quit, doing as little as they can, not seeming to care whether what they do is well done. They do not seem to care to learn or improve. They never subscribe to any trade journal and in short, they are a class really not worth talking about.

A second class, regrettably much smaller, is made up of men like Jimmie O'Connor, who is, I think, the best boiler maker in the world, or, any way, the best I ever saw. He could not do a poor job. When he was a cub he would get the boys' dinner pails (they had them in those days), and he was sure to have their coffee hot when the whistle blew. He never failed. When he started to heat rivets he very soon learned to get them at just the right heat and just when wanted. It was the same when he started to chip, calk, hold on or drive a rivet. Every journeyman wanted him as a helper, and when as a journeyman he was sent on a job he never came back with a hard luck story or any long tale of woe, and all the tools that he had taken out on the job were brought back. On his return he would poke his head in at the office door, hand in his time tickets, report the job done and hunt up the foreman to get another job.

No boss ever thought of laying him off; he never hunted a job, but every boss or foreman in the section was after him. Yet Jimmie could no more lay out a piece of work than a cat could enjoy a holiday. He could put anything together, but chalk lines on a board meant absolutely nothing to him. He would put a blue print in his pocket and erect the work without it. While he said nothing, he had an utter contempt for a high brow. A firebox, if called a combustion chamber, grated on Jimmie's nerves. I do not believe that he was ever sure what tensile strength was, and as to B. T. U.'s, he had a dim notion that they had something to do with feed-water heaters. Carbon meant absolutely nothing to him. Jimmie was in short a magnificent doer, and he never bothered his head about anything except getting on the patch so that it would not leak. It was really a poem to see him calk a seam, or do any manual work whatever. Everybody liked him; he got top wages and he made money for the concern.

George Wright belonged to the third class of boiler makers. He was not anyway near as good a workman as was Jimmie. Perhaps he was as good a workman but not as rapid, nor did his work look as well when finished. He could lay out any piece of work that was wanted. If the draftsman had put down a wrong figure, George would spot it every time. He saved his boss lots of money by detecting errors. He read THE BOILER MAKER and everything he could get hold of about mechanics generally. He went to night school, and in three weeks he had learned all the instructors could teach him. He took to figuring and drawing as a duck does to water. At noontime he would pore over a blue print, pointing out to anybody who would listen to him any defects which he thought he saw, and he always wanted to change something. Almost everything he suggested in the way of a change was for the better. He would get red-headed mad when a journeyman would shear a piece off the plate for a patch when there were plenty of small pieces that could be used from the scrap pile. He knew all about B. T. U.'s and tensile strength, yield point, amount of carbon, and he figured out the strength of every seam that he calked. In short, he was an absolute sponge as to knowing why and he was unhappy if he did not know why. If it was a choice between George and Jim as to which should be laid off the foreman was puzzled.

I have said that all these three classes of men had their shadings. George and Jim were extremes. You might say that one was a contented doer while the other was a discontented doer, not in the sense of being peeved or with a grouch, but discontented unless he understood the why and wherefore of what he did.

It came about as might be expected that George got it into his head that he would like to have a shop of his own, so he hunted up a locality where he thought a small boiler shop would pay, and went to work making an estimate of what it would cost to start up. He showed this to some friends who were willing to back him with money, and then suggested that he take on Jimmie O'Connor as his partner.

To this one of the men, who had been a boiler maker, said, "What do you want Jimmie for?" "Why," said George, "he is the best boiler maker that ever stood on two legs." "True enough," was the answer, "but when you have said that you have said all you can about Jimmie. He can do work to beat anybody but he can't direct other men, so the best thing to do is to hire Jimmie to do boiler work and not take him into partnership."

Now, Mr. young (and old) boiler maker, there is a good deal to ponder on concerning what I have written. Laying aside the first class of men, the poor dub (as not being of any interest to those reading THE BOILER MAKER), to which of the other two classes do you think it is best to try to belong? We will clearly admit, all of us, I think, that every boss boiler maker would be glad to get Jim at any time, and get as many like him as they could. Has he not a shade the better of George from the employer's standpoint? Is not George in a shade the better position for the good of the boiler trade? And to come right down to it, as a very interesting question for the readers of THE BOILER MAKER to decide, which man would you rather be, and which man would you employ if you were a boss? Let some of the readers of this paper speak up and express themselves on this matter.

