The Boiler Maker

VOLUME XIX

JANUARY TO DECEMBER, 1919

PUBLISHED BY

ALDRICH PUBLISHING CO.

6 EAST THIRTY-NINTH STREET, NEW YORK, U. S. A.
8 BOUVERIE STREET, LONDON, E. C.

THE BOILER MAKER

INDEX TO VOLUME XIX

INDEX

JANUARY TO DECEMBER, 1919

Note—Illustrated articles are marked with an (*) asterisk.

ARTICLES

COMMUNICATIONS

EDITORIALS

ENGINEERING SPECIALTIES

LAYING OUT PROBLEMS

PARAGRAPHS

QUESTIONS AND ANSWERS

THE BOILER MAKER

JANUARY, 1919

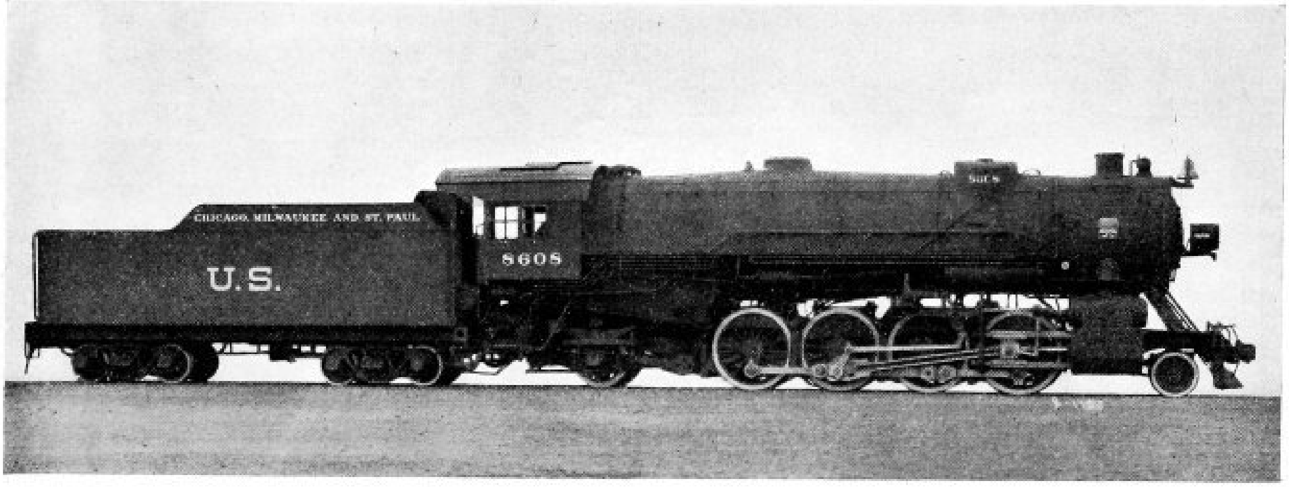


Fig. 1.—Standard Locomotive for Chicago, Milwaukee and St. Paul Lines

New Locomotives of Standard Design

Four Types Designed to Meet Special Needs—Totals of Boiler Heating Surfaces Vary From 4,285 to 1,891 Square Feet

Four new locomotives of standard design have been delivered to the United States Railroad Administration by the American Locomotive Company. The largest of the four types, illustrated in Fig. 1, has been built to operate upon the lines of the Chicago, Milwaukee & St. Paul. With cylinders of 27 inches diameter and 32-inch stroke, and with driving wheel diameter of 63 inches, this type exerts a maximum tractive force of 60,000 pounds. The steam pressure is 190 pounds. The weight on the driving wheels is 239,000 pounds. The total engine weight is 320,000 pounds.

Another type will operate on the Chicago & Eastern Illinois lines. The cylinders and driving wheel are of the same dimensions as the one above. The steam pressure is rated at 200 pounds; the tractive power 54,700 pounds. The weight on the driving wheels is 220,000 pounds; the total engine weight 292,000 pounds.

The third type, built for the New York Central, with a cylinder diameter of 25 inches, stroke of 28 inches, and driving wheel diameter of only 51 inches, exerts a maximum tractive power of 51,000 pounds. The working pressure is 175 pounds. The weight on the driving wheels is 214,000 pounds; the engine weight is the same.

The fourth type, a still lighter design, will run on the

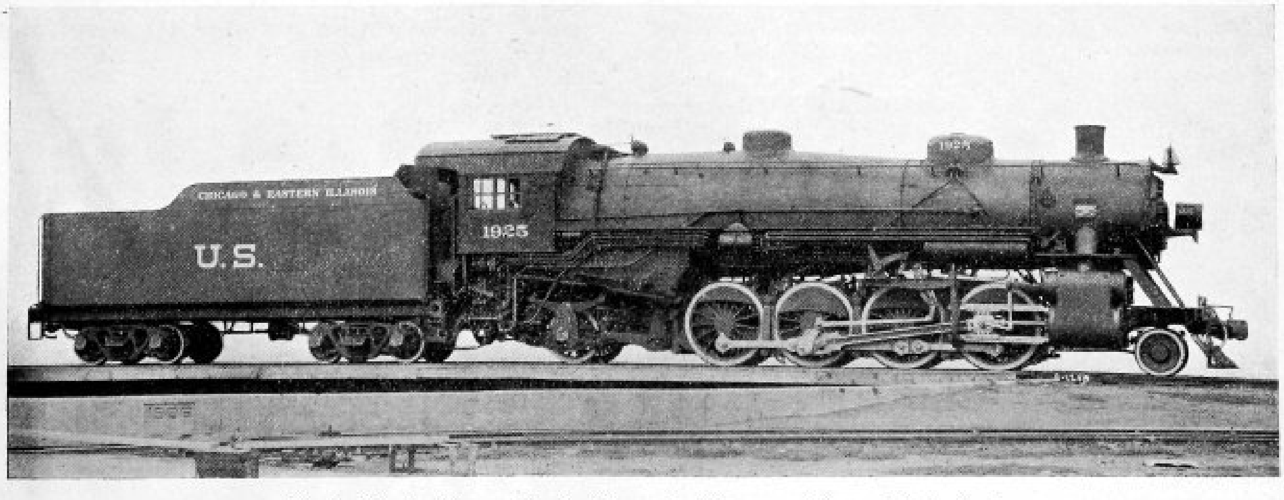


Fig. 2.—Standard Locomotive for Use on the Chicago and Eastern Illinois Road

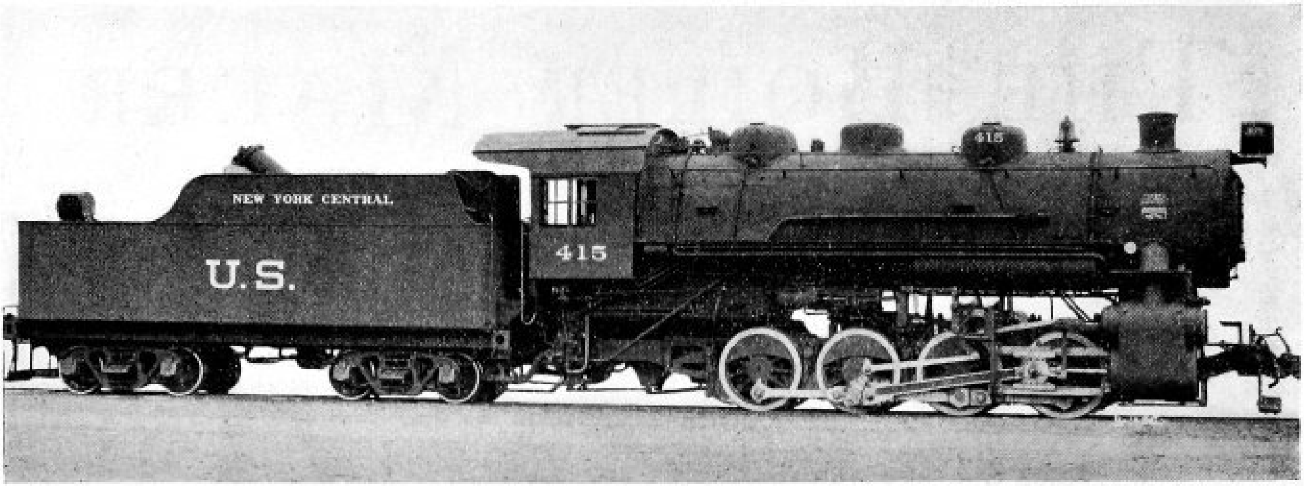


Fig. 3.—Lighter Type of Locomotive Adopted for New York Central Use

rails of the Chicago Junction. The weight upon the driving wheels totals only 163,500 pounds, with a similar engine weight. The cylinders are 21 inches by 28 inches; driving wheel diameter, 51 inches; steam pressure, 190 pounds; maximum tractive pressure of 39,100.

The dimensions of the locomotives are as follows:

Service and Weights.	Chicago, Milwaukee & St. Paul.	Chicago and East Illinois.	New York Central.	Chicago Junction.
Gage	4 feet, 8½ inches	4 feet, 8½ inches	4 feet, 8½ inches	4 feet, 8½ inches
Fuel	soft coal	soft coal	soft coal	sof t coal
Weight on driving wheels	239,000 pounds	220,000 pounds	214,000 pounds	163,500 pounds
Weight on truck, front	24,000 pounds	20,100 pounds	....	....
Weight on truck, back	57,000 pounds	51,900 pounds	....	....
Total weight, engine	320,000 pounds	292,000 pounds	214,000 pounds	163,500 pounds
Total weight, tender	183,800 pounds	185,400 pounds	167,900 pounds	168,800 pounds
Maximum tract ve power	60,000 pounds	54,700 pounds	51,000 pounds	39,100 pounds
Driving wheel diameter	63 inches	63 inches	51 inches	51 inches
CYLINDERS				
Diameter	27 inches	26 inches	25 inches	21 inches
Stroke	32 inches	30 inches	28 inches	28 inches
BOILER				
Inside diameter	84½ inches	76⅝ inches	78⁹/₁₆ inches	64¹¹/₁₆ inches
Working pressure	190 pounds	200 pounds	175 pounds	190 pounds
Firebox, length	120⅛ inches	114⅛ inches	102⅛ inches	72¼ inches
Firebox, width	84¼ inches	84¼ inches	66¼ inches	66¼ inches
Tubes, diameter	2¼ and 5½ inches	2¼ and 5½ inches	2 and 5½ inches	2 and 5½ inches
Tubes, length	19 feet, 0 inches	19 feet; 0 inches	15 feet, 0 inches	15 feet, 0 inches
Tubes, number	5½, 45; 2¼, 247	5½, 40; 2¼, 218	5½, 36; 2, 230	5½, 24; 2, 158
Heating surface, firebox	279 square feet	253 square feet	190 square feet	130 square teet
Heating flues	1,226 square feet	1,090 square feet	773 square feet	515 square feet
Heating tubes	2,752 square feet	2,407 square feet	1,796 square .eet	1,233 square .eet
Heating arch tubes	28 square feet	27 square feet	18 square .eet	13 square feet
Hasting total	4,285 square feet	3,777 square feet	2,777 square feet	1,891 square feet
Heating superheater	1,063 square feet	882 square feet	637 square feet	475 square feet
H. ating grate area	70.3 square feet	66.7 square feet	47 square feet	33.2 square feet
WHEEL BASE				
Driving	16 feet, 9 inches	16 feet, 9 inches	15 feet, 0 inches	11 feet, 0 inches
Total, engine	36 feet, 1 inch	36 feet, 1 inch	15 feet, 0 inches	11 feet, 0 inches
Total, engine and tender	71 feet, 8½ inches	71 feet, 4½ inches	53 feet, 0½ inches	49 feet, 9½ inches
Factor of adhesion	3.98	4.02	4.19	4.18
TENDER				
Wheels, number	8	8	8	8
Water capacity	10,000 pounds	10,000 pounds	8,000 pounds	8,000 pounds
Fuel capacity	16 tons	16 tons	16 tons	16 tons

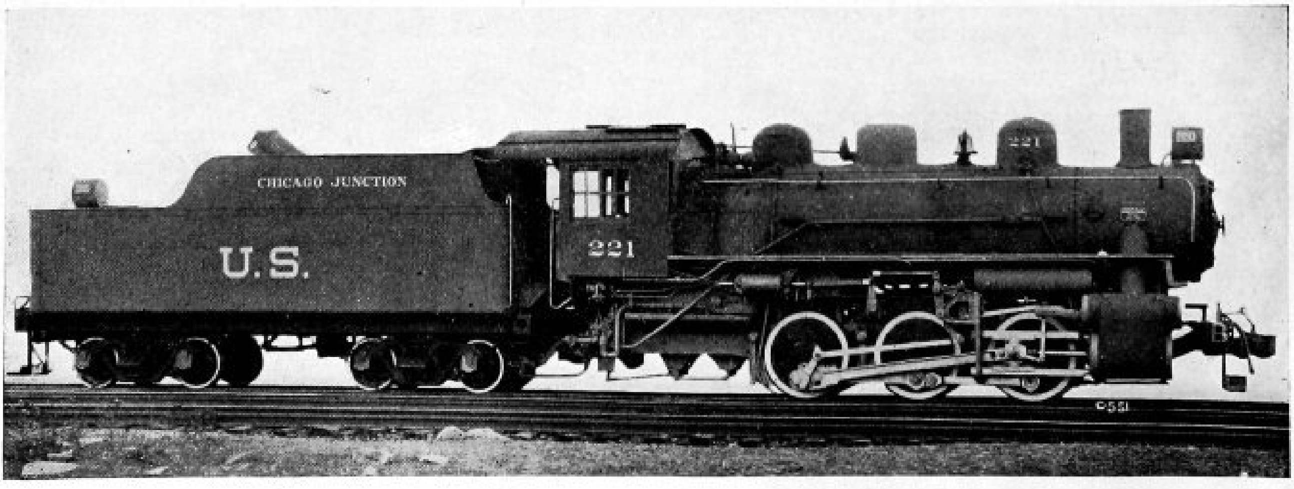


Fig. 4.—Standard Locomotive of Light Design for Chicago Junction Road

New Foreign Markets for American Made Boilers and Boiler Equipment

Exports Increased Over One-Sixth—New Fields Developed in South America and the Far East—European Markets Remain on War Footing

BY L. W. ALWYN-SCHMIDT

The last years have brought an increasing foreign demand for American boilers and boiler equipment. As a result $10,000,000 have been added to the yearly income of the American boiler making industry. The full significance of these figures may be better understood if it is known that the total value of the production of the United States boiler industry during the year 1914 was only $67,000,000, which included all general steamfittings, as well as steam boilers. To manufacture the boilers, boiler tubes and boiler fittings which were exported during the last year must have required approximately 2,200 additional men. More than $2,000,000 were earned as wages alone on work connected with that part of the production of the industry. The American boiler industry, therefore, has reason to be satisfied with this development. It is to be hoped that American boilers, having once found the appreciation of the foreign power engineer in other countries, will continue to hold their own against the competition which must be expected to return with the coming of peace.

Boilers Heavy Export Commodities

Boilers and boiler material do not make good export commodities. Because of their great bulk and weight, the freight charges on such shipments are naturally very high, and, therefore, these commodities, as a rule, can only be exported to nearby markets. But war has changed the standards of ocean transportation. After peace there will be a large American mercantile marine. The American boiler industry will have its assistance in support for the export trade. Great changes have taken place in other respects. Countries which before the war were content to import most of their industrial requirements have been compelled to manufacture these products. Much of the industrial equipment required for that purpose has also been supplied by the United States.

The time has come when the American boiler manufacturers should make an attempt to consolidate the favorable position they have gained in their new markets by working them methodically with a view to having also their peace business. To do this they must know approximately where their new customers are located.

Markets Open in South America

It appears that at the present time the South and Central American industries are those most interested in American boiler and general steam equipment. A considerable part of this trade, especially that going to the principal South American markets, Brazil, Argentine, Chile and Peru, is carried through the port of New York. Brazil, for instance, had received up to the end of July steam boilers at the rate of $120,000 this year alone. Argentine received boilers at a value of $18,000, Chile for $32,000 and Peru for $26,000. After July there has been a decline in shipments both to Brazil and Argentine, due to the difficulty of forwarding the goods. Business with Chile, however, has been brisk, and several shipments of boilers could be made to that country. Peru has also received a number of American boilers. Judging from the inquiries which have been received by manufacturers in this country and the orders in hand, there is a good promise for future business with the four principal South American markets.

Cuba has received American boilers valued at $100,000 by way of New York. Other orders were sent via southern ports. San Domingo also has been a heavy purchaser of boilers and boiler material. Mexico has bought several complete outfits and a number of single boilers. Four $25,000 boilers were shipped through New York. Among the smaller markets at our doors, Colombia, Venezuela, Panama, Ecuador, Haiti and the Guianas have shown much interest in American boilers. There was less demand for supplementary boiler equipment, such as boiler tubes, from South America than might have been expected considering the large orders that were given for boilers.

Probably the supplementary equipment supplied with the principal installation was of sufficient quantity and quality to make additional purchases unnecessary.

Opportunities in Europe

Business with European markets remains still strictly upon a war footing. This may continue to be so until conditions have become normal. The statistics of the port of New York are an excellent indicator for this part of the export trade. France, for instance, received by way of New York boilers valued at $44,000 during the first seven months of the year, and boiler tubes valued at $523,000.

Next to France, the best customer for American boilers and boiler material in Europe appears to be Spain. Spain is to-day the principal neutral in Europe, having taken the lead after the United States joined the fight against Germany. Industrially, the country was not well equipped when the war broke out, and considerable additions to its industrial equipment have accordingly been necessary. During the present year Spain has invested more than $120,000 in American steam equipment. Much more would have been taken if the usual shipping facilities could have been provided. As is is, the trade has been very erratic. Although most of the Spanish orders were given over a year ago, the first shipments could not be made before February of the present year. During that month nearly $60,000 worth of boiler tubes were sent to Spain. Deliveries were resumed during May, and a third large shipment was made during August.

Norway is the only other European neutral which seems to have shown any appreciable interest in American boilers and boiler equipment. England also has appeared as a customer for American boilers and boiler material. Shipments so far, however, have not been very extensive, and are not likely to increase very much in the near future. Italy, on the other hand, needs much industrial equipment to make herself independent of Austrian and German supplies.

In Asia, British India has proved the best customer for

American steam equipment. Since the beginning of the war New York alone has shipped boilers at a value of $62,000 to India. There has also been a very heavy demand for parts and boiler tubes. Our next best market in Asia is Japan, which has taken a great number of complete boilers and also a good deal of general steam equipment, most of which was shipped via Pacific ports. A small quantity valued at $30,000 has gone through the New York port. Although China is only now starting to buy American boiler equipment, it is doubtful whether she will be a big customer after the war.

Among the British colonial markets, New Zealand seems to hold, next to Canada, the best promise for our boiler makers, apparently last to make use of American boiler equipment. Several orders, however, were placed during the present year, and shipments dispatched. South African figures show that this continent has bought boiler tubes and similar equipment.

An entrance, therefore, has been gained to some of the best markets of the world, and the business so far obtained is large enough to make it worth our while to follow the trail.

Efficient Supervision of Railroad Shops*

Locomotive Mileage Increased by Speedy Repair Work at Roundhouse—Success of Government Management Rests with Men

BY FRANK MC MANAMY†

I have not come before you this evening for the purpose of holding any post mortems over past performances or to make any extravagant predictions for the future, but simply to talk to you for a short time about what I believe to be the most important factor in the successful and efficient operation of railroad shops, namely, efficient and sufficient supervision.

The importance or, in fact, the necessity of efficiency in the railroad organization cannot be overestimated, and, as stated by the Director-General in his report to the President, the efficiency of the railroads depends entirely upon the supply and condition of the motive power and the efficiency with which it is operated.

Supply and Maintenance of Equipment

The supply of locomotives has never been such as to cause serious apprehension, because with 18 percent, which is approximately one locomotive in every six, out of service for repairs, which was the situation last winter, we could not well say that a shortage of locomotives existed. The important question was to get the locomotives in shape to perform efficient service and maintain them in that condition. The big factor in this is the question of supervision of shops and shop work.

Reports show that there are employed in the mechanical department of the railroads under federal control 393,000 persons, of whom 255,000 are in the locomotive department and 138,000 in the car department. These are the persons who make up the maintenance of equipment forces, and the amount paid them for wages with the value of the material they use makes up the enormous sum under the caption "maintenance of equipment."

Essentials of Adequate Supervision

To insure efficient and economical handling of this labor and material, organization is required, and the prime factor in any organization is supervision. This supervision, to be effective must be adequate in quantity. Persons who have studied military and industrial organizations state that one man can properly supervise not to exceed 25 to 35 men, a figure much below that which is often used in railroad work, which has been known to extend to nearly 100 men.

Supervision, to be effective, must also be constant. The withdrawal of the foreman or supervising officer from his duties many times each day to answer summons from those in authority, the preparation of reports and routine office work which could be done in much less time by persons with clerical experience, the daily attendance of staff meetings, which necessitates absence from usual duties for periods ranging from thirty minutes to two hours, are not conducive to efficient supervision.

Many supervisory positions have been permitted to become supervisory positions in name only. We find superintendents of shops, master mechanics, general foremen, roundhouse foremen, and even men in positions of lesser responsibility, required to devote so much time to office work, to transmitting reports personally to superiors and to other work of like character, that they can devote little or no time to the direction of the active work.

Supervision, to be effective, must be instructive. Someone has said that the principal reason for not getting the result we anticipated was because we failed to explain just what was wanted.

The issuance of orders is the easiest thing in the world, but to issue a large number of orders is to insure their being disregarded. Voluminous instructions, therefore, should be carefully avoided, and if this is done and the instructions issued are brief and to the point, better observance may be expected. Instructions alone, no matter how carefully prepared, are of little value without a proper follow-up or checking system to see that the instructions are observed and the work up to the required standard.

Supervision, to be effective, must be courageous. The quality of production comes from the top, downward. We get from the average workman as good a job as we accept —no better. Supervision must maintain the accepted standards.

Responsibility of Executives

Since the government has assumed control of the railroads supervising officers have often made the statement that they did not know just what authority they had. In many instances, when matters which have always been handled by certain officials have been put up to them, their reply has been "I do not know whether I can handle this without instructions from Washington."

Paragraph 1 of General Order No. 1, issued by the Director-General on December 29, 1917, reads as follows:

"All officers, agents and employes of such transportation systems may continue in the performance of their present regular duties, reporting to the same officers as heretofore and on the same terms of employment."

This, in the absence of subsequent orders to the contrary, seems to me to effectually dispose of any doubt as to

* Abstract of address delivered before the New York Railroad Club, October 18, 1918.
† Assistant Director of Operation of the United States Railroad Administration.

the authority of supervising officers, and leaves the question of failure to properly supervise the work squarely up to the official involved.

There can be no question as to the authority of railroad officials under government control to perform all of their usual duties and there has been no lack of support from the Railroad Administration when those duties were properly and diligently performed.

A discussion of the question of supervision would not be complete without considering co-operation in connection therewith. The extent to which the supervising officer can get his force to work together for a common object depends almost entirely upon his attitude towards the men and his interest in the work that is being done. The supervising officer who considers that his full duty has been performed when he has issued instructions covering the work to be done is not going to secure any great amount of co-operation. He must show the employes that he has a personal interest in not only the work, but in the workmen. They must know that in addition to passing out the work slips he is going to follow them to see that the work is promptly done and in workmanlike manner.

Co-operation between shops and roundhouses is extremely important, and roundhouse jobs should be given preference and promptly handled.

Increasing Freight Locomotive Mileage

The freight locomotive miles for the period from January 1 to June 30, 1918, was 370,489,316. This mileage was made by 31,197 serviceable freight locomotives and represents an average daily mileage of 65.6 per locomotive. An increase of five miles per day for each freight locomotive will result in an increase of 7.62 percent in our freight locomotive miles, and would be the equivalent, measured by any standard, of 7.62 percent increase in our freight locomotive stock. It would be equivalent to adding 2,377 locomotives to our present equipment. With three exceptions, this exceeds the present number of locomotives on any railroad in the country. It is 962 locomotives more than the total number ordered by the Railroad Administration for their 1918 requirements, and represents the entire production of our locomotive builders for five months.

Figuring the average cost of a locomotive at $60,000, it represents a capital expenditure of $142,620,000. With the average mileage per serviceable freight locomotive down to 65.6 percent, is there any conceivable plan by which the expenditure of this vast sum of money can be so easily avoided as by increasing our existing freight locomotive mileage by five per day? This is particularly evident when we compare the average performance with the best mileage made by any class 1 railroad during that period, which is 101.9, made by one of the coal-carrying roads with heavy traffic and numerous branch lines and mine runs, and which, therefore, cannot be said to have been made under exceptionally favorable conditions.

Efficiency and Government Management

The railroads were taken over by the government, not because it desired to go into the railroad business, but because, under the conditions which existed at that time, increased efficiency was absolutely necessary.

The efficiency with which the railroads had been operated prior to that time was not the question at issue, because, however great that may have been, still greater efficiency was required.

The question before me at the present time is not as to whether government control or government ownership of railroads is a good thing or a bad thing; that will be settled by the people after the war.

The question before the railroad officials and employes to-day is solely one of operating efficiency and still greater efficiency in order to meet the demands placed upon them. The operation of the railroads of the country as a unit during the war is the most severe test that has ever been placed upon the railroad men of the country.

The operation of railroads is not only the Railroad Administration's job; it is also the railroad men's job. It is not the Railroad Administration's reputation that is at stake; it is the reputation of the railroad men that is at stake, which brings the issue down to each individual, which is just where it should be.

Conclusions

The railroad men of the country to-day, as I get their sentiments, are just a little bit in doubt as to what the future has in store. The Railroad Administration, as I have said, is not any one man's job. It is *our* job. There is no one man in the country big enough to look after all this work. But all of the railroad men in the country working together and trying to make a success of it, which is what most of them are doing, can put it over the top without very much effort.

The Railroad Administration desires to co-operate to the fullest extent to work together for the common end. We want to work together with a full realization of the statement that men cannot successfully co-operate for any purpose if the sole bond between them is self-interest. We realize that the men composing the railroad organizations of the country are about the best that can be found anywhere, and when the record of achievements is written for the past year the record of the work done by the railroad men will be second to none.

Increased Output of Standard-Gage Steam Locomotives

The standard-gage steam locomotive industry of the United States, operating under the direction of the War Industries Board, has increased its rate of production approximately 100 percent in the past three months, according to an announcement made by B. M. Baruch, chairman of the War Industries Board. Since 1910 and up to last August the highest number ever turned out in a single year was 3,776, which would represent an average weekly output of 72.6 locomotives. A recent week shows an output of 144.

The achievement is particularly noteworthy from the fact that in bringing about this tremendous jump in production it has been unnecessary to expend a dollar to increase plant facilities or enlarge the existing works—items of considerable expense in the development of most of the other war industries of the country. Redistribution of orders and concentration by each of the plants on particular types of locomotives have made possible an intensity of effort unprecedented in the industry.

The "Pershing" locomotive, built on standardized plans designed for the United States military railways, has not only been made the sole type of steam locomotive in use behind the American lines in France, but, at the instance of the War Industries Board, has been adopted by the British and French governments as the standard type for their armies on the Western front.

Last August the government, face to face with an immediate and urgent demand for steam locomotives for use in this country and France, was seriously considering the establishment of government plants to meet the emergency. At the suggestion of the War Industries Board, expenditure was held up in favor of the present plant.

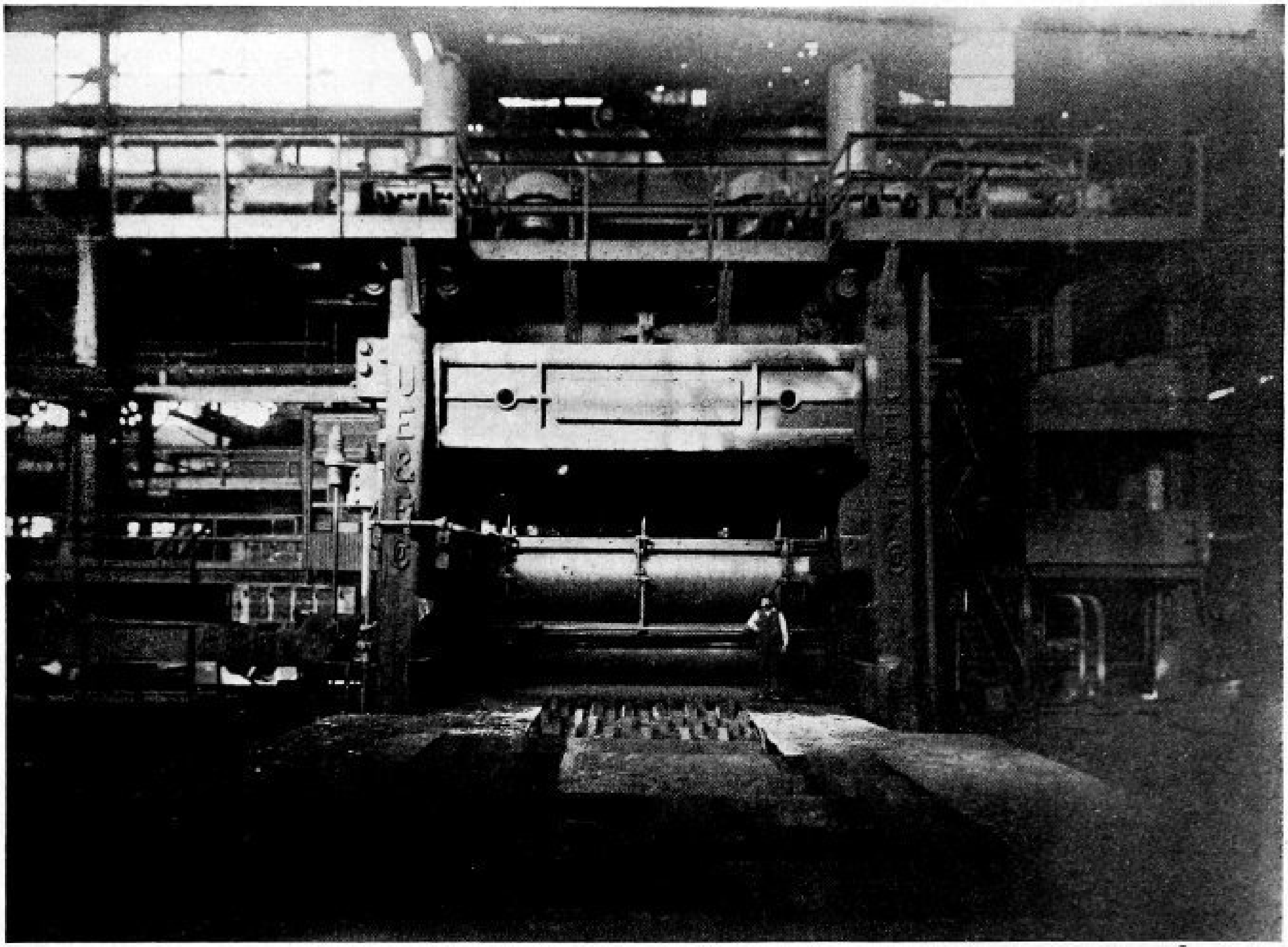


Fig. 1.—Showing Rolls of 4-High Reversing Type of Mill. The Two Cast Iron Working Rolls, 34 Inches in Diameter, Weigh 20 Tons Each. The Backing Rolls, 50 Inches in Diameter, of Cast Steel, Weigh 60 Tons Each

Lukens New Plate Mill Largest in the World

Of 4-High Type With Rolls 204 Inches Wide—New Mill Will Roll 5,000 Tons of Plate Per Week—Six Furnaces Added to Steel Plant

For the fourth time in history the largest plate mill in the United States is now in operation at the Lukens Steel Company's plant, Coatesville, Pa. In 1890 the company began operations with a 120-inch sheared plate mill, which was then the largest of its kind. Subsequently this mill was surpassed in size by a new mill installed by another plant. The Lukens mill was then rebuilt to 134-inch size. The advent of a new 136-inch mill again temporarily deprived the Lukens Steel Company of the distinction of operating the largest mill. The lead was regained in 1903, when the present 3-high 140-inch unit was put into service; then two 152-inch 3-high mills were installed in another plant in this country. Now the Lukens Steel Company comes forward to operate a 204-inch mill, which not only exceeds any unit in the United States, but also anything in any other country in the world. This mill, a 4-high reversing type, is capable of rolling plates up to 192 inches in width and circles a few inches wider. It will exceed by a wide margin the 178-inch mill of the Witkowitz Works in Austria and the 168-inch mills which are the present limit of the 2-high plate stands in the British Isles.

The Lukens Steel Company has established other precedents. It was at their plant that the first boiler plate in America was made. This was about 1820. This boiler plate was rolled at the plant under the direction of Dr. Charles Lukens, grandfather of Abram Francis Huston, who is now president of the company, and Charles Lukens Huston, vice-president. The finished product at that time was hauled by team to Philadelphia, a distance of forty miles; fuel was also hauled a distance of forty-two miles to the mill.

Capacity of the New Mill

The new mill has just been started as an independent unit. Until now, the shortage of men (since many were needed to complete some of the equipment and to operate the mill) has prevented running it except for a few hours a week. Judging from the work done so far, however, the mill has proved to be the stiffest ever built. Even on extreme widths the variation in gage at center is comparatively slight.

A novel plan for handling and weighing the plates after shearing, designed by C. L. Huston, has been installed. Further devices are being planned to eliminate almost entirely all hand labor about the shearing department. More accurate shearing than has been possible by the old-fashioned methods heretofore in use will also be achieved.

MILL BUILT FOR BOILER PLATES

This mill was built to take care of the large plates required by builders of locomotives, ships and marine boilers. A picture of one of these huge marine boiler heads is here illustrated. Not only were the flat plates made in the Lukens plant, but the flanging upon these one-piece heads was done in the flanging department of the same company. Heretofore, these heads have been flanged in two pieces, and hand flanged besides. Now heads can be flanged in one piece for 15-foot boilers. Flanging boiler heads of these sizes in one piece has never before been done in this country. Making them in one piece enables this company to furnish machine-flanged heads, which are excellently finished. When flanged in one piece, the complete head is heated and flanged at one time by the rolling process; whereas, if made in two pieces at the boiler shops, the head is heated a number of times and flanged all the way around, a process which sets up internal strains on the metal on account of the heating and cooling. Some of the pictures shown herewith give an idea of the loading of these plates and heads. For the larger heads it is necessary to use the drop or well-bottom car.

FURNISH LOCOMOTIVE BOILER STEEL

The Lukens Company furnish the greatest percentage of the railroad locomotive boiler steel used in this country. They also specialize in steel for marine boilers, of which, it is claimed, they furnish the largest percentage. The new mill will make other records possible.

4-HIGH TYPE USED TO HANDLE HEAVY WORK

The decision of the Lukens Steel Company to build the largest plate mill in the United States came about in an interesting way. As is frequently the case, obstacles encountered in an entirely different direction were responsible for the new venture. Because of the growing demands from ship and car builders, railroads and other large plate users for greater widths, the Lukens Company took into consideration the building of a 180-inch 3-high mill after the accepted American standard.

As first planned, this mill would have been larger than any in the United States or in Europe. When it came to obtaining the chilled rolls of the size and weight desired, however, no manufacturer in this country could be persuaded to undertake the contract. The 50-inch diameter rolls required for a mill of the 3-high type that had been settled upon were greater than anything the roll makers in this country had previously attempted. The difficulties of manufacture forbade them bidding for this business. Consequently, the adoption of the 4-high reversing type of mill which Vice-President Huston had previously been studying was proposed. This change, he believed, would make it possible to maintain the fine chilled roll finish upon the plates, thereby avoiding the difficulties of roll manufacture that had been encountered, and to admit of using a still larger size than 180 inches. The detail designing of the mill has been carried out by the joint collaboration of the engineering staff of United Engineering and Foundry Company, and Paul C. Haldeman, master mechanic of the Lukens Steel Company.

DESIGN OF THE NEW MILL

The new mill is built on the principle of the 2-high reversing plate stand commonly used in the British Isles, with a modification, viz., that the two finishing rolls are backed by two large supporting rolls. The purpose of these latter rolls is to stiffen the mill and to give it the added strength necessary to prevent springing of the operating rolls when rolling wide, thin plates, thus insuring uniform thickness in the finished product. This arrangement also enables the use of operating rolls of smaller diameter, and thereby overcomes the difficuties of obtaining chilled rolls of the size which would be required in a 3-high mill of this extreme width. There are two 34-inch diameter by 204-inch working face operating rolls of chilled iron with 27-inch necks weighing about 30 tons each, and two 50-inch diameter backing rolls of cast steel with 36-inch necks, weighing about 60 tons each.

The housings of the mill are of steel and are built up in four parts, consisting of two side pieces—a top bridge piece containing the screw box, and a bottom bridge piece in which is located the seat for the bottom rolls. This novel method of construction is necessitated by the unusual size of the housings, which preclude their being cast in one piece, since their machining and transportation in such form would be impossible. Each housing thus built up weighs over 400,000 pounds. The mill stands about 40 feet from the top of the screw cover to the bottom of the shoes, and its overall dimensions are slightly over 42 feet. The housing shoes are spread 16 feet 9 inches between centers and are of special design with extra large bearing surfaces.

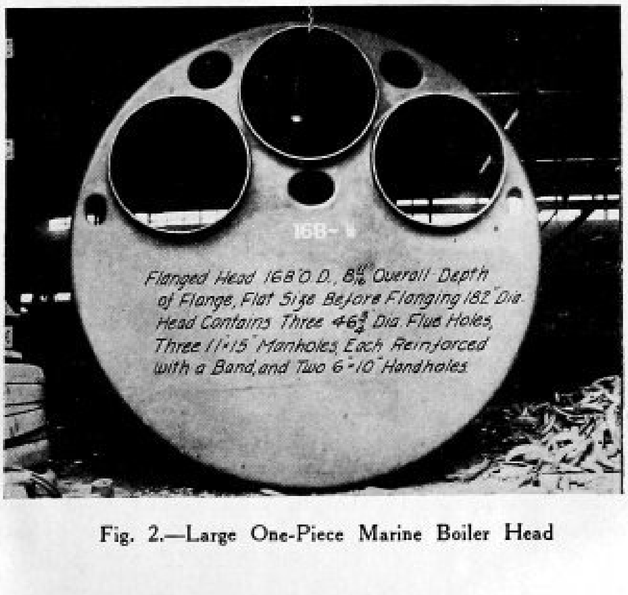


Fig. 2.—Large One-Piece Marine Boiler Head

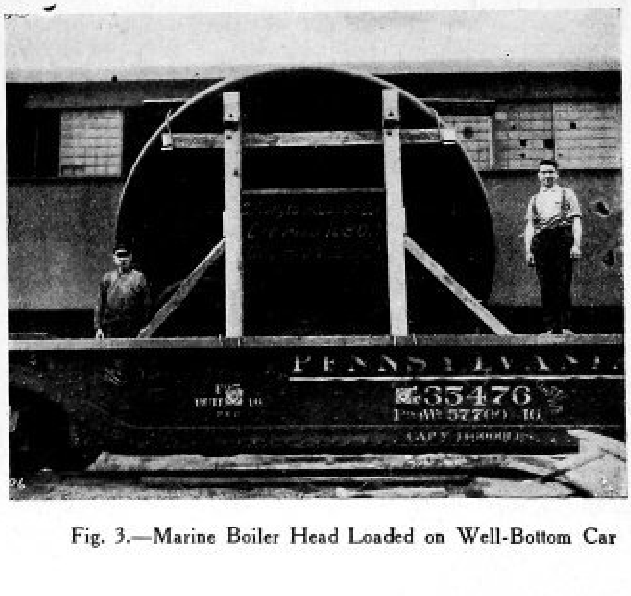


Fig. 3.—Marine Boiler Head Loaded on Well-Bottom Car

The foundation of the mill is of concrete built on solid rock. It is of strong, simple design, which is made possible by the cylinder arrangement. The two-top roll supporting cylinders are carried on the top spreader between the housings, and are so arranged that they can be used as operating cylinders for changing rolls. The screw-down rig is of the well-known worm and worm wheel design, and is driven by two 150-horsepower motors, one on each housing. These motors act as a roll release in case of a stall.