By the way, in writing on patents a short time ago, I intended to say that a caveat is no longer issued by the United States Government, but I forgot to put it in.

New London, Conn. W. D. FORBES.

What's the Real Reason?

I have often wondered if anybody can give a real reason why a boiler should ever explode. I can't do it despite my many thoughts on the subject. If anyone can name a *real* reason I would be much pleased to know what it is.

To be sure, instances can be cited where a boiler could do little else, such as where lightning struck a tall brick chimney, shattering the top, and the top falling onto a boiler shed through the roof, and upon the boilers, thereby "touching them off." No wonder they exploded.

Again, it is quite possible that the boilers on the *Lusitania* exploded. So far as I know, nobody knows at this time whether they did or not. But for fear some one might name these last two instances as *real* reasons, I will bar them, for the boilers themselves had nothing to do with the case. However, even such cases as these could probably be prevented if we would earnestly go about looking for a preventive. We usually can find means to prevent almost anything if we only want to. Nearly all problems can be solved, as, I think, Thomas Edison says.

In looking over last year's list of boiler explosions and causes for same, it struck me that "bound-to-be-explosions" talk is considerably overdue. Just take a look at the list yourself and see if you can select a *real reason* why a boiler should explode. You cannot do it, for it cannot be done.

So much is known about boilers nowadays that one should almost be able to operate a boiler whose factor of safety is only one, let alone a factor of safety of five or six.

Why should there be excessive grooving, cracked plates, broken stays, scale, oil, etc., as long as we know preventives as well as we do?

New York. N. G. NEAR.

THE IRONTON BOILER WORKS COMPANY, Ironton, Ohio, has been organized to operate the boiler plant of the Ironton Punch & Shear Company.

New Russian State Railways Locomotives Made in America

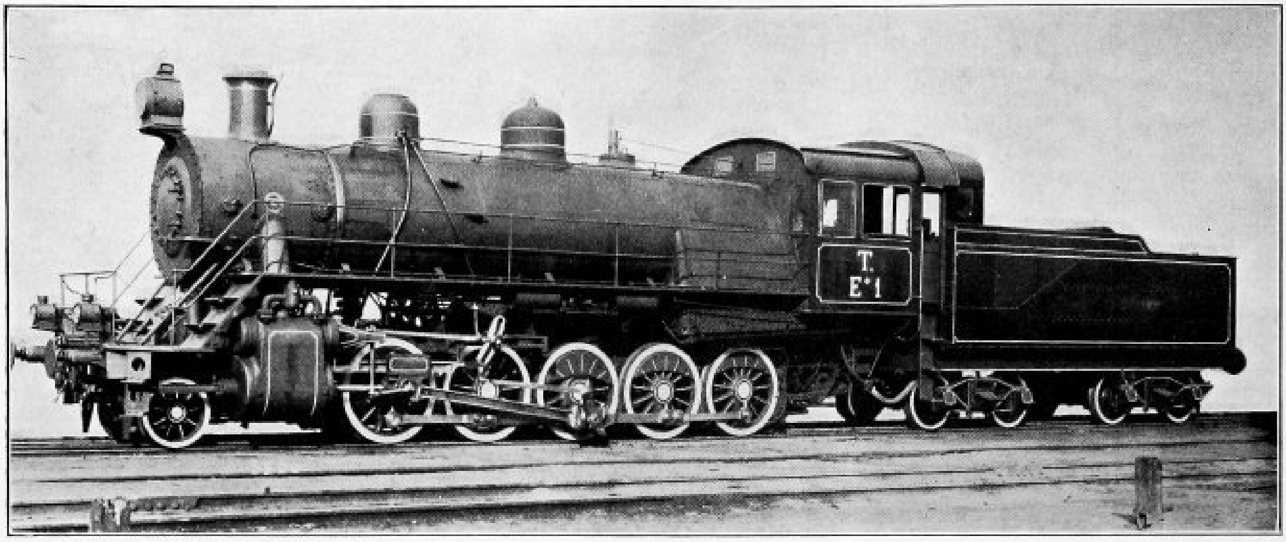
The accompanying illustration shows one of 250 locomotives of the Decapod (2-10-0) type built for the Russian State Railways, at Philadelphia, Pa. Apart from the magnitude of the order, these engines are of interest because of their design and the urgency with which they are being constructed. Although the axle loads are light, as compared with American practice, the locomotives are of considerable capacity, as they exert a tractive force of 51,500 pounds. The ratio of adhesion, however, is unusually low.

It is of interest to note that these locomotives are designed to haul 1,000 metric tons up a straight grade of 0.8 percent at a speed of approximately 8 to 10 miles per hour. This they should be able to do easily while working at a fairly economical cut-off. While special materials and equipment are used to a considerable extent in the construction of these engines, the design is generally in accordance with the practice of the builders. The fuel used is a most inferior grade of bituminous coal, and this is burned on a rocking and drop grate with an area of 64.5 square feet. The firebox is placed above the driving wheels, and is equipped with a sectional brick arch supported on watertubes. The fire doors are pneumatically operated. The inside firebox is of copper, and copper stays are used in the water legs.

It may be stated that the front end of the firebox crown is supported by three rows of expansion stays, which are of a new design recently introduced by the builders. The nut on the upper end of the radial stay is seated in a die-forged stirrup, which is screwed into the roof-sheet. After the nut has been adjusted to give the proper tension, the thread on the stay is set into the nut with a punch. This is a simple arrangement, which has ample flexibility and utilizes ordinary staybolt taps in the boiler and firebox sheets; while the water space above the crown is not obstructed, as is the cars where T-iron stays are used.

These locomotives are equipped with Schmidt superheaters and outside steam pipes. The superheater is composed of 28 elements, with a superheating surface of 563 square feet. The steam distribution is controlled by 12-inch piston valves, which are arranged for inside admission and driven by Walchaerts motion. The Rushton power reverse mechanism is applied. This device is operated by a small rotary air engine. It is exceedingly compact, and if necessary can be arranged, without difficulty, for manual operations.

The boiler has a diameter of 70 inches, the thickness of sheets being 5/8 inch, and the working pressure is 180 pounds. The fuel is low-grade soft coal and the firebox has a length of 108 1/8 inches and a width of 36 inches, and the thickness of sheets, sides, 1/2 inch, and the back being 1/2 inch, and the tube sheets 1 inch and 5/8 inch. The total heating surface is 2,601 square feet, and the grate area is 64.5 square feet. The weight on driving wheels is 176,000 pounds, and on truck 22,000 pounds, while the total weight of engine and tender is 330,000 pounds.



Decapod Type of Locomotive Built at the Baldwin Locomotive Works for the Russian State Railways

Should Scale be Cleaned Off?

There is no use arguing with Joseph Smith about his assertion in the November issue that both ends of the flue should be filed clean after annealing and before expanding into the coppers, for anybody can see with half an eye that he is right. Cleanliness is always an essential to best workmanship. Even in laying rough concrete foundations on bed rock the engineers specify that the "rock must be *cleaned* from all dirt." This is especially true where a bond is desired between the rock and concrete. It should be all the more true in the case of a steam boiler which operates under such high pressures and in which leaks are serious.

Also, we know that where tubes are to be welded into the sheets the specifications read "surfaces must be clean and free from dirt, scale and grease."

Wherever we make steam-tight bolted fittings we always specify a "finished" surface. For the same reason flue ends should also be finished, even though they are not bolted.

This can be done inexpensively. They need not necessarily be filed. The operation could be performed wholesale after annealing by means of a sand-blast or by tumbling.

In my mind, Mr. Smith is right.

New York. N. G. NEAR.

We are often influenced by colors. A boiler front painted a robin's egg blue would work just as well as one painted black. So would a horseshoe magnet painted yellow, but anyone would hesitate in buying it if it was not painted red.

Selected Boiler Patents

Compiled by

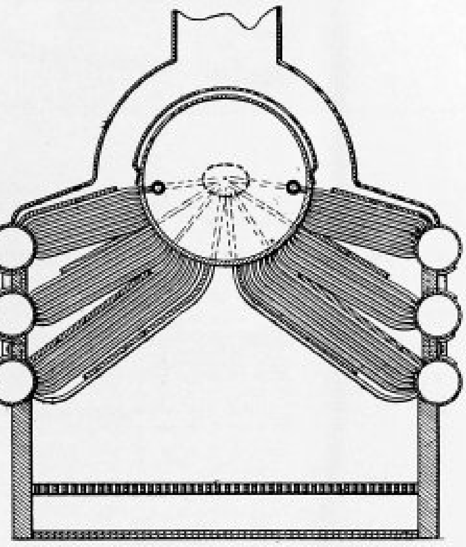
DELBERT H. DECKER, ESQ., Patent Attorney,

Millerton, N. Y.