The mill pinions are of cast steel and have double helical cut teeth, 42-inch pitch diameter by 60-inch face. These pinions are connected to the working rolls by spindles 20 feet long. The bottom spindle is of the usual design, while the top or vibrating spindle has special universal couplings. To insure the driving of the bottom backing-up roll, C. L. Huston deemed it necessary that this should have some suitable power connection between the pinions and the mill, as he feared there would not be sufficient friction between the bottom working roll and the backing-up roll to drive the latter at all times. This power connection has been accomplished by means of a friction clutch, which gives a sufficient drive to the bottom roll and allows slippage between the two bottom rolls, preventing breakage. The friction is driven by gear on an extension to the neck of the bottom pinion driving into a third spindle, which connects with the bottom backing-up roll through the friction clutch, located midway between the pinion and roll housings. This friction is in duplicate, and is so arranged that the device can be replaced in a short time, should it become necessary. The large backing-up rolls are turned in the mill, places for turning rests being provided in the housing design. These rests are left in position in the housings all the time, and only require adjusting to the roll for use in turning. The 34-inch chill rolls are removed and ground in a special grinding machine, which has been built for the Lukens Company by the Norton Company, of Worcester, Mass. This is the largest grinder ever constructed for this class of work. The changing of the 34-inch diameter rolls has been worked out very carefully and incorporated in the mill design. In this operation the rolls are lifted by the top roll balancing cylinders and placed on a specially constructed buggy, which runs in on the middle roll rest bars. This arrangement allows the roll to be pulled out of the housing window, where it is picked up by the overhead crane. The 50-inch diameter backing-up rolls are removed in the same manner if at any time this is found necessary.

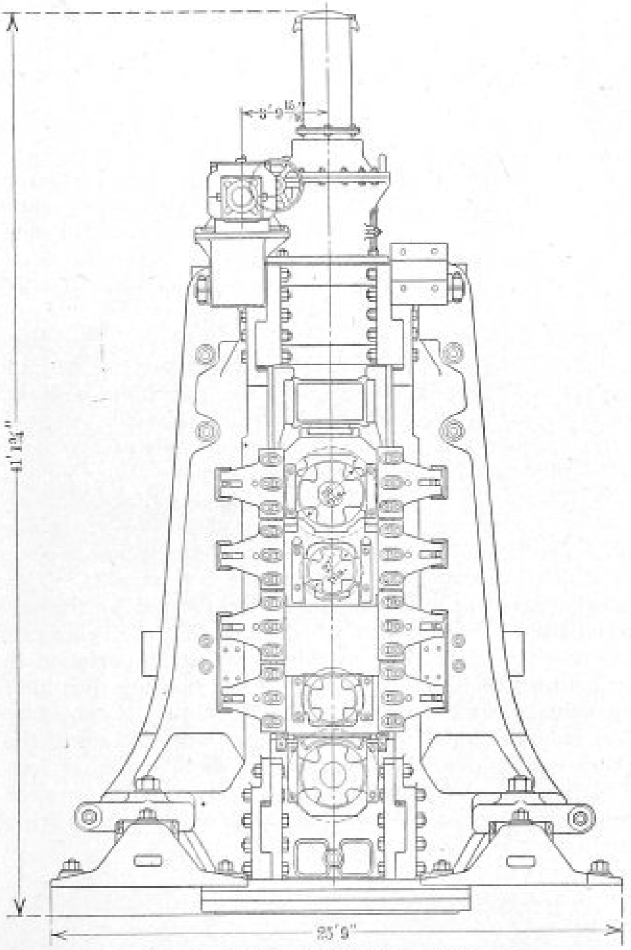


Fig. 4.—Exterior End View of Mill

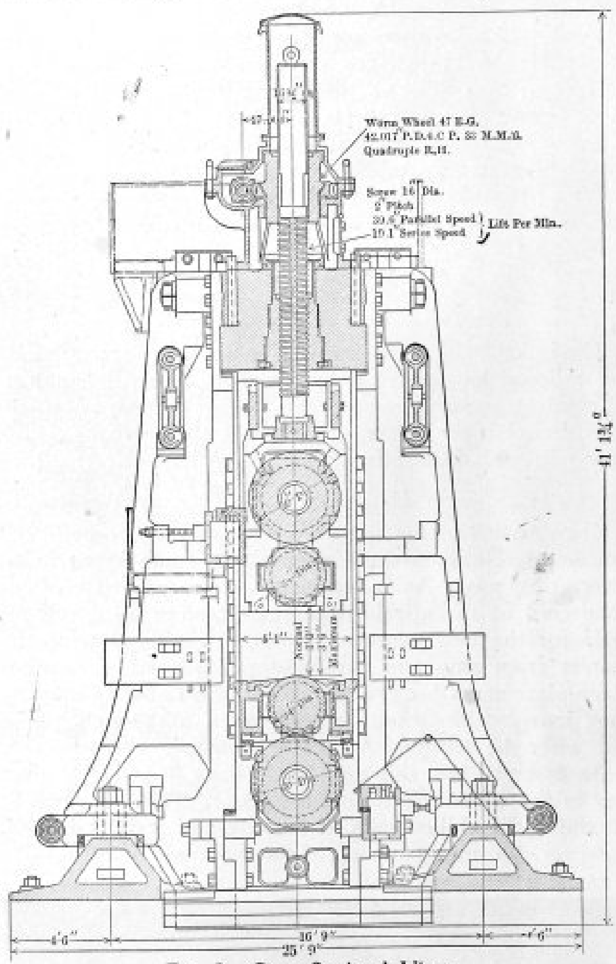


Fig. 5.—Cross Sectional View

The bottom pinion is connected to the engine jack shaft by a finely machined leading spindle of the universal type. This connection is to insure a minimum of back lash. This leading spindle is so arranged that it can be quickly removed and a slow-motion turning rig slid in place to be used in dressing the 50-inch backing-up rolls. The mill has a slack-up of 40 inches.

Driving Mechanism

The mill is driven by a 46 by 70 by 60-inch twin tandem compound condensing engine, fitted with a jack shaft and a gear ratio of one to two, which renders it capable of giving an enormous torque for rolling wide plates. The engine was designed and constructed by the Mesta Machine Company, of Pittsburgh. The steam for operating this engine is obtained from Babcock & Wilcox waste heat boilers located on open hearth and re-heating furnaces; these boilers are operated at 160 pounds pressure and 100 degrees superheat.

Process of Rolling the Plates

The mill is fully equipped with tables so arranged to do away with hand labor wherever possible. The ingots are received from the furnaces by a hydraulically operated ingot tilter, from which they go to the approach table, and from there to the mill tables. The approach table is about 40 feet long; the mill tables are of about equal length. Each mill table consists of ten cylindrical rollers and five disk rollers. These rollers are driven by cut gearing, and the bearings and gearings are flood lubricated by an oil-pumping system, which is installed in duplicate. These tables are equipped with mechanical appliances for handling large plates, so that it is not necessary for them to be touched by hand power, as is usually the case in other present-day mill practice.

Routing of Plate After Rolling

The plates, after being rolled, pass over the runout table, 65 feet long, to the straightening rolls. These straightening rolls, furnished by Hilles and Jones Company, Wilmington, Del., after C. L. Huston's special design, are motor-driven. After leaving the straightening rolls, the plates pass to the cooling tables. These are mill transfer chain roller tables, arranged so they can be operated in triplicate. Either one, two or three tables are used, depending on the length of the plate transferred. If the plate is over 35 feet long, two tables are needed; if over 70 feet, three are used. An inspection tilt-up device for turning up the plates so that the bottom side may be inspected is located in this table. It is operated by hydraulic cylinders. This rigging is of the necessary size and strength to accommodate plates 204 inches wide.

Cut-Off Shear with 210-Inch Gap

After inspection, the plates proceed to the shear runout table through the cut-off shear, which is hydraulically operated and has a 210-inch gap. The cut-off shear is located in the shearing building, as is also the side shear, which is of the same size, and the necessary scrap shears. Between these shears are located tables specially designed by C. L. Huston for the handling and turning of wide, long plates. These take the place of the usual caster roller arrangement, avoiding hand labor. Another set of transfer chains carry the plates sidewise to the shipping building, where they are weighed and loaded.

The Heating Building

The heating building contains eight gas-fired pit furnaces; some of these contain three holes 7 by 9 feet, while the others contain four holes 5 by 9 feet. This furnace building is served by two 30-ton cranes. The main mill building is 70 by 215 feet and contains one 75-ton

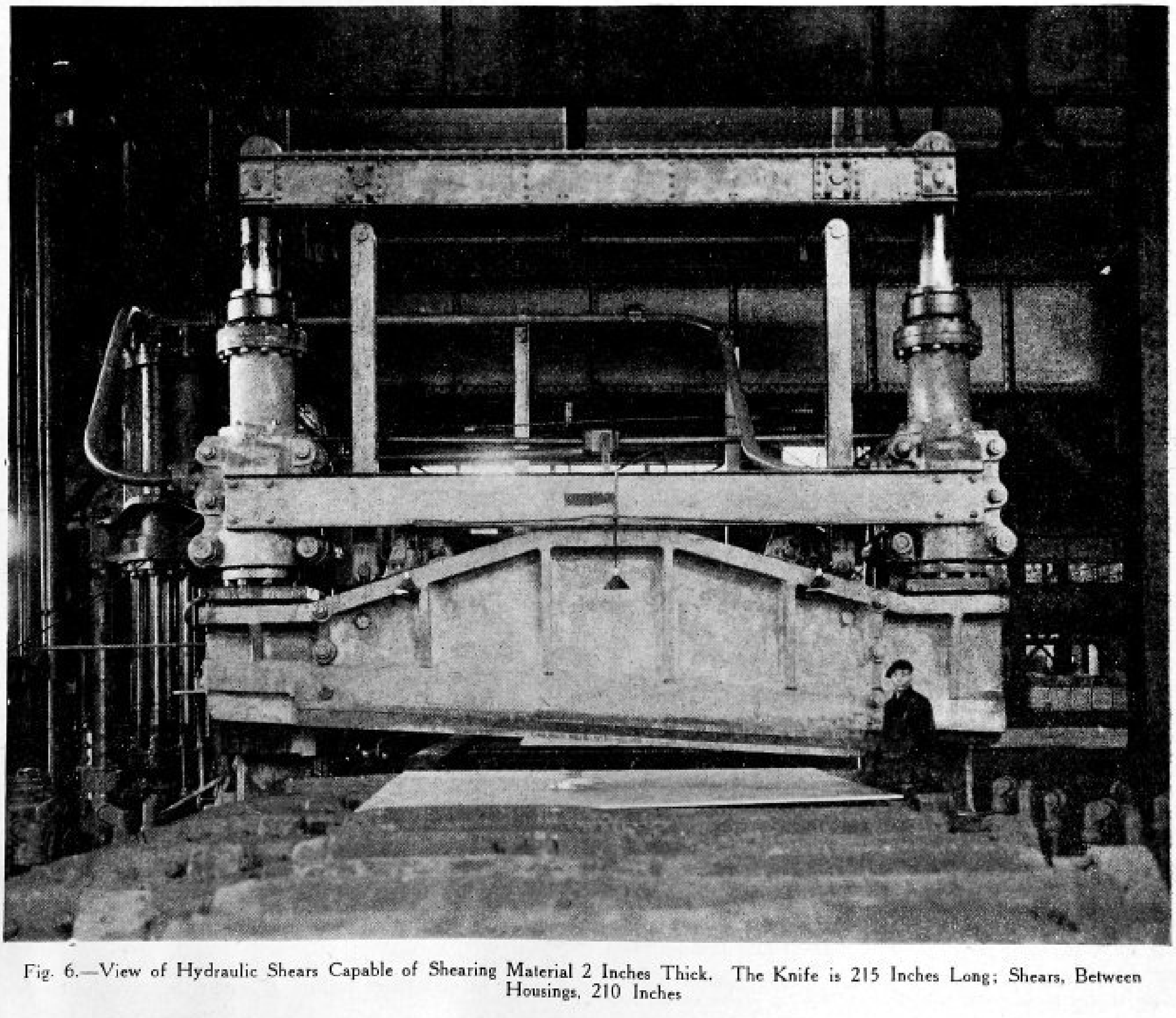


Fig. 6.—View of Hydraulic Shears Capable of Shearing Material 2 Inches Thick. The Knife is 215 Inches Long; Shears, Between Housings, 210 Inches

repair crane for the mill. The cooling building is 100 by 240 feet; the shearing building 80 by 240 feet, and the shipping house 90 by 505 feet. Two smaller buildings are located on either side of the main mill building.

Since it is possible to roll ingots up to 60,000 pounds in weight, all the machinery is constructed with a view of handling these heavy plates. These large plates are rolled direct from the ingots, but, since this has always been the practice in the Lukens plant, no serious trouble is experienced from this. When the mill is operating at its full extent, it is estimated that it will have a rolling capacity of 4,000 to 5,000 tons per week. The new mill is known as the No. 5 mill and is located parallel to the present 140-inch 3-high plate mill. The position of the two mills and the arrangement of the tables permit easy transfer of hot ingots between these two units by means of a transfer buggy. By this arrangement, ingots can be drawn from the No. 5 mill and rolled in the 140-inch mill, or vice versa.

New Steel Plant to Furnish Material

To supply the increased metal to operate the new mill, an additional steel plant comprising six basic open hearth furnaces of 100 tons each has just been finished. There is room for two more furnaces, work on which has been started. Including this group of eight furnaces, which presents a distinct open hearth installation, the Lukens plant will consist of twenty-three basic furnaces and one acid furnace. The estimated annual capacity will be about 500,000 tons of finished plates.

How to Design and Lay Out a Boiler—III

Thickness of Butt Straps—Rivet Failures Due to Tearing of Plate, Stretching of Holes or Tendency to Shear

BY WILLIAM C. STROTT*

To continue the calculations begun in previous numbers, the distance between the centerline of ring seams is found to be 17 feet 11 inches—(3½ + 3½ inches) or 208 inches. The shell will be made in two equal courses. Hence, the distance between which the rivets on the calking edge of the longitudinal butt joint will be spaced is one-half of 208 inches, or 104 inches.

It should now be recalled that we decided on a calking pitch of 3½ inches, which will go into 104 inches $\frac{104}{3.5} =$ 29.7 times, but we should have a whole number of spaces—preferably an odd number, as this will balance the arrangement at each end, which can be proved by trial—hence we will try 29 pitches, which will make the length of pitch $\frac{104}{29}$, or very nearly 3⅝ inches. This will give a maximum pitch of four times 3⅝ inches, or 14½ inches.

In order to design joints of maximum efficiency for given shell plate thicknesses, experience has proven that the butt straps must be at least 80 percent of the thickness of the shell plate material. Table 4 gives the minimum thickness of butt straps permissible in connection with shell plates from ¼ inch to 1¼ inches thick.

TABLE 4.—MINIMUM THICKNESSES OF BUTT STRAPS

Thickness of Shell Plates, Inch	Minimum Thickness of Butt Straps, Inch	Thickness of Shell Plates, Inch	Minimum Thickness of Butt Straps, Inch
¼	¼	17/32	7/16
9/32	¼	9/16	7/16
5/16	¼	⅝	½
11/32	¼	¾	½
⅜	5/16	⅞	⅝
13/32	5/16	1	¾
7/16	⅜	1⅛	¾
15/32	⅜	1¼	⅞
½	7/16		

From the table we find that with 17/32-inch shell plates, butt straps 7/16-inch thick are required.

We finally have all the necessary "dope" to calculate the efficiency of the joint, but before proceeding with these calculations it might be advisable first to familiarize the student with what is meant by rivets being in single or in double shear.

A comparison of the two portions of joints, illustrated in Fig. 9, will readily show what we are talking about. If sufficient stress be applied to a joint, as in (*a*), it may at once be surmised that the rivets will be cut or sheared on one line which forms the juncture of the surfaces of the two overlapping plates; but in (*b*) the rivets must be cut through in two places, which will be on the two lines forming the juncture of the surfaces of three plates. The student should be aware of the fact that it requires just twice the stress, or pull, to make joint (*b*) fail by shearing as it does in joint (*a*). For convenience and future reference, we shall denote this method of joint failure by *Sh*.

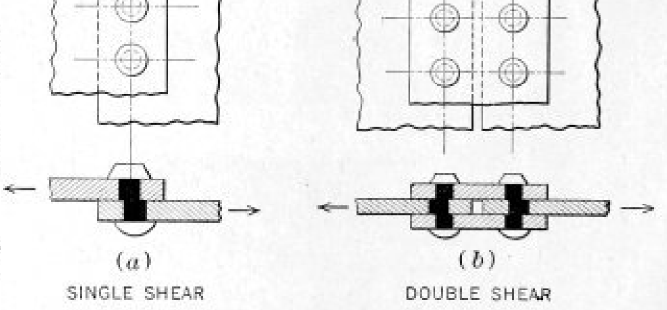


Fig. 9.—Comparison of Single and Double Shear Joint Failure

In addition to the rivet failure just cited, a joint may also fail by tearing of the plate ligament between the rivets, as illustrated in Fig. 10. We shall hereafter refer to such failure as *T*.

Still another method of failure, which must be provided against and which also enters into the calculations for joint efficiency, is the tendency of the plate just in front of the rivets to crush and result in stretching of the rivet holes, as indicated by Fig. 11. This method of failure we shall term *Cr*.

In summing up, failure *A* occurs when the rivets are too small in diameter; failure *B* when the rivet pitch is

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

either too great or the plate too thin, or both; in short, when the cross sectional area of the metal between the rivet holes is not sufficient to resist the tension in the plate. Failure by method *Cr* will occur when the plate is too thin, regardless of the rivet diameter or pitch. These three methods of failure may occur singly, independent of each other, in any type of joint, but in butt-strapped joints having inside and outside straps of unequal width, these failures may also occur in pairs, as will be demonstrated later.

It might be stated here that the true value sought for E in formula (1), given previously, is in reality the efficiency of the weakest part of the joint, which recalls the former statement that "a chain is no stronger than its weakest link."

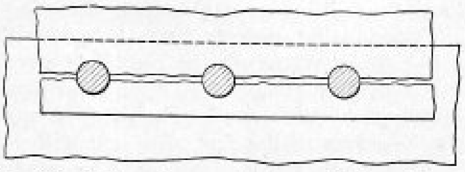


Fig. 10.—Failure Due to Tearing of Plate Ligament

In the "old days," before State boiler laws were enacted, it was the usual practice to assume that any riveted joint was weakest through the net section of plate between the rivets on the line of maximum pitch; in other words, that it was always supposed to fail by method T explained above. However, the net plate strength is but one link in the chain, and the danger in making such an assumption lies in not being absolutely certain whether all other parts of the joint are correctly proportioned. Nevertheless, it is quite true of any riveted joint that if the least efficiency occurs at the net plate section, that joint is designed for maximum efficiency. In all future work, covering riveted joint calculations, the following notations will be employed, in which all dimensions will be in inches:

P = maximum rivet pitch.
p = calking pitch (except for saw-tooth joints).
p_1, p_2 or p_3 = diagonal pitch (either one or all, depending on type of joint.)
x, y or z = back pitch (either one or all, depending on type of joint).
t = thickness of shell plate.
b = diameter of butt straps.
a = area of rivet hole = $.7854d^2$.
L = lap = $1.5d$.
T_s = ultimate tensile strength of shell plate material in pounds per square inch.
c = ultimate crushing strength of shell plate material in pounds per square inch.
s = ultimate single shearing strength of rivet material in pounds per square inch (as given in Table 5).
S = ultimate double shearing strength of rivet material in pounds per square inch (as given in Table 5).
N = number of rivets in double shear in a unit length of the joint.
n = number of rivets in single shear in a unit length of the joint.
w = number of rivets in the innermost row in a unit length of the joint.

TABLE 5

Iron rivets in single shear..............	38,000
Iron rivets in double shear..............	76,000
Steel rivets in single shear..............	44,000
Steel rivets in double shear..............	88,000

For convenience, one unit length of the joint (meaning all that part contained between the centerlines of two rivets of maximum pitch) is all that need be reckoned with. Fig. 12 illustrates in detail one such "unit length" of a quadruple riveted, double butt-strapped joint, the notations given on which are a few of those previously referred to.

The student should realize that the calculations will apply to but one-half of the joint on each side of the centerline, because each half carries the full stress developed in the boiler shell.

The first thing he must find, when about to calculate the efficiency of any joint, is the maximum plate strength that would be available at that point if there were no rivet holes; in other words, if the shell were seamless. The efficiency of such a joint would be 100 percent.

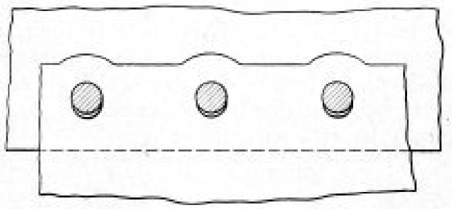


Fig. 11.—Failure Due to Stretching of Rivet Holes

Good practice would seem to demand that all parts of a riveted joint be evenly balanced. If the plate value gives a 92-percent efficiency, the shearing value of the rivets, together with the crushing value of the plate in front of the rivets, should also fall around 92 percent, and vice versa, since there is no necessity in having one part of a joint any stronger than any other part.

Denoting this value desired by W, we write:

$$W = PtT_s.$$

Substituting values for letters, it becomes:

$$W = (14.5 \times .53125 \times 55{,}000) \text{ or } 423{,}671 \text{ pounds.}$$

However, on account of cutting rivet holes in the plate, the available net strength is only

$$(P - d)\ tT_s.$$

Substituting, we have

$$(14.5 - .9375) \times .53125 \times 55{,}000, \text{ or } 396{,}279 \text{ pounds.}$$

Hence the efficiency of the joint with regards to failure, previously designated T, is found by dividing the available plate strength by the "possible" or solid-plate strength. Therefore:

$$T = \frac{396{,}279}{423{,}671} = .9351, \text{ or } 93.51 \text{ percent.}$$

The next method of failure in order of importance is the tendency of all the rivets to shear, as explained before, and designated as failure *Sh*. It will be advisable, at this stage, for the student carefully to study Fig. 13 until he thoroughly understands which rivets are in single and which are in double shear. He should convince himself of the fact that those rivets shown solid, of which there

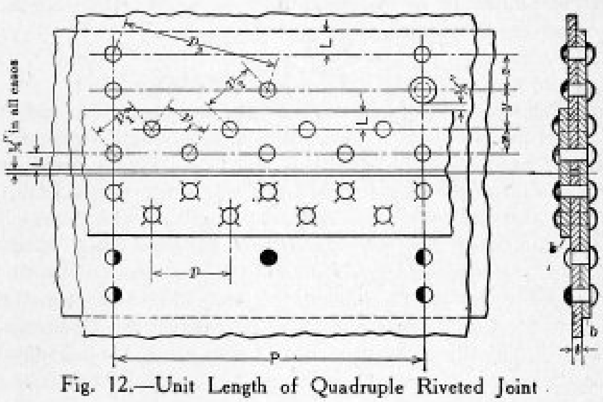


Fig. 12.—Unit Length of Quadruple Riveted Joint

are three (one hole and four half), are in single shear; likewise, that there are eight rivets in double shear, designated by a circle with four projections.

Steel rivets, on account of their greater strength, thereby permitting the use of smaller diameters, will be employed. Referring to Table 5, and to the previous notations, we find that s = 44,000 pounds per square inch, and S = 88,000 pounds per square inch. The shearing value of the three rivets in single shear is

$3 \times 44{,}000 \times a$ (in which $a = .7854d^2$, or .6903 square inch). Solving, we get

$$3 \times 44{,}000 \times .6903 = 91{,}120 \text{ pounds.}$$

The value of the eight rivets in double shear is found to be

$$8 \times 88{,}000 \times .6903, \text{ or } 485{,}971 \text{ pounds.}$$

Therefore, the total rivet strength of this joint is

485,971 pounds + 90,120 pounds, or 576,091 pounds, and the efficiency of the joint with regards to failure by this method is found by dividing the combined rivet shearing strength by W, whence

$$Sh = \frac{576{,}091}{423{,}671} = 136 \text{ percent.}$$

This seems entirely too high, and we may encounter a very decided weakness in some other part on this account.

The next method of failure to be introduced is one of the combination variety, concerning which previous mention was made, but which was not explained due to its complexity.

With reference again to Fig. 12, it should be readily seen that a break may occur in the net section of shell plate between the rivets of the third row (which is on the calking edge of upper butt strap). This failure is similar to method T, except that in this case there also exists the shearing resistance of the rivets in the outside rows, from which it may be inferred that the failure of the plate and the rivets will occur simultaneously, therefore the efficiency at this point is based on their combined strength. Occasionally students have raised a question something like this, "Why isn't the combined strength of shell plate between the rivets of all four rows figured instead of merely the fourth row? The clearest answer to this is that the stress in the first row is exactly what it is in each of the other three, the plate in neither row assisting the others, so we consider the weakest section. There is no reason at all why the plate ligaments in the third row cannot fail, leaving the inside edge intact, since the net plate sections are the same.

(To be continued.)

New Lights on the Economic Factors of Business Efficiency

When the members of the Society of Mechanical Engineers came together at their annual meeting, December 3 to 6, 1918, many special economic problems which bear upon efficient business administration were taken up in the papers read before the society. Active participation in war industries and contact with men and methods in this country, Canada and England have brought new light into the engineering camp. These ideas are passed on in the following abstracts.

Why has the word efficiency, which should stand for so much, fallen into disrepute in this country, is the question answered by H. L. Gantt, in his remarks before the society. We all recognize the importance of both individual and collective efficiency. Yet in the mind of the average business man or mechanic the term "efficiency engineer" raises a feeling of hostility. To some of us the reason seems plain, simply that we have in the past measured the "efficiency of our business" by the dollars acquired, rather than by the goods produced. In other words, the efficiency engineer has served the business system primarily in the accumulation rather than in the production of wealth.

Efficiency and Democracy

A business system bent on the accumulation rather than on the production of wealth, which would even curtail the production of wealth if thereby a larger measure could be brought into its own coffers, must needs finally run to the limit of its tether. A method which makes more efficient such a system shortens the time which it has to run. An efficiency engineer who, consciously or unconsciously, served the business system in the exploitation of workmen, necessarily got the ill will of the workman. He later got the ill will of the business man, who found that the amount of wealth he could get by exploitation was strictly limited.

When the great war broke out in 1914 it became evident that the production of goods for the benefit of the community, and not the production of wealth for the benefit of those who control the industries, was the task which had been set the nations engaged. It took England more than a year to learn this lesson, and we should have been fully prepared for it in 1917. That we were not prepared for it, and that many believed we could still continue business as usual, is now history. We have learned, however, that production for the benefit of the community was the only basis on which we could carry the war to a successful conclusion. This has been emphasized by the elimination of "non-essential" industries.

Idle Machinery Indicates Inefficiency

There is another reason why the term efficiency has been brought into disrepute. In the past our cost-keeping methods have always loaded onto the part of the shop which produced the goods the total expense of the shop, including the part that was idle. The term "efficiency" then seemed to have no connection with capital or investment, but only with labor. Under such conditions there was but little inducement to the owner to make his machines produce more, and the reverse of an inducement to the workman, who was thereby laid off or saw his friend laid off. This fatal error which caused the opposition of the workman, and the lack of sympathy on the part of the employer, was evidently due to a false accounting system, which was devised to put all the burden of inefficiency on the workman.

When the great war started in 1914 it became impossible for the product turned out to bear the expense which had previously been distributed over a production three or four times as large; most people said, "These are extraordinary times; therefore we shall have to lay our cost system aside to keep till the war is over." Some people, however, realized that a system which is not good for an emergency, when it is most needed, has something radically wrong about it. This was the answer: The product of a factory must bear only the expense used to produce it. It cannot bear the expense of idle machinery which did not contribute to its production. The keener business men have realized that idle capital is no more entitled to wages than idle labor, and have begun seriously to study their plants to find out how they can use them to their full capacity. The result of this investigation is twofold:

(a) It does not result in laying off men, but gives employment to more men, which secures the good-will of the worker.

(b) It not only reduces the expense of maintaining machinery in idleness, but turns out a greater product from which revenue is gotten.

In a few words, then, if we will eliminate our false cost-keeping methods, and put in those that are correct, we shall not only benefit both employer and employee, but go a long way toward the democratization of industry.

Labor Dilution as a National Necessity

Not only in the field of efficiency has war acted as an educator. Its schooling is catholic. That the term "labor dilution" originated in England shortly after the declaration of war with Germany was brought out in a paper by Frederick A. Waldron. Its original application was intended to carry out in effect what the word "dilution" literally implied; namely, a thinning or spreading out. As applied to labor, it means the thinning out or spreading of the functions of the skilled workmen among those that are less skilled. A Bureau of Labor Dilution was therefore established by the Government to supervise and carry out its requirements.

The original objective of this bureau was to relieve the skilled workman in the performance of certain elementary functions of a task by employing less skilled workers for this purpose and thereby accomplishing a given task in a shorter time. This bureau has created an element in labor dilution which was not included in the original programme in that it has already established in the minds of the consumer the fact that waste of labor and materials is the greatest foe to labor dilution. It is the engineer who must solve this problem in a scientific and satisfactory manner.

Ultimately it must be "the survival of the fittest." A nation's industries must be those for which it is particularly adapted; they must be conducted in the most economical manner, and facilities for vending and transporting their products must be on an equally economical basis. For products of equal quality, those having the lowest unit costs will naturally maintain commercial and industrial supremacy. The nation, therefore, which can deliver to the consumer its converted natural resources in the minimum time with the least expenditure of human energy is the nation which will lead the industry and commerce of the world.

This will involve the engineering of men and materials in the broadest sense. To accomplish this means a most broad and comprehensive national policy in the organization of our legislative, banking, business, agricultural, transportation, mining and manufacturing policies.

Labor dilution, as a part of the reorganization problem, should include the questions of the functionalizing of the work of the skilled operative for the less skilled operative, the eliminating of all work except that which is absolutely necessary to produce the results, and the economizing in the use of the necessities of the day.

After discussing the post-war problem of the scarcity of unskilled labor, due to cessation of immigration and the return of so many foreigners to Europe in war service and for reconstruction work over there, Mr. Waldron held that standardization of products and processes, aided (1) by co-operation of legislators, engineers, capital and labor, (2) by elimination of non-essential effort for compiling statistics, office and administrative work and of the non-essential citizen—the idle man—and (3) by education of executives and workmen so that the *fullest use of all the available man power would be possible*—all these factors would bring about results in this reconstruction period.

The English, with their customary conciseness, have expressed in the two words "labor dilution" that which it would require volumes to describe or discuss.

A study of the problem indicates that, in its broadest meaning, labor dilution and the engineering of men are practically synonymous, since the former involves all that the latter implies.

British Engineering Standard Association

The subject of standardization was very ably handled by C. Le Maistre, secretary of the British Engineering Standards Association. It may fairly be said that the primary objects of standardization are to secure interchangeability of parts, to cheapen manufacture by eliminating the waste of time and material entailed in producing a multiplicity of designs for one and the same purpose, and also to expedite delivery and so reduce maintenance charges and stores. In 1901 the British Engineering Standards Committee was founded. From the small nucleus of seven members, a far-reaching organization has developed with some 160 committees, sub-committees and panels, including in all over 900 members, and dealing under one central authority with standards relating to practically the whole field of engineering. The British Engineering Standards Association has provided the neutral ground upon which the producer and the consumer, including the technical officers of the large spending departments of the Government and the great classification societies have met and considered this subject of such vital interest to the well-being of the engineering industry of the country.

The standardization of steel sectional material was the first work taken up by the committee. Standardization in other fields followed. The Indian Government requested the committee to undertake the question of standard design of locomotives, and these have proved of immense value.

It would appear from the steelmakers' returns for 1913, giving the tonnage of lengths rolled of each section, that 95.7 percent had been produced by standard rolls, and only 4.3 percent by non-standard rolls, the work thus having proved of immense utility to the steel makers.

Financing the Association

In regard to the question of finance, the funds for carrying out the work of the committee have been provided by the Government and the industries concerned. In 1903 the Government included in the estimates a substantial contribution, which was subsequently extended for the years 1904-5-6 by a grant-in-aid equal to the amount contributed by the supporting institutions, manufacturers and others. This was continued on a smaller scale down to 1916, and a further grant on the same condition is being continued to March, 1919. The Indian Government has been a generous supporter of the committee, and the governments of other overseas dominions have also given financial assistance.

The expenses of the whole organization up to the war were under £4,000 a year, but, owing to the widening of the field of its labors, this amount has been very greatly exceeded.

The Main Committee, as the governing committee is called, consists of members nominated by the leading technical institutions, viz., the Institutions of Civil Engineers, Mechanical Engineers, the Iron and Steel Institute, the Naval Architects, and the Institution of Electrical Engineers; there are also two representatives of the Federation of British Industries; and three members, not representative of any institution or association, but elected for their eminence in the profession.

The Main Committee is the sole executive authority, and all specifications and reports are presented to it for final adoption. The procedure before embarking on any new subject is to ascertain by means of a representative conference that there is a volume of opinion favorable to the work being undertaken. If such is the case, the Main Committee nominates the chairman of a sectional committee to take up the work in question, this committee being formed of technical officers representative of the various Government departments interested, representatives of the trade organizations concerned, and, lastly, experts in the subject to be dealt with.

Standardization, after all, is no more and no less than proper co-ordination. To effect it may necessitate the sinking of much personal opinion, but, if its goal, through wideness of outlook and unity of thought and action, is the benefit of the community as a whole, standardization as a co-ordinated endeavor is bound increasingly to benefit humanity at large.

"Don'ts" for Apprentices and Others

Don't "monkey" with a machine "just for fun," as a machine will not take a joke, and you will be punished every time.

Don't try to operate a machine for the first time without receiving full instructions from some one in authority.

Don't shift heavy belts by hand unless you are an expert, and then great care should be taken not to get caught.

Don't wear shoes that are so worn out that a splinter or nail will go up through the sole and cause a serious injury.

Don't wear ragged, loose sleeves when running machines, as the ends are likely to be caught somewhere, and you will lose a finger or two.

Don't chip toward anyone without a screen between you.

Don't lean against a machine that is running, and it is better to keep a safe distance from any mechanism in motion or likely to be set in motion. Never ride a planer table.

Don't stop a planer by half shifting the reversing belt; always stop it by the countershaft.

Don't use the emery wheel without wearing goggles provided by the company.

Don't touch the teeth of a moving gear or cutter.

Don't set a lathe or planer tool when the work is in motion.

Do not allow a tool to run by the work so far as to cut into a lathe spindle. A machine looks strong, but it can be very quickly and easily injured.

Don't score a planer bed or make holes in a drill table.

Don't lay a long file or any tool on the ways of a lathe; don't cut into a lathe arbor.

The running part of a machine should be oiled every day, and sometimes oftener. If you take a machine that someone else has just been running, don't trust that it has been oiled that day; oil it yourself, but stop it first.

Don't waste oil by pouring it on so that the greater part runs away; the company loses a great deal of money through the careless use of oil; a drop in the right place does more good than a cupful on the floor.

Don't be afraid of soiling your hands, as it is impossible to work in a railroad shop and keep your hands white and smooth. Don't wear gloves except for the roughest work, and never when running machines.

Don't get your suit of overalls covered with grease and dirt; with a little care you can keep much cleaner than you think. A dirty suit doesn't always mean that you have done a lot of hard work; it more often indicates a careless, untidy disposition.

Don't put your tools where you can't find them easily; "have a place for everything and everything in its place."

Don't let files destroy one another by throwing them together in the drawer. Don't use a monkey wrench for a hammer.

Don't put finished work in a vise without using copper or lead jaws.

Don't swing a sledge or hammer that you know is working loose on the handle, thinking that it won't come off 'til next time; you may not get hurt, but what about the other fellow?

Don't strike highly tempered steel with a hammer; many eyes are destroyed from this cause alone.

Don't do a bad job; any man to whom a bad job is not a lasting mortification shows himself lacking in self-respect. A long job may soon be forgotten, a bad one never.

Don't go over your foreman's head with your grievances, as the man you go to will send you back to the foreman and give you no satisfaction; moreover, the foreman will never forget it.

Don't get excited and cross over little things. Many a man has lost splendid opportunities by letting his temper run away with him.

Don't spend your entire life in the shop, and don't talk too much shop outside of working hours. All your leisure time (except that spent in study) should be given up to rest and wholesome recreation.

Don't worry about your work; if you have made a mistake and spoiled a piece of work, don't be afraid of what the boss will say; take what he has to say and don't do it again.

Don't think that you are so important that the company can't get along without you; there is always someone waiting to take your place and do your work as well or perhaps better than you did.

Don't be afraid to work a few minutes overtime without pay; no matter what the foolish ones say, you will make an impression on the boss, which may put you ahead of them all some day.

Don't have a grouch. Be cheerful and willing at all times. Smile once in a while.

Don't spend your money foolishly. Save a little if you can. Start a bank account, if only a very small one.

Don't be too thin-skinned and touchy; many a competent young man has taken off his overalls and quit because he couldn't stand the jokes of the shop men or some hasty order or censure given him by a busy foreman.

Finally, don't forget that there is always room at the top. Keep striving for that goal, as no one knows just when he will arrive there. Keep plugging away every day doing your best, and time will tell. If you are not kept in the service after serving your time, there is generally a good reason, and nine times out of ten you will guess the reason without anyone telling you.—Henry Gardner in *Railway Mechanical Engineer.*

Boiler Manufacturers Meet in Cleveland to Discuss Reconstruction Problems

Better Organization Planned to Aid in Stabilizing Prices—Adoption of Standard Data Sheets and Uniform Cost Accounting System Recommended

At a special meeting of the American Boiler Manufacturers' Association held at the Hollenden Hotel in Cleveland on December 16, to discuss the problems facing the boiler making industry during the reconstruction period, W. C. Connelly, president of the association, first called for a report on the activities of the War Service Committee since the convention in June at Philadelphia.

G. S. Barnum, of the Bigelow Company, New Haven, senior member of the committee, presented the following report:

Activities of War Service Committee Covering Period from July 1 to December 16, 1918

At our annual meeting in June, Charles M. Schwab, Director General of the Emergency Fleet Corporation, stated that between eighty and ninety ship hulls had been launched and were awaiting boilers. Believing that this condition reflected upon the patriotism of the members of this association, the committee secured an interview with Mr. Schwab on August 5, and we firmly believe that the boiler manufacturing industry was taken out of a false position through the facts presented by the committee. At the same time we endeavored to have Mr. Schwab agree to Item "D," under clause No. 30, of the standard specifications and contract form, covering marine water-tube boilers, which your committee prepared. This clause reads as follows:

"The price is based upon the present rate of wage now being paid by the contractor, and any increase or decrease in the price of labor during the time that these boilers are under construction will be figured as follows (which difference is to be paid by the contractor or purchaser, dependent upon increase or decrease in the hourly rate of labor):

"Take the difference between the present average shop rate as shown by contractor's payroll and the new average rate of pay per hour and add to this difference an amount equal to 150 percent of said difference as the contractor's overhead charge, equal to 10 percent for profit on labor.