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

1,152,248. WATERTUBE BOILER. CHARLES WARD AND CHARLES E. WARD, OF CHARLESTON, W. VA.; SAID CHARLES E. WARD, ADMINISTRATOR OF SAID CHARLES WARD, DECEASED, ASSIGNOR, AS ADMINISTRATOR AND FOR HIMSELF, TO THE CHARLES WARD ENGINEERING WORKS, OF CHARLESTON, W. VA., A CORPORATION OF WEST VIRGINIA.

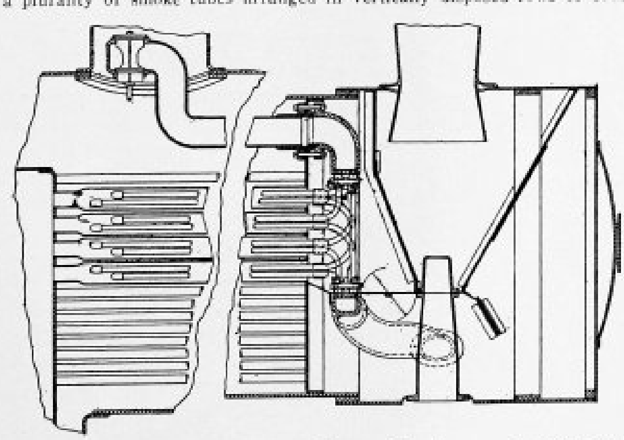
Claim 1.—In a watertube steam boiler, the combination with a furnace, of front and rear headers, a drum connected with the upper portions of the headers, banks of tubes of relatively smaller diameter connecting



the headers, the said banks of tubes being arranged one bank above another, rows of tubes of larger diameter connecting the said headers, one of the said rows of larger tubes being arranged next above the lowest bank of smaller tubes, and another of the said rows of larger tubes being arranged next below the said lowest bank of smaller tubes and directly exposed to the furnace whereby when the boiler is fired circulation is established in the said lowest bank of smaller tubes and in the said larger tubes next below and above the said bank as described prior to the circulation in the boiler above the said lowest bank of smaller tubes and the said adjacent larger tubes. Two claims.

1,153,216. LOCOMOTIVE SUPERHEATER. ERNEST G. GOODWIN, OF ROANOKE, VA., ASSIGNOR TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

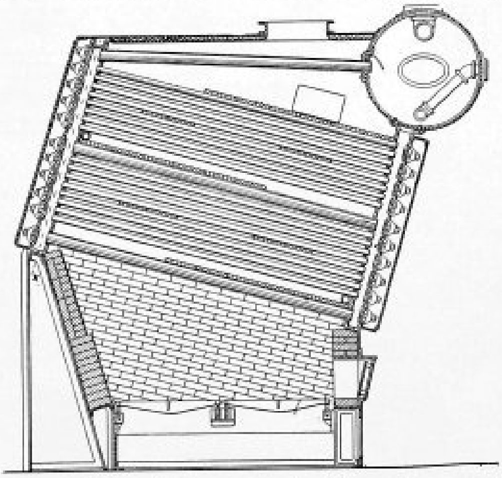
Claim 1.—In a superheater, the combination of a horizontal top header for saturated steam, a horizontal bottom header for superheated steam, a plurality of smoke tubes arranged in vertically disposed rows of four



tubes each between the said top and bottom headers, superheating pipes for each of said smoke tubes connecting said top and bottom headers, the superheating pipe for each of the first or upper of said smoke tubes in the said vertically disposed rows originating near the inner edge of said top header and terminating near the outer edge of the said bottom header, the superheating pipe for each of the second of said smoke tubes originating near the inner edge of said top header and terminating near the outer edge of said bottom header, the superheating pipe for each of the third of said smoke tubes originating near the outer edge of said top header and terminating near the inner edge of the said bottom header, and the superheating pipe for each of the fourth or lower of the said smoke tubes in the said vertically disposed rows originating near the outer edge of the said top header and terminating near the inner edge of said bottom header, the said points of origination and termination of the superheating pipes for the first and third smoke tubes in each of said vertically disposed rows being disposed to one side of the vertical center line of that row of smoke tubes and the points of origination and termination of the superheating pipes for the second and fourth smoke tubes in the same vertically disposed row being disposed to the opposite side of the same vertical center line, substantially as described. Eight claims.