"The amount to be added or deducted to the price of each boiler due to the increase or decrease in wages as stated will be obtained by multiplying the said increase or decrease in the hour rate by the number of hours required to manufacture each boiler or portion thereof. Contractor must notify purchaser promptly after change in average shop rate, stating what said change amounts to per boiler."

We regret to have to report that we were not successful in this—principally for the reason that we could not state that all of our members were using a standard form of cost accounting. For this reason, Mr. Schwab stated that the auditing of the books of so many boiler manufacturing plants at a time when the Government had so many other things to do was impossible. Payment for the exact difference between estimated cost and final cost of labor will be possible, we believe, however, on the basis of a guaranteed number of shop hours per boiler, this to be multiplied by any difference in the average hourly rate between the rate at which the work was figured and the hourly rate in effect when the boilers were built. But it will be necessary for any manufacturer at once to notify the proper department regarding said advance in hourly rate and obtain their sanction.

During our interview with Mr Schwab, he requested that we have on file not only a complete statistical report regarding all boiler manufacturing plants in reference to their buildings and equipment, but also data as to the total horsepower on order at that time, volume of work ahead, on a horsepower basis, and their total monthly output on a horsepower basis. Your committee at once prepared and mailed to all boiler manufacturers a new form of questionnaire embodying the above information, and prompt replies were received from practically all boiler firms. Copies of these questionnaires were then placed on file with the Power and Electrical Section of the War Industries Board, and, we believe, were of invaluable service to that department.

Mr. Schwab also asked for suggestions as to a proper course to avoid a repetition of having ship hulls launched and no boilers available. On August 12 your committee offered the following recommendation:

First.—Have Purchasing Department of Emergency Fleet Corporation consult frequently with our War Service Committee, and when large numbers of boilers were to be ordered to consult with your committee as to the quantity to be given to each firm.

Second.—That all orders for boilers be "cleared" through the Power and Electrical Section of the War Industries Board. This would avoid getting too many orders in one plant and the facilities of other good plants would be brought into use.

Third.—By seeing that materials entering into the construction of Emergency Fleet boilers be delivered to the boiler manufacturers in proper quantities and in sufficient advance of delivery date of boilers as to enable the boiler manufacturing plants to maintain their shop schedules.

Representative of Boiler Industry on War Industries Board

About July 15 a representative of the Power and Electrical Section of the War Industries Board requested a meeting at New York, with a view to having your committee suggest to them the name of some man qualified to enter their department for the handling of the boiler industry exclusively. Your committee is gratified to be able to report that the Edge Moor Iron Company, of Edge Moor, Del., volunteered to donate the services of one of their branch managers, which was accepted by the War Industries Board. The Edge Moor Iron Company neither sought nor obtained any Government contracts during the time that their representative was in the service of aforementioned department.

On October 17 the War Industries Board, through the Power and Electrical Section, summoned your committee for a conference regarding the boiler problems. At this meeting it was decided that it would be necessary for every boiler manufacturer at once to file a complete report of all orders, size of units, working pressure, for whom being built, etc., and that following this report a semi-monthly report be filed, showing shipments during that period, as well as new business. A standard form of report was prepared, but the signing of the armistice removed the necessity of sending out these blanks.

At the request of the Priorities Section of the War Industries Board, your committee filed with them a list of the members of this association, and also informed them that full data regarding shop facilities of each plant were on file in the office of the Power and Electrical Section, in the form of the questionnaire referred to. These two departments work together very closely, and, further, furnish the Fuel Administration with the information bearing upon your classification in reference to your obtaining coal.

ATLANTIC CITY RECONSTRUCTION CONFERENCE

Following the request of the Chamber of Commerce of the United States, calling for a convention of all War Service Committees of American industries at Atlantic City, December 4, 5 and 6, we report as follows:

"At the 'Related Group No. 11' meeting there were about two hundred representatives, representing perhaps thirty lines of industry which were more or less related, especially as to raw materials. A resolution committee of seven was appointed, representing seven of these various industries, including the boiler industry. This committee worked for about three hours in going over the various sets of resolutions offered by each of the organizations in Related Group No. 11, and same were then acted upon by the two hundred delegates and forwarded to Major Group No. 3, which constituted those in the iron and steel lines.

"At both meetings of Major Group No. 3, your committee recommended the continuance of fixed prices on iron and steel products at least until April 1, 1919. This resolution carried in both group meetings after considerable debate, but was lost when it went to the final Clearance Committee. The action of the Iron and Steel Institute during the past few days in recommending a reduction in the price of iron and steel products evidently was known by some of the steel men attending the above-mentioned group conferences.

"Your committee learned that a great many other industries were receiving very heavy cancellations. The Machine Tool Manufacturers' Committee stated that practically all of their members had received very heavy cancellation of orders. Alba Johnson, president of the Baldwin Locomotive Works, stated that his firm had received cancellations to the extent of sixty-five million dollars.

"During the Related Group Conference a resolution, bearing on the matter of 'Taxation,' advocating the 1919 War Tax Budget not to exceed four billions instead of eight billions as originally planned prior to the close of the war, was submitted and favorably acted upon. This resolution also received favorable action at the Major Group Meeting, as well as the Final Meeting of the entire conference.

"Your committee wishes to bring to your attention that priority will probably continue for some little time on orders for the Emergency Fleet Corporation and the navy.

"W. C. CONNELLY, Chairman."

THE CHAIR: During the reconstruction or readjustment period upon which we are entering there will be a greater need of co-operation among the manufacturers of boilers than there ever has been in the past. In my opinion, industry is now undergoing a very radical change, and it is more than probable that some former business customs may never come back into use. As suggestions for your consideration, I offer the following:

Reconstruction Problems

First: Find a method of stabilizing the prices of your product.

Second: Industrial relations between employer and employee.

Third: Adoption of some method to secure foreign trade and avail ourselves of the Webb-Pomerene Act recently passed by the Government, regarding combination of manufacturers for securing foreign trade.

Fourth: The use of trade acceptances in securing prompt payment for the deferred payments on your sales.

Fifth: Completing of a standard cost accounting system along the lines suggested in papers prepared for this association by some of its members during the past three or four years. This important subject was one of the thirty-five resolutions accepted at the Reconstruction Conference of American Manufacturers.

Sixth: Wherever possible standardizing a method of estimating amount due to members of our industry on contracts cancelled by the Government, where some material was purchased and work has been performed.

Seventh: Appointment of a committee of boiler manufacturers to act as appraisers on all boilers which the Government will now offer for sale, in this way endeavoring to avoid a break in the market and at the same time see that the Government obtains what is a fair value for such boilers as they may offer for sale.

Eighth: Appointment of a committee of our members to work with a similar committee of stoker manufacturers in working out a standard clause regarding guaranteed efficiency of boiler and stoker.

Ninth: Preparing of a standard form of data sheet and urging all states and cities to use the same standard form.

Tenth: Whether or not this association wishes to follow the following recommendation offered at the recent Reconstruction Conference, said resolution being one of said thirty-five offered to the convention by the General Committee on Resolutions:

"It is the conviction of your committee that it is absolutely essential to the stability of the business in this country and the prompt and wise solution of our problems that the War Service Committees should continue their work of co-operation with Government agencies and now turn their attention to the new questions with which the country is faced.

"We therefore recommend that all present committees so represent their industry and that an executive committee be named with as little delay as possible.

"It is believed that the time has now arrived when a council representing these industries be formed, and it is recommended that this council be composed of the chairman of each of the War Service Committees."

Those are some of the things we have brought for your attention this morning, but they are only the suggestions of your committee, and we hope that some of the members here have other questions for discussion.

Future of Emergency Fleet Programme

You are all more or less interested in the future of the Emergency Fleet programme; promptly at the close of the war your committee got in touch with the Emergency Fleet and asked what might be expected from them in the future in the way of boiler needs. Their reply is as follows:

"In reply to your letter of November 12 in regard to the future programme of the Fleet Corporation, I beg leave to advise you that as yet a definite future programme has not been established.

"It is probable that future contracts for wooden vessels will not be placed, and for the present at least additional contracts for steel vessels are not to be awarded. The steel shipbuilding programme for 1919 will continue.

J. L. ACKERSON,
Vice-President and Assistant General Manager."

Foreign Trade

THE CHAIR: Getting back here to the problems that we have to take up to-day, first on the programme is the adoption of some methods to secure foreign trade and avail ourselves of the Webb-Pomerene Act recently passed by the Government regarding combinations of manufacturers for securing foreign trade. I would like to hear from some of the members if they have given any thought to going after export business.

MR. DRAKE: We have been doing considerable exporting in the last three or four years and a little before that. We have established agencies in only one foreign country—Japan.

MR. FISHER: We have done a very little exporting through New York commission houses, but we have no foreign representatives.

MR. SHOULDER: We do a little exporting in packing house machinery, but not in boilers; we get those orders through a concern in St. Louis that has a foreign representative.

Trade Acceptances

THE CHAIR: How many firms here are obtaining payment on their deferred payments in the way of trade acceptances? Unless we get trade acceptances for our boilers we will find that we need much more working capital than we have had in the past for paying bills by trade acceptances, unless we collect in the same way.

MR. HAMMERSLOUGH: We think it is a very good thing and will adopt it.

MR. WEIN: We have tried to use it, but the buying public is not educated up to the trade acceptance. We intend to use it as far as we can.

MR. BARNUM: I think we will automatically have to come to it; the mills will start it. Whether it is policy for us to adopt it before the mills force it on us is a question.

MR. WEIN: We should get in on this right off. If, eventually, we have to use the trade acceptance in paying for our tubes and plates and other things and do not have a source of immediate income, it simply means that we have got to go out and borrow money to finance both ends of the business.

MR. WOODMAN: There is no question but what trade acceptances are coming quite rapidly. It would be a good plan if the Boiler Manufacturers' Association would come to some definite conclusion about it and adopt a uniform practice. I believe it will be very desirable for this Association to make up its mind definitely to-day or else turn the matter over to a committee for a very early report, so that the thing may actually be accomplished.

MR. CAMPBELL: It will be only a short time before we will have to adopt trade acceptances. We ought to go on record either right now or later in the day as agreeing to that.

It was voted to postpone further consideration of trade acceptances until later in the day.

Unfilled Contracts for High-Priced Steel

THE CHAIR: I presume we are nearly all in the same boat on the question of unfilled tonnage from the rolling mills ordered on a high-priced market. Steel running anywhere from 5 to 10 cents a pound was purchased in the latter part of 1917, prior to the fixing of the price by the Government, and we have unspecified tonnage at the mills. Now that the bars are down, the mills are asking you to take that high-priced tonnage. We ought to be a unit on the method of procedure in adjusting that matter and make all the mills and all the boiler manufacturers stand together in the way that seems to be the most equitable.

MR. BRODERICK: Some action should be taken to-day to show that this organization stands for a reduction on anything not delivered or shipped before the thirty-first of December.

MR. FISHER: We do not have any of the high-priced tonnage coming from the mills, but some tonnage on the Government price. My understanding is that some of the mills have already stated that they would invoice that material at the price ruling at the time of shipment. That seems to me the only fair thing they can do. I feel that if we are a unit in recommending that to the mills they would accept it.

MR. CAMPBELL: The mills ought to agree to bill the material to us at the market price prevailing at the time. We have had to take some 8-cent steel this last week; I tried to get out of it, but I couldn't do it, so I took it.

MR. BACH: We have some 10-cent plates, but not many. We admit the validity of a contract, but we had specified that material for shipment, and it is due to the failure of the mill to supply it that we have got it still on our books. They could not ship it and now they want us to take that 10-cent plate. We don't want to cancel the tonnage, but we will take it at the prevailing prices, not at the old prices.

MR. BAKER: If you buy high-priced steel, they have got to make you a reasonable delivery or they cannot hold you to the contract, and they cannot cancel a low-priced contract with us when the fault was theirs in not shipping it.

A MEMBER: It might be mentioned that the mills were often willing to cancel the unspecified portion of previous contracts, but the price kept coming up, and a man was fortunate to have a contract at a little lower price; and if he did not specify the proper tonnage to be shipped at a certain time, they were mighty glad to cancel that and did so.

MR. WOODMAN: We have a small amount of 10-cent steel. The contract was for a comparatively small tonnage and was placed in July, 1917, which was well before the establishment of the government-fixed price. The contract calls for shipment of the steel in approximately equal monthly allotments at the convenience of the mill. There is a clause in it, as I remember, which gives the customer a corresponding right. A few weeks ago the steel company started out to call upon all their old 10-cent customers to specify the balance of their contracts and take the goods. I wrote a frank and friendly letter to them pointing out the fact that where they required for themselves a privilege they also extended to their customers a like privilege. I stated that as the order was old, months had elapsed during which they had made no effort to make a shipment, there was no reason why, at the present time, they should not accept a cancellation. I never received an answer to that letter, and doubt very much if they will ever come through and ask me, in the present condition, to accept the balance of that 10-cent steel.

MR. CHAMPION: I do not buy any boiler plate, but we buy a great many rivet bars. Up to the end of the year we paid a price that we intended to pay on our contracts up to the end of this year. For all shipments after January 1, we will pay the new price.

I would advise everyone here to buy only what they absolutely need until the end of the year. Don't let anyone hang a high-priced contract over your head and try to bamboozle you into the notion that you are morally bound to take it out on that contract. You are entitled to the market price at the time of shipment.

MR. BRODERICK: As late as Saturday I wanted some tubes shipped in immediately, and the steel corporation asked if I could wait for the shipment until after the first of the year. They said there would be a reduction of $5 a ton, and if I would wait the tubes would be billed at the reduced price. If they would bill the tubes that way, I am satisfied they would bill plates and bars the same way. The corporation has been always very fair along that line.

CLEARING HOUSE ARRANGEMENT PROPOSED

MR. COX: I think it would be a good idea if we could have a clearing house so that we would each know what the other man is doing and what action is being taken and what position is being taken by the steel mills about cancelling contracts, so that we can argue with the steel mills if the question does come up.

THE CHAIR: I think that that is a very good point and the only way that the matter will be adjusted to mutual advantage.

MR. BARNUM: I think the independent mills are morally bound to take the same attitude as the United States Steel Corporation.

MR. BRODERICK: In order to bring pressure against the individual mill or any concern that undertakes to hold up the boiler manufacturer under those high prices, I would like to make a motion that this entire matter should be referred to the War Service Committee of our association.

Mr. Broderick's motion, amended to include this year's prices on unfilled tonnage, was adopted.

Cancellation of Government Work

THE CHAIR: How many present have had cancellations on direct government work?

REPRESENTATIVE OF CASEY & HEDGES, of Chattanooga: We have.

THE CHAIR: Had you performed any of the work prior to cancellation?

CASEY & HEDGES: Yes.

THE CHAIR: Have they sent appraisers out to see what work you have performed and make an adjustment with you?

CASEY & HEDGES: No sir. I would like to know what the attitude of the members of the association is in connection with the adjudication of those contracts.

General Goethals' letter regarding the matter follows:

TERMINATION OF CONTRACTS AND ORDERS

WASHINGTON, November 9, 1918.

1. Whenever the appropriate officers of the Government determine that it is necessary, in the public interest, to terminate in whole or in part a contract of a purchase or procurement order for materials or supplies, such termination shall be effected as herein directed.

2. Whenever such contract or order expressly provides that it may be terminated in the public interest, termination may be effected only in accordance with such provisions unless it shall be in the public interest to terminate it in accordance with the provisions of this circular and the parties shall agree thereto.

3. Whenever such contract or order does not expressly provide that it may be terminated in the public interest, the contractor, if the public interest so requires, shall be requested to suspend work thereunder in whole or in part and to supply promptly a report under oath showing in detail the following information in so far as applicable:

(1) Raw materials on hand, cost plus inward handling charges, plus such portion of overhead as is directly applicable.

(2) Partly finished products on hand; cost of raw material and labor, plus such portion of overhead as is directly applicable.

(3) Finished products on hand; contract price, less freight charges if the contract or order specifies delivery at point other than factory.

(4) Special facilities; cost of facilities specially provided and paid for by the contractor for the performance of the contract, the necessity of which was contemplated at the time the bargain was made, and the cost of which was included in the contractor's original estimate. From the cost of such facilities, deduct their fair value at the time the contract or order is terminated, and state such portion of the remainder as is represented by the ratio of the uncompleted portion to the whole contract or order.

(5) Commitments; the contractor's commitments to suppliers, sub-contractors and others for contributing materials or work, to be determined in so far as applicable in the same manner as indicated in (1), (2), (3) and (4). If the contractor claims additional compensation by reason of any other item or items, he may add such item or items together with a detailed statement of the facts on which his claim is based.

4. Unless otherwise directed by the Chief of the Bureau, the contractor shall be requested to suspend work and shall not be given notice of cancellation. If a notice of cancellation is given, the contracting officer of the Government loses his power to enter into a supplemental agreement with the contractor.

5. No allowance will be made for prospective profits, provided, however, that with the consent of the Chief of the Bureau an allowance of not more than 10 percent of the cost of partly finished products on hand may be allowed.

6. If the agreement is reached on a just and reasonable compensation to be made to the contractor by reason of the suspension and termination of the contract or order, such agreement shall be embodied in a supplemental contract which shall set forth the agreed compensation and shall provide in specific terms that it constitutes full and final settlement of all questions and claims growing out of the original contract or order. Such supplemental contract shall also provide that all raw materials, partly finished products and finished products on hand shall become the property of the United States, unless to the extent that the parties agree that such materials and products shall remain the property of the contractor, in which event the Government shall be credited with the agreed value of the same.

7. Each such supplemental contract shall provide that it shall not become a valid and binding obligation of the United States until it has first been approved by the Board of Contract Review of the Supply Bureau affected.

8. The Chief of the Bureau may direct that no such supplemental contract, or no such supplemental contract providing for payment in excess of a specified sum, shall be executed by the contracting officer unless first approved by the Chief of the Bureau.

9. Attention is directed to General Order No. 103, November 6, 1918, creating the Board of Contract Adjustment and empowering such board to hear and determine all claims, doubts and disputes, including all questions of performance and non-performance which may arise under

any contract made by the War Department in instances in which the contractor and the contracting officer have been unable to agree.

10. This circular applies solely to the termination of contracts or orders in whole or in part in the public interest, and does not affect the right of the Government to cancel a contract or order by reason of the contractor's default, which subject is left to be determined by the provisions, if any, of the contract or order and the principles of law applicable thereto.

By authority of the Secretary of War,

GEORGE W. GOETHALS, Major General,
Assistant Chief of Staff; Director of Purchase, Storage and Traffic.

MR. FISHER: We had some cancellations from the Navy Department. On work that is completed they gave us shipping instructions, but on work that is in progress they want a bill of materials and an estimate of how much labor you have put on it; then they want to know whether the labor can be used on some other job or whether you would have to let it go if you did not use it on their work.

MR. JOHNSON: In our factory we furnished a large quantity of cast iron stands, cesspools for drainage, and other staple stuff. We have had a dozen telegrams cancelling boiler stands and cesspools and that sort of stuff for various cantonments, and all contained this reference Mr. Fisher speaks of to the disturbance of labor. They wanted to know whether labor would be thrown out of work or transferred to other departments, etc. The labor feature seemed to be paramount.

MR. COVELL: I would move that it is the sense of this meeting that the basis of settlement of canceled contracts offered by General Goethals under date of November 9 be accepted by this body as a fair method of cancellation of all contracts in which our industry is involved.

The motion was seconded and adopted.

AFTERNOON SESSION

THE CHAIR: Coming back to the morning programme and dwelling again on the War Service report at the Atlantic City convention, I would like to read to you some of the resolutions that were passed there by Major Group No. 3, of which the boiler industry was one.

In the Related Group meeting, our committee stood for fixed prices on iron and steel products. The clearance committee of that group killed it. It went in before the assemblage and the assemblage reversed the clearance committee and passed it as follows: "Iron and steel prices should be maintained until July 1, 1919." When the Major Group meeting came, embodying perhaps a thousand men, this same resolution was killed in committee there, but was passed as we wanted it in the main meeting; but when it went to the final clearance committee for the entire conference, it was killed again, evidently at the request of the Steel Corporation, which has since then reduced the price on that particular commodity.

Some of the other resolutions follow: "No. 2; for fair tax purposes, the Government should allow depreciation on inventory value of materials and machinery purchased at excessive prices. No. 3; the Government should settle immediately for canceled contracts. No. 4; would fix federal taxes for 1919 at four billion dollars payable in four installments; would not fix taxes at this time for 1920. No. 5; gradual disposition should be made of Government stores." By that was meant material that the Government has purchased, in some instances boilers that had not been installed or boilers that have been installed at cantonments that will come out for resale. "No. 7: suspend Sherman Anti-Trust Law, to permit a more thorough co-operation in industry. No. 8; would have Congress better equip the Patent Office. No. 9; would extend foreign trade and develop American merchant marine under private ownership and operation. No. 10; would return railroads to private control and subject them to federal regulation. No. 11; opposed to Government control and operation of wire lines. No. 12; opposed to the adoption of the metric system. No. 13; recommended sending a business delegation to the Peace Conference. No. 14; favored highway development by the Federal Government. No. 15; opposed alternative tax system on war profits. No. 16; would continue war service committees. No. 17; favored co-operation by employers and employees with development of greater business." I will bring that up as some of the work of the recent convention.

Sale of Government Boilers

The question comes up about the boilers that the Government is going to have to offer for sale, and among the things that we suggested to you was that this association offer to furnish the Government with men in our line of business who would be the right sort of appraisers on these boilers that will come into the market sooner or later from cantonments and other projects that are being abandoned.

MR. KELLOGG: Mr. McDonough, Chief of Disposition of Materials for the Housing Corporation, said in Atlantic City that they had not arrived at any basis of disposition of raw materials which they had on hand, but it was his opinion that they would endeavor to dispose of the materials in such a manner that it would not demoralize the market or affect labor, and that before they attempted to dispose of any material they would take the matter up with the respective war service committees of the different lines and consult with them.

MR. BAKER: Perhaps it will quiet the fears of some of the boiler makers to say that practically all the boilers that have gone into cantonments were seventy-two by eighteen tubular boilers made for one hundred pounds working pressure, and we could not sell them if we wanted to. The balance of the goods are largely water heating boilers and tanks. I don't know what will be done with those, but I do not think we need have any fear of the seventy-two by eighteen boiler.

Standard Form of Data Sheet

THE CHAIR: One of the points to be brought out is a standard form of data sheet for all types of boilers. The A. S. M. E. has completed its new code, and in addition has prepared a standard form of data sheet. After we get that data sheet we ought to urge every city and state to adopt one form, so that we will not have so many different types of sheets to make out to file with the state inspectors. Massachusetts has one form, Ohio another, etc. If we get them all using the one sheet, we can make out our reports in about half the time, because the same information will be in exactly the same place.

Stabilizing Prices

MR. KELLOGG: Among the resolutions presented at the conference in Atlantic City was one which recommended that the Government should provide some means of stabilizing prices until July 1 next. I wanted the maintenance of price until July 1, but we found that there was no power in Washington and no law whereby they could provide for any machinery to stabilize prices after December 31.

The prices of material must decline, but they will not decline at present, to speak of. There will probably be some readjustments, but the cost of labor cannot be reduced. With that question facing you, with the uncertainty as to market conditions on material, the question comes up, what are the manufacturers of tubular goods going to do?

With a large amount of capital invested and little likelihood of getting a large amount of new business right away, are you going to guess at what the market is going to be, and do business on a basis that means suicide or bankruptcy? That is what you are facing unless you can get together and co-operate.

The difficulty with all industry to-day is that you do not know your costs. I do not mean by that the actual cost of the material and the labor, but the cost of doing business, your cost of marketing. Your cost is going to be higher as soon as you get back into commercial business, by reason of the increased cost of labor and the decreased amount of production.

Another thing, this country produced about thirty million tons of iron a year, up till the war; it now has a capacity of forty-five million tons. They expect that that surplus, in time, will be shipped across the water, but for a time it will not. How are you going to regulate yourself on this declining market? It is not going to decline rapidly; it is going to decline gradually, and how are you going to regulate yourself unless you do it through co-operation with one another and regulate, to a certain degree, the prices that you are going to ask for your production? And how can any individual company do it?

The old way of doing business is past; we have struck a new era. Every line of industry throughout the country has been organized in the last three months—everyone on a co-operative plan except the boiler industry.

How can this be done? By simply getting together and saying first that you will lay your cards on the table. First ascertain your cost roughly: afterwards you ought to have an absolute system of arriving at cost on the same basis. Arrive at what should be a reasonable basis of profit. Then, as you make your quotations, file them. Meet frequently. Come in and be willing to tell your competitor or your associate what you are actually doing, and gradually you will find that you are all working on the same basis. That is a simple, easy way of doing it. We are doing it in other lines, and we are able to control market conditions absolutely.

Uniform Cost Accounting

Mr. Andrews: We believe in the adoption of a uniform cost accounting system and believe that it will do more to stabilize prices among the manufacturers than any other one thing that could be done. If men know their costs, they will all sell at a profit.

Mr. Kellogg: So as to bring this matter up properly, I would move that the chair appoint a committee of five who, with the chair, should work out a plan of co-operation which will include cost finding, not necessarily cost accounting but cost finding, which shall include manufacture and distribution, to report back to a meeting to be called in the near future.

Motion seconded.

Mr. Barnum: I think that the first thing we should do is to get confidence in each other, and the only way to get confidence in each other is to have frequent meetings and lay our estimates on the table.

Mr. Campbell: My idea is to get a committee and have that committee get one good man at, say, $10,000 or $15,000 a year.

Mr. Kellogg: In 1906 we formed an organization known as the National Tubular Boiler Association, which was in the central west. That organization stood together until 1916, an dduring a large portion of that period we got together. I think they will all say they made money. In any organization you need somebody that can go around to the manufacturers and go into the details of the business with them. There is bound to be overlapping territory where the people do get into one another's territory and bid against each other. In the case of our organization the action of the eastern manufacturers broke up the central western manufacturers on account of cutting prices.

It would not be necessary for the entire body of manufacturers throughout the United States to meet at all of the meetings. After a plan is formed and the cost and a reasonable profit determined, the work could be handled by sections of the country. Manufacturers in each section could meet once a month and send an able representative to attend a joint meeting. By that means you would get joint action throughout the entire territory without the necessity of everybody attending a joint meeting.

My motion is that a committee of five, together with the chairman, should prepare a proposed plan of co-operation and submit it to the boiler manufacturers in the near future and see who will be willing to attend that meeting, to discuss it, at least.

Motion seconded by Mr. Baker.

Co-operation Through Organization

Mr. Simon: Co-operation can only come into existence through organization, and I do not believe that this association is organized as it really should be. The motion has been made to appoint a committee. If this committee's business is to organize the boiler industry, I will be in favor of having a man hired that will devote his entire time to the work, and then we could have meetings in various localities.

Mr. Covell: I sympathize with what Mr. Andrews said about the necessity of accurate costs. I am convinced that without a uniform cost system, all co-operation and all sympathy with each other falls by the wayside. We have got to come down to uniform costs: that is, the stepping stone for doing something tangible.

Mr. Kellogg's motion was carried.

The Chair: Mr. Kellogg's idea, it seems to me, of sub-dividing the industry into groups is really the only way out, and if the New England people would organize a body of themselves and send a representative to these monthly meetings, and then the entire association meet quarterly, for instance, I think we would make some headway on this proposition. I would like to get an idea from Mr. Kellogg, before we adjourn, how long a time he thinks ought to elapse before we call this meeting together again?

Mr. Kellogg: I think it should be called not later than the last of January.

Adopting Trade Acceptances on Deferred Payments

The Chair: Has anybody studied any further on the subject of adopting trade acceptances on deferred payments? I think that applies principally to the watertube boilers—the return tubular boilers are practically all sold on a net thirty days. The terms for watertube boilers are about 50 percent at the time of shipment, 25 percent when the boilers are delivered and set up in the purchaser's power house, as some types have to be, and the balance on thirty or sixty days after that date.

Mr. Kellogg: Unless you change your form of contract, I'm afraid you would have trouble getting trade acceptances.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY, INC.
6 East 39th Street, - - - - New York
8 Bouverie St., London, E. C.

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor.

Branch Office
Boston, Mass., 733 Old South Building, S. I. CARPENTER.

Unsigned letters are frequently addressed to the editor of this paper asking us to publish information in answer to a great variety of questions. Most of these questions relate to some phase of boiler shop work or to laying out problems, all of which come within the legitimate scope of the Question and Answer Department which we publish every month. We are always glad to get such questions and are ready to do everything in our power to supply the information desired, if we are satisfied that the inquiry comes from a reader of the magazine. Unsigned or anonymous letters, however, will receive no consideration. The letter must contain the real name and address of the writer and state the question clearly and definitely. Sketches should be enclosed, if necessary for a clear understanding of the question. Such inquiries will receive prompt attention and the answer will be mailed to the inquirer, as soon as it can be prepared, so that it will not be necessary for him to wait for the publication of the issue of the magazine containing the question to get the information. Such inquiries will be treated confidentially and the identity of the inquirer will not be disclosed when the question and answer is published unless the writer gives us his permission to do so. We wish to make the department of questions and answers as useful and helpful to our readers as we can make it, but to do this we cannot pay any attention to irresponsible correspondents. By conforming to the simple rules outlined above you will have our whole-hearted co-operation and assistance.

Before the war the boiler making industry was poorly organized, if it might be said to have had any organization at all from a business point of view. This is not deprecating the work of the American Boiler Manufacturers' Association, which for a quarter of a century has stood consistently for the highest standards in quality of materials and methods of construction in boiler making, but there has been an apparent lack of initiative and willingness on the part of individual manufacturers to get together and co-operate in the actual transaction of business for the good of all. Jealously guarded business secrets and destructive competition have antagonized manufacturers in different sections of the country and, worse still, those in the same locality. Lack of an accurate understanding of the true cost of production has led to destructive competition, from which no one has benefited, and the train of lesser evils has multiplied.

With the outbreak of war, unity of action and consolidation of aims and purposes became imperative. The demands upon the production capacity of the industry multiplied over night. It became necessary to investigate the resources of the industry in shops, equipment, materials and men, so that the monthly output could be increased to meet the demand. All of this had the salutary effect of emphasizing the lack of organization which had hitherto existed, and also of pointing to the advantages which nearly every other industry is obtaining by co-operation through organization.

Short as the duration of the war has been, it is now followed by a period of reconstruction which presents problems even more difficult for individual manufacturers to face without the support of a strong organization. By calling a special meeting of the Boiler Manufacturers' Association last month, to discuss reconstruction problems, the executive committee of this body showed its realization of the needs of the industry, and the results give excellent promise of a new form of organization which will be of real benefit. The first step provides for the appointment of a committee to preface a plan of co-operation which is to be submitted to a general meeting of representatives from the various sections in the country for discussion. Apparently the basic idea is for the boiler manufacturers in each locality to hold informal meetings frequently, say once a month, to compare notes and discuss business conditions in that locality and then to have general meetings of the entire organization, or of representatives from each section, quarterly or at least oftener than once a year. By subdividing the industry into groups for dealing with affairs in each locality and then providing a means for co-operation among the groups in matters of common interest, the entire organization will be in a position to act wisely and intelligently when there is need for making its influence felt.

To have any control over market conditions through such an organization, however, it will be necessary for individual manufacturers to be willing to tell their competitors and associates just what they are doing and to adopt a uniform system of cost accounting, so that business can be conducted on a common basis. This, we believe, the majority of manufacturers will be willing to do, and after the beneficial results become apparent there should be less difficulty in securing the co-operation of all.

With the addition of about $10,000,000 to the annual income of the American boiler making industry from foreign trade during the past year, as recorded elsewhere in this issue, the question of securing foreign markets for American boilers and their equipment should receive careful consideration. Very little interest in the subject was shown at the recent meeting of the Boiler Manufacturers' Association; but if the domestic market is to be uncertain during the year, efforts should be made to develop the export trade, particularly to South and Central American countries, where the demand for American products is active.

Engineering Specialties for Boiler Making

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

Huge Gang Drill for Forty-two 1-Inch Holes in Steel Work

Three minutes to drill 18 feet of circular seam on the flat with one setting of the machine is the record of a huge gang drill invented and designed by Aaron Hill, Los Angeles, Cal. The inventor has been working on the plans of the machine for the last three years. Actual manufacture was begun upon the machine, which is now completed, early in February, 1918. This new machine, which has an eighty-drill capacity, can be set to any ordinary assembly desired. Spacing is facilitated by a steel scale on the machine, thus entirely eliminating laying out or the use of tack holes in the plate previous to rolling. The machine can handle angles of every shape, channels, I- and H-beams, and plates of any length and almost any width.

Some idea of the size of the machine may be realized when it is recorded that the weight of the unassembled parts, including some light boxing, when these were loaded for shipment at Bound Brook amounted to 56,000 pounds. The machine has a 20-foot span, with a height, overall, of 14 feet.

The machine is particularly valuable for boiler work. Here it eliminates the older, slower process of punching small holes and then rolling shell plates and reaming. Warping, dishing, stretching and crystallizing of the metal are accordingly dispensed with, and in assembling the delay and annoyance of making oversized holes.

In drilling the drums of boilers, the inner butt strap is placed upon the beam and held in position by special gage bolts. The beam, having wheels on each end, is then run

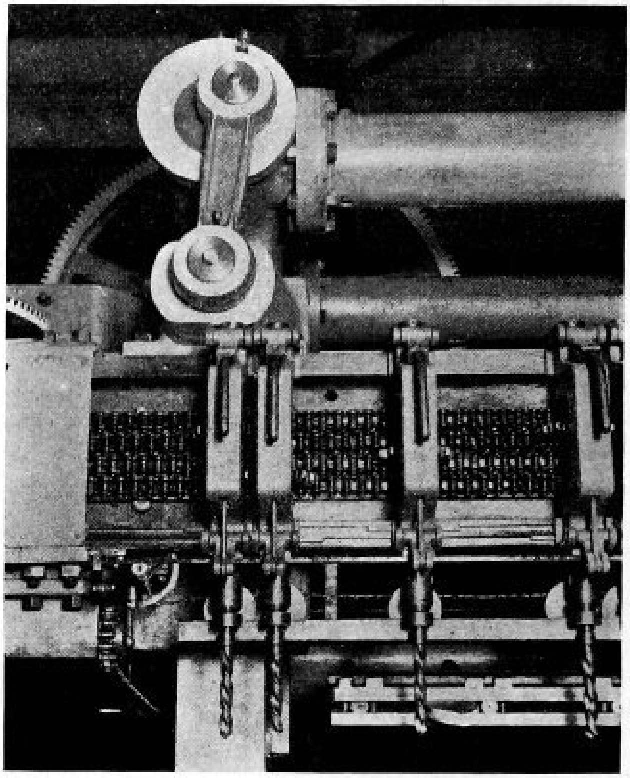


Fig. 2.—Spindles of Gang Drill

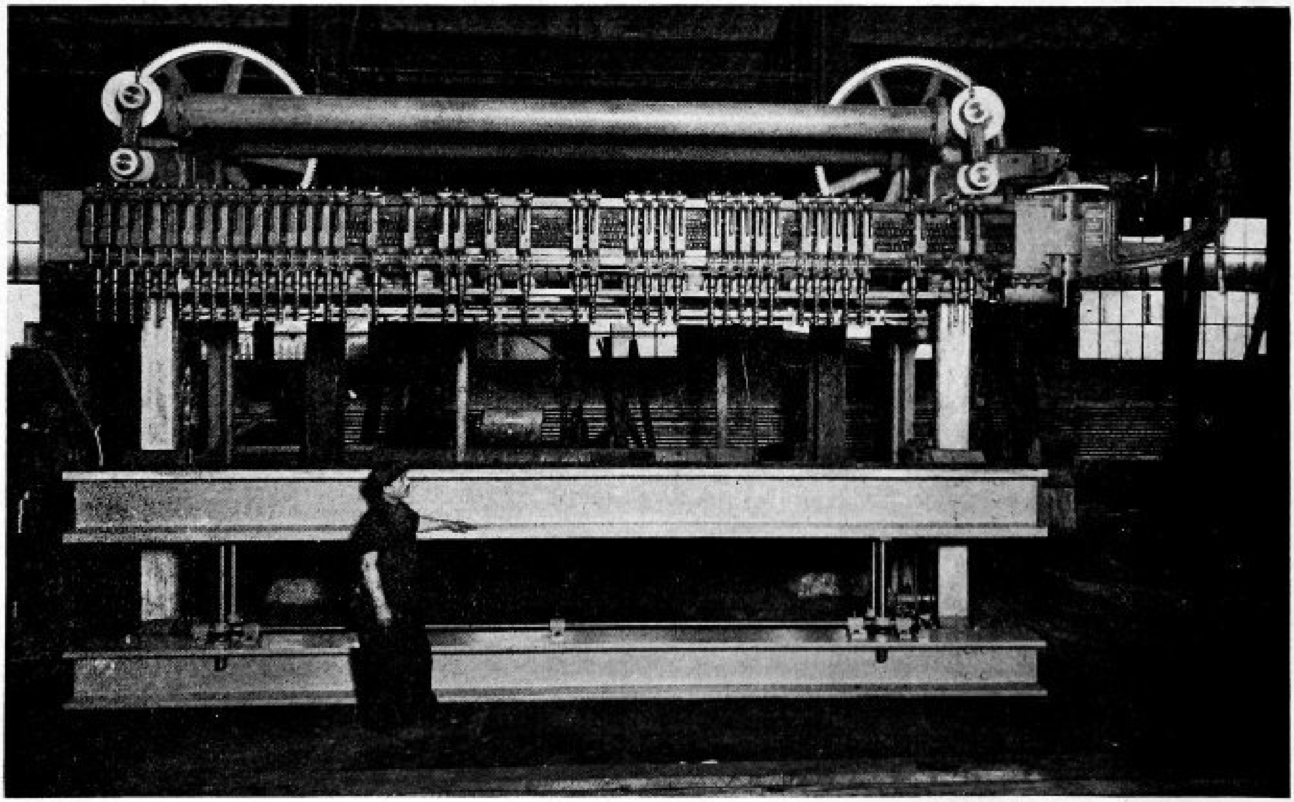


Fig. 1.—Gang Drill for Boiler Plate Work

inside of the drum shell, which is already rolled up without holes in it. By special slings the beam and drum are lifted onto cradles. The outer butt strap is then placed in position, when the automatic clamps with which the machine is fitted clamp the straps and drum down upon the beam with a pressure of over 20 tons. Properly set and spaced, the drill runs one complete row longitudinally and then releases itself automatically. Boilers 50 inches in diameter can be accommodated. Actual trial has shown that thirty-two drills can be set at varying spacings in five minutes. Other experiments have proved that with operations planned in advance, three men can complete a ship's plate in fifteen minutes.