1,152,341. WATERTUBE BOILER. FREDERICK P. PALEN AND WILLIAM BURLINGHAM, OF NEWPORT NEWS, VA.

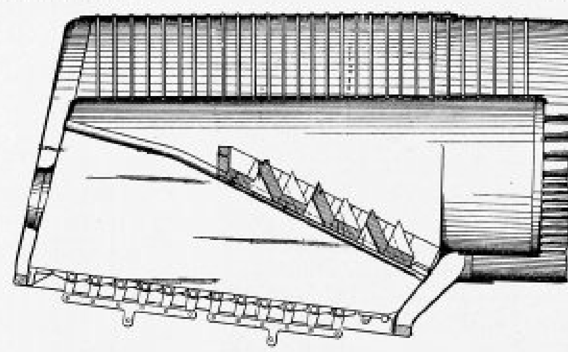
Claim 1.—A watertube boiler, comprising an upper steam drum, lower water drums, nests of tubes connecting the steam and water drums, a set of baffle plates extending from the steam drum toward the water drums and located near the lower portion of the tube nests whereby an opening is provided between the ends of the baffle plates and the water



drums for the admission of hot gases to the tube nests, a second superimposed set of baffle plates located in the tube nests and extending from the water drums toward the steam drum, a third superimposed set of baffle plates located in the tube nests and extending from the steam drum toward said water drums and a fourth set of superimposed baffle plates located at the upper portion of the tube nests and extending from the water drums toward the steam drums, and said superimposed sets of baffle plates forming openings to cause a circuitous travel of the hot gases around the nests of tubes. Eleven claims.

1,153,648. BRICK ARCH FOR BOILER FURNACES. CLEMENT F. STREET, OF NEW YORK, N. Y.

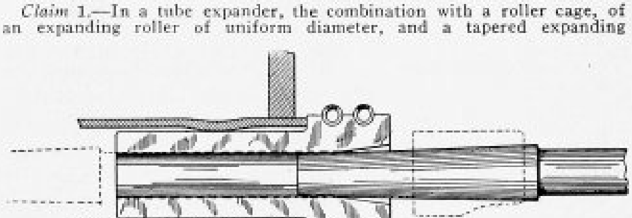
Claim 1.—In a boiler furnace, the combination with water tubes extending longitudinally from the front of the firebox upwardly and rearwardly, of a brick arch comprising a series of longitudinal rows of



bricks supported between adjacent watertubes, some of the bricks being formed of two vertical side walls and a rearwardly and upwardly inclined top wall to provide openings through the arch, the vertical side walls resting upon the watertubes. Five claims.

1,153,662. TUBE EXPANDER. OTTO WIEDEKE, OF DAYTON, OHIO, ASSIGNOR OF ONE-HALF TO GUSTAV WIEDEKE, OF DAYTON, OHIO.

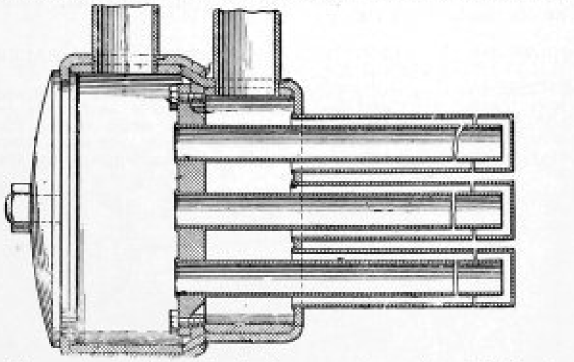
Claim 1.—In a tube expander, the combination with a roller cage, of an expanding roller of uniform diameter, and a tapered expanding



roller, the axial opening in the tapered roller being of greater area than that of the roller of uniform diameter, a common axial support for said rollers, and a mandrel engaging said rollers to expand a tube and bell the end thereof, substantially as specified. Four claims.

1,154,194. HEADER. EDWARD C. MEIER, OF PHŒNIXVILLE, PA.

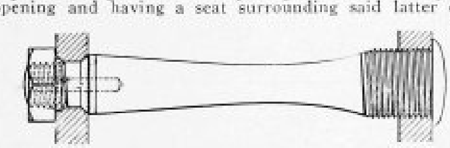
Claim 1.—A header, comprising two sections, each section composed of a single metal sheet, the intermediate portions of the respective sheets constituting the ends of the header, one section smaller than the other,



the smaller section fitting within the larger section and secured thereto, and a ring fitting within the larger section and against which the edge of the smaller section bears, substantially as described. Eight claims.

1,154,468. STAYBOLT. HENRY V. WILLE, OF PHILADELPHIA, PA., ASSIGNOR TO THE BALDWIN LOCOMOTIVE WORKS, OF PHILADELPHIA, PA., A CORPORATION OF PENNSYLVANIA.

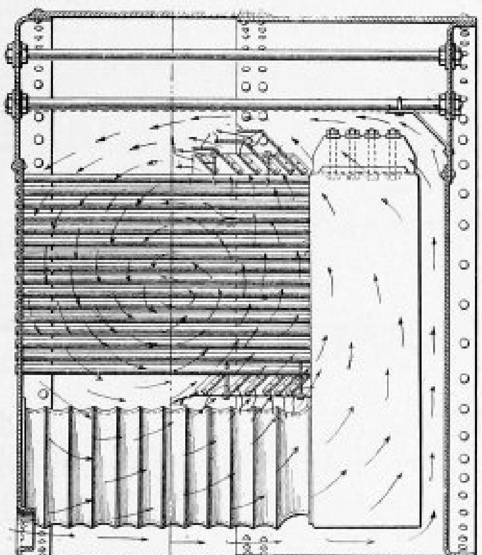
Claim 1.—The combination of an inner and an outer plate of a boiler, the inner plate having a threaded opening and the outer plate having a plain opening and having a seat surrounding said latter opening; a



staybolt having a thread at one end adapted to the threaded opening in the inner plate and having a seat portion ot the opposite end arranged to bear against the seat of the outer plate and having a threaded extension beyond the seat extending through the plain opening; and means, independent of the plate, for holding the bolt to its seat. Four claims.

1,155,832. BOILER CIRCULATOR. ALEXANDER McNAB, OF BRIDGEPORT, CONN., ASSIGNOR TO THE McNAB COMPANY, OF BRIDGEPORT, CONN., A CORPORATION OF CONNECTICUT.

Claim 3.—In a boiler circulator, a series of spaced blades adapted to be transversely arranged with respect to the boiler tubes, some of said



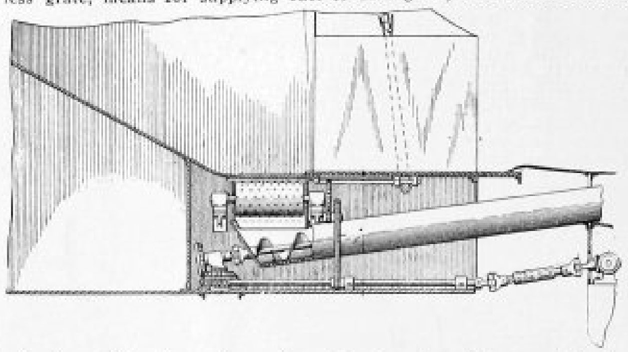
blades being formed into nozzle portions, which latter extend in horizontal successively overlapping relation to form superposed water passages. Six claims.

1,156,368. LOCOMOTIVE FIREBOX CONSTRUCTION. LE GRAND PARISH, OF NEW YORK, N. Y.