The cradle is geared so that it can be moved circumferentially to bring the next pitch in line for drilling the next row of holes. The handles shown in the front of Fig. 2 make it possible to remove any spindle which may not be required for certain drilling. Larger spindles can also be put in place and 3¼-inch tube holes drilled—about thirty-two can be accommodated at once. Five of these drills are being built by the Badenhausen Company, manufacturers of watertube boilers, 1425 Chestnut street, Philadelphia, at their Bound Brook factory. The first one has been installed at the boiler shop at Cornwells, Pa. One other machine will be installed at that shop, two at Bridgeport, Pa., and one at Bound Brook, N. J.

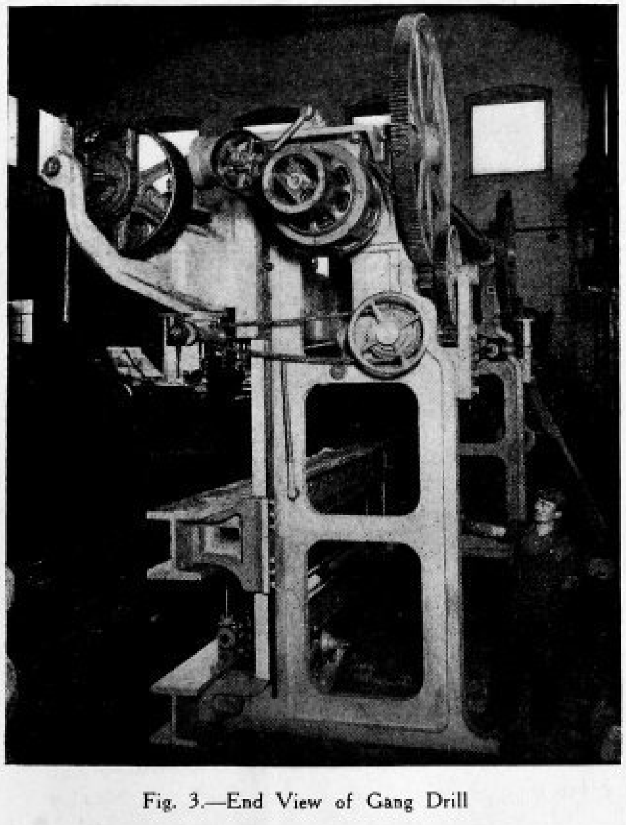
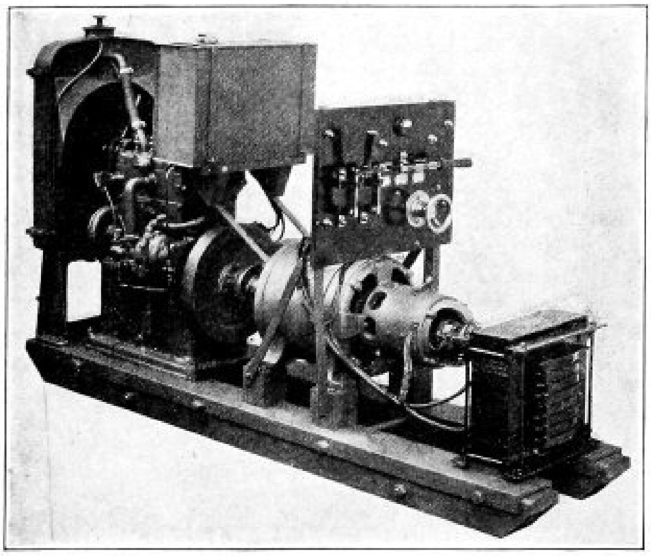


Fig. 3.—End View of Gang Drill

Portable Lincoln Arc Welder

A new pattern of Lincoln arc welder which should prove of considerable use in branches of the boilermaking industry is shown in the accompanying illustration. Since the entire equipment of this new type can be placed on a motor truck and transferred from place to place, operating independently of any other source of power, it is possible for the boiler maker to obtain the advantages of electric arc welding in many situations where gas welding and riveting have hitherto been resorted to.



Portable Lincoln Arc Welder with Generator Driven by Gasoline Engine

The generator is direct connected to a Winton gasoline engine. Like other Lincoln arc welding generators, the heat of the arc is kept constant at the point desired by the operator by automatically varying the voltage and current whenever the resistance of the arc to the passage of the current changes. The company claims that by using the generator to regulate the heat, instead of relying upon complicated external systems of clapper switches, relays and ballast resistances, a saving in power of more than 75 percent results. The elimination of the "ballast resistance," the company points out, greatly reduces the weight, an important feature in the case of portable equipment. Fifty-three Lincoln arc welders of this type were supplied to the United States Government for repairing broken and worn locomotives and other war material behind the battle line.

Film Used to Show Industrial Development

The Louisville Industrial Foundation, the so-termed "million dollar factory fund" of Louisville, will present part of the annual report in motion pictures.

About twenty new industries have been located in the city of Louisville as the result of the Foundation's activities. Camera men are engaged in photographing the salient features of the new factories in order that an intimate review of the industries, their processes and products may be presented to the stockholders and the citizens of Louisville. It is the idea of the Foundation directors that the stockholders and citizens should be afforded an opportunity to visit all of the new plants located in the city. The motion picture method was adopted as the most practicable.

One of the prominent features of the film will be to show that, although a large number of new manufacturing enterprises were located in Louisville during the period of the war, none of them are strictly war industries. The film will include views of the manufacture of automobile axles, overalls, clothing, tobacco, wood products, soap, oil, bed springs and heating apparatus.

The death of Dr. Angus Sinclair, publisher of *Railway and Locomotive Engineering Magazine*, on January 8 marks the passing of one of America's notable pioneers in engineering journalism.

Questions and Answers for Boiler Makers

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

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *6 East 39th street, New York City.*

The True Size of Valley Angles

Q.—Please explain a method of getting valley angles. I refer to the angle a bevel would be set at for bending sides for tank work—the sides sloping—otherwise the angle obtained at right angles to plate.
J. A. H.

A.—The valley angle problem is one that relates to roof valleys, tanks, bins, evaporation pans, hoppers and the like. The method of getting the correct angle is quite easy after one has a thorough understanding of the requirements.

Thus, in Fig. 1 is shown a valley angle *A*. This angle is also sometimes stated as the angle at *B*, because the planes forming the angle *A* also form the angle *B*. The angle *A* is always equal to 180 degrees *B*. The valley angle *A* means the angle of the two planes when measured square with the intersection line *CD*. Therefore, in the illustration the line *ac* is square with the line *CD*, and the lines *ad* and *ae* are drawn perpendicular to their respective planes. Then the lines *cd* and *ce* on the planes form the true valley angle *dce*. The problem for the layer-out is to find the correct size of this angle from the drawing, the angle generally being in an oblique position, so that it cannot be directly measured.

A hopper with valley angles is shown in Fig. 2 with lines lettered as in Fig. 1. The layout of the true sizes of the valley angle of the hopper is shown in Fig. 3. A plan

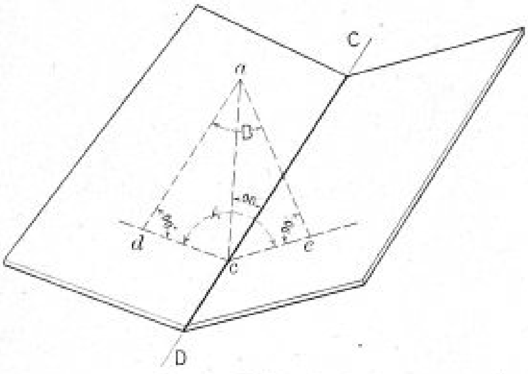


Fig. 1.—Valley Angle

view with side and end elevations are necessary. The construction lines used in Fig. 1 are applied in Fig. 3.

Assume any point as *c* on the valley line *CD* in the plan view and project it to the elevations. Revolve the valley line about the vertical corner *CP* until its plane is parallel to the side elevations, giving *Ce* as the true length. Then at the point *c* draw the perpendicular *ca* and find its contact *a* with the top plane of the hopper. Now swing the valley line *Cc* with its perpendicular *ca* back to its normal position *CD* in the plan view, and the upper end *a* of the perpendicular *ac* will be located as shown on the plan. Pass a plane through the perpendicular *ac* and at the same time square across the valley line *CD*, and this plane will cut through the top plane or cover of the hopper along the line *fag*. The lines forming the valley angle are *fc* and

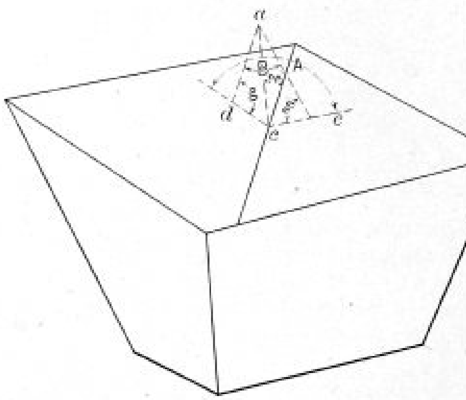


Fig. 2.—Hopper with Valley Angles

gc. Draw their vertical projections on the elevations and proceed to get their true lengths as follows:

Construct a triangle, using *fc* of the plan for the base *hk*, and *hc* for the altitude, and *Ck* will be the true length of *fc*. Likewise, in the end elevation, lay off *cg* at *lm*, and with *ln* for the altitude get *mn* as the true length of

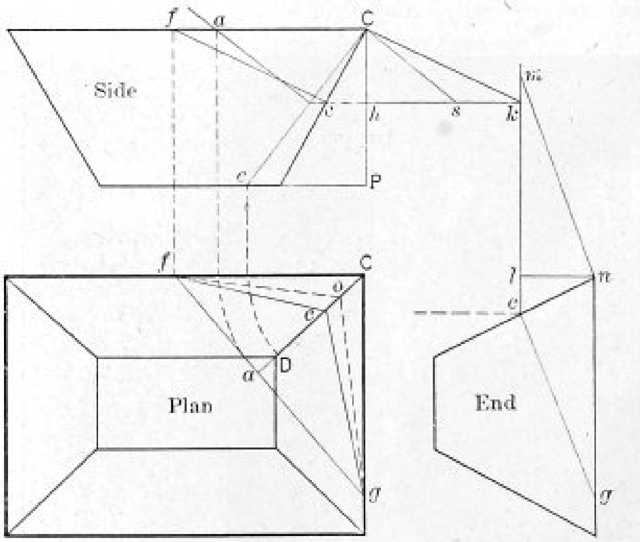


Fig. 3.—Measuring Valley Angles

cg. Finally use *f* and *g* in the plan as centers, and with the true lengths of *fc* and *gc* for radii, describe the arcs intersecting at *o*, and the angle *fog* will be the true angle of the valley.

A short method of getting *ao* in the plan, which is the true length of *aC*, as seen when the point *c* is swung up into the top horizontal plane, is to make the triangle *hsC*. Use *aC* for the base *hs*, and *hC* for the altitude. Then *Cs* gives *ao*.

Horsepower of Boilers—Collapsing Pressure of Flues

Q.—I would like to ask a couple of questions: (1) Your methods of figuring horsepower of boilers; (2) your methods of figuring strength of flues before they would collapse. C. W. L.

A.—(1) The horsepower of a boiler has been defined by the American Society of Mechanical Engineers as the evaporation of 30 pounds of water per hour from a feed water temperature of 100 degrees F. into steam at 70 pounds gage pressure. This is equivalent to 34½ units of evaporation, which means that 34½ pounds of water are evaporated from a feed water temperature of 212 degrees F. into steam at the same temperature. Since 970.4 heat units are required to evaporate a pound of water from and at 212 degrees, a horsepower is equal to 970.4 × 34½ = 33,479 British thermal units per hour. An arbitrary rule is to allow 10 square feet of heating surface per horsepower.

(2) It is not possible to deduce a formula that will give the exact collapsing strength of flues. Formulas for this purpose are based on experiment and give only approximate results. One formula that is recommended is as follows:

$$P = 86{,}670\ \frac{t}{D} - 1{,}386.$$

In this formula, P is the collapsing pressure in pounds per square inch, t is the thickness of the flues in inches, and D is the outside diameter of the flue in inches. This formula has been applied to get an approximation where the pressure per square inch is equal to or greater than 580 pounds. When the pressure is much less than this, the following formula is recommended:

$$P = 1{,}000 \times \left(1 + \sqrt{1 - 1{,}600\ \frac{t^2}{D^2}}\right)$$

The following examples show how to apply the formulas:

1. If a 3-inch steel boiler tube is .1 inch thick, what pressure will collapse it?

2. If a 6-inch steel boiler tube is .12 inch thick, what pressure will collapse it?

Solution 1. Try formula No. 1. Then

$$P = 86{,}670 \times \frac{.1}{3} - 1{,}385 = 1{,}503 \text{ pounds per square inch.}$$

Solution 2. Try formula No. 2. Then

$$P = 1{,}000 \times \left(1 - \sqrt{1 - 1{,}600\ \frac{.12^2}{6^2}}\right) = 400 \text{ pounds per square inch.}$$

Riveted Joint and Tank Problems

Q.—Will you please explain how to get the efficiency of a single riveted lap joint; diameter of rivets ¾ inch; pitch, 2 inches; ⅜-inch plate. Explain how to find the amount of gallons contained in square tank, 36 inches by 12 inches by 12 inches. Also how many gallons of water a cylindrical tank will contain 36 inches in diameter and 96 inches long? J. P.

A.—Assuming in answering your inquiry that 38,000 pounds per square inch equals the shearing resistance of the rivets and 55,000 pounds per square inch the tensile strength of the plate, we will first find in this example the strength of the solid metal within the pitch, which is 2 inches, as follows:

55,000 × 2 × .375 equals 41,250 pounds tensile strength of solid plate.

Strength of net section of plate equals: Pitch of rivets — diameter of one rivet (driven size) × plate thickness × tensile strength of plate. Substituting values in example we have—

2 — .8125 × .375 × 55,000 = 24,492 pounds.

Efficiency of net plate section as compared with solid plate section in percent equals 24,492 ÷ 41,250 equals 59⅜ percent.

A short method for finding the efficiency of the net plate section is as follows:

$$\frac{2 - 13/16}{2} = 59\tfrac{3}{8} \text{ percent.}$$

So far we have considered only the efficiency of the net plate section as compared with the solid plate. It is also necessary to consider the rivet strength and crushing strength of plate in front of rivets. After so doing, the smallest efficiency is used in determining the allowable working pressure the joint will withstand. In this case, figure the strength of one rivet (driven size) in single shear, as number of rivets within the pitch is one.

Driven size of one rivet ¾ inch in diameter equals 13/16 inch. Area equals $13/16^2 \times .7854 = .5185$ square inch. Shearing resistance of one rivet equals 38,000 × .5185 = 19,703 pounds. 19,703 ÷ 41,250 = 47¾ percent efficiency of rivet as compared with strength of solid plate.

In calculating the joint efficiency, the crushing strength of plate in front of one rivet (in this case) should also be figured. Crushing strength of mild boiler steel equals 95,000 pounds per square inch of cross sectional area.

Crushing strength of plate in front of one rivet equals:

.8125 × .375 × 95,000 = 28,945 pounds.
28,945 ÷ 41,250 = 70 percent efficiency of joint to resist crushing of plate in front of one rivet.

Summing up the joint efficiencies, we have:

Efficiency of net plate section = 59⅜ percent.
Efficiency of rivets = 47¾ percent.
Efficiency of plate in front of rivet to resist crushing = 70 percent.

The smallest efficiency is 47¾ percent, which is to be used in basing the pressure on the joint.

TANK PROBLEMS

To find the number of gallons in a cylindrical tank, employ the following method:

Determine the number of cubic inches in the tank and divide by 231, number of cubic inches in one U. S. gallon.

In this example proceed as follows:

Area of 36-inch circle = $36^2 \times .7854 = 1017.9$ square inches.
1017.9 × 96 = 97,818.4 cubic inches volume of tank.
97,818.4 ÷ 231 = 423½ gallons, approximately.

For a square tank proceed in the same way, thus:

12 × 12 = 144 square inches, area of base of tank.
144 × 36 = 5184 cubic inches, volume of tank.
5184 ÷ 231 = 22.88 gallons, capacity of the tank.

In handling problems of this kind, employ engineers' handbooks as guides, since data of this kind are given therein.

600 More Standard Locomotives Ordered

The United States Railroad Administration has ordered for 1919 delivery 600 locomotives in addition to the 1,415 which it has already ordered. Of these, 500 will be built by the American Locomotive Company and 100 by the Lima Locomotive Corporation. The orders are distributed as follows: American Locomotive Company, 150 eight-wheel switchers, 200 light Mikados, 50 heavy Mikados, 25 light Santa Fe and 75 2-8-8-2 type Mallet; Lima Locomotive Corporation, 50 six-wheel switchers and 50 light Mikados. Bids have been asked for the specialties, which will be in accordance with the standard specifications used for the previous orders.

Letters from Practical Boiler Makers

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

Re-Tubing Locomotive Boilers

Upon reading carefully the answer to the question on re-tubing locomotive boilers, which appeared in the November issue of The Boiler Maker, I would like to make a few suggestions regarding this subject.

In asking this question, the subscriber wishes to know the best and cheapest method of re-tubing locomotive boilers; also taking out the old tubes and cleaning the boilers of scale. It is, of course, a well-known fact that no two boiler makers have the same method of installing or taking out tubes. I have, however, found the following method to be very successful.

Supposing the dry pipes are to be removed so that they can be ground in; with these out of the way I would cut the tubes on the inside of both flue sheets with a flue cutter controlled by air pressure* in order to remove the tubes from the dry pipe hole in the smoke box end. These flue cutters can be set to cut a flue on the inside of the tube sheet or any distance on the outside of the tube sheet.

In a case where the dry pipes are not to be removed, enlarge one hole in the smoke box, making it 2¼ inches in diameter. This hole should be in the center of the tube sheet, five tubes from the bottom. After removing the tube, the next question is how are we going to enlarge the hole to 2¼ inches in diameter? Some shops are well equipped for this work, having all the tools required. The hole may be enlarged by reamers, but in case a reamer is not accessible make two hand chisels shaped on the working end at an angle of 30 degrees, in order to be able to cut on the inside of the flue sheet as well as on the outside. Cut the hole to very nearly the required size; then procure a set of roller flue expanders and roll out all lumps and flat places in the hole. Then strike a 2¼-inch circle around the hole to be enlarged, centering same to use as a guide for chipping. With the hole enlarged, we are now ready for the next step.

Cut off all beading from the flue sheet in the firebox end with an air hammer, using hexagon shank tools for this work. The next tool needed would be a ripper, which is made in the form of a half moon at the working end and should be forged out to a thickness of ¼ inch, 3 inches up from the working end. The tubes are then ripped about 2½ or 3 inches on the firebox end, which insures success in bending and also gives them a good leeway in forming together. The next tool to use in the firebox end is the oyster knife, which is shaped somewhat similar to the tool used for opening oysters. It is oval in shape and the working end should be 6 inches long with a good taper. The finer the taper the better it will work, since if the taper is too thick it will have a tendency to bind in the flue hole. The oyster knife will cause the end of the tube to curl or overlap the bottom side of the tube, thereby insuring success.

In extracting the tubes, remove all copper ferrules from the end, so that the tubes may be transferred to the large hole in the center of the tube sheet on the smoke box end. The tubes in the smoke box end must now be chipped off flush with the flue sheet, providing they project out more than ¼ inch.

In clearing out the dry pipes a flue bar is used. This flue bar is made from good tool steel, using 1¼-inch stock. It should be about 7 feet long, with the working end 1/16-inch smaller than the tube. There should be two flue bars for this work—one straight and one having an offset. Begin with the straight flue bar, working from each side of the enlarged hole. Extract the tubes in the form of a V, which allows ample room in working from both sides of the flue sheet. Use an 8-pound maul; by delivering four blows the flues are driven from the flue sheet. Then move these flues over to the large hole and out. Proceed in the same manner throughout until all the tubes are extracted. Assuming that the tubes are now all extracted, the process of scaling the boiler is begun.

Get on the inside of the boiler and use the scaling hammer, which can be made on short notice. Place a man on each side of the shell on the inside of the boiler. By tapping light blows the scale falls off. In removing the scale from parts of the boiler that are not accessible, a spray with a light coating of kerosene oil is used. The scaling being finished, remove all scale from the boilers by scrapers, also all copper ferrules that fall from the tubes while being extracted. The boiler is now ready for the installing of the new tubes.

Carefully examine all tubes taken from the boiler, and if they seem fit to be used again cut off the ends to about 12 inches, welding on a safe end. After the tubes have been welded, they should be tested by hydraulic pressure. The tubes are then put into a rattler to loosen all scale, or, if this is not convenient, they may be sprayed with a light coating of kerosene oil, thus making it easy to remove the scale from the tubes. A dull scaling hammer is used for removing the scale from the tubes. Anneal both ends of the tubes to insure that they will not crack or split when they are worked. Before installing the new tubes, go over carefully all flue holes in the firebox, also in the smoke box, with a ½-pound rough file 16 inches long.

We are now ready for the copper ferrules, which may be installed by using a sectional expander, or, if this is not to be had, a pair of tube expanders will do the work. Use air pressure wherever it is possible.

To install the new tubes, have them project past the firebox tube sheet about 5/16 inch and 3/16 inch or ¼ inch in the smoke box end. Tighten the tubes with a sectional expander, or tube expanders, using air pressure in rolling them; also use air pressure in turning over all tubes. Then procure a beading tool with a round shank to fit the air hammer. After beading the tubes, roll them lightly and the job is about finished. In the smoke box end all that is required is a good rolling, using air pressure.

In all cases, I would use the flue cutter in extracting all tubes, as that, in my opinion, is the fastest method; but in small shops, where they have not the equipment, the hole must be enlarged in the smoke box end.

Youngstown, Ohio. Wm. J. Kelly.

* If the acetylene and oxygen is convenient, use same in cutting out old tubes, as it is cheaper and quicker than air pressure.

Leaking Flues

Being in charge of roundhouse boiler work, I recently sent an engine to the back shop for new tube sheet and new tubes. When the engine arrived from the shop I found that the flue sheet had been filled with electric weld and the new flues had been inserted in it. At present this engine is giving me a great deal of trouble because of leaking flues. I have done everything possible to keep it in service, but expanders and prossers are useless in this case.

I have recommended that this engine be sent to the back shop for a new flue sheet.

Any information bearing upon such difficulties which you or any of your readers can give through your columns will be appreciated.

Bridgeburg, Ontario. F. AMESBURY.

Charts for Contents of Cylindrical Tanks*

BY E. EARL GLASS

Charts which give, without computation, the number of United States gallons of liquid remaining in any horizontal cylindrical tank when the depth of liquid is known, are shown in the accompanying illustrations. One chart gives the total volume of any cylindrical tank when the diameter and length are known. The other shows the actual number of gallons in the tank in functions of the depth of contents in decimals of the diameter, and the total capacity in United States gallons.

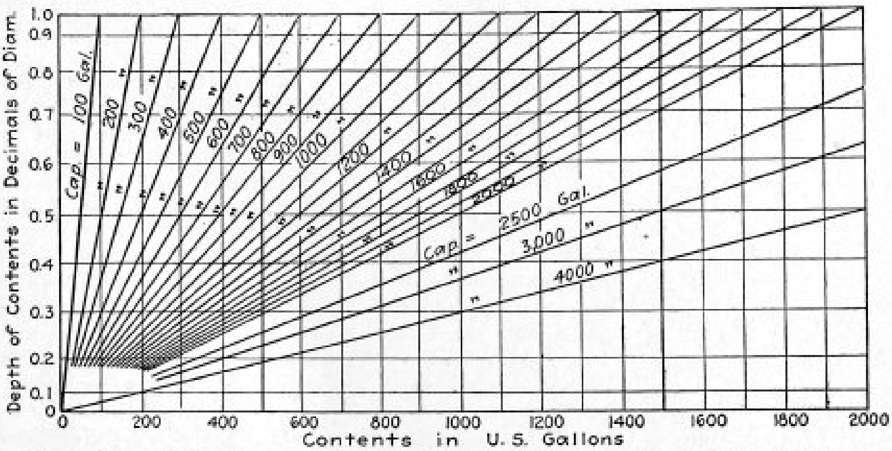


Fig. 1.—Chart Giving Contents of Cylindrical Tank in Gallons When Depth of Liquid Is Known

As an example of the use of the charts, if the depth of oil in the tank is 3.4 feet and the tank is 4.5 feet in diameter and 9.5 feet long, Fig. 2 gives its total capacity as 1,130 gallons. Dividing 3.4 by 4.5, the tank is seen to be 0.76 of the diameter full. For a tank having a capacity of 1,130 gallons, this decimal, as shown by Fig. 1, gives the contents as 920 gallons.

Seventy Years Ago

To those to whom the Bourbon steam gage is an everyday object, it may be of interest to learn what preceded this boiler fitting.

Recently there came into my temporary possession one of the first engineering pocketbooks ever published; its date is 1851. From this the following extract is taken:

"The most important apparatus for ascertaining the state of an engine is the steam gage; this is a short bent tube of iron nearly half an inch in diameter, open at both ends, one of which is fixed in the boiler, or steam pipe, and the other is open to the atmosphere; in the bent part of the tube there is placed a quantity of mercury, and the steam pressing on its surface at the one end raises it in the other leg of the tube; the height to which it is raised is measured on a scale by the recorder stem of a float on the surface of the mercury. This apparatus shows the excess of the elastic force of the steam above the pressure of the atmosphere. In some engines the gage pipe is made of glass terminating in a cistern of mercury inclosed in an iron box. The steam has free access to the surface of the mercury, and the action is like that of a common barometer."

The author goes on to describe a condenser gage for the measurement of vacuum, which is very similar in type. Further on, a note headed "Safety Valve" elicits some particulars of interest and a speculation which has a humorous bearing quite unconscious on the part of the author.

"A common form of this apparatus is that of a lever of the third order, where the fulcrum is a point at one end of the lever, the resistance, a movable weight at the other end, and the power, the pressure of the steam upon the valve, which acts upon the lever somewhere between its extremities. From similarity of form, this apparatus is called the *steel-yard safety* valve. The pressure of the steam is increased or diminished either by the motion of the weight, along the arm or by altering the weight itself; this is consequently a very dangerous form of the apparatus, as was unfortunately exemplified in the case of the explosion of the *Earl Grey*. A more usual and safer form is the valve with spindle loaded with circular weights until the whole weight per inch exceeds, just a little, the force of steam per inch required to work the engine, the orifice being so large as to permit the steam to escape faster than it is generated. To prevent accidents similar to that above mentioned, the valve should be enclosed in a box communicating with the chimney, or perforated with holes, so that the steam, when forced through the valve, may escape into the atmosphere. This box, of course, should be kept locked, and the key placed in the proprietor's or captain's charge, so that the valve could never be overloaded without his cognizance.

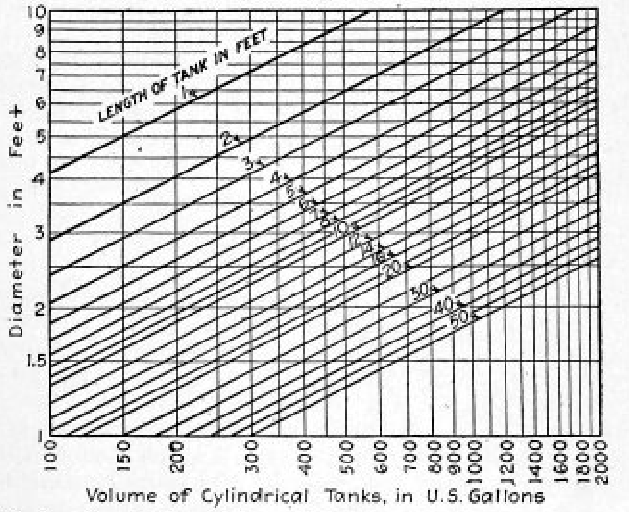


Fig. 2.—Chart Giving Volume of Cylindrical Tank When Diameter and Length Are Known

"To prevent oversight, a number of such valves might be constructed, so that the probability of accidents would

* From *Engineering News-Record.*

be greatly diminished; they might also be placed in steamboats so as to communicate with the atmosphere by the sides of the vessel, or with the sea by the bottom; in the former case, besides being out of the reach of danger, they would give proper warning of the excess of steam pressure."

The idea of placing the safety valve in communication with the sea below the boilers is certainly original; it would also have acted as a blowdown valve.

Further interesting particulars are to be gleaned from this "Practical Mechanic's Guide":

"The force of low pressure steam in the boiler is generally equivalent to 35 inches of mercury." This engine is termed "The Common Atmospheric." The highest pressure noted is 45 inches of mercury in the case of the "High Pressure Expansive Engine." Again, "The proportions of the dimensions of boilers are commonly stated to be, for width, 1; for depth, 1.1, and for length 2.5; otherwise, 5 square feet of surface of water is allowed for each horsepower. Boulton and Watt allowed 25 cubic feet of space in the boiler for each horsepower."

Another interesting feature is a table giving, among other details, the coal consumed in the case of single-acting steam engines with "the elastic force of the steam at 35 inches." From which it appears that at the date of publication, 1851, it took over 500 pounds of coal per hour to generate 50 horsepower, and this proportion with slight differences remains constant at 10 pounds of coal per horsepower hour throughout.

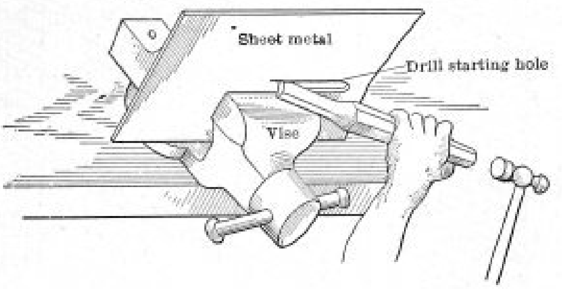
The present writer has had conversation with men who had care of steam plants in the days when the chief difficulty was to keep a vacuum off the boiler, when to allow a boiler to cool down without admitting air to prevent so untoward a happening was to start seams leaking, by reason of excess external atmospheric pressure.

It is surely unnecessary to point out that both economy of operation and rise of pressure render workmanship of this date antique. It is the continual rise of pressure to serve economic ends which has revised the art of boiler making. Unfortunately, the author dealing fully with prime movers says nothing much as to boilers, details of which would have made interesting reading to-day.

London, England. A. L. HAAS.

Metal Slotting Kink

Sometimes it is desired to cut slots in sheet metal. For thin metal, say up to 3/16 or ¼ inch, this can be very

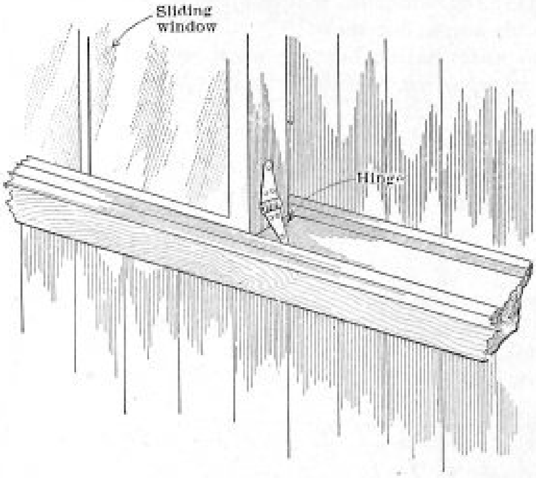


nicely and easily performed, as shown in the sketch, by a ripping chisel, holding the work in a bench vise, or if the work is too bulky it is clamped to a table with suitable straps that will act on the same principle as the vise jaws.

Now a number of the readers will say, "Who doesn't know that?" Well, it has been noticeable to the writer that a lot of time is still being wasted in certain shops and places he has visited by doing it the old way—drilling or punching a lot of holes and then filing—so this simple kink is passed on to those who need it. C. H. WILLEY.

Sliding Window Lock

For ready means of locking the tool room sliding window, the tool room keeper used a common door hinge such as shown in the sketch. The free end of the hinge



being sharpened, it digs in when one tries to open the window. When the man inside desires to open it, all that is necessary to do is to lift the lower part of the hinge. C. H. W.

Improvements in Planer Design

Although the planer, which plays an important part in the production of the allied department of the machine shop, is frequently called upon to assist the boiler shop, it can hardly be considered as a fit subject for discussion in THE BOILER MAKER. The insertion of the following may perhaps be permitted, however, as a means of securing a criticism from some of your experienced contributors.

During the past twenty-five or more years the planer has reecived attention in certain details. A more scientific distribution of material has brought about increased strength or stiffness. Some changes have been made in its driving arrangement, with the installation of the quicker return motion. Special designs have also been developed for special lines of work. The addition of a second tool holder marks another improvement. Apart from these changes, the machine is the same old, reliable, but slow-working, appliance.

In watching the opertaion of a large planer on wide surfaces of about 15 feet long, with two tools taking good cuts on the forward travel, reversing, and then trying to hurry back over the 15 to 18 feet course for another start, the writer has often wondered if the operation on long work could not be quickened. If the larger sizes of machines, for instance, were constructed with a second cross-rail on the backs of the standards, by carrying one or two tool holders on each rail, the machine could cut in both directions when operating on this class of work. The lost motion would then be equal to the width of the standard.

If the tools were held on both sides of the same cross-rail, this cross-rail being fitted in suitable guides between the standards instead of on prepared surfaces on their edges, this lost motion could, perhaps, be still further reduced. The latter construction would necessitate a different arrangement of the feed mechanism, clamping device and other details. The machine as a whole, therefore, might be less easy to handle than the present design.

The insertion of the foregoing suggestions in your columns may reach someone whose wheels are turning in the same direction.

Montreal. JOHN T. GARDHAM.

Grooving in Steam Boilers*

BY EDWARD INGHAM†

The defect known as "grooving" is familiar to all who have to do with steam boilers. It is usually regarded as a form of internal corrosion, but external grooving is not uncommon.

Most forms of internal corrosion are the result of chemical action of the feed water, but grooving is really a mechanical defect, although it may be aggravated by the chemical action. It is generally found at such parts of the boiler as are subjected to a continual bending to and fro, the result of variations of temperature and pressure within the boiler. A piece of thin metal plate may easily be broken by bending it backwards and forwards a few times. In the same way, if a piece of boiler plate be continually bent the skin of the metal will eventually be broken, and although, owing to the thickness of the plate, it would take a long time to break completely through, the mechanical action, combined with the chemical action of the feed water, may soon produce a groove which will seriously reduce the strength of the plate.

Boiler Design Eliminates Excessive Bending

Obviously, if grooving is to be prevented, the boiler must be so designed that there will be no excessive bending action at any part. Although it is often a most difficult matter to provide against this, much may be done by a careful and skillful designer. The great thing is to design the boiler in such a way that expansive movements may be properly accommodated.

Take the case of the modern high pressure Lancashire boiler, which is particularly liable to suffer from internal grooving.

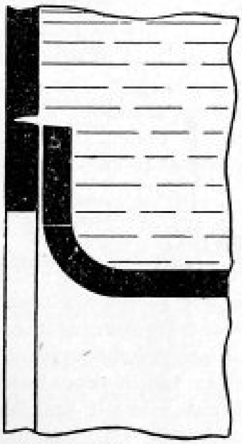


Fig. 1.—Sharp Grooving Resulting from Pure Feed Water

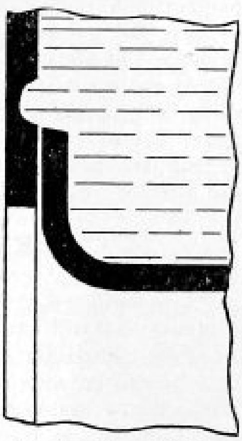


Fig. 2.—Rounded Form of Groove Due to Impure Feed Water

Under working conditions the furnace and flue tubes, being exposed to the direct heat of the gases, expand more than the shell. The extra movement must be taken up mostly by the end plates. Since expansion and contraction are constantly taking place, it is clear that the end plates are repeatedly moving outwards and inwards. The movements become principally concentrated in the end plates, around the flanges of the tubes (or perhaps in the roots of the flanges), and the metal at these parts is thus being bent repeatedly to and fro, with the result that the skin of the metal is eventually broken and a crack or groove develops. If the feed water is pure the groove takes the form shown in Fig. 1, but in perhaps the majority of cases the corrosive ingredients in the water attack the broken surface and change the fine form of groove to the rounded form shown in Fig. 2.

It should be evident that the severity of the bending at the parts affected will depend upon the distance between the rivets in the furnace flanges and the bottom or "toe" rivets of the gusset angle irons. If the distance is considerable, a certain amount of elasticity is provided, and the tendency to grooving is much reduced, but otherwise the movements of the tubes have to be taken up by a small length of plate, and severe bending of the plate around the flanges is the result. At one time the distance in question was commonly not more than 4 or 5 inches; nowadays it is rarely less than 10 inches.

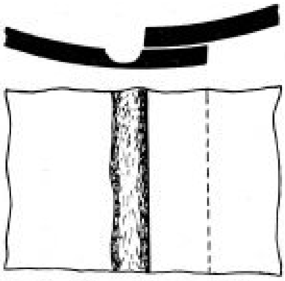


Fig. 3.—Form of Internal Grooving at Longitudinal Seam

The provision of ample "breathing" space, as it is termed, between the gusset angle "toe" rivets and the furnace flange rivets is often all that is required to prevent grooving in the end plates so far as low pressure boilers are concerned, but the case is different with high pressure boilers, because if the plates be made sufficiently elastic to prevent grooving they may not be stiff enough to resist the high steam pressures. Much attention has been given to this question within recent years, and a special design of "toe" screw has been introduced to take the place of the ordinary "toe" rivets. One end of the screw is formed into a rivet head, while the other is fitted with a hexagon nut. At each extremity is a square, provided for the purpose of turning the screw around. The latter is introduced from the front, being screwed through the end plate until the rivet head nearly bears against the plate, actual contact being prevented by a small fillet under the head. The nut is then screwed up from the inside until it is within 1/32 or 1/16 inch from the flange of the gusset angle iron. To prevent leakage, the threaded part of the screw in the end plate is made a tight fit, while the nut is also made tight so that it will not work loose. The arrangement enables the end plate to move slightly; i. e., 1/16 or 1/32 inch, depending on the position of the nut, but the nut prevents any further movement of the plate.

New Flexible Staying Arrangement

A form of flexible staying recently introduced is claimed to have proved very successful. The rivets pass through the gusset plate and the angles are replaced by turn bolts. The holes in the gusset plate are elongated, the amount of the elongation being gradually increased from a minimum in the uppermost hole, to a maximum in the lowermost one. The arrangement makes the end plate very flexible, the "breathing" space extending from the rivets in the furnace tube flanges to the upper rivets in the gusset angles.

Sometimes the furnace and flue tubes are designed in such a way that they are capable of taking up a considerable amount of expansion, so that there is not the same movement of the end plates as when the ordinary design is adopted. The necessary elasticity may be ob-

* From *Cheap Steam*. † A.M.I. Mech. E.

tained either by arranging the tube flanges to act as flexible joints, or by corrugating the tubes. Corrugated tubes are, of course, both stronger and more elastic than ordinary plain tubes, but they are more costly.

Internal grooving is sometimes found at the longitudinal seams of cylindrical lap-jointed boilers, and here again the trouble is the result of imperfect design. A lap-jointed boiler is not truly circular, but the internal pressure is constantly tending to make it so, and there is thus a tendency to bend the outer plate over the edge of the inner lap, so that in course of time a groove may develop (see Fig. 3). Since a boiler is weakest at the longitudinal seams, being only one-half as strong longitudinally as circumferentially, it will be understood that grooving at the longitudinal seams is a most serious defect. In modern boilers the trouble is obviated by adopting the butt instead of the lap joint, as with this form of joint the true circular shape of the boiler is retained, and there is no tendency to straining. Vertical and locomotive type boilers are, however, in many cases still made with lap joints. In a locomotive type boiler the lap joint is very objectionable, because, owing to the presence of the smoketubes, the barrel is inaccessible, so that a groove may develop and remain undetected until an explosion results. In the past a number of very disastrous explosions of this type of boiler have been caused by longitudinal grooves.

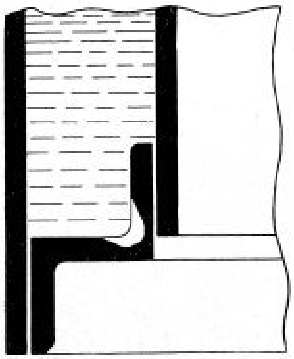


Fig. 4.—Form of Grooving Around Foundation Seams

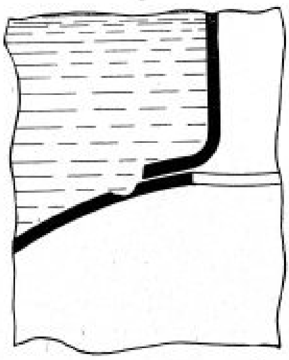


Fig. 5.—Grooving in Tube Flange of Firebox Crown

Careless calking has sometimes been responsible for severe internal grooving at the seams, the calking tool having been allowed to break the skin of the metal and the corrosive ingredients in the feed water having afterwards attacked the affected part, eventually forming a more or less deep groove.

Provision for Expansion

The movements of expansion and contraction commonly give rise to grooving about the foundation seams of locomotive type boilers (see Fig. 4). The general system of staying the flat sides of the firebox and the outer casing—i. e., by numerous screwed stays—is a rigid one and makes practically no provision for expansive movements, and since the firebox casing expands more than the outer casing, it is not surprising that the lower parts should suffer from straining and consequent grooving. The stays themselves also frequently become grooved and are then liable to fracture sooner or later.

The necessary flexibility may be provided by a suitable design of flexible staybolt, which will allow the firebox plates to expand freely and so prevent not only grooving but other troubles. Such bolts have been much used in the construction of American locomotive boilers, but on account of certain practical objections have not been adopted in Great Britain.

In ordinary vertical boilers the expansion of the uptake or chimney tube is always liable to set up grooving in the firebox crown, usually around the flange of the tube (see Fig. 5), but occasionally in the bend of the crown near the circumferential joint the top of the firebox and the crown. With the object of providing sufficient elasticity to prevent this, the shell crown is sometimes made flat instead of cambered, since a flat crown is not so stiff and rigid as a cambered crown.

External grooving is usually brought about by leakage at a seam or mounting. Unlike internal grooving, it can, as a rule, be easily remedied; all that is required being to stop the leakage, and this can in most cases be done by a little calking. If the seam is hidden under brickwork, the grooving may ultimately prove to be a very dangerous defect, since it may evade detection until the plate becomes deeply corroded.

Frequent Examination

To ensure safety, parts liable to suffer from grooving, such as the end plates of Lancashire and Cornish boilers, the lower parts of the locomotive type and vertical boilers, screwed stays, the firebox crowns of vertical boilers, etc., should be frequently examined for any signs of the trouble, and to facilitate the examination the parts should be cleared thoroughly of scale.

If the grooving is of a fine character it may be difficult to ascertain its depth, and a small hole should then be drilled through what is believed to be the worst part when the actual depth can be measured. For this purpose, a core drill is very useful; the drill takes out a small core from the affected part, and the depth of the groove can then be accurately determined.

Seriously grooved parts should be made good without delay. A suitable repair may often be effected by acetylene welding, but, generally speaking, this process should only be applied to parts not in tension, and in cases where the grooves are not of an extensive nature. The practice of making up grooves at longitudinal seams by acetylene welding is not to be recommended under any circumstances; the only satisfactory repair is to cut out and renew the affected part.

PERSONAL

Harry D. Vought, secretary of the Master Boiler Makers' Association, has thoroughly recovered from his recent illness and will act as representative at the convention of the United States Railroad Administration.

L. E. Schumacher, who for the past eight years has been chief inspector of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa., has become works manager of the Krantz Manufacturing Company, Brooklyn, N. Y., the latest subsidiary of the former company. Prior to his coming to the Westinghouse Electric and Manufacturing Company in 1900, Mr. Schumacher was employed at the Niagara Falls Power Company. His first duties at the Westinghouse Electric and Manufacturing Company were the erection of switchboards. Later he was promoted to the position of general foreman of the testing department. In 1910 he became chief inspector, which position he has held until the present. He is especially prepared by his long experience in the manufacture of safety switches, panel doors and floor boxes for his new position with the Krantz Manufacturing Company.

Don't forget that you are an inexperienced young man learning a trade, and that everyone in the shop can teach you something, and there is an easy way to get this knowledge; simply be respectful and they will help you.

Selected Boiler Patents

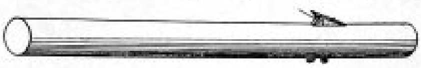
Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,278,685. BEADING TOOL FOR BOILER TUBES. OSCAR C. KROSHAUG, OF VOLGA, S. D.

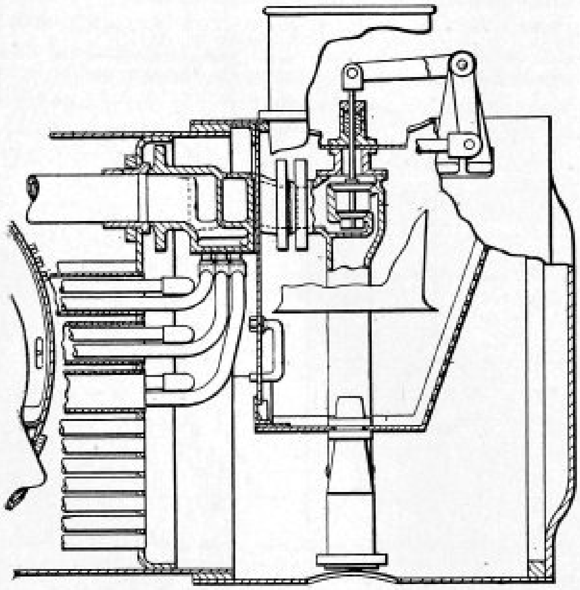
Claim 1.—A beading tool for boiler tubes comprising an elongated mandrel, a tube engaging hook carried by said mandrel and extending from one side thereof and an adjustably mounted strip supported upon



the opposite side of said mandrel for holding the mandrel firmly in a tube as the same is being reciprocated and as said hook engages the end of the tube. Four claims.

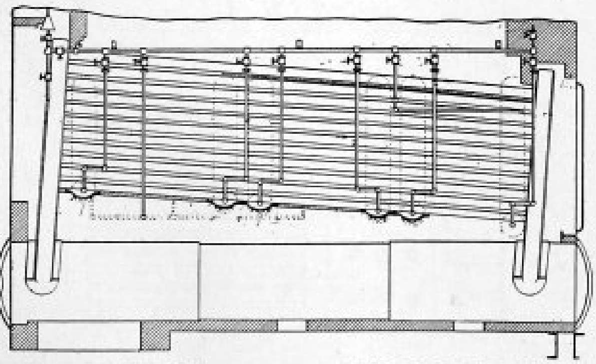
1,279,132. LOCOMOTIVE THROTTLE FOR SUPERHEATING DEVICES. WILLIAM J. McLEAN, OF BELLINGHAM, WASH.

Claim.—In a locomotive construction, the combination with the boiler, and its smoke box, of a plurality of superheating pipes extending through some of the boiler flues, a casing spaced from the front tube sheet of the boiler and located within the smoke box, a two chamber header located transversely of the boiler and between the front tube sheet and the casing and above the plane of the superheating pipes, the oppo-



site ends of the superheating tubes being respectively connected with the chambers of the header, a pair of throttle valves located within the casing and located substantially in the plane of the header, connections between the casings of said valves and one of the chambers of the header, means to supply steam from the boiler to the other chamber of the header, means for conducting steam from the throttle valves to the cylinders of the locomotive and means located outside of the smoke box and projecting thereinto for controlling the throttle valves. One claim.

1,279,382. SOOT CLEANER FOR WATERTUBE BOILERS. FREDERICK W. LINAKER, OF DUBOIS, PA., ASSIGNOR, BY

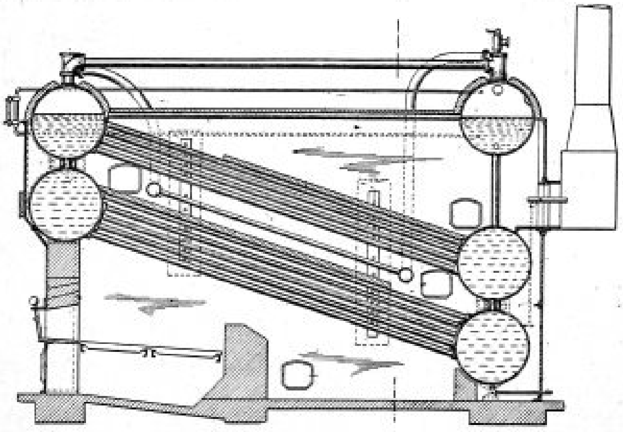


MESNE ASSIGNMENTS, TO THE VULCAN SOOT CLEANER CO., OF DUBOIS, PA., A CORPORATION OF DELAWARE.

Claim 1.—A soot cleaner including a cleaning fluid distributing pipe, discharge nozzles carried by the pipe, a hood for the pipe slightly spaced therefrom to provide a clearance for the nozzles, and a baffle having an opening therein for the reception of the hood. Nine claims.

1,276,858. WATERTUBE BOILER. FREDERICK E. ARNOLD, OF SALT LAKE CITY, UTAH.

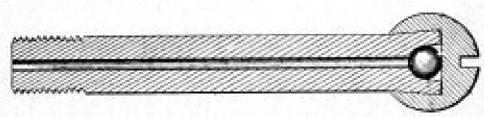
Claim 1.—In a watertube boiler, a pair of front horizontal cylindrical drums at different levels, straight water circulators connecting the same, three rear horizontal cylindrical drums at different levels, straight water circulators connecting the same, a bank of inclined straight tubes connecting the lower drums, a bank of inclined straight tubes connecting the upper front drum and the middle rear drum, a row of straight tubes



connecting the upper front drum with the upper rear drum, and a baffle arranged to direct the gases from the front of the boiler rearwardly along the lower bank of tubes, a baffle arranged to direct the gases from the rear end of the boiler forwardly along the upper bank of tubes, a baffle resting on the top row of tubes forming the roof of the boiler and causing the gases to travel rearwardly along this top row of tubes and out past the rear water circulators between the middle drum and upper drum. Three claims.

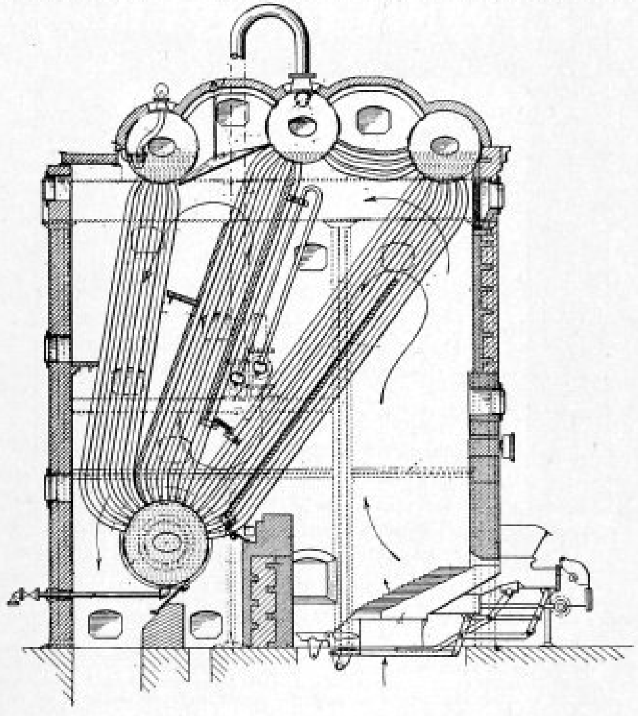
1,281,929. STAYBOLT. JOHN ROGERS FLANNERY, BENJAMIN E. D. STAFFORD, AND ETHAN I. DODDS, OF PITTSBURGH, PA., ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

Claim 1.—A staybolt comprising a body portion, a separate head having a socket therein receiving one end of said body portion, and means



expanding the metal of the body within the socket of the head and rigidly securing said head on the end of said body portion. Five claims.

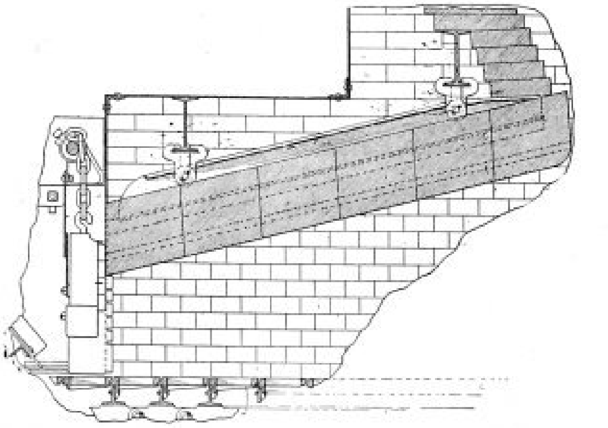
1,280,745. STEAM BOILER. DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.



Claim 1.—A steam boiler comprising a bank of generating tubes, upper and lower drums into which said tubes are expanded, a longitudinal baffle in said bank to direct the course of the gases, a furnace having a bridge wall, a cross baffle extending from said longitudinal baffle, and a yielding seal between said cross baffle and said bridge wall. Six claims.

1,278,326. FURNACE ARCH. JOHN S. S. FULTON, OF CHICAGO, ILL., ASSIGNOR TO UNITED STOKERS CORPORATION, A CORPORATION OF ILLINOIS.

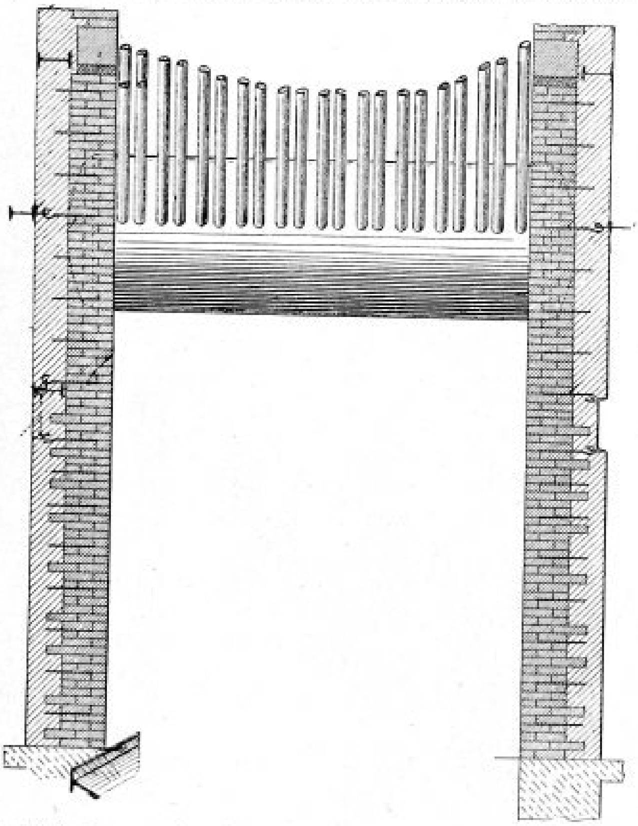
Claim 1.—In a furnace, a flat arch made up of a plurality of fire bricks, each provided with a shoulder, a longitudinally arranged bar en-



gaging said shoulders and projecting above the fire bricks, a transverse beam above said bar, and a pair of suspension clamps, each having a body portion and an upper hook-shaped portion for engaging said beam and a lower offset extension for connection to said bar, and a laterally projecting lug, the lugs of the pair of clamps having parallel interlocking faces engaging with one another at right angles to the body portion to prevent positively a lateral displacement of the clamps when they are placed in operative position relative to the beam. Three claims.

1,275,037. FURNACE-WALL STRUCTURE. DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

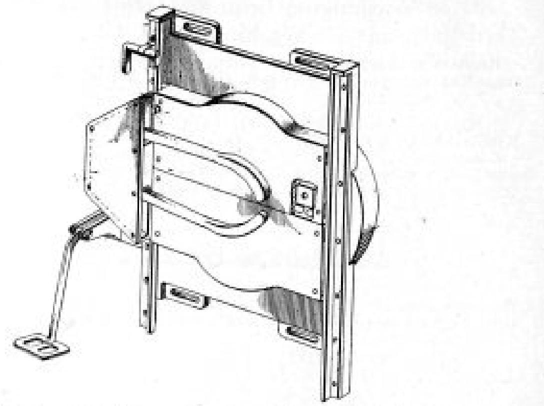
Claim.—A furnace wall comprising a plurality of horizontal courses of brickwork, tie pieces inserted between the contiguous courses, said tie pieces consisting of metallic grids or mesh construction of flexible ma-



terial having a series of separated points or projections arranged to space apart the bricks between which it lies and to engage and frictionally hold the bricks, and wall-retaining members supported independently of the wall and to which the projecting flexible portions of said tie pieces are attached, whereby the wall is permitted to move independently of said retaining members and is prevented from bulging by reason of the holding power of said tie pieces and the stiffness of the retaining member. One claim.

1,278,293. LOCOMOTIVE FIRE-DOOR. JAMES R. BAZZILL, OF COLUMBIA, S. C.

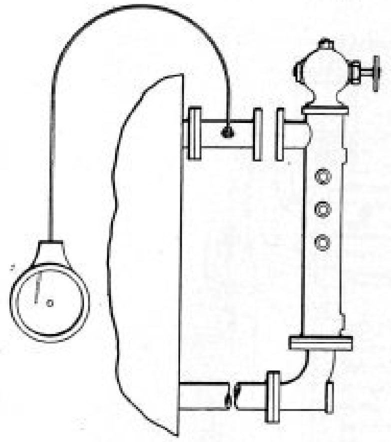
Claim 1.—A device of the character described including a door frame, flanges carried thereby, angle members having corresponding flanges thereof co-operating with the flanges of the frame to provide guide ways, complemental door sections having flanges at their vertical edges slidable in said guide ways, guide rollers carried by the vertical edges of said door sections to engage with opposite corresponding flanges of the said angle members in front of the flanges of the door sections for directing the said door sections in their sliding movement, means connecting the



said door sections for simultaneous movement in opposite directions, one of the door sections gravitating to shift the said sections toward each other and normally hold the door closed, and foot operated means connected with said first-mentioned means for shifting the door sections away from each other to open the door. Four claims.

1,279,187. STEAM BOILER INDICATOR AND RECORDER. CHARLES V. WALKER, OF LONG BEACH, CAL.

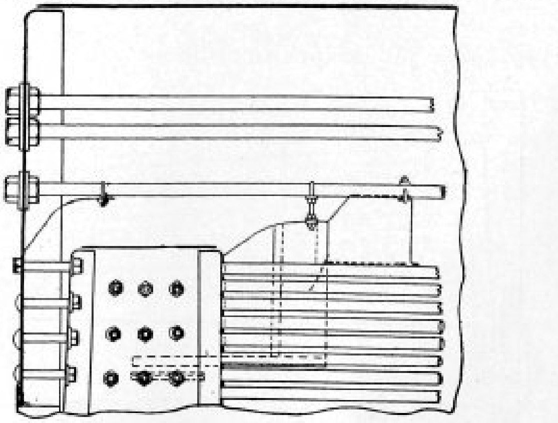
Claim.—A steam boiler indicator and recorder comprising the combination with a steam boiler and a water gage having upper and lower legs



in connection with the boiler and having a test cock extending from the lower leg, of a chronologically recording thermometer connected to the lower leg to record the sudden fluctuations in temperature caused by opening the test cock. One claim.

1,281,973. MEANS FOR PROMOTING THE CIRCULATION OF WATER IN STEAM BOILERS. HAROLD W. E. JOSLING, OF WESTMINSTER, LONDON, ENGLAND, ASSIGNOR TO MARINE APPLIANCES, LIMITED, OF WESTMINSTER, ENGLAND.

Claim 1.—The combination, with a boiler provided with a plurality of combustion chambers each having a set of fire tubes; of a hood formed



of a continuous plate having its rear edge arranged adjacent to the front ends of the said combustion chambers and extending upwardly and forwardly over all the sets of tubes and having downwardly projecting wings at its sides arranged in the water spaces between the tubes and the side walls of the boiler, and a directing plate secured adjacent to one of the wings of the hood and extending forwardly thereof and diagonally of and above the adjacent fire tubes. Two claims.

THE BOILER MAKER

FEBRUARY, 1919

New Type of Firebox Construction

Boiler Efficiency Increased 28 Percent and Coal Consumption Decreased 25 Percent bv Installation of "Thermic Syphons"

In order to increase the firebox heating surface in a locomotive boiler and also to improve the circulation of the water and thereby increase the evaporation from the firebox heating surface, the Nicholson Firebox Company, Marquette Building, Chicago, Ill., has developed a new type of firebox construction in which the customary arch tubes are replaced by a repair of so-called "thermic syphons." As shown by Fig. 2, the thermic syphon consists of tubular sections extending from the lower part of the throat sheet up to the rear end of the crown sheet. The upper part of the tubular section, however, is extended in the form of flat plates, spaced 4 inches apart, up to the crown sheet for nearly the entire length of the firebox. The syphons therefore form two additional water legs in the firebox. The lower extremity of the syphon is flanged into tubular shape and is inserted into and secured to the throat sheet of the firebox, giving to the tubular portion the slope corresponding to that of the customary arch tubes. The vertical edges of the syphon are flanged inwardly and joined by autogenous welding. The horizontal or upper edges of the syphon are flanged outwardly, forming a part of the crown sheet and are welded to the crown sheet. The flat sides of the syphon are stayed with hollow rigid staybolts in the same manner as the water legs of the firebox.

In a later design of throat sheet connection, shown in Fig. 1, a flexible diaphragm plate is used, which not only gives more flexibility for the movement of the syphon due to contraction and expansion, but also greatly simplifies the manufacture of the syphons, in that by doing away with the flanged connection at the throat sheet it is possible to use one set of forms and dies for practically al firebox installations.

In order to determine the merits of the device, engine 7615, class C-2, of the Chicago, Milwaukee and St. Paul Railroad was equipped with two Nicholson thermic syphons and tested out in road service against engine 7142 of the same class equipped with a standard arch supported by arch tubes. Both engines had recently undergone shopping for heavy repairs, engine 7615 having been in service about six weeks at the time of the tests, and engine 7142 for about ten days.

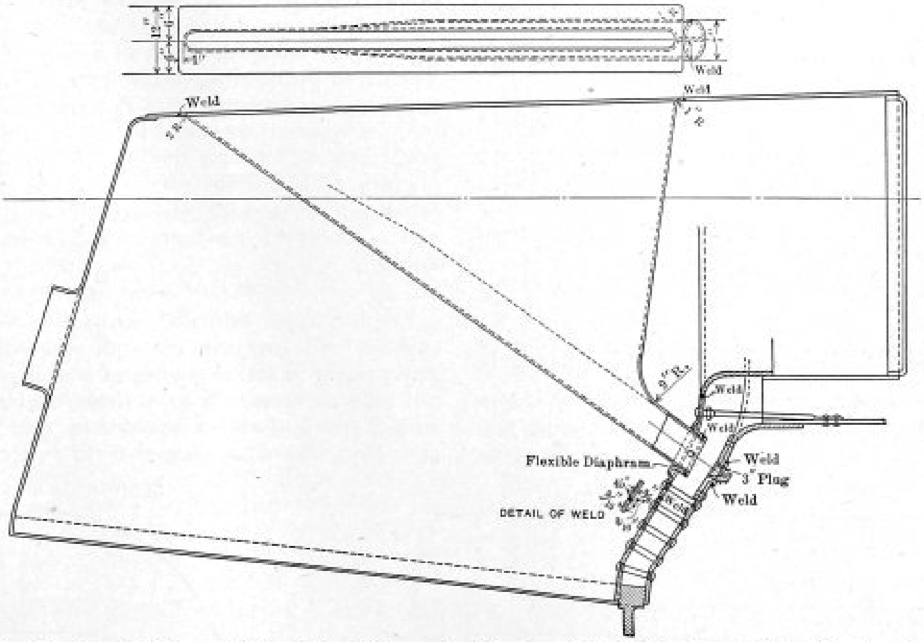


Fig. 1.—Latest Design of Throat Sheet Connection Showing Flexible Diaphragm Plate for Attachment of Syphon

Locomotive Data

The locomotives tested were of the saturated, consolidation type with piston valves and Walschaert valve gear, and were alike in all respects, except that the firebox of engine 7615 was equipped with the Nicholson thermic syphons supporting the brick arch, while engine 7142 had the ordinary type of arch supported on four 3-inch arch

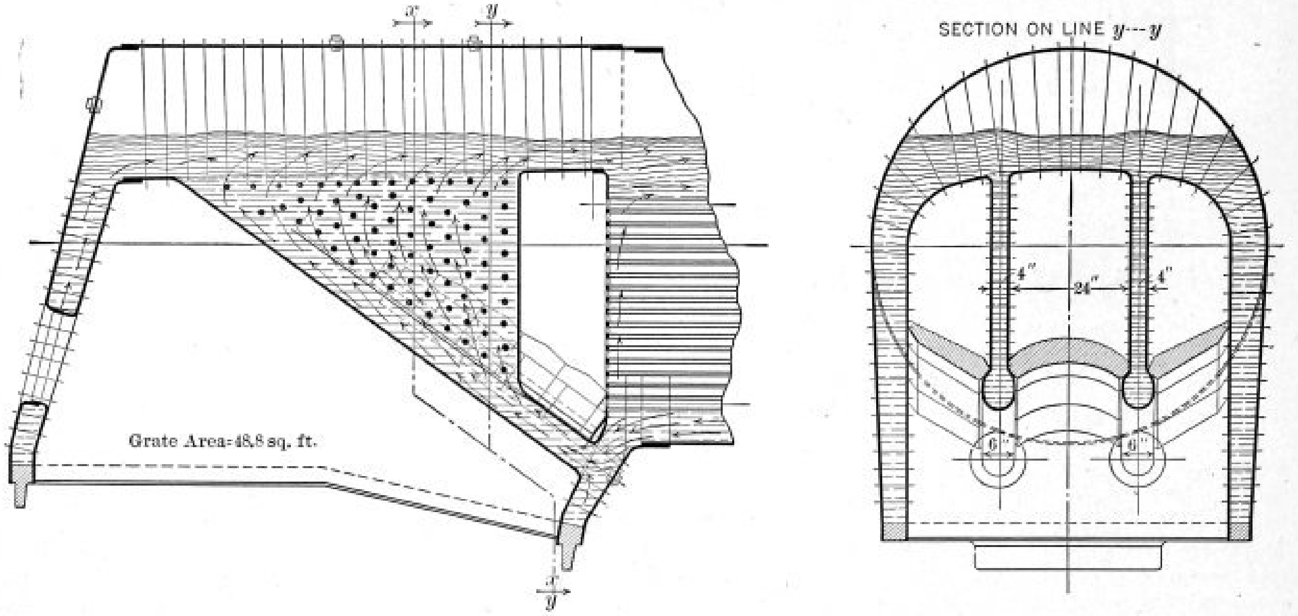


Fig. 2.—Firebox of Engine 7615, Equipped with Nicholson Thermic Syphons

tubes. The principal dimensions and data are given below:

TABLE 1.—LOCOMOTIVE DATA

	Engine 7615	Engine 7142
Cylinder diameter and stroke, inches	23 x 30	23 x 30
Drivers, diameter, inches	63	63
Tractive power, pounds	42,800	42,800
Weight on drivers, pounds	190,400	189,200
Total weight of engine, pounds	216,900	215,700
Total weight, engine and tender, pounds	351,450	350,250
Boiler type	Straight, radial stay	Straight, R.S.
Boiler diameter, first course, inches	75¼	75¼
Grate area, square feet	48.8	48.8
Tubes, number and outside diameter	414—2"	418—2"
Tube heating surface, square feet	3,143.0	3,173.4
Normal firebox heating surface, square feet	195.7	195.7
Heating surface added by arch tube, square feet		29.3
Heating surface added by thermic syphon, square feet	53.0	
Total firebox heating surface, square feet	248.7	225.0
Total heating surface, square feet	3,391.7	3,398.4
Total heating surface ÷ grate area	69.5	69.6
Firebox heating surface ÷ total heating surface, percent	7.3	6.6
Firebox heating surface ÷ grate area	5.1	4.6

An elevation and cross-section of the firebox of engine 7615 is shown in Fig. 2, while the firebox of engine 7142 is shown in Fig. 3. The two fireboxes are of the same dimensions throughout, the only differences being those noted above.

The tests were run between Milwaukee and Portage. In the following tables the letter "W" following the test number indicates that the run was westbound, from Milwaukee to Portage, while the letter "E" indicates that the tests were eastbound, from Portage to Milwaukee.

No attempts were made to control the make-up of the test trains other than limiting the tonnage to what the engines could handle over the ruling grade, the trains being run extra with whatever loads and empties available. Distance, westbound, 91.8 miles; eastbound, 89 miles.

RESULTS OF COMPARATIVE TESTS

Engine 7615, equipped with the Nicholson thermic syphons and carrying an arch, showed a reduction of 24.7 percent in actual pounds of coal fired per gross 1,000-ton mile as compared to a sister engine, 7142, equipped with a standard arch supported by four arch tubes. Engine 7615 showed a saving of 30.3 percent in coal fired

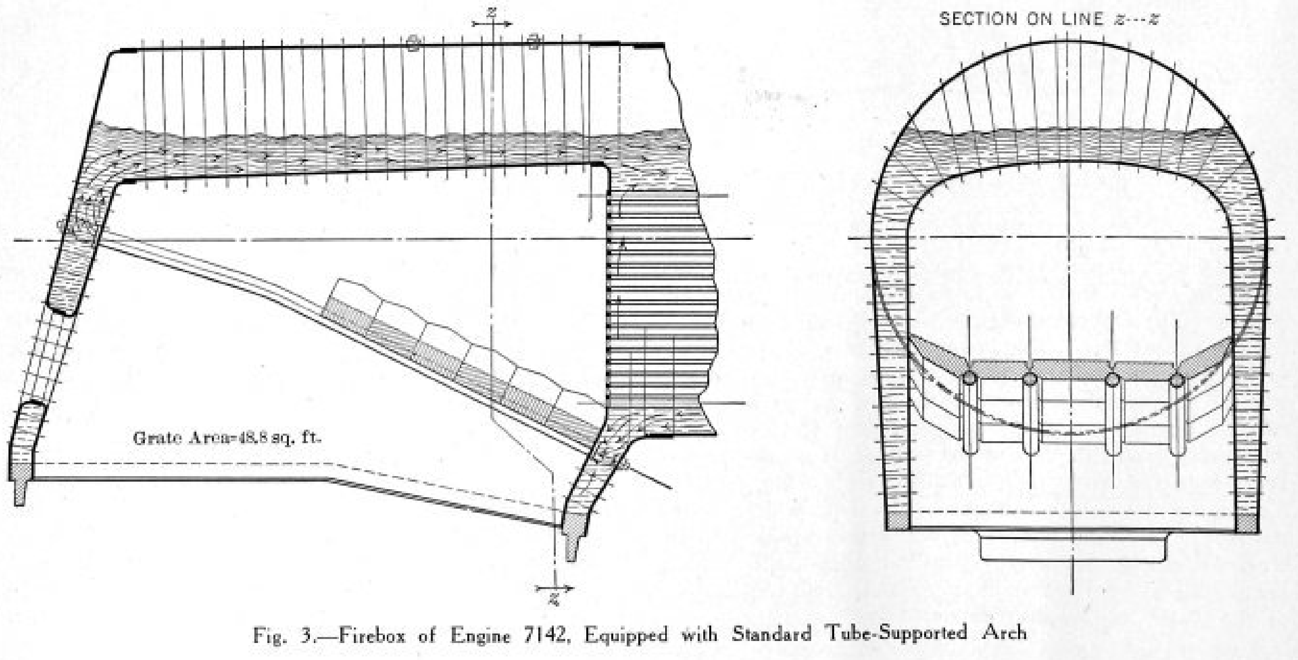


Fig. 3.—Firebox of Engine 7142, Equipped with Standard Tube-Supported Arch

per gross 1,000-ton miles with coal equated to a common B.t.u. basis. Engine 7142 worked with an average boiler efficiency of 57.65 percent, which is a fair performance considering the design of the boiler, rate of combustion and quality of fuel, while engine 7615, with the syphons, had an average boiler efficiency of 73.75 percent, an increase of 27.92 percent over engine 7142. Engine 7615 used 11.1 percent less water per 1,000-ton mile.

The use of the syphons effected an indicated reduction in front-end temperatures of 75 degrees, and future tests will probably show greater drops in this temperature. Combustion of the gases in the firebox was seemingly improved by the combination of the syphons and brick arch. Engine 7615 was remarkably free from smoke at all times and discharged less cinders than engine 7142.

The syphon heating surfaces had an indicated evaporation approximately 50 percent higher than other heating surfaces in the same firebox and 100 percent higher than firebox heating surfaces of engine 7142.

The location and shape of the syphons and the consequent high heat absorption produces a syphoning action sufficient to circulate all the water in the boiler through the syphons in five minutes' time. At normal rates of working the calculated velocity of circulation at the intake was 4.26 feet per second, and at the discharge end was 1.26 feet per second.

The high efficiency and responsiveness of the boiler equipped with the syphons is due to a combination of the following factors:

First: The increase in combustion of the gases that burn above the fuel bed, due to the syphons acting as baffles that break the gases up into several streams and thereby facilitate the mixing of the combustible gases with air.

Second: The increase in radiant heat available for absorption by the firebox heating surfaces, due to the syphons acting as baffles that break up one large body of flame into several smaller bodies, thereby increasing the exterior flame surface, or zone, that radiates heat.

Third: The increase in heat absorbing surfaces that are located in such a manner as to derive full benefit from the increased radiant heat, and at the same time receive an appreciable amount of converted heat by the direct impingement of the hot gases.

Fourth: The greatly increased circulation, due to a particular location and shape of the syphons that takes full advantage of and accelerates the natural circulation currents; that is, the flow of water is directed through water channels surrounded by heating surfaces that are discharging large quantities of steam into the channels and thereby producing a syphoning action that greatly increases the velocity of circulation.

The principal differences in the performance of engines 7615 and 7142 as developed by the tests, and directly attributable to the syphons, are shown below:

	Engine No. 7142	Engine No. 7615	Difference, Percent
Pounds coal fired per gross 1,000-ton mile, actual	124.36	93.64	24.7
Pounds coal fired per gross 1,000-ton mile, equated	124.36	86.63	30.3
Pounds coal fired per locomotive mile	271.9	218.9	19.4
Average tonnage hauled	2,190	2,340	6.8
Pounds of water used per gross 1,000-ton miles	670.72	596.22	11.1
Pounds water evaporated per pound coal fired	5.39	6.36	18.0
Equivalent evaporation per pound coal fired	6.54	7.74	18.3
Equivalent evaporation per pound dry coal	7.28	8.60	18.1
Equivalent evaporation per pound combustible	8.37	10.49	25.3
Boiler efficiency	57.65	73.75	27.92
Front-end temperature, degrees	625	550	13.6

Numerical quantities under engine 7142 considered as 100 percent in the above.

Coal Consumption

Table 2 shows the coal consumption, column 3 showing

TABLE 2

COAL CONSUMPTION.							
1	2	3	4	5	6	7	8
Eng. No.	Test No.	Total Pounds Coal Fired	Average Lbs. Coal Fired Per Hour	Lbs. Coal Per Hour Per Sq. Ft. of Grate	Lbs. Coal Fired Per 100-Car Mile	Lbs. Coal Fired Per Locomotive Mile	Lbs. Coal Fired Per Gross 1000 Ton Mile
7615	1-E	18400	3262	66.64	382.8	206.7	80.60
	2-W	20450	3903	80.00	589.0	222.7	102.84
	3-W	20820	3523	72.19	513.7	226.8	101.35
	4-E	19505	3744	76.72	317.6	219.1	91.61
	Ave.	19794	3599	73.75	440.6	218.9	93.64
7142	1-W	29450	4558	93.40	486.0	320.8	162.12
	2-E	22100	4300	88.11	483.9	248.3	108.22
	3-W	25855	4568	93.60	688.1	281.6	141.51
	4-E	20930	4120	84.42	461.1	225.1	94.10
	Ave.	24584	4401	90.18	510.8	271.9	124.36

the total pounds of coal fired while train was in motion. Coal weights were obtained by weighing tender on track scales at each end of the run after all water had been emptied out. Sacked coal was carried on tender for use while at terminals and standing or switching on road.

Coal Analysis

No attempt was made to select coal for the tests, engines being coaled up at the chutes at each end of the run, taking the coal as it came. It was noticeable that a little better grade of lump coal was obtained at Portage than at Milwaukee on all of the test runs, and that engine 7615 was a little unfortunate in securing rather poor grades of slack coal on three of the trips, a fairly good grade of lump coal being obtained only on the first trip.

Boiler Performance

Table 3 gives the actual coal fired per hour and water evaporated during the different tests. The factor of evaporation shown in column 9 is too high, owing to the fact that no correction was made for moisture in steam; but the values given are strictly comparable.

Steam Pressure

Column 8, Table 3, shows the average boiler pressure maintained during the different tests. There was very little difference in this respect between the two locomotives, as both were free steamers; but it was noticeable that the boiler of engine 7615 was more responsive to the demands made upon it than that of engine 7142.

During the course of the tests some 475 readings were taken of the boiler pressure of engine 7615, and of these only 19 showed a pressure below 195 pounds, the pop valve being set at 204 pounds.

Full steam pressure could be maintained without trouble against both injectors when engine 7615 was working its hardest on grades, and at no time was it necessary to favor the engine in order to maintain full steam pressure.

Table 4 shows the equivalent evaporation, boiler horsepower and efficiency, the boiler efficiency being based on the heat in the coal as fired.

TABLE 3

BOILER PERFORMANCE - COAL AND APPARENT EVAPORATION								
1	2	3	4	5	6	7	8	9
Eng. No.	Test No.	Lbs. Coal Fired Per Hour	Lbs. Water Evaporated per Hour	Lbs. Water Evaporated Per Pound Coal	Lbs. Water Evaporated Per. Sq. Ft. Heat. Surf.	Temp. Feed Water	Average Boiler Pressure	Factor of Evap.
7615	1-E	3262	21782	6.68	6.42	49°	198.3	1.2187
	2-W	3903	23563	6.04	6.94	52°	199.2	1.2149
	3-W	3523	22825	6.48	6.72	52°	198.9	1.2149
	4-E	3744	23589	6.30	6.95	51°	198.4	1.2159
	Ave.	3599	22912	6.36	6.75	51°	198.7	1.2159
7142	1-W	4558	23707	5.20	6.97	50°	198.8	1.2170
	2-E	4300	24554	5.71	7.22	54°	198.3	1.2189
	3-W	4568	23394	5.12	6.88	58°	196.6	1.2066
	4-E	4120	23338	5.66	6.88	52°	197.6	1.2149
	Ave.	4401	23728	5.39	6.98	53°	197.9	1.2139

BOILER HORSEPOWER

Table 4 shows that the average boiler horsepower of engine 7615 was 807.4, while that of 7142 was 834.8. As neither of the boilers were forced to their capacity throughout the tests, a comparison of these figures means little. Engine 7615 was able to handle full tonnage and maintain the boiler pressure and speed while developing an average boiler horsepower of 807.4, while it was necessary to work engine 7142 harder in order to do the same.