Claim 1.—In combination, a locomotive firebox having water walls and a flue sheet, a plurality of flues extending through the flue sheet and forwardly thereof, two rows of circulation tubes inclining rearwardly and upwardly from a point below the flues and connecting the front and rear water walls of the box, one of said rows being located above the other, and spaced apart to permit the introduction of locomotive firebox arch bricks between the rows, and an arch supported on the circulation tubes extending from a point adjacent the front water wall of the firebox rearwardly a portion of the distance to the rear water wall, said arch comprising a plurality of removable refractory arch bricks arranged in rows, the wing rows of bricks being supported on the end members of the rows of circulation tubes and on the side sheets, and the central rows of bricks being supported on circulation tubes extending in different planes so as to provide spaces between the rows, whereby the bricks are subjected to the cooling action of the tubes and the gases of combustion are thoroughly mixed, while the ends of the flues are protected. Two claims.

1,156,263. LOCOMOTIVE STOKER. AUGUSTINE R. AYERS, OF CHICAGO, ILL., ASSIGNOR OF ONE-HALF TO JOHN J. BERNET, OF CHICAGO, ILL.

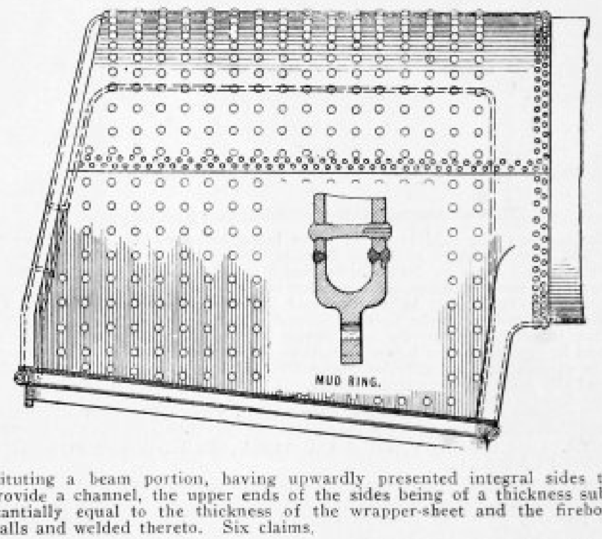
Claim 1.—In a device, the combination with a locomotive of an endless grate, means for supplying fuel to said grate, and means for dis-



tributing said fuel over the surface of said grate, said means including vertically-adjustable deflectors located at the point of fuel supply and means for vertically adjusting each end of each deflector. Eight claims.

1,156,455. MUD RING. WILLIAM L. BEAN, OF CHICAGO, ILL.

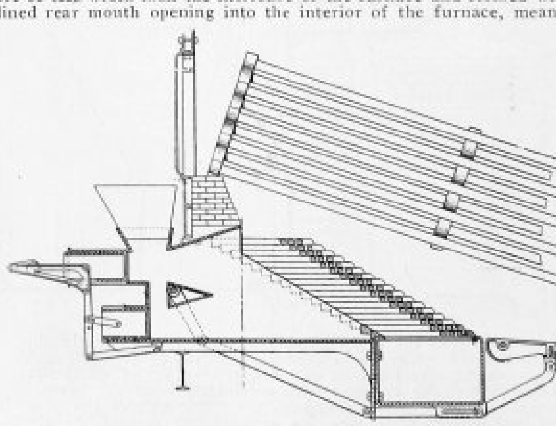
Claim 1.—In combination with a locomotive firebox and the outside or wrapper sheet, a mud-ring comprising a comparatively thick body, con-



stituting a beam portion, having upwardly presented integral sides to provide a channel, the upper ends of the sides being of a thickness substantially equal to the thickness of the wrapper-sheet and the firebox walls and welded thereto. Six claims.

1,156,628. FURNACE. ROBERT S. RILEY, OF PROVIDENCE, R. I., ASSIGNOR TO AMERICAN ENGINEERING COMPANY, OF PHILADELPHIA, PA., A CORPORATION OF PENNSYLVANIA.

Claim 1.—A furnace, including an inclosure, a vertical fuel passage or retort of less width than the inclosure of the furnace and formed with an inclined rear mouth opening into the interior of the furnace, means for



admitting air on each side of the retort mouth, horizontally reciprocating top and bottom pushers in the front of said retort for feeding fuel therethrough, and an inlet above said pushers, the retort having a passage extending substantially vertically directly from the inlet to the bottom of the retort in rear of said bottom pusher, whereby fuel may be forced into the lower portion of the fuel bed by the lower pusher without being previously acted on by the upper pusher. Fifteen claims.