TABLE 4

BOILER PERFORMANCE - EQUIV. EVAP. HORSE POWER & EFFICIENCY

Eng. No.	Test No.	Equivalent Evaporation - From and at 212° F. Lbs. Per Hour	Per Hr. Per Sq. Ft. Heat Surf.	Per Lb. of Coal As Fired	Per Lb. of Dry Coal	Per Lb. of Combustible	Boiler Horse Power	Boiler Efficiency
7615	1-E	26546	7.62	8.14	9.04	9.42	769.4	67.00
	2-W	28615	8.43	7.34	8.14	10.22	826.5	73.63
	3-W	27730	8.16	7.87	8.74	11.09	803.7	77.96
	4-E	28668	8.45	7.66	8.81	10.77	831.3	77.26
	Ave.	27858	8.21	7.74	8.60	10.49	807.4	73.75
7142	1-W	28851	8.48	6.33	7.10	8.26	836.2	68.00
	2-E	29781	8.76	6.93	7.35	8.96	863.2	61.35
	3-W	28274	8.31	6.19	6.96	7.88	819.6	63.89
	4-E	28563	8.34	6.88	7.59	8.66	821.8	68.10
	Ave.	28808	8.47	6.54	7.28*	8.37	834.8	67.65

Engine 7615 developed a maximum boiler horsepower of 1,015 while working on the grade from Milwaukee to Brookfield. This gives an equivalent evaporation of 35,000 pounds of water per hour, or 10.62 pounds of water per hour per square foot of heating surface, and these figures do not represent the evaporating capacity of the boiler. The maximum capacity of all locomotive boilers is governed by furnace conditions that limit the amount of heat that can be liberated, rather than by the amount of heat that can be absorbed.

Engine 7615, as now equipped, has an ample reserve of boiler power and her hauling capacity is limited by the weight on drivers, rather than by the sustained steaming capacity of the boiler.

DRAFT AND FRONT END TEMPERATURE

Table 5 shows the draft in front end, firebox and ash pan, also the front end temperatures secured during one round trip of each locomotive. The draft readings were obtained while double nozzles 3½ inches in diameter were in use. The nozzles of the 7615 were opened up to 3 11/16 inches in diameter during the last round trip and effected some reduction in the draft readings. A still larger nozzle could no doubt be used on this engine with a fair grade of lump coal, but it was not deemed advisable to increase the size beyond 3 11/16 inches during the test on account of the large amount of slack coal the engine was receiving.

TABLE 5

DRAFT AND FRONT END TEMPERATURE

Engine No.	Test No.	Lbs. Coal Fired Per Hour	Lbs. Coal Fired Per Sq. Ft. Grate Per Hour	Draft - Inches of Water: Front End	Firebox	Ash Pan	Front End Temp.
7615	1-E	3262	66.84	5.2	1.67	.27	520°
	2-W	3903	80.00	5.3	1.66	.29	536°
	Ave.	3582	73.42	5.25	1.66	.28	526°
7142	1-W	4558	93.40	5.3	1.56	.22	610°
	2-E	4300	88.11	5.0	1.27	.17	589°
	Ave.	4429	90.15	5.15	1.41	.195	599°

The front end temperatures were obtained by means of a Hoskins pyrometer attached to a recorder from which the temperatures in degrees Fahrenheit were read. Owing to a misadjustment of the recorder the temperatures recorded for engine 7142 are too low. Temperatures averaging 54 degrees higher were afterwards obtained with a correct adjustment of the recorder.

The wires of the hot couple of the pyrometer were about 2/10 inch in diameter, and for wires of this size there is always a considerable loss, resulting in temperature readings that are too low, the errors in the readings increasing as the temperatures increase. It is estimated that on this account the temperature readings of engine 7615 were about 22 degrees too low, and those of 7142 about 26 too low, and in calculations to be shown later on, front end temperatures of 550 degrees for engine 7615 and 625 degrees for engine 7142 were used. These figures show a reduction of 75 degrees in the temperature of the front end gases, and, while this is a most favorable showing, the indications are that the actual temperature difference was approximately 125 degrees.

COMBUSTION CONDITIONS

As no analyses were made of the front end gases, it is impossible to tell exactly what changes in combustion conditions were brought about by the introduction of the thermic syphons; but, judging by the reduction in coal consumption, the increase in evaporation, and the marked absence of smoke, the design and location of the syphons has a tendency to improve the combustion conditions by breaking up the stream of gases and securing a better mixture of the combustible gases and the air.

Engine 7615 was singularly free from smoke at all times, and even when being worked the hardest on long grades there was practically no smoke emitted. Considering the nature of the coal used, this is an almost certain indication that approximately perfect combustion was being obtained.

It was also noticeable that the cinder discharge was much less from engine 7615 than from 7142, notwithstanding that the former was burning a poorer grade of coal that was mostly slack.

FIREBOX EVAPORATION

The marked reduction in fuel consumption and increase in boiler efficiency shown in the foregoing tables warrants some explanation, for it is evident that a mere increase in firebox heating surface of some 23.7 square feet is not of itself sufficient to cause such a showing. The improvement is due rather to the shape and location of the syphon and the arrangement of its heating surfaces with respect to the flame contents of the firebox.

The reduction in the front end temperatures indicates that the firebox of engine 7615 absorbed a greater proportion of the total heat generated than did the firebox of engine 7142. The amount of water evaporated by each of these fireboxes can only be determined accurately by actual and rather expensive tests, but it can be approximated in the following manner:

Knowing the temperatures of the gases entering the flues at the firebox end, the temperature of the gases leaving the flues at the front end, and the weight of the gases passing through per hour, the evaporation from the flue heating surfaces can be obtained. This amount subtracted from the total evaporation will give the firebox evaporation.

As no front end gas analyses were made, the amount of air supplied per pound of coal fired is unknown; but under similar conditions as to grade of fuel, rate of combustion and type of grates, numerous locomotive test plant records indicate an average air supply of 10½ pounds of air per pound of coal at the rate of combustion of 73.75 pounds of coal per square foot of grate per hour, for engine 7615, and 9.75 pounds of air per pound of coal at the rate of combustion of 90.18 pounds for engine 7142.

Assuming this amount of air to be approximately correct, we can determine the weight of gases passing through the flues per hour for the two locomotives.

Knowing the front end temperatures and the weight of gases passing through the flues, the temperature of the gases entering the flues can be approximated by means of an empirical formula devised by Professor Fessenden and based upon the results of numerous tests made at the University of Missouri.

Having determined the temperature of the gases entering the flues, and knowing the temperature of gases leaving the flues and the weight of air passing through per hour, the amount of heat absorbed by the flues and the water evaporated is determined as shown below—Langen's values for the mean specific heats being used:

		Engine No. 7615	Engine No. 7142
Equivalent evaporation from flues per hour, pounds	=	12,752	18,800
Equivalent evaporation from firebox per hour, pounds	=	15,106	10,003
Total equivalent evaporation per hour, pounds	=	27,858	28,803
Firebox evaporation, percent of total	=	54.2	34.7
Flue evaporation, percent of total	=	45.8	65.3
Equivalent evaporation per square foot firebox heating surface per hour	=	60.74	44.44
Equivalent evaporation per square foot flue heating surface per hour	=	4.05	5.92
Equivalent evaporation per square foot total heating surface per hour	=	8.21	8.47
Flue efficiency, percent	=	87.7	86.0

As shown by the above figures, the *firebox* evaporation of engine 7615 was approximately 5,100 pounds per hour greater than that of engine 7142, while the flue evaporation was 6,050 pounds an hour less in engine 7615 than in engine 7142. Such a condition, that is, high firebox evaporation accompanied by a reduction in flue evaporation, results in higher overall boiler efficiency. The reason is that the firebox heating surfaces can be worked at a high rate of evaporation with very little decrease in efficiency, while the efficiency of the flues decreases rapidly as their rate of working is increased; that is, increasing the weight or the temperature of the gases flowing through the flues per hour increases the evaporation from the flues, but decreases the efficiency.

Short flues, such as the 14½-foot flues in the C-2 class engines, are of advantage in many ways, the only disadvantage being the higher temperature at which they generally discharge the gases. The data obtained in these tests indicate that an installation of heating surfaces, such as is obtained by the use of the Nicholson syphon, will result in such a great increase in absorption of heat in the firebox that the flues will have correspondingly less work to do, will work with increased efficiency and will discharge the gases at the front end at a much lower temperature.

Short flues give greater activity of combustion and of evaporation than long flues, and when used in conjunction with syphons, as here shown, high overall boiler efficiency is obtained with low front end temperatures, which removes the only advantage claimed for long flues.

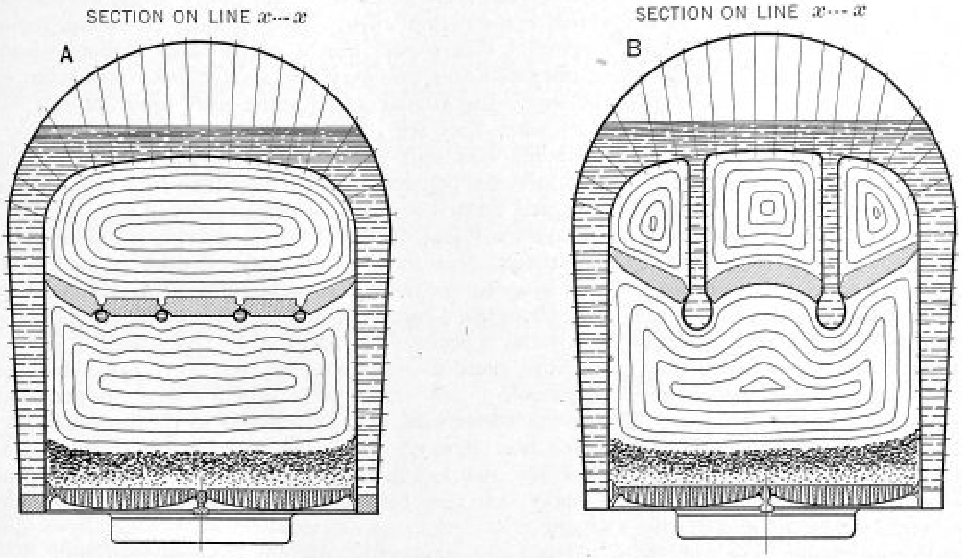


Fig. 4.—Sections Through Firebox Showing Increased Flame Radiating Surface Attained with Nicholson Thermic Syphons

Practically all of the heat absorbed by the heating surfaces of the ordinary firebox is radiated from the fuel bed and from the flames to the heating surface. The amount of heat radiated from the flames depends on the temperature of the flames, the area of the flame surfaces exposed, and the temperature of the firebox sheets which are absorbing the heat. The hot gases in passing from the fuel bed to the flues give off a negligible amount of heat by contact with the firebox heating surfaces.

FIREBOX HEATING SURFACE

The amount of heat absorbed by the firebox heating surfaces will therefore depend on the area and temperature of the heat radiating body, rather than on the area or extent of the heat absorbing body, i. e., the firebox heating surfaces.

When the firebox is completely filled with flame, the outer surfaces of the flame, which are radiating the heat, are practically in contact with the firebox surfaces at all points and are therefore equal to the firebox surfaces in area. The radiating surface, in the case of a box completely filled with flame, equals the firebox heating surface, and, increasing the firebox heating surface, also increases the flame-radiating surface. The increase in evaporation will then approximately equal the increase of heating surface or of flame-radiating surface, the combustion conditions being unchanged.

The relation of the flames to the heating surfaces is shown diagrammatically in Fig. 4. Sketch "A" is a cross-section of an ordinary firebox equipped with an arch, and sketch "B" shows a cross-section of a firebox containing two syphons supporting an arch. As shown in Sketch "A," the flame is divided into two portions by the arch. The flame below the arch is generating heat within itself, and in addition is absorbing heat from the fuel bed and from the hot fire brick above. The flame is also radiating heat to the fuel bed, to the fire brick above, and to the firebox surfaces on each side. That portion of the flame above the arch is acting in a similar manner, generating heat within itself, absorbing heat from the arch, and radiating heat to the arch and to the surrounding firebox surfaces.

Heat is radiated from the inner zones of flames to the

(*Concluded on page 61.*)

Discussions on Luck by Bobbie and Jimmie

How the "Boss" Built Up His Boiler Shop—More Luck, the College President, Prexy, Gives Jimmie a Scholarship

BY W. D. FORBES

Bob gave an extra-long puff on his pipe and then continued: "I suppose it was luck or hard work or something. What do you say?"

"Or something" has been the basis of many unanalyzed business successes. Take, for example, the rise of John McClaren. His climb in the boiler making field was destined to have a direct bearing on the future careers of Bobbie and Jimmie.

When John McClaren, known as the Boss, had been out of his time a couple of years he married. The following year a great business depression swept over the country. One Saturday he came home and told his wife that the shop had closed down. He had a good deal of Scotch blood in him away back, and he had not spent all he had earned. His wife, too, was a clear-headed woman. They made up their minds to give up their little house at once and board. Previous to the panic the town in which they lived had grown considerably. The business depression, however, stopped all building; everything was dead.

McClaren went out to look for a job of any kind, but found nothing to do. Finally he went over to Millville to apply for a job at the bleachery. As he was walking along the street he met the superintendent of one of the mills where he had often gone to make boiler repairs.

"Any openings in the mills?" McClaren asked. "Well, there is no steady work available," the superintendent said, rather bluntly; "but there is some patching and repairing to be done on two of the boilers in the works. If you can get an expander, ratchet and drills and other tools you can have the work."

This started McClaren. Despite the dull times, he managed to keep going, and even to save a little money. Walking out with his wife one day at the west end of the town, he noticed two men with a surveying instrument set up on a tract of land of about three acres. Some employee of the group had not appeared; the men offered McClaren a dollar to hold the end of the steel tape line and help them for a couple of hours. While handling the apparatus he noticed that the surveying instrument belonged to the railroad running through that part of the town. The main railroad line to Millville ran along the south side of the property. On the tract McLaren noticed a shed in fair repair. He went to the owner and rented it from him for a year.

That was the beginning. He had already bought several tube expanders and a small foot press, which he had set up in the cellar of his boarding house. It was useful for odd punching jobs on light material. Before long he got quite an amount of work in light metal. Finally he bought some other tools and began bidding on anything he could handle, wisely refraining from taking work which was beyond the capacity of the shop.

One day McClaren surprised his wife by announcing that he had bought the piece of property on which the shed stood, paying 60 percent of the amount cash; the rest was left on mortgage. Business increased; he ran a street through the east end of his property, leaving a lot 110 feet deep, on which he built two four-story tenement houses.

He still kept at work in the little shed, but plans for his present boiler shop were in the brew. Finally he sold a corner of his property to the railroad at a pretty good figure. He still dreamed of his boiler shop, but did no actual construction work. Instead, more tenement houses went up. These paid him a comfortable income. Luck or circumstances, you may say, started John McClaren on the way. But Bobbie and Jimmie were ignorant of these facts when they tried the wheel.

Jimmie was still puffing on his pipe, thinking of his own luck away at school. He took time to scrape out his pipe, and lighted it again before he opened up.

"Old Professor Rumsey, the man who is making the boiler test over in Freedom, says 'Luck's a fool.' He ain't so awful old, either, come to think of it. He's forty-five, though. (To a young man of twenty-three forty-five seems a pretty good age.)

"Now, there is something in luck, as I can show you right now in my own case. When I went to the institute the whole class was introduced to the president; we called him 'Prexy.' He made speeches, and we used to meet him now and then in the halls or on the campus, but I really saw very little of him; in fact, didn't know him at all."

"Kind of a stand-offish old boy," commented Bob.

"Well, not so much at that," continued Jim." I was down in the Physical Lab. one day when Professor Tenny was going to test a chain on the testing machine, but he didn't like the anchors or hold fasts. I spoke up and said that I could do a pretty good job at forging and I could make what he wanted if he would give me an order for the material. He did that, and I went down to the blacksmith's shop, which was in the cellar, and in a couple of hours had knocked out the forgings all right.

"There was a cast iron plate on the floor where we used to put forgings to cool. When I got the last of the two forgings done I laid it down on this plate. At that moment I noticed a forging that had been lying on the plate a number of days marked 'hot.' I marked my forging 'hot,' too, but wrote on the plate just under it 'October 20, 3.41 P. M.,' and drew a chalk mark around the writing and forgings. Well, when I straightened up there was Prexy looking at what I had written. He asked me my name, and I told him 'Jim Mann.' There is an old professor there that looks as if he came out of some plate. Gray beard, thick eye-glasses, and all the rest of the make-up. His name is Webber, and he's awful absent-minded and queer; but you bet your life no X gets away from him if he starts after it. I was in one of his classes.

"Well, the old man was pounding up some coal for some experiments, over by the window. Prexy called to him. When he came over Prexy said, pointing to what I had written: 'What do you think of that, Professor?' The old man lifted up his specs and read out loud: 'Hot, October 20, 3.41 P. M.' 'Yes, yes, yes,' he continued, who wrote that, Mr. President?' "

" 'This young man who says his name is Jimmie Mann,' was Prexy's answer. 'Ah, yes,' says the Professor; 'Mr. Jimmit Mann, I've seen him in some of my classes, I think, Mr. President. We can watch Mr. Jimmit advantageously.' "

"Two or three days after this the president sent for me. I was scared cold. I thought he was going to give me 'rats' about taking care of the heating plant, but nothing of the kind. When I came into his office he said: 'Mann, Professor Webber and I have been looking up your record. You have been here only a short time, but you have done very well. Now, I understand that you are working your way through this institution, and that you are a boiler maker. This practical knowledge has helped you a great deal, and we think that if you will study a little harder from now on to New Year's you can skip a semester. If you can pass the examinations for this advance you will have a scholarship so that you will not have to pay any more tuition for the rest of your course.' Well, you bet I felt bully. I saw old man Webber just before I came up here. He gave me the last of the exams, and I passed. When I went in to see if I had passed he said to me: 'Mr. Jimmit, what was your mental process when you placed the hour and minute on the cooling plate?'

"I was kinder feazed, because I didn't know what he meant. But I managed to say: 'If I get your idea, it looked to me, all of a sudden that just chalking 'hot' on a forging wasn't enough. It wouldn't stay hot. I learned early from old man Reed, the blacksmith, where I served my time, never to pick up anything in a blacksmith's shop without spitting on it first. He told me this after I had picked up a piece of hot metal and burned my hand badly. I asked him why he hadn't told me sooner, and he said: 'You wouldn't have remembered it as well as you will now.'"

"Old man Webber replied: 'Very practical, but very unsanitary.'

"Now, Bob, wasn't that all bullheaded luck for me? True, it was not luck that I could make forgings. I had learned to do that, and I had studied hard and made a pretty good record. But that I wrote something on a plate and that Prexy saw me do it was nothing but pure luck. I had nothing to do with his coming down in the blacksmith's shop. It just happened that what he saw me do tickled his fancy. There was nothing much in it. I tell you, Bob, there is a lot in luck."

Difficulties Encountered in Welding Steel*

Fundamental Knowledge of Welding Principles Necessary to Accomplish Good Work—What to Study—Problems of Expansion and Contraction

BY B. K. SMITH†

The question of steel welding is one of the most important of all the problems which confront the oxy-acetylene welder. A large part of this problem, however, has to do with his knowledge of steel and his habits of handling the blowpipe in steel welding. The weld itself is, apparently, most easy to obtain, and the misfortune is that some welders have, therefore, considered steel welding as a subsidiary problem of their trade, and have passed it with a light heart, because their welds looked so well. Steel welding, on the other hand, notably in boiler welding, requires thought and care, and should be studied not only from the practical point of view, but also from the theoretical end.

What are the enemies of steel welding, or what shall we study so that we can become proficient? The enemies of steel welding are: (1) the incorporation of iron oxide; (2) the thermal disturbance in the vicinity of the weld; (3) the expansion and contraction problems. Therefore, one needs to study the technique and properties of various steels, the phenomena produced during the melting of the metal under the oxy-acetylene torch, and boiler construction.

If the welder has this knowledge welding will be comparatively easy. If he lacks this fundamental conception of welding principles and failures or accidents occur to him, he will consider and insist that certain operations are impractical or impossible to perform with the oxy-acetylene blowpipe. This is one reason why certain companies will not trust apparently good-looking welds, and reserve to themselves the right to sanction or forbid boiler or pressure welding.

Pressure of Iron Oxide in the Weld

In studying the theory of the incorporation of iron oxide in the weld, the welder must know what iron oxide is and what it looks like. Iron oxide is a burnt element developed on the surface of molten steel under action of the blowpipe and atmospheric oxygen, in appearance like white veins and foaming spots.

In the early days when I found that my "good-looking" welds failed immediately, or six months later, I thought that this oxidation was an uncontrollable enemy in the weld trade, and was ready to drop all welding on pressure vessels. Inwardly, however, my conscience told me there was a remedy and that I needed to study the anatomy of steel, as the surgeon studied the anatomy of a human body before he commences to weld a human limb.

Iron oxide will dissolve in molten steel at the rate of a little higher than one percent. In this reaction it may destroy the carbon elements; a decrease in the strength and elasticity of the weld results.

To reduce oxidation the oxygen pressure should be made as low as possible—just enough pressure to produce a free and soft flame, that will cause continuous melting of the metal without running it over the edge or, in plainer words, a melting without too much exaggeration. This operation depends largely on one's blowpipe and the flame maintained throughout the weld.

With a proper flame the flow of the metal is clean and regular. With a too rigid flame, which requires more oxygen, white veins and foamy spots appear in the molten metal. These are streaks of oxide of iron. They will dissolve and create new ones with the progress of the weld. The molten metal is swept, rather than laid, in formidable, clean layers, and in some cases the metal is adhered instead of welded.

Oxide of iron cannot be altogether eliminated from any of the various kinds of welds as long as we cannot protect them from the effects of the atmosphere, but it can be so eliminated from the interior of the weld that its presence will not weaken the weld.

Another way to decrease the oxide of iron is to use a good and well-known make of blowpipe that will deliver a normal flame and consume about an equal proportion of

* Paper read at monthly meeting of the Northwestern Welding Association, Minneapolis, Minn., October 9, 1918.
† Welding Engineer, United States Welding Company.

oxygen and acetylene. Reliable regulators and strong gages will also help to maintain a continuous, steady and normal flame. The welding rod must be of clean, soft charcoal or electrolytic iron to secure good results.

Some of the men who are known as good and experienced welders and probably have been welding for five or six years have met with some failures in steel welding. They will not admit that the main cause of failure is on the improper regulation of the flame. Why is this so? Because the regulation of a welding flame is the letter "A" in the alphabetical study of oxy-acetylene welding. The experienced welder feels like a college student compelled to return to the grades and learn th A, B and C. Yet it is so. Most of our welders, having previously mastered some other craft, have begun welding important operations without any preliminary instructions. In other words, they began college without knowing the primary and high school work, which is the rock foundation of craftsmanship.

What would a boiler maker think if a novice should try to put in a set of flues in a boiler? or a machinist if an apprentice should make a set of dies? Yet the same boiler maker or machinist looks upon the welding blowpipe only as a helping instrument in his trade. He thinks that all he needs to do is to go ahead and weld.

Thermal Disturbance

In studying the thermal disturbance that is produced by the action of the gas flame on the metal when it is raised to a fusing temperature it should be emphasized that a considerable change is brought about in the growth of crystals that will set in the vicinity of the steel weld. The agent which causes this trouble is heat. We must not forget that heat, which has created the birth of many new steels and has been employed to increase the life of metals, can also reduce and destroy their life and strength. Therefore, we should study to employ it so as to obtain the best results.

It is a well-known fact that the structure of any gas weld at the welding line, on a boiler plate for instance, is a cast metal. This metal is much lower in elongation than the boiler plate. The original structure of the boiler plate, on the other hand, was at the mill a cast metal or something similar to the gas welding line metal. It has been refined, by the operations of heat and mechanical treatment, to a strong metal that we call boiler plate. The question is, can we employ the heating agent with the aid of the gas blowpipe, to refine the grain at the weld and its vicinity? My answer is "yes," provided the operator knows the physical and the chemical properties of boiler steel.

Personally, I was not exempt from failures. When I look back at the times when I could not understand why my "good-looking" welds would crack in a boiler, it is like looking back upon our ancient welders, who hammered the metal with a stone in the form of a half globe on a flat rock anvil. It is now quite possible to take care of expansion and contraction in steel welding, and the problems of solving this phenomena are great and interesting.

Problems of Expansion and Contraction

In boiler welding, the welder will find these problems difficult to solve unless he has a full knowledge of boiler construction. Yet the effects of expansion and contraction are less feared by some boiler welders, because the metal to be welded possesses the property of elongation. However, my advice is that no welder should depend upon the fact that the metal will give and that a little strain will not hurt the weld.

To begin with, in almost all cases an intelligent welder can find a solution of the expansion and contraction problem. On the other hand, no human being can ever measure the strain left in the metal. Such a weld may crack during the progress of a weld or a few days after the welding, or even six months after. At any rate, the welder is not excusable, and failure will condemn the operator, the process and the whole industry.

One point an oxy-acetylene operator must bear in mind —to make a strong weld. Economy should always be considered as secondary. While there should not be waste in time or material, we must not forget that a defective weld is a waste of time and material.

Electric Versus Oxy-Acetylene Welding

Furthermore, there is our competitor, the electric welder, who claims economy over the oxy-acetylene process. Efficiency and reliability are, however, on the side of the oxy-acetylene process, and, although we temporarily lost out at the shipyards on account of careless and ignorant welders, we will win in the end after we can educate our welders and prove efficiency in this work as well as in the other lines.

The welder who can make the strongest weld will get the business and preference, regardless of the higher cost. Therefore, I believe it is time that some of our operators investigate these three theories in steel welding and make further improvements for the benefit of themselves and of the welding industry.

Locomotive Built by Australian Government

Type 2-8-0 from the Government Railway Work Shops—Total Heating Surface 2,421 Square Feet—Walschaert Valve Gear and Robinson Superheater Fitted

BY J. O'TOOLE

To handle the heavy traffic on the main railway lines in Victoria (Australia), the commissioners adopted a standard type of Consolidation engine. However, when the standard designs of locomotives for the Victorian railways were first adopted, including the Consolidation type, it was found that some of the bridges and structures on the main lines would require strengthening before these locomotives could be operated upon them. From year to year strengthening and renewal of the structures has progressed, until in 1915 the chief mechanical engineer was authorized to prepare designs for a pattern Consolidation locomotive with axle loads not exceeding 18 tons.

This locomotive, illustrated herewith,* is of the 2-8-0 type recently completed at the Government railways work-

* The photograph is furnished through the courtesy of the works manager of the Victorian shops with the authority of the chief mechanical engineer.

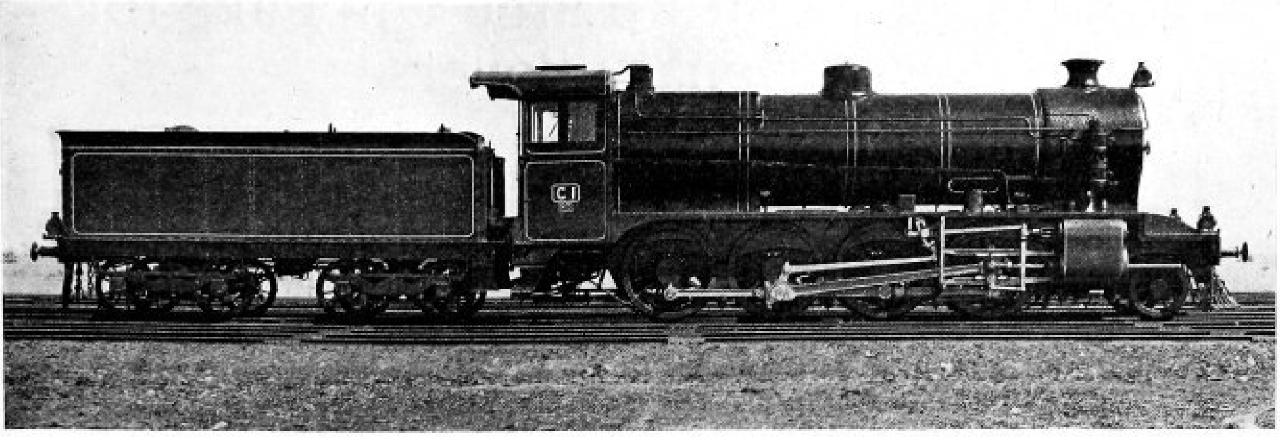


Fig. 1.—Australian Locomotive, Type 2-8-0

shops, Newport, Victoria. The following dimensions of the new locomotive give an estimate of its capacity:

Diameter of driving wheels	5 feet
Cylinders	22 inches diameter by 28 inches stroke
Tractive power	36, 138 pounds
Tender capacity	water, 4,600 gallons; fuel, 6½ tons
Total length over all engine and tender	64 feet 4¼ inches
Total weight	empty, 91 tons; roadworthy, 127 tons

A sketch of the longitudinal section of the boiler of this locomotive, Fig. 2, shows its large proportions, particularly as regards the firebox and grate. This construction is essential for economic operation with the coal used on the Victorian railways. The funnel, which is very short to clear overhead bridges, projects inside the smokebox, its lower end terminating in a bell-mouth. The "Walschaert" valve gear has been adopted.

The superheater is of the "Robinson" type. Other modern appliances are fitted, such as the "Flaman" speed recorder, "Detroit" 5-feed "Bullseye" lubricator, Victorian railways standard injector (made at Newport), and "Reflex" gage glasses.

The Boiler

The boiler is designed for a working pressure of 200 pounds per square inch. The grate area is 32 square feet. Heating surface reaches a total of 2,421 square feet: firebox, 173 square feet; tubes, 1,879 square feet; superheater, 369 square feet. The firebox is constructed entirely of copper sheets, the side sheets being supported by linear stays. As an interesting experiment, the stays on one side of the firebox are made of copper, the other side of "Stones" bronze flexible stays, so that a comparison may be made when both materials are working under similar conditions.

The weight of the boiler, complete with tubes, is 19 tons 5 hundredweight 3 quarters 14 pounds. The dimensions are shown in Fig. 2.

All the steel and iron castings, including wheel centers and cylinders, are of Australian manufacture. The magnesia boiler covering is also of Newport make.

Improvements

Several improvements have been incorporated in this locomotive. The ash-pan door slides can be operated by compressed air from a cylinder provided for that purpose. Contrary to the usual practice of emptying the smokebox from the front, an ash ejector is here provided. By turning a jet of hot water from the boiler, the driver is able to flush out the ash chute and thoroughly empty the smokebox.

It is anticipated that this engine will haul 555 tons behind the tender up a 1 in 50 grade; on flat or level country it will take 1,600 tons.

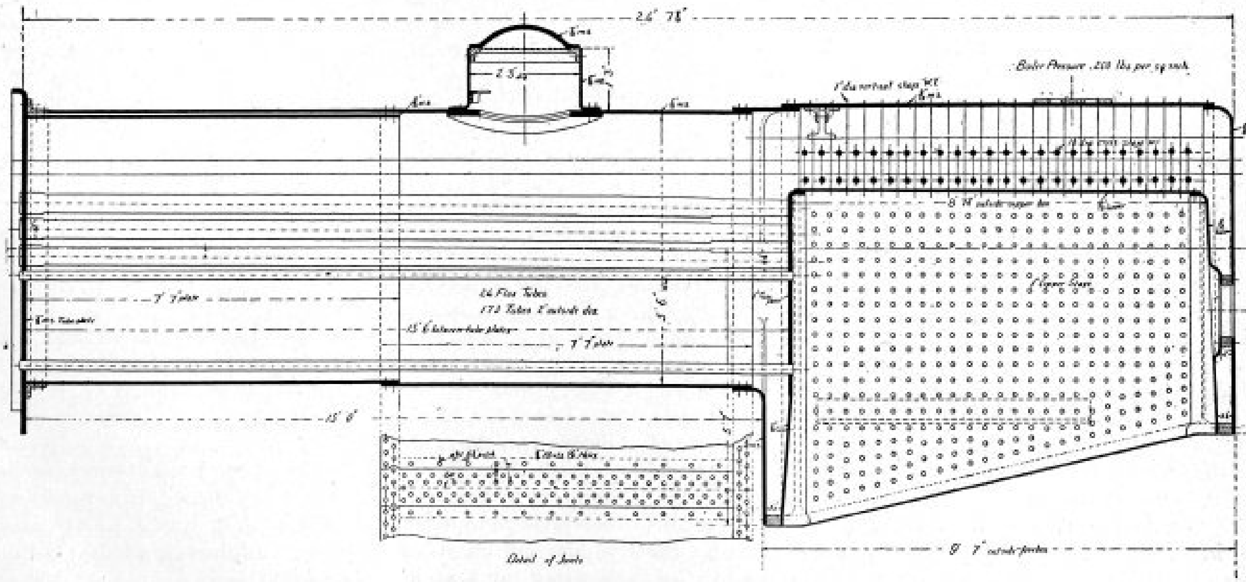


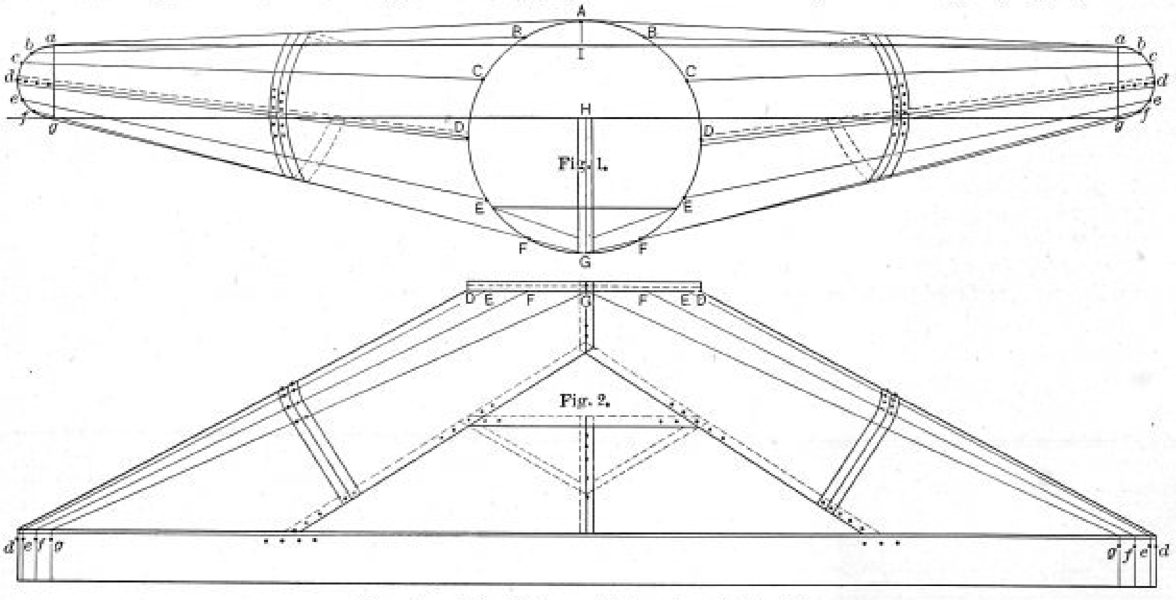
Fig. 2.—Longitudinal Section of Boiler

How to Lay Out a Large Up-Take for Stationary Boilers

One Uptake Covers Two Boilers—Method Advocated Saves Job of Shearing—Advantages Gained

BY PHIL NESSER

When we have such an irregular-shaped article to make as a smoke up-take for Stirling boilers, especially when making one up-take long enough to cover two boilers in one battery, one finds not only the difficulty of laying out the sheets, but first we must know how to "lay in" the sheets. The best way to solve this is to get out our drawing board, make a small sketch of the article to a certain fractional scale, then develop the article into patterns on paper. Upon the paper we can easily determine how best to "lay in" our sheets in such a way as to have the least amount of scrap and save shearing sheets on the edges. The mill edges are nice and straight, and when using the method suggested by this article we can set all holes where possible to do so along the mill edges, saving the job of shearing, besides being a nicer edge than most shearing in the shop would make.



Figs. 1 and 2.—Plan and Elevation of Up-Take

Fig. 5 shows the development of a full pattern for half of such an up-take. By putting a seam on the line *O-D*, we could make up an article such as shown in Figs. 1 and 2, and leave very little scrap by placing the sheets and cutting them in the way shown. The angles marked M° in Fig. 5 are sure to be equal to each other, and, by considering this, a little study would make it plain to the experienced layerout what advantages are gained in this way.

By making up the article to a scale, we could tell just where to start upon the steel and keep on and not waste the material. Thus we would have to start but once and could tell how much shop room is needed to clear all points before setting up our sheets.

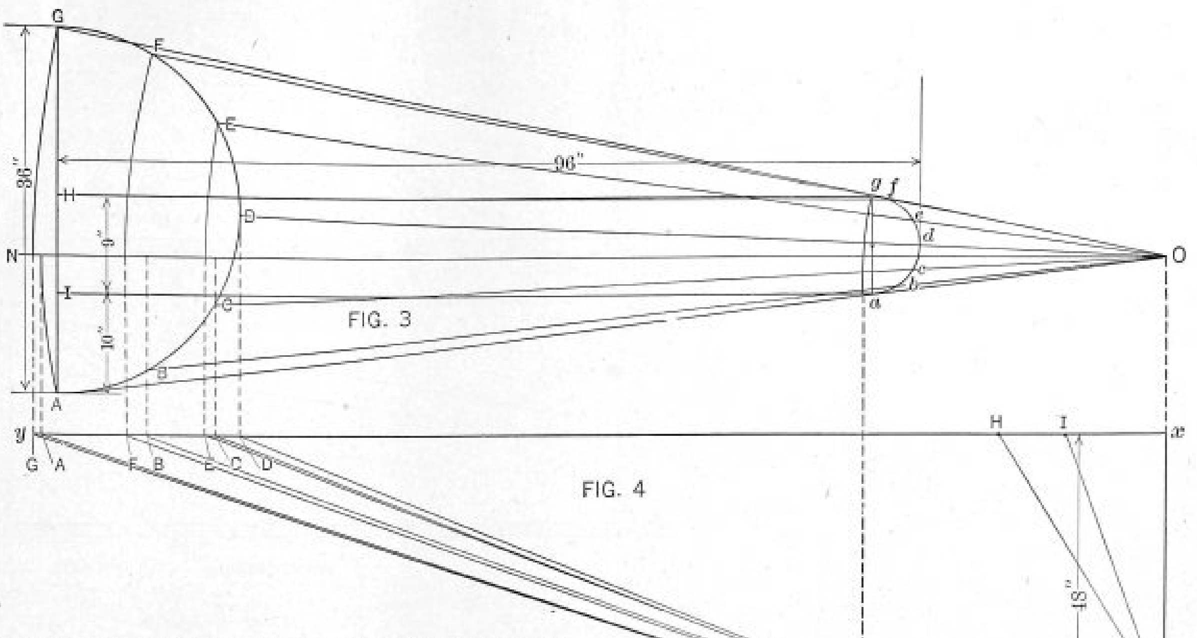
Fig. 3 is an example of the first step to be taken in such a problem. Suppose we had to make it to the dimensions given, we could draw it up to a scale as follows: Draw a semicircle, say $4\frac{1}{2}$ inches; this would be $\frac{1}{8}$ inch to the inch. The semi-circle is then divided into any number of equal divisions (for simplicity, we used but six, as *A, B, C,* etc. Locate point *I,* 10 inches from *A* (on scale), or 10 "eighths" of an inch, to be correct; also locate point *H,* which is 9 "eighths" of an inch from *I* on line *A-G.* Draw horizontal lines through *I* and *H* to points *a* and *g,* which are $4\frac{1}{2}$ "eighths" of an inch less than 96 inches (in eighths) in length. Then draw a semicircle with *a-g* as a diameter. Draw a line cutting *G* and *g,* Fig. 3, and continue towards point *O.* A line cutting points *a* and *A* will thus locate point *O* by intersection.

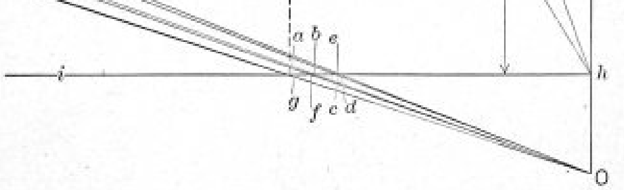
Next draw the horizontal *N-O* to point *O,* Fig. 3, and with point *O* as a center and *O-G* as a radius, draw an arc to the line *N-O,* thence dropping a perpendicular into Fig. 4, cutting line *x-y* at *G.* Having drawn line *x-y,* Fig. 4, of indefinite length, drop a perpendicular from *O,* Fig. 3, and continue indefinitely toward point *O,* in Fig. 4. Draw *h-i,* in Fig. 4, parallel to *x-y* at a distance of 48 inches (on the scale).

With *O-g,* Fig. 3, as a radius and *O* as a center, scribe arc *O-g* to the line *N-O,* and from thence drop a perpendicular line to cut the line *h-i* at *g,* in Fig. 4. Next draw a line cutting *G* and *g* and continue towards *O,* thus locating point *O* by intersection.

With *O,* Fig. 3, as a center, each letter in the semicircle is carried with an arc to line *N-O,* thence spotted perpendicularly to line *x-y* in Fig. 4. Lines drawn from *A, B, C,* etc., on line *x-y* are continued to *O,* cutting the line *h-i,* making it unnecessary to bring any more arcs from the small semicircle as *a, b, c,* etc., Fig. 3. Take *G-H* on trammels from Fig. 3 and step from *x* to *H,* Fig. 4; take *A-I* on trammels from Fig. 3 and step from *x* to I, Fig. 4; this gives a diagram of lines from which all lengths in the pattern, Fig. 5, are taken.

To lay out Fig. 5 on the drawing board, take a point *O*





Figs. 3 and 4

and draw a horizontal line *O-D* about the middle of the paper. With *O-D*, Fig. 4, as a radius scribe an arc, locating *D*, in Fig. 5; from *O* as a center take *O* to *A*, *O* to *B*, *O* to *C*, etc., all from Fig. 4, and with *O*, Fig. 5, as a center scribe arcs respectively with each of these lengths, marking each arc with the letter to be located thereon.

After all arcs are drawn, take the exact length of one of the divisions of the semicircle *A*. *B*, *C*, etc., in Fig. 3, set the dividers and step from *D*, Fig. 5, cutting the arc *E* at *E*, arc *F* at *F*, and arc *G* at *G*; also step off to point *A* in like manner. Then draw lines from *O* to *A*, *O* to *B*, etc. Set the dividers from *O* to *a*, in Fig. 4, and step from *O* to *a* on line *O-A*, Fig. 5; set from *O* to *b*, Fig. 4, and step off *O-b* on line *O-B*, Fig. 5; likewise locate points *c*, *d*, *e*, etc., Fig. 5. Set the dividers from *h* to *I*, Fig. 4, and with *A*, Fig. 5, as a center, scribe an arc towards *I*; set from *a* to *I* in Fig. 3, and with *a*, Fig. 5, as a center scribe an arc, cutting arc *A-I* at *I*. Draw lines from *A* to *I*, and from *a* to *I*. The triangle on the other side, as *G*, *H*, *g*, is drawn in a similar manner.

By considering that we put the lap holes on the line *D-d*, allow a lap beyond *D-d*, and make the sheet wide enough to go beyond the points *A* and *G* on the sides. The length could be made to suit by trammeling the distance *I* to *K*, Fig. 5, and making *I-K* on the outside of the pattern (or sheared off piece) to suit.

In this figure has been shown an up-take made from four pieces, but the writer recently had a job of making two large up-takes where the sheets could not be "laid in" in such an easy way as shown in Fig. 5. The method employed was as follows:

We drew up the article to a scale, but the sheets we had were only 60 inches wide—not enough to fill up the triangle as in the other case just described—so we had to leave another triangular gap to be filled later with one piece. This happened to be very lucky for us, because the triangles were made and bolted on the inside of the up-take with the points hanging down (as shown by the dotted lines in Fig. 2). The hole then served as a manhole while fitting up the breeching; also by laying boards through, it made a place to set a ladder, and, finally, a scaffold to hold on the rivets in the circle *A-B-C*, etc., in Fig. 1. When everything else was complete it only remained to put on the triangles and cap off the job, so the holes saved a lot of extra climbing around. As the triangles are not small, they do not have the appearance of patches.

To lay out the article full size would have required a very long trammel, and to overcome this we decided to lay out the whole thing on the steel just half length; then to double all dimensions and have it made without taking the trouble of handling extremely long trammels.

Fig. 6 is not made exactly as we made it, because the center, *O*, was above or on the same side of the line *M-N* as the semicircle, but in this article it is placed below the line to avoid confusion. It will be noticed that Fig. 6 embraces the work of Fig 3 and Fig. 4 in one figure; also to avoid confusion we considered only one-quarter of the semicircle.

Fig. 6 is explained as follows: The length marked 96 inches is half of 16 feet, which is in fact not quite half the length of the one of which we are writing. The semicircle, 36 inches, represents half of the round or top end, which was 72 inches in diameter. Having drawn the bottom to the dimensions here shown, a line was carried from point 1 through *a* toward *N* and from 7 through *e* to intersect line 1-*N* at *N*.

The divisions 1, 2, 3 and 4 were equally spaced and, with *N* as a center, arcs were drawn through each point until they came to the horizontal line *M-N*. Next *H-I* was drawn at a distance of 48 inches parallel to line *M-N* and an arc *N-a* was carried to line *M-N*, thence perpendicular to *H-I*, and a line drawn through from this intersection with the arc *N*-1 on line *M-N* was continued toward point *O*. A perpendicular from *N* located point *O* by intersection. This is a very short explanation, but should be understood from what has been said of Figs. 3 and 4.

The distance *O-I* is doubled to *I*, and this makes the points *a*, *b*, *c*, *d*, "true lengths," full size. The arcs in Fig. 6 are marked to correspond with those in the pattern, Fig. 7.

The sheets having been drawn to scale, the point *O*, Fig. 7, was spotted on a built-up surface (as will be noticed, it falls outside the outline of the sheets) by measuring on the small drawing. After locating point *O* in Fig. 7, the length from *O* to arc 4, Fig. 6, was taken and scribed as arc 4 in Fig. 7; then arc 3 was also transferred from Fig. 6 to Fig. 7; arc 2 and arc 1 were likewise transferred into Fig. 7 from Fig. 6. Then one of the equal divisions from the semi-circle was taken very carefully on the dividers (in the real work we used 24 divisions to the semicircle) and stepped from the spotted point on one-half the line *O*-4, Fig. 7, to arc 3 to arc 2 to arc 1. This was exactly half as large as the full pattern.

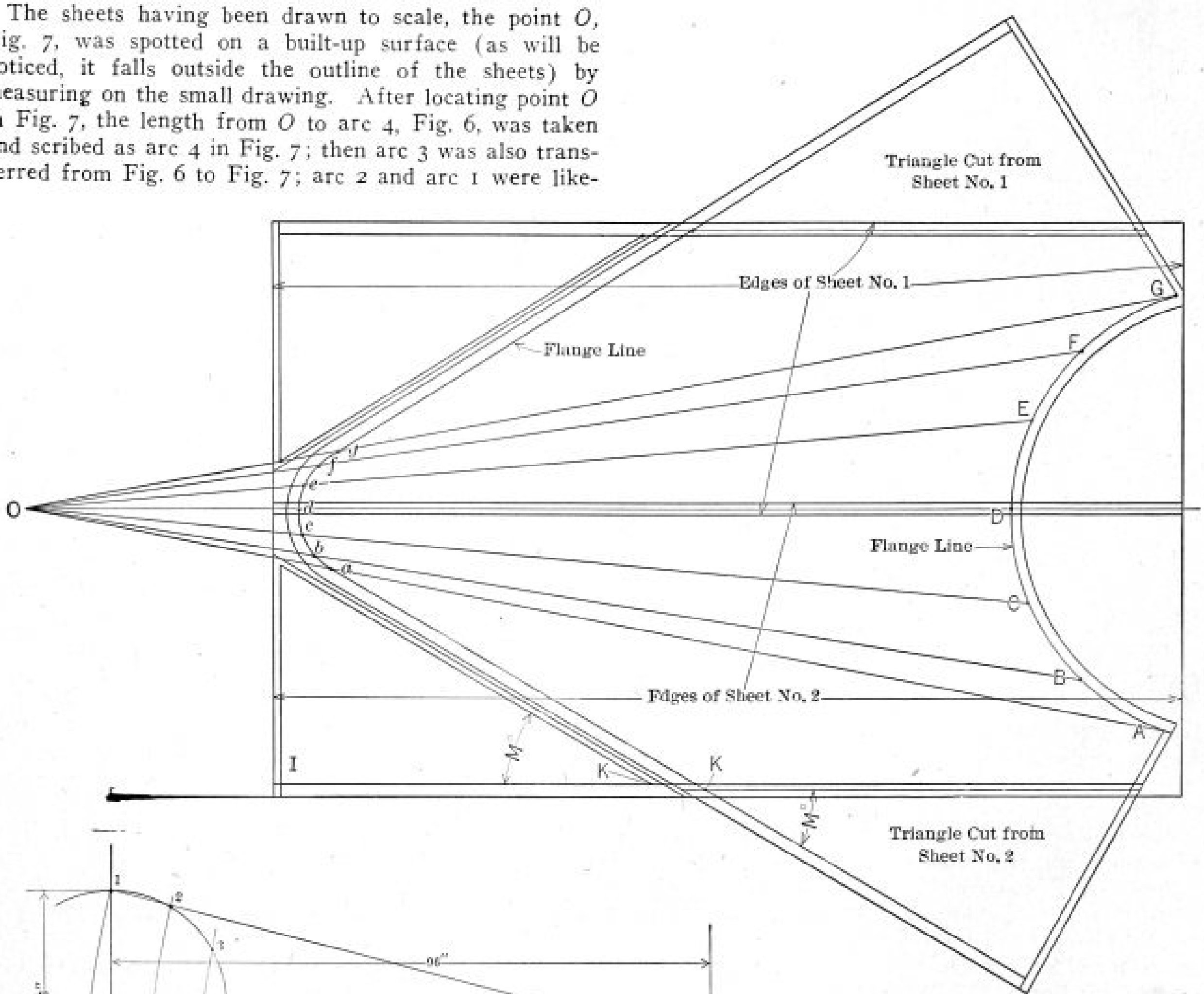


Fig. 5

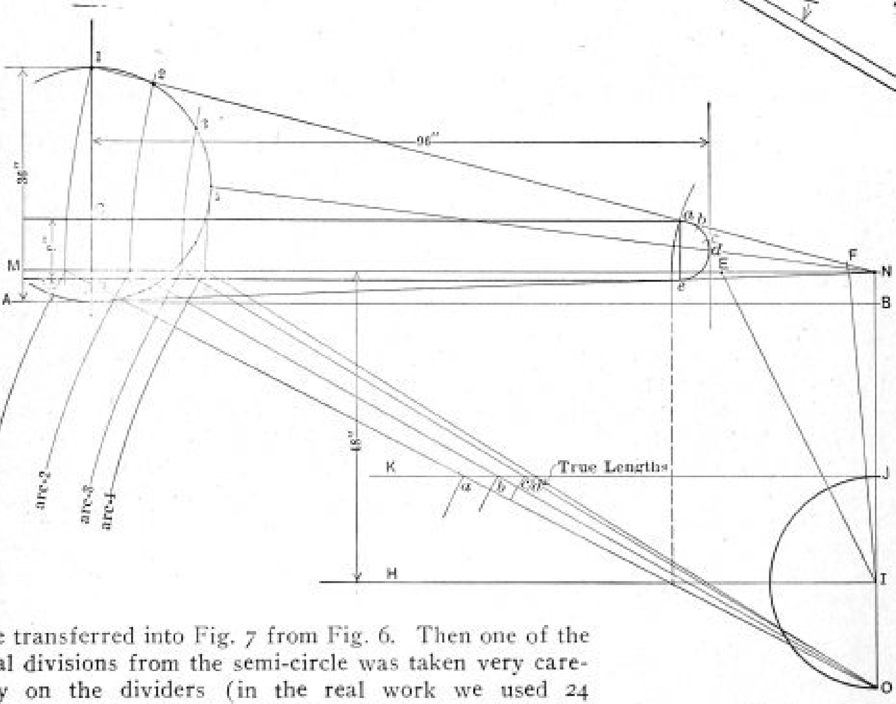


Fig. 6

The line on which *O*-4 was drawn on the new sheets was the center of the rivet holes and was drawn 1 inch from the edge, as we used ½-inch rivets. Then the sheets were laid with the ends butted and a fine, strong twine was drawn over this line and the sheets swung to become straight under the line. We took the distances *j*-*k* and 1 and drew parallels marked 2*j*, 2*k* and 2*l*, each twice the respective lengths; then, taking arc 1, arc 2 and arc 3, each from the previously mentioned points, stepped each in turn, over to points 1, 2 and 3, respectively. As these points are on the flange line, we must allow for a flange, so we put on two inches parallel to the flange line. We also spotted the holes straight out from equal spaces on the flange line, and punched the holes when the sheets were straight. The holes were all nearly as good after flanging as if they had been spaced off the flange.

Where the sheets were joined together we applied a butt plate, as shown in Figs. 1 and 2. This was done to overcome the difficulty of allowing for the take-up of material in the bends. Lines were drawn to connect *O* and 4, *O* and 3, etc., and the points *a*, *b*, *c* and *d* were taken from Fig. 6 as *O* to *a*, *b*, *c*, *d*, "true lengths." These are full size, because the distance *O*-*I* was doubled to become *O*-*J*, Fig. 6, thus doubling each length of the lines.

To locate point *C* we built upon the floor, by placing a pair of trestles with a sheet upon them about where the point would come. We took the distance 1-*C* and transferred it to *N-E*, in Fig. 6; then took distance *E-I* from Fig. 6 and stepped this twice on a long straight line, thus doubling its length. Then, with 1, Fig. 7, as a center, and double the length *I-E*, Fig. 6, as a radius, an arc was scribed upon the sheet on the trestles; next we took the middle point on line *a*-1, Fig. 7, as *M*, and with *M* as a center and *M*-1 as radius an arc was scribed cutting the arc formerly made upon the sheet on the trestles, thus locating point *C* graphically. On going over the work we found that point *C* was as nearly correct as if laid out by triangulation.

As our sheets were 60 inches in width, we made a line on the opposite side from the line *O*-4 and parallel at a distance of 58 inches; then from point *C* we took on the trams the distance to the intersection of the flange line and the 58-inch parallel rivet line, as point *X*, in Fig 7. This we stepped off to the part outside the outline, making the distance *C* to *X* come to like intersections, as stated before. The dotted line shows how this "scrap" piece was used up. We will not endeavor to explain how the straight band at the bottom was applied, as, after having the foregoing part made up, anyone could make the straight band.

The triangular pieces can also be marked off after the up-take has been flanged, if so desired. We had them marked before we saw how simple it was to lay them against and mark all holes right through, so we would recommend the latter method.

From the manner in which the lines are made upon Fig. 7, it should be easy to pick up the point of this article, and anyone should be able to understand it. Of course, sheet 2 and sheet 3 are the same sheet before they are cut in two pieces, but this seemed the best way to illustrate it.

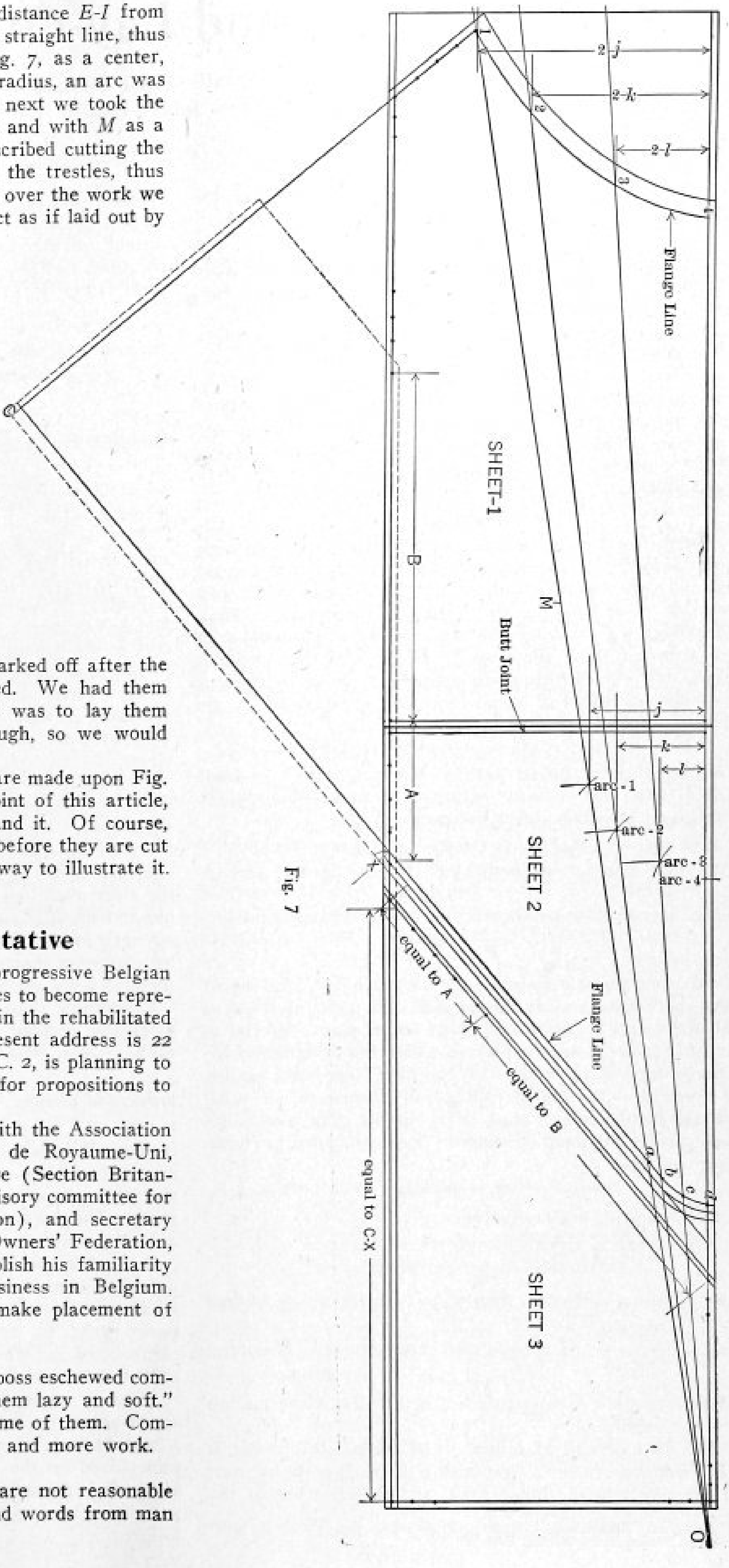


Fig. 7

A Belgian Representative

With the signing of the armistice, progressive Belgian agents are already seeking opportunities to become representatives of American manufactures in the rehabilitated country. W. C. L. Lamot, whose present address is 22 Northumberland avenue, London, W. C. 2, is planning to return to Antwerp, and will be open for propositions to handle American products.

Mr. Lamot's previous connections with the Association des Industriels Belges, Etablis dans de Royaume-Uni, Secretary to the Ligue Maritime Belge (Section Britannique), member of the Government alvisory committee for Belgian inland transportation (London), and secretary and treasurer to the Belgian Barge Owners' Federation, are sufficient recommendations to establish his familiarity with the progressive constructive business in Belgium. His connections in the marine field make placement of marine boiler orders a possibility.

It has not been so long ago that the boss eschewed comforts for his men. "It would make them lazy and soft." Modern bosses know better; that is, some of them. Comfortable surroundings make for better and more work.

All the comforts in a boiler shop are not reasonable warmth, light and dryness. A few kind words from man to man helps a lot.

How to Design and Lay Out a Boiler—IV

Rivet Pitches Too Small—Final Method of Failure—
True Efficiency of the Joint—Use of Larger Rivets

BY WILLIAM C. STROTT*

Proceeding now with our calculations, we write the following:

$$(P - wd)\ tT_s,$$

which will give the strength of the net section of plate between either the third or fourth rows of rivets. Substituting, we have

$(14.5 - 4 \times .9375) \times .53125 \times 55{,}000 = 314{,}105$ pounds.

The shearing strength of the three rivets in the two outside rows we found previously under failure Sh; it was 90,120 pounds, giving a combined strength at this part of the joint of 314,105 pounds + 90,120 pounds, or 404,225 pounds. Denoting this method of joint failure by ST, its efficiency in this case is $\frac{404{,}225}{423{,}671}$, or 95.4 percent.

In the next case we have almost identically the same condition as the former, with the exception that instead of the shearing resistance of the three rivets in the two outside rows assisting the inside plate section, we shall deal with the crushing resistance of the inside butt strap in front of these three rivets as the assisting medium. The strength of this plate against crushing is ($3dbc$), whence, substituting values for letters and solving, we have

$$3 \times .9375 \times .4375 \times 95{,}000 = 116{,}898 \text{ pounds.}$$

Adding this to the strength of the net section of shell plate found in the last example, as 314,105 pounds, their combined resisting power becomes

$$314{,}105 + 116{,}898, \text{ or } 431{,}000 \text{ pounds.}$$

We shall denote this method of failure by TC, and its efficiency in this instance is $\frac{431{,}000}{423{,}671}$, or approximately 101 percent.

Another possible failure is by the combined crushing of the shell plate and of the outside butt strap in front of all the rivets. This tendency of boiler plate material to crush was previously explained under the designation Cr. Analyzing Fig. 13, we see that the shell plate bears against 8 rivets and the outside butt strap against three. (Although the inside butt strap bears against eight rivets also, we consider the strap offering the least resistance.) Therefore we have

$$(8tdc + 3bdc),$$

which, substituting and solving, gives

$$8 \times .53125 \times .9375 \times 95{,}000 + 3 \times .4375 \times .9375 \times 95{,}000 = 504{,}950 \text{ pounds.}$$

The resulting efficiency, with regards to failure by method Cr, is $\frac{504{,}950}{423{,}671}$, or a little over 119 percent. This high efficiency again seems to indicate that our rivet pitches are too small.

The final method of failure to be taken into account is the combined crushing strength of the shell plate in front of the rivets in the inner rows, and the sheering of the rivets in the two outer rows. A further analysis of Fig. 13 will prove this as being possible, since these two conditions act together; the failure of one will throw twice the load on the other. Calling this method of possible joint failure by CS, and writing out the equation, we have

$$8tdC + 3as.$$

Substituting and solving gives

$$8 \times .53125 \times .9375 \times 95{,}000 + 3 \times .6903 \times 44{,}000 = 399{,}220 \text{ pounds.}$$

Dividing this by the strength of the solid plate $= \frac{399{,}220}{423{,}671}$, or 91.6 percent as the efficiency with regards to failure by method SC.

This is the least we have encountered, and therefore is the true efficiency of the joint. It should, however, be recalled that we cannot "get away" with a longitudinal joint having an efficiency less than 92.4 percent, and unless the shell is made heavier, which the increased cost would prohibit, some improvement will be necessary in the joint design to give the additional .8 percent efficiency. That part of our joint SC which gave the least efficiency is wholly dependent on getting sufficient plate area in front of the rivets to resist crushing, and also rivets of such diameter that they will resist shearing.

The cheapest way out would seem to be in using larger rivets, which will improve both these conditions at the same time. By doing so, on the other hand, we reduce the plate ligament between the rivet holes, thus losing in one place what is gained at another. By also increasing the rivet pitch, however, we get the desired results without endangering any other part; in fact, we increase the strength of the joint throughout. The next larger commercial rivet diameter, above ⅞ inch, is 15/16 inch and requires holes 1-inch diameter.

Concerning the pitch, it should be recalled that we had originally decided on 29 calking pitches at 3⅝ inches each. Decreasing the number of pitches to the next lower odd number, or 27, gives $\frac{104}{27} = 3.85$, say 3 13/16 inches. This is but 3/16 inch more than our previously assumed calking pitch, but, having also increased the size of rivets, we will not have affected the calking of the joint. The maximum pitch we shall now figure on is 4×3 13/16, or 15¼ inches.

It should be noticed that the weakest part now lies in the net plate section between the rivets in the outside row, which condition is always conducive to a well-proportioned joint, as was stated before. Also note that the efficiency of SC, which in the former case was but 91.6 percent, has increased to $504{,}414 \div 445{,}610$, or 113 percent.

As an example for the student to test his ingenuity in applying the foregoing calculations, he is expected to make a complete set of figures covering the efficiency of this joint based on the revised rivet diameter and pitch. If his work is correct, he will find that the following results will have been obtained for the different methods of failure:

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

W = 445,610 pounds (strength of solid plate not a method of failure),
T = 415,800 pounds,
ST = 432,573 pounds,
TC = 453,588 pounds,
Sh = 656,595 pounds,
Cr = 528,438 pounds,
SC = 507,414 pounds,

of which T is the least. Dividing this value by W, we find that the true efficiency of the joint is $\frac{415{,}800}{445{,}610}$, or 93.3 percent. This being equal to or greater than the minimum efficiency demanded, our latest figures will be final.

The foregoing work, covering riveted joint calculations, will appear to the student as a long and laborious process, which is quite true. At best, it is a system of "cut and try" until the desired result is obtained. To the experienced designer, however, this is not always a difficult matter, as he is usually able to decide intelligently just about the proper combination of plate thickness, rivet diameter and pitch, so that seldom more than one set of calculations would have to be carried out. Nevertheless, it is tedious work, and has resulted in preparation of many tables covering every known type of joint and giving the true efficiency of every possible combination. A complete list of such tables would cover many pages of this magazine.

Since it is not to the best interests of the future boiler designer to depend on such tables before he has gained a working knowledge of the theory, no further reference will be made thereto, other than that they are usually available in most boiler shop drafting offices and may also be found in the handbooks distributed by some of the boiler plate manufacturers and boiler specialty companies. For the student's convenience, a ready reference list of the formulae used in calculating the efficiencies with regards to the various methods of failure previously explained is here appended. By means of these formulae, it is not necessary to divide by the strength of the solid plate W each time, but the efficiency of each individual method of failure is found direct.

TABLE 6

(6) $$T = \frac{P\text{-}d}{P}$$

(7) $$ST = \frac{(P\text{-}wd) + nas}{P}$$

(8) $$TC = \frac{(P\text{-}wd) + nbdc}{P}$$

(9) $$Sh = \frac{NaS + nas}{PtT_s}$$

(10) $$Cr = \frac{Ndc + nac}{PT_s}$$

(11) $$SC = \frac{Ndc + nas}{PT_s}$$

Note.—For all forms of butt joints having inside and outside straps of *unequal* width, each of the six formulae apply. Only formulae (6), (9) and (10), however, are required for *all* lap joints and butt joints with single straps, or with double straps of *equal* width.

In addition to the foregoing discussion of riveted joints, there are two other possible methods of failure, which, however, cannot be included in the investigations for efficiency, since no definite basis upon which to calculate the probability of such failures can be derived.

Fig. 13 illustrates how one of these failures may occur by the rivets pulling out through the edge of the plate before the full shearing strength of the rivets is developed. Failure from this cause may be produced by either of the two methods shown, (a) being purely a shearing stress, and (b) probably a combined shearing and tensile stress.

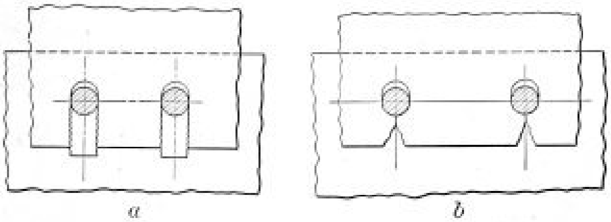


Fig. 13.—Failure Due to Rivets Pulling Out

It has been demonstrated, however, in tests on riveted joints, that if the distance from the *edge* of rivet hole to the edge of the plate be not less than the rivet diameter, failure by this method is not probable, and it was by the establishment of this standard that the "Code" has decided on a rivet gage of 1½ times the diameter of the rivet hole.

The student should not confuse the method of failure just cited with the crushing of the plate in front of the rivets. Since the latter may take place, resulting in enlargement of the rivet holes, regardless of the width of the lap, unless it is much less than 1½d, in which case the plate would break through, as in Fig. 13, long before the full crushing strength of the plate was developed. Lap L for our purpose will therefore be made 1½ by 1 inch or 1½ inches.

The second method of joint failure which must be provided against in the design, but for which, through lack of positively accurate analysis, no definite formula has as yet been developed, is depicted in Fig. 14. Although the illustration shows a double-riveted lap joint, the condition is nevertheless true whenever there is staggered riveting.

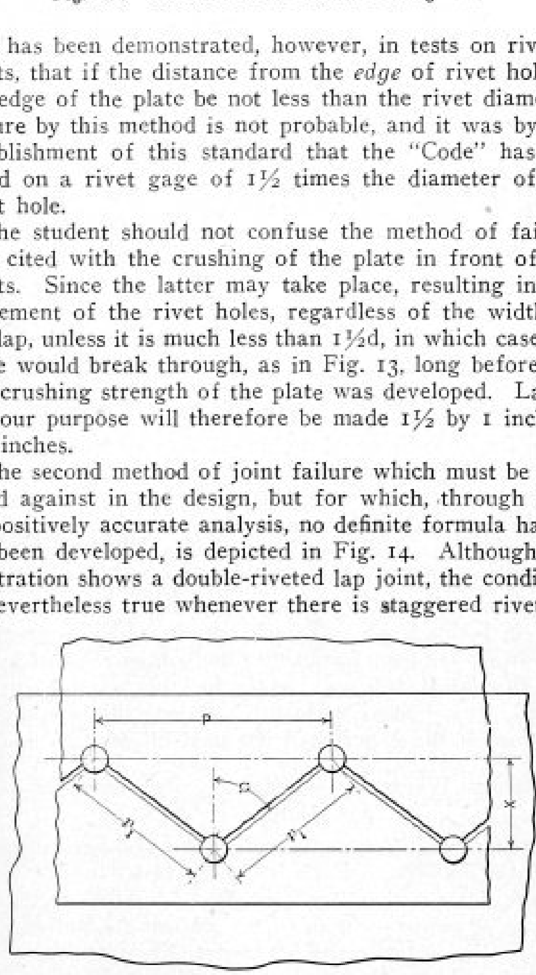


Fig. 14.—Failure of Danher Riveted Joint

The combined stress on the two diagonal sections through p is exactly equal to the stress in the horizontal section through P. By setting up practical conditions, this fact may be proved experimentally:

(*To be continued.*)

Lines of pipe which carry oil or any fluid in which there is sediment should be cleaned out from time to time. They should be fitted with plugged tees instead of ells, so that the plugs can be removed and the cleaning done. Remember, brass plugs should be used.

Inspection Reveals Carelessness of Boiler Operation

BY F. H. SWEET

Too often there is a lack of hearty co-operation between the owner or engineer and the man who comes to examine the boilers. This sometimes manifests itself in deliberate antagonism. The cause may be disinclination to incur any additional expense. As an example, I might mention the case of an owner who objected to the removal of a manhole cover from a boiler to facilitate inspection, on the ground that a gasket would be needed to make out the new joint. He made this objection despite the fact that the cover had not been removed in a year.

Circulating Tubes Clogged With Scale

In another instance, the engineer or owner may affect indifference toward the existence of dangerous conditions. As a point in question, a certain electric light plant contained a battery of four Babcock & Wilcox boilers, of which only three were working when the expert arrived. The steam gages registered a pressure of 125 pounds per square inch. The expert was about to test the water gages when he noticed a difference in level of about six inches in the glasses of two of the boilers (each of the boilers having two drums). No water could be seen in one of the glasses of the other boiler.

After testing, the inspector found that the connections were clear. He then asked that water be pumped into the third boiler until water showed in the glass then empty. Water was pumped in until one glass was full. On trying the water cock at the bottom of the other glass, however, dry steam issued. The engineer was asked whether this condition had not caused him to worry. He admitted that it had at first. But since the boiler had been in that condition for some time and nothing disastrous had happened, he acknowledged that his fears had somewhat abated.

The inspector had the boiler put out of commission immediately, removed the caps from some of the headers and found the circulating tubes at the rear of the boiler plugged practically solid with scale. When this was removed and the boiler refilled, the water level was the same in both glasses. It appeared that all the attention to cleaning had been confined to the bottom rows of tubes. The circulating tubes evidently had not even been examined. It is impossible to say how long this would have continued if the expert had not paid his visit.

Careless Work on Horizontal Return Tubular Boilers

Two horizontal return tubular boilers had been installed in a bank building. Each had been tested under water pressure by the heating contractors. They were left ready to be put into commission. Before the boilers were fired, the inspector arrived. During his examination he found that screwed plugs had been fitted into the safety valve discharge openings during the hydrostatic tests and had not been removed.

In another case an expert was called to make an external inspection of a horizontal return tubular boiler in a creamery. He looked for the blow-off cock in the usual place at the rear of the boiler setting, but was unable to find it. The engineer told him that it was in the combustion chamber. The expert pointed out the fact that it could not be opened when the boiler was in operation.

"Moreover," he said, "it will burn out."

"Yes," replied the engineer, "I know that. In fact, one did."

"And what did you do?" asked the expert.

"I put in another in the same place."

An inspector called at a wholesale warehouse building for the purpose of complete internal and external examination of a horizontal return tubular boiler. On looking under the shell from the firedoor he noticed that the shell plates were covered with a thick layer of soot. He remarked that it would be impossible to inspect the boiler thoroughly in that condition, and required that the soot be cleaned off. Although it was found that the layer was about two inches thick, the boiler attendant protested that the cleaning was unnecessary, as no one had been under the boiler in seven years. He even accused the inspector of being "fussy." Since that time this man has learned what boiler inspection means, and is now only too pleased to get his boiler ready whenever he is required to do so.

Ignorance of a Boiler Attendant

In another warehouse building a single boiler was examined. The attendant was asked how the boiler was working.

"All right to-day," was the answer. "But I had some trouble yesterday. I couldn't get water to show in the working.

"What did you do?"

"Oh, I shut the steam valve on the top of the gage glass, and then the water showed all right." This man was given another job!

On another occasion an expert was called in to examine two locomotive-type boilers in a large life insurance building. On entering the firebox of one of them, which was equipped for burning gas, he observed an addition to the brick arch and baffling arrangement. In fact, the crown of the firebox was filled with hard cement about two inches thick. He was at a loss to account for this, and asked the engineer to explain. The engineer did not know what it meant. The inspector called up the heating contractor who had installed the boilers, and asked him to explain. The contractor was greatly concerned about it, and made an investigation. It was then discovered that while the building was under construction the boiler was lying upside down. The cement had fallen into the firebox by accident and had solidified there. The boiler had been erected and was to have been put into operation the day after the inspector's unexpected arrival.

These are only a few examples of the condition that inspection reveals, but they show what dangers carelessness and neglect occasion.

Speedy Boiler Installation

The following records recently reported by a rigging gang in the Ecorse plant of the Great Lakes Engineering Works are destined to put a crimp in previous records:

Two boilers were hoisted onto and put into place in a 5,000-ton freighter in 52 minutes by means of a stiff-legged derrick.

Another gang transported on cars from the shearlegs to a boat on the stocks, a quarter of a mile away, three boilers which they rolled up onto the boat on skids and into their saddles in three hours and twenty minutes. Neither derrick nor crane was involved in that job. But the unusual part of it was that the boilers reached their saddles right side up and in perfect position.

The accurate measurements taken by the foreman of the gang before the work was begun account in some measure for the speed with which the installations were accomplished.

Among Railroad Boiler Shops—VI

Ingenious Devices Developed for Special Work—Front-End Staging, Handling Locomotive Tenders and Special Tools

BY JAMES F. HOBART

Recently the writer visited the round house shops of the Texas Pacific Railroad at Donaldsville, La., a town just across the Mississippi River from the New Orleans terminal station of that railroad. These shops are surely monuments of the highest type of efficiency, ingenuity and "getting there" on the part of the men directly in charge, since the lack of strictly modern equipment is a constant drawback to good work. The men succeed in keeping up the round-house repairs on upwards of 150 "chain gang" locomotives. The home-made tools and appliances scattered thickly around the shop testify to the fact that the men in direct charge have used brains to keep the shop running at this capacity. In doing this work almost every bit of metal and every particle of scrap is utilized for some purpose.

A Home-Made Punch

For example, in the sheet metal working department, the writer noticed a fine home-made machine for punching thin sheets. The device consisted of a simple lever, at one end of which was fitted a punch and die, and at the other a steam cylinder.

Fig. 1 gives an idea of the manner in which the punch was arranged. The casting *B* is supported by a wooden block *A* with overhang so adjusted at either end that the die *D* and steam cylinder *G* are easily accessible. Two heavy angle castings, shown at *CC*, serve to connect lever *I* with base *B*. The upper punch *E* is removably fitted to

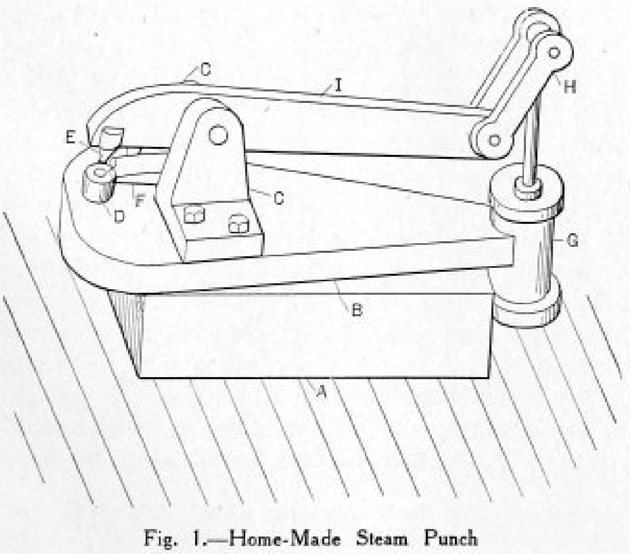


Fig. 1.—Home-Made Steam Punch

lever *I* and made to swivel slightly against the resistance of a stout spring located within the hub which carries punch *E*. The cylinder *G* is bolted firmly to the end of base-plate *B* and its piston rod is connected with lever *I* by means of stout links *H*. These links are so arranged that the pull is directly in line with the piston rod when the stress is the greatest; that is, at the time when the punch is entering the sheet.

The steam cylinder which the workman had used in "rigging up" this tool was a relic of bygone days—one of the old steam-brake cylinders in universal service before the air brake put the steam cylinder out of business. There were a good many of these air cylinders around the shop, and several of them had been put to work in a manner similar to that shown by Fig. 1.

The punch above described, working under the average air pressure used in the shop, would punch a ½-inch hole in 5/16-inch plate; but the air had to be well up to the mark to do that. As thin sheet metal was used more than anything else in this shop, the tool was found to be a very useful one.

It should be understood that only minor repairs were done in these boiler shops. No large or heavy work was attempted. Patches were the heaviest boiler work attempted and the oxy-acetylene welding process was used in pressure work wherever it could be applied. It was reported that not a failure had yet been observed from a weld made by that process.

Of the several other old steam brake cylinders which have been pressed into service, one is employed for cutting off round iron for bolts or stays. This machine is arranged about like the one shown in Fig. 1, but with a sort of short shears taking the place of the punch and die. In Fig. 1 the "stripper," shown at *F*, was used to pull the sheet off the punch after a hole had been made. In the bolt-cutting machine, the stripper is retained, but changed in form so as to hold a rod, which prevents the bolt from tipping up endwise during the cutting-off operation.

Bolt Cutter and Straightener

In another part of the shop I discovered a cylinder that had been used to drive a straightener. For this operation the air-cylinder was inverted and bolted to a post. A sort of "ram" was arranged in place of the usual crosshead. The ram bore against an anvil about four inches thick and ten inches long, impinging directly against the middle of it. Across this section was laid a piece of ¼ by ¾-inch black steel, the ends of which were turned down an inch front and back of the anvil to keep the clip in place.

To straighten a bolt, the clip was moved to one side of the point where the ram would come down; then the bolt was placed "bow side up" on the anvil and on the clip. The ram would be brought down, straightening the bolt in short order, frequently by a single descent of the ram.

I noticed another cylinder "rigged up" in the forging shop for clamping bars or plates which had to be bent after the object had been heated. This tool was arranged in much the same manner as the bolt-straightener, save that instead of using a single post to carry the cylinder and ram these were mounted between a stiff bar-steel frame and the anvil was made long and wide enough to accommodate a heavy pattern or form. The heated bar was placed upon the pattern which overhung the anvil. Then the ram was brought down by steam pressure against the heated bar, holding it firmly against the overhanging pattern, against which the hot bar would be speedily shaped down under the blows from a sledge.

Steam Sheet-Clamp

A fine tool was observed in use in the sheet metal shop, where all the boiler shell and tube work is done. The tool consists of heavy vertical cast iron clamps about twelve feet long, with a steam cylinder located vertically at either end of the tool. These cylinders are operated by compressed air and are double-piped in a manner which permits the cylinders to raise the upper portion of the clamp for the insertion of the work.

By admitting air to the opposite ends of the two cylinders, the work will be held in place, not only by the weight of the upper clamp but by all the power of the air-filled cylinders as well. With the 90 pounds of air pressure in the two 10-inch cylinders, the clamping force, when this pressure is added to that of a half-ton upper clamp-member, is surely considerable, and the writer noticed that no work slipped out of place after the clamp had gripped it. This machine was not "home-made." It was purchased complete nearly a half century ago and has been in constant use ever since by workmen from the plate shop, the machine shop and from the smithy.

Shearing in the Clamp

This shop did not possess any shearing tools which could handle metal thicker than the tinner's bench shears

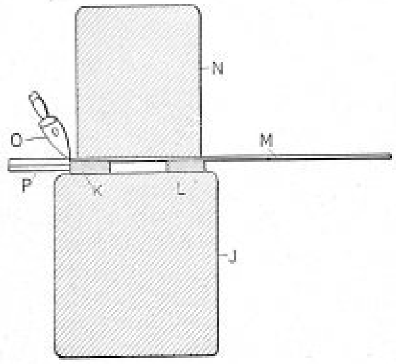


Fig. 2.—Shearing in the Steam Clamp

could get away with. Thus handicapped, the foreman of the metal-plate shop—who, by the way, is more venerable than any of the tools in the shop, over 70 years of age and able to "get away" with two-thirds of the younger men yet—rigged up an excellent steam clamp, for cutting or more properly shearing metal plates and sheets.

The appliance enables the shop men to readily shear plates ⅜-inch thick. On one occasion, a ½-inch plate was

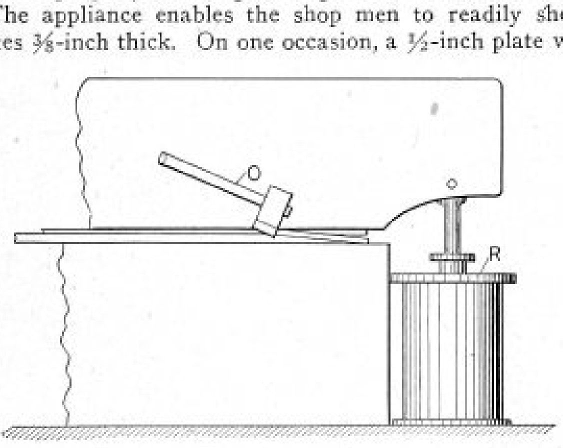


Fig. 3.—Side View of Clamp Shearing

sheared, but the process was rather slow. The arrangement for shearing in the clamp is shown by Figs. 2, 3 and 4, herewith. As shown in Fig. 2, upon the lower member of the clamp *J* is laid the tool steel strip *K*, which extends the entire length of the clamp. This strip is squared up occasionally in a planer after its corners have become dull or rounded. All four of the corners are used. When one corner gets out of shape, another corner is brought into use until all four edges have been used to cut against.

The bearing of the upper member of the clamp *N* is evened by placing a bar of plain black, soft steel, *L*, on the back side of the lower member, so that the device may be used for clamping without removing the shearing strip. To operate as a shear, the plate is put in position as shown at *M*; the line to be sheared is brought up fairly with the front edge of steel strip *K*; the cutter is then applied as shown at *O* and driven with a sledge.

Cutter *O* acts as one jaw of a shear, and strip *K* as the other. By moving cutter *O* along at each sledge blow, and by keeping it at a certain angle, the plate *M* is cut as smoothly as if in a regular shear. The piece *P* which is cut off is driven down about three-quarters of an inch until it bears against the lower clamp member *J*, thus making strip *P* come from the cutting operation nearly straight and free from dents or kinks.

Fig. 3 shows the angle at which cutter *O* should be held in order to do its work properly. This picture also shows the manner in which the steam cylinder *R* is disposed and its connection with the upper and lower shearing members. There is a light guide to prevent the upper shear member from moving sidewise. That detail was not shown in the engraving.

A more detailed view of the cutter is shown in Fig. 4. It will be observed that the cutting edge *S* is slightly

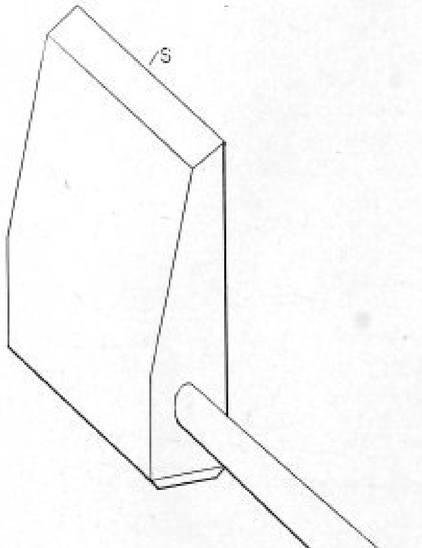


Fig. 4.—Cutter Used for Shearing

beveled, also that the tool is quite wide. This gives more chance for the shear action of each blow and prevents bringing either corner of the tool against the metal. Should a corner come into action, it would make a mark on both the cut edges. On the other hand, as long as the tool is wide enough to prevent either corner from touching the sheet, the cutting may be done by the middle of the cutter, and the work will come out very smooth—as smooth, in fact, as though it had been cut on a high grade shear.

In order to prevent the strip *K* from moving along under the stress of the sledge blows, it was fastened at each end by means of two metal-plate clips, one of which

(*Concluded on page* 60.)

The Boiler Maker

Published Monthly by

ALDRICH PUBLISHING COMPANY, INC.

6 East 39th Street, - - - - - New York

8 Bouverie St., London, E. C.

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor.

Branch Office
Boston, Mass., 733 Old South Building, S. I. CARPENTER.

Manufacturers in all lines of industry have been waiting for months for some definite action by the United States Government regarding the readjustment of business affairs. So far no American policy has been developed. On the other hand, the vital interests of the country seem to be ignored, and conditions are daily becoming more difficult for the manufacturer to keep his business in shape and develop plans for the future.

Long ago definite action should have been taken by the Government to promote American industry and our foreign trade. The serious conditions under which employers of labor are operating call for a definite policy of action. As conditions stand, it is nearly three months since the armistice was signed and still no action has been taken on the question of canceled contracts and claims. Surely American manufacturers are entitled to some consideration, inasmuch as the developments of the next five years are contingent upon the work which is done now. Just as long as readjustment problems are left to chance and accident, industry will suffer.

The unemployment question is already becoming serious—due largely to the Government's failure to make any preperations to meet an expected emergency. There is official authority for the statement that the Government was ready last August to discuss the terms of an anticipated peace, but it was not ready on November 11 to make provision for keeping its contracts with manufacturers. The result is that many employers of labor are compelled to reduce their establishments until such time as the Government sees fit to take care of the financial matters involved in the Government's contracts. While billions of dollars are tied up and production is hampered, there is necessarily a laying off of men.

A timely warning is given in a recent issue of the *Railway Age* regarding the disastrous conditions which threaten railway supplies' companies. The railway supply industry is one of the largest in the country and employs in the neighborhood of a million and three-quarters men. This is not far below the number of workers employed by the railways themselves, and, counting the dependents of the supply men, it will be seen that a very considerable percentage of the entire population of the country is affected directly and indirectly by the conditions in the supply industry. One official goes so far as to insist that the industrial prosperity of the country follows the prosperity of the railway supply interests.

At present through the deferment of railway purchases the supply industry is confronted with a most serious situation. The policy of the Railroad Administration is to cut down purchases to a minimum, simply because they have no money to buy materials and equipment. The *Railway Age* prints letters from 26 leading manufacturers of railway supplies and equipment and from 19 of the leading builders of cars for both steam and electric railways. All point out that the development of railway purchases is impending and is going to impede in greater degree the process of readjustment in this important industry. Some say that in order to keep their men at work they are manufacturing stock ahead; others, that they have already had to lay off men, and all express their fear of widespread unemployment in the industry—and this at a time when conditions should be just the opposite so as to make it possible to hire the men returning from overseas.

These conditions should not be regarded as the inevitable result of war, but as the result of a lack of foresight and preparation on the part of the Government in readjusting conditions to cope with business on a peace basis. It may not be exaggerating the situation to say that the form of disaster which threatens the railway supply industry may be impending in other lines of business of no less importance.

Early this month foreign orders for sixty-two locomotives, approximating in cost five million dollars, were placed with the American Locomotive Company, of Schenectady, N. Y. This is the largest contract for American manufacturers from abroad since the signing of the armistice.

The orders call for several different sizes of locomotives. The largest order is from the South African railways for forty mountain-type engines, of which twenty will weigh 97 tons and twenty 94 tons each. Next comes an order from the Chemins de Fer de la Province de Santa Fe of Argentina for twenty Pacific type engines weighing 53 tons each, and a railroad operating in Portuguese East Africa has contracted for two 19-ton Mogul locomotives. The engines to be shipped to South Africa will be manufactured at the company's Montreal plant and the others at its Cook works.

All American companies manufacturing locomotives are looking for an increased export demand, since the railroad lines all over the world are said to be operating with wornout rolling stock as a result of the war, which tied up the output of most of the plants.

Details of the programme of the forthcoming convention of master boiler makers are printed on another page of this issue. This will be the first convention of the Master Boiler Makers' Association since 1916 and every member should plan to attend.

Engineering Specialties for Boiler Making

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

Geyser Self-Actuated Boiler Cleaner

Simplicity is the basis of the action of the Geyser circulating boiler cleaner, which is designed for use with Scotch marine boilers. Fig. 1 shows the details of the apparatus as installed in a two-furnace Scotch boiler.

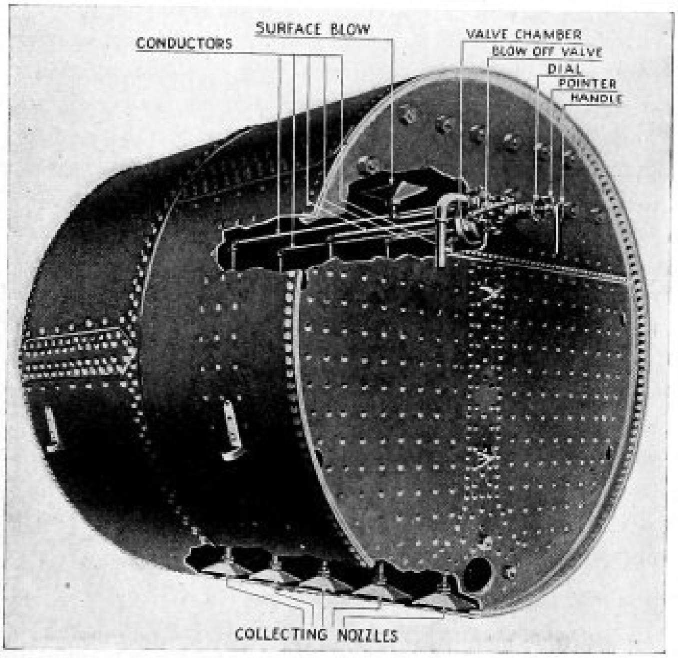


Fig. 1.—Showing Installation of Geyser System in a Scotch Boiler

The principle of operation is as follows: The valve chamber placed at the top of the boiler is provided with three ports, one on each side and one at the top. The ports on the side are fitted with pipes that terminate at their other end in the bottom of the boiler. The heat which is imparted to all water above the grate line, when steam is being raised in a Scotch boiler, soon raises the temperature of the water. The valve chamber, situated in the position where the water becomes the hottest, absorbs this heat and conducts it to the water contained within the chamber. As the water in the chamber expands and its specific gravity changes, it soon rushes out through the circulator outlet, shown in detail in Figs. 2 and 3; the chamber is continuously refilled from the water drawn by the conductor pipes from the bottom of the boiler.

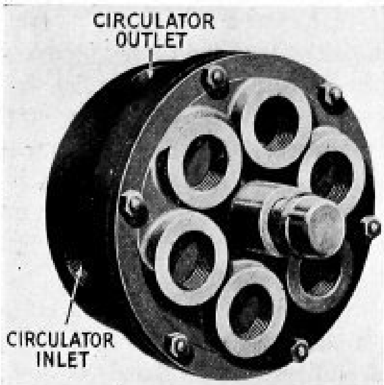


Fig. 2.—Showing Exterior View of Valve Chamber

It is obvious, therefore, that a continuous water circulation is assured by the Geyser system as long as the temperatures at the top and bottom of the boiler vary. In actual operation, communication is opened between a collecting nozzle (the turning of the handle on the valve shaft, until the pointer is even with the numbers indicated on the dial plate, determines which nozzle shall be operated) and the main blow-off pipe by adjusting the main blow-off valve. The pressure on the boiler and the efficient shape of the collecting nozzle produce a sweeping current of water, which by actual test is shown to extend approximately 6 inches on each side of the collecting nozzle. When all sediment and scale are removed from that part of the boiler to which the collecting nozzle sprays, the pointer on the dial is turned to operate another nozzle. It is allowed to remain in this position until all solids are removed, when the operation is repeated until a complete revolution is made. In this way all sediment and scale-forming ingredients are removed from the bottom of the boiler.

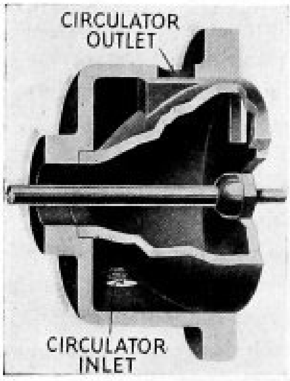


Fig. 3.—Showing Cross Section of Valve Chamber

The valve control is particularly valuable when operating boilers in harbor, river or shoal water, especially when vessels are backing or filling and mud and sediment are being stirred up by the propeller wheel.

A New Welding Compound

The welding compound herein described is the invention of Cecil C. Roberts, of Mount Vernon, Ohio. This invention has relation to chemical compounds and mixtures for use in promoting the joining of metallic parts in welding processes, soldering or the like, depending upon the property of dissolving the oxides which form on the surface of the parts when heated, as a scale, which, if not removed, destroys the cohesion of the parts, thereby preventing the formation of a rigid joint.

While this compound is intended primarily and particularly for welding or joining iron and steel parts, nevertheless the welding of other metals may be accomplished with various degrees of success. A certain proportion of finely divided iron is employed in the compound when the same is to be used for welding iron or steel, and if the compound is to be used in joining or brazing copper or the like, it is obvious that a certain proportion of that metal in a finely divided state may be substituted for the iron.

The most satisfactory results from the use of the compound may be obtained when the ingredients are combined in the following proportions:

Iron (or steel) filings	20 parts
Sand	50 parts
Powdered glass	5 parts
Cryolite	10 parts
Borax (calcined)	15 parts

These materials are first reduced to a fine or pulverized condition, and subsequently mixed in the proportions named.

The sand employed is preferably of the character known as "glass sand," as the same is practically pure silica. The borax before pulverizing should first be calcined, so as to expel its water of crystallization; and it is claimed that the commercial variety of borax is better adapted and is more productive of the best results in the use of the compound than the more purified variety. This is due to the fact that the borax contains, in addition, small proportions of oxide of iron, aluminum, and calcium, which facilitates the action of the compound in a matter to be presently obvious.

To those familiar with the art to which this invention applies, its use will be quite obvious. It may be stated, however, that the parts to be joined are heated to the desired temperature and the compound sprinkled thereover before joining the parts by forging or otherwise. The action of this compound, as in compounds of a similar nature, is to dissolve the metallic oxides which are formed on the heated parts, which oxides, if not removed, would form a scale separating the meeting surfaces and thereby preventing the formation of a firm and rigid joint. The compound therefore acts as a flux. Sand and borax are the agents whereby the oxids are dissolved and the glass is used to reduce the fluidity of the metal or to prevent the same from running.

PERSONAL

ALDEN R. LUDLOW, former vice-president of the Liquid Carbonic Company, of Chicago, Ill., assumed his new duties as second vice-president and sales manager of the Air Reduction Company, Inc., January 1, 1919.

FRANK GRAY, of Bloomington, Ill., treasurer of the Master Boiler Makers' Association, suffered a severe stroke of paralysis some weeks ago and, although his condition is slowly improving, it will probably be some weeks before he is able to resume active work in connection with the association, or his regular duties as general foreman boiler maker of the Chicago and Alton Railroad.

GEORGE SHERWOOD HODGINS, editor of *Railway and Locomotive Engineering*, New York, died recently of pneumonia at his home in New York at the age of fifty-nine years. Mr. Hodgins was connected with the *Railway and Locomotive Engineering* for about fifteen years. Before taking up editorial work he was for a number of years mechanical engineer of the Canadian Pacific Railway. In addition to the editorial work in which he was engaged he also spent much time in scientific research.

BUSINESS NOTES

Contracts have been let by the Acme Boiler & Tank Company, Chicago, for the construction of a one-story addition, 52 by 85 feet, to its factory, to cost $10,000.

The Hodges Boiler Works, Mobile, Ala., is planning for the rebuilding of part of its plant, recently destroyed by fire, with a loss reported at $10,000.

To better serve their customers, the International Oxygen Company announce the removal of their general offices from 115 Broadway to their main works at 796 Frelinghuysen avenue, Newark, N. J.

Duntley-Dayton Company Enters Pneumatic Tool Field

On January 1, the Duntley-Dayton Company took over the entire output of the Dayton Pneumatic Tool Company, of Dayton, Ohio, and announced its entry into the pneumatic tool field. W. O. Duntley, former president of the Chicago Pneumatic Tool Company, is president of the new concern, and his son, Captain C. A. Duntley, is vice-president. Captain Duntley has not yet been relieved of his command in the 27th Field Artillery, Camp McClellan, Anniston, Ala.

The Dayton line of pneumatic tools has been on the market for many years and has been developed to a high

W. O. Duntley

stage of mechanical perfection. A new plant thoroughly equipped with modern machinery has just been completed to take care of the growing business of the company.

In addition to handling the output of the Dayton Pneumatic Tool Company, the Duntley organization is putting out a complete line of portable electric drills and grinders, as well as a full line of accessories, such as hose and hose couplings, rivet sets and chisel blanks.

W. O. Duntley is one of the pioneers in the pneumatic tool business and has been closely connected with both the manufacturing and selling ends of the industry for the past twenty-five years. He has many pneumatic and electric tool inventions to his credit, the Duntley electric drill being perhaps the most widely known. The offices of the Duntley-Dayton Company are located on the fourteenth floor of the Westminster Building, Chicago. The eastern offices are located at 295 Fifth Avenue, New York, and the Philadelphia branch is in the Commercial Trust Building of that city.

Questions and Answers for Boiler Makers

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

This department is open to subscribers of The Boiler Maker *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of The Boiler Maker, *6 East 39th street, New York City.*

Patterns for Large Dome Roof

Q.—I would like to have some reader of The Boiler Maker show me the best way to lay out the patterns for a 30-foot dome roof made of 3/16-inch metal. I have made a pattern development, but want to be sure of its accuracy before going ahead. E. M.

A.—As the surface of a sphere or any other circular arched construction has a double curvature the pattern for the plates will be approximate. A perfect development cannot be made. However, there are two or three methods that are accurate enough for work of this kind. The sheets may be cut either for zones or for gores. The latter method is the easier one, because only one pattern is required. With the zone system a different pattern must be made for each zone. Fig. 1 illustrates the principle of the layout for the gores. The circumference of the base of the hemisphere, or any other arched surface, is laid off into a number of equal arcs, depending upon the size of the circle and the width of the sheets available. In this problem the length of the circumference is 30 by 3.1416 = 94¼ feet, and it will require 34 sheets in case 36-inch sheets are used. The total length of each gore is equal to that of a quadrant, or 23½ feet. The illustration shows how to make the layout. Divide a quadrant into equal arcs and project the division points on to the radii forming the sides of the gore in the plan view. Make the stretch-out equal to 23½ feet and project the widths on to the equally spaced division lines of the stretch-out. Increase the widths equal to the amount that the arcs are greater than the chords, and, in addition to this increase, the laps should be added. The trimmings could be riveted up and much material saved.

A construction of this kind of thin metal without a framework support will likely be unstable. It may distort or crush not only from its own weight but from the wind pressure or any other outside force. The design of the supporting structure is a problem for the consulting engineer and is not considered here.

The layout of the sheets for the zone system of the principle illustrated in Fig. 2 is used. Each zone or ring is different from all the others. The curves forming the edges of the sheets should be arcs of circles drawn by radii, including the slant heights of the gores. For small work these layouts can be made very readily, but on large work, such as that in this question, only those zones above 45 degrees could be made in this way. The other radii are so long that their use is not practical. Therefore, for the lower zones the patterns would have to be laid off by triangulation, by the use of ordinates or in a manner similar to that used for laying out railroad curves by the use of the transit.

The method of calculating the length of a long radius not included within the borders of the drawing is as follows: Assume the case where the slope of the zone is 85 degrees, as in Fig. 3. Then the angle at the center of the curve will be 5 degrees. As the base of the triangle is 15 feet, $R = 15 \div \text{Sine } 5 \text{ degrees} = 15 \div .0872 = 172$ feet. In order to find the camber, assume a sheet 20 feet long and make the layout as in Fig. 4, and the camber will be found to be 4 inches. The height of the triangle is $72 \times \cos 5 \text{ degrees} = 172 \times .9981 = 171.6732$ feet, and

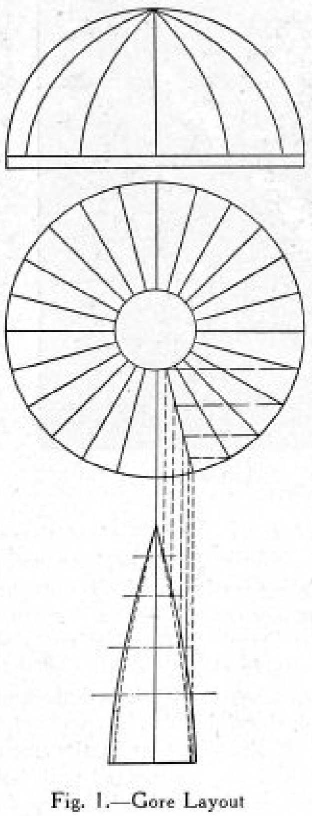


Fig. 1.—Gore Layout

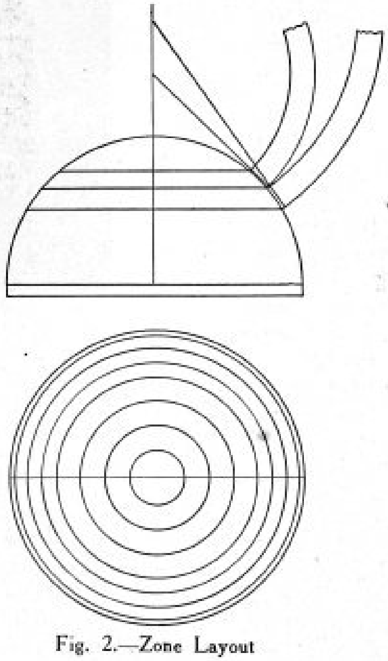


Fig. 2.—Zone Layout

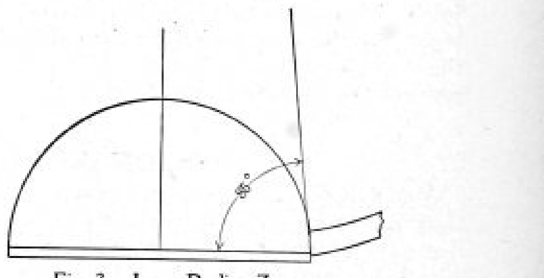


Fig. 3.—Long Radius Zone

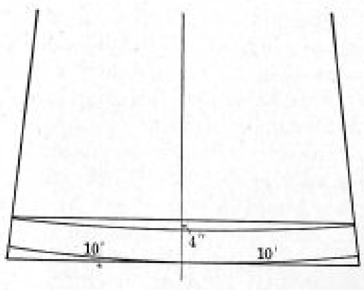


Fig. 4.—Arc Camber

the camber is 172 — 171.6732 = .326 feet = 3.9 inches. In order to get a point on the curve midway between the middle point and the end of the sheet, draw the chord of half the arc, as in Fig. 5, and at the middle of this chord give a camber of one-fourth that at the middle of the

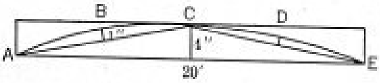


Fig. 5.—Camber of Half Arc

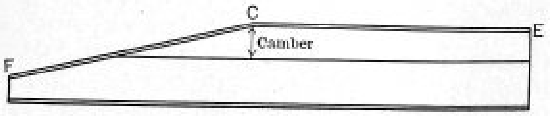


Fig. 6.—Long Arc Templet

sheet. In this case the camber is 1 inch. Draw the curve *A, B, C, D, E,* so as to form the edge of the sheet.

An arc too large for the dividers or trammels can be laid off by the use of a templet, such as shown in Fig. 6. From the drawing lay off on paper or sheet metal the lines *FC* and *EC* so that *EC* will be parallel to the given chord and *FC* will be in line with the chord of half the arc.

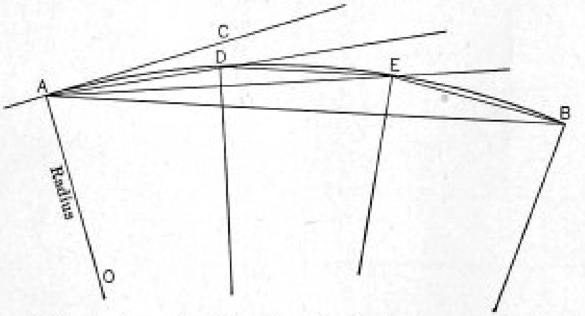


Fig. 7.—Layout of Arc by Equal Angles and Chords

These lines form the edge of the templet. Apply the edge *FCE* to the side that is to be laid off, keeping the edge *EC* always in contact with the middle of the sheet, and the line *FC* in contact with the point *A* at the end of the sheet. Mark the locations of the corner *C* of the templet and draw the curve through these points.

A long radius curve can also be laid out by means of equal chords and tangential angles. In Fig. 7, let *AB* be the chord of the proposed curve, which would equal the length of the sheet. Draw the radius *AO* and the tangent line *AC* at right angles to it. Set up the transit or a long arm protractor and lay off equal angles, as *CAD, DAE, EAB,* etc. Then from *A* measure off equal chords *AD, DE, EB,* etc., to locate the points on the curve. The length of the chord equals $R \times 2$ sine tangent — angle *CAD*. The tangent of angle

$$CAD = \frac{\text{center angle of curve}}{2 \times \text{number of chords}}.$$

Danger from Hydrostatic Tests

Q.—Having never seen a destructive test on a boiler or other pressure vessels, I would like your opinion on a few points. Say, for instance, we have a boiler built for 150 pounds working pressure, with a factor of safety of 5. Theoretically it should take 750 pounds to cause failure. If testing with hydrostatic pressure, what would take place at the moment of failure? Would the shell explode or merely rip? Would it be dangerous to remain close enough to see the effect of the failure? I have seen a firebox in a vertical boiler collapse under test at 150 pounds. The boiler was second hand and was being tested to find out its condition before repairing. A boiler maker had his head in the firebox when it collapsed and didn't get anything but a good wetting. Any information on this subject will be appreciated. S. R. W.

A.—There is no danger of an explosion when making a hydrostatic test. A bulge of the plate or a leak in the seams will generally relieve the pressure unless the water is being pumped in very rapidly. When a split occurs, the pressure is relieved immediately, and the outrush of water is caused, not from the hydrostatic pressure, but from the gravity pressure of the weight of the water above the opening.

There is a vast difference between the effects when cold water is released from pressure, and when the temperature of the water is above 212 degrees F. In the latter case the energy stored up in the hot water becomes effective, and often with disastrous results.

Master Boiler Makers' Association to Hold Convention in Chicago

The 1919 convention of the Master Boiler Makers' Association will be held in Chicago May 26, 27, 28 and 29 at the Hotel Sherman. This will be the first convention since 1916, the association having suspended activities on account of the war. The subjects to be discussed at the convention, together with the committees, follow:

1. Proper method of threading radial stays and tapping the holes in the boiler for them.
   Is it necessary to give radial stays the same lead as the tap with which the holes were tapped?
   Committee: H. J. Raps, chairman, Andrew Hedberg, J. J. Keogh, J. B. Smith, T. J. Reddy.
2. Which is the better method of drilling tell-tale holes, before or after application of the bolts?
   Which is the better method for drilling in either case?
   What is the best style of drill for opening up tell-tale holes in old staybolts?
   Does it pay to use a high-speed drill for this purpose?
   What is the best lubricant for the drill?
   Committee: L. R. Porter, chairman, A. N. Lucas, S. M. Carroll, Bernard Wulle, C. E. Erwin.
3. Effect of proper upkeep of ash pan and front end draft appliances on fuel economy.
   Method used in determining proper design for various classes of locomotives.
   Committee: George Austin, chairman, E. J. Nicholson, Fred Bayer, H. F. Weldin, George Hewitt.
4. What is the best method for scaling superheater flues in the boiler?
   What is the best method of rattling flues?
   What is the best method of handling flues in and out of the rattler?
   How many revolutions per minute should the rattler make for 2-inch and for 5⅜-inch flues?
   Describe method for safe ending superheater flues.
   Committee: Frank Gray, chairman, W. J. Murphy, Andrew S. Green, John Harthill, J. J. Mansfield.
5. What is the best style grate for bituminous coal?
   Where should the dump grate be located, (a) in road engines, (b) in switch engines?
   What should be the percentage of opening in grates?
   What should be the percentage of draft opening in ash pans compared with area of grates?
   Committee: W. H. Laughridge, chairman; L. M. Stewart, T. P. Madden, C. P. Patrick, C. A. Nicholson.
6. What should be the minimum distance between the grates and the lower part of arch tubes for different classes of locomotives?
   What is the proper distance from the door sheet to the brick arch and from the crown sheet to the brick arch for the various classes of locomotives?
   Committee: C. L. Hempel, chairman, W. F. Fantom, A. E. Brown, E. W. Young, G. B. Usherwood.
7. What is the best method of bracing locomotive tenders? Describe method used.
   Committee: Thomas Lewis, chairman, E. J. Sweeney, J. J. Orr, J. P. Malley, J. T. Johnson.
8. Oxy-acetylene and electric welding.
   Committee: H. J. Wandberg, chairman, B. F. Sarver, L. M. Stewart, T. F. Powers, J. J. Davey.
9. What is the advantage of cutting off stay ends with oxy-acetylene over old method of nippers and chisels?
   Committee: W. S. Larason, chairman, John McGarrigal, J. B. Tynan, E. H. Hohenstein, A. E. Shaule.
10. General discussion.

Letters from Practical Boiler Makers

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

Bearings for Sheet Metal

When it is necessary to support a spindle running through thin gage material, a rather troublesome problem is experienced. No ordinary bearing purchasable through the usual sources is designed for the purpose. If an ordinary plummer block (intended for use upon a casting and provided with two bolt holes) is used, this means riveting angles or bearers to the tank or other thin gage article. The job, when completed, looks disproportionate and is certainly costly. A simple hole strengthened by a piece of plate provides insufficient bearing area for the spindle and causes grooving of the shaft, as no provision for effective lubrication can be made. To design a special bearing involves the expense of patterns, the cost of machining and fitting, which, for an isolated or occasional job, is prohibitive. Even if the plate employed is of reasonable thickness, say ¼ inch, the trouble is not minimized even for a small diameter spindle; while, if the thickness be 10, 16, 18, or even 20 wire gage, the job is difficult and almost impossible to solve by any usual method.

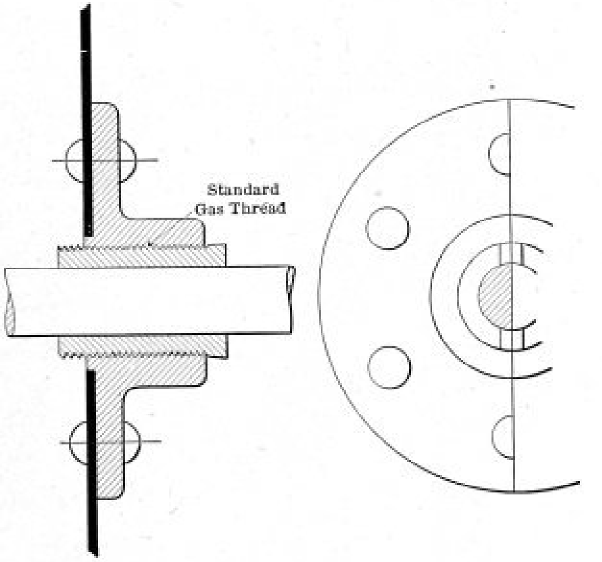


Fig. 1.—Plain Pipe Flange with Piece of Barrel Put Home with Pipe Wrench or End Slots

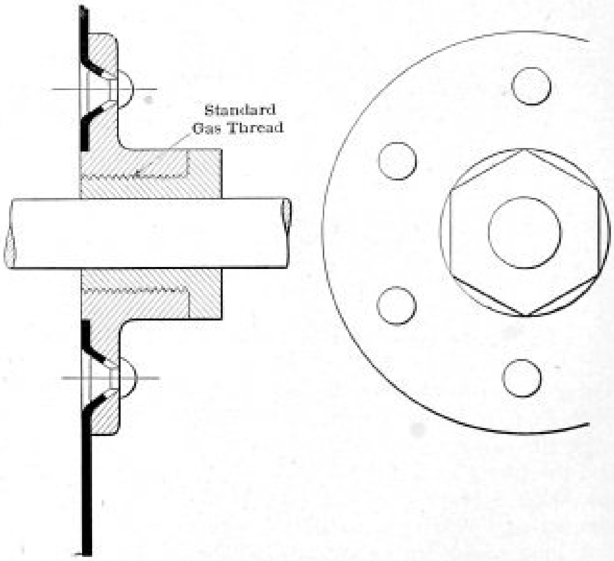


Fig. 2.—Flush Face Interior to Job Showing Special Riveting. Cast Iron Screwed Hexagon Bushing Forms Bearing

Instances in point are damper doors in steel chimneys, mixing and agitating tanks, casings and shrouds for various purposes. The problem becomes even more acute where removal of the spindle and its attachments complete is desirable, or where the spindle is required to be liquid tight against a standing fluid.

In the chemical trade and in the manufacture of various substances, agitation and mixing are essential processes. The plant involved is usually of a special and non-repetitive order, and a reputation for satisfactory work means a good deal to a jobbing shop. It is galling to be called upon to furnish what seems to the customer quite a reasonable job, when the only seemingly practical solution results in a flimsy or unsatisfactory and ugly article.

The engineer is apt to assume that anything whatever can be made up in sheet metal, and is inclined to despise the plate worker for the limitations of his craft. Another misconception is the belief that a sheet metal article must be cheap; it is on this ground mainly that other materials are discarded, and in this wise it is essential to study the cheaper solutions of the problems from time to time brought forward for special work. It is also much more interesting and certainly more profitable to undertake work of this character than to turn out the ordinary commercial articles in large quantities at cut rates.

There is one point often not understood about bearings for running spindles; this is the question of bushing. It is often assumed that a brass bush is used for the sake only of employing a better bearing material, while the spindle, if properly lubricated, will run efficiently in a plain hole. The cheapest and easiest solution is certainly the latter, if prime cost merely is considered. When, however, the possibility of repairs is taken into account, the value of bushing is paramount. A new bush is easily made locally to replace a worn one at small cost, and the original alinement of the spindle is restored undisturbed. On the other hand, if a plain hole becomes badly worn, the restoration of original conditions is costly. Even where a cast iron bearing is sufficient, it is better to babbit or bush the hole.

If it be possible to provide a well-designed bearing for use with the usual thickness of tank material, which is proportionate and fulfills the conditions, the solution of the problem merits notice. Such a bearing should afford an adequate bearing surface, be a bushed not a plain hole, provide an adequate attachment to the sheet, afford proper lubrication, and be satisfactory to maker and customer, neat in appearance and cheap to make.

Four solutions or designs are herewith illustrated which fill most of the conditions usually met with.

The main portion in each instance is an ordinary screwed pipe flange. Such flanges are procurable in limited quantities at a low cost and are made in a variety of strengths. For heavy loads where the spindle will be belt-driven, hydraulic quality flanges are the stiffest made

The order of succession is steam, water, gas. As these differ in strength, they provide three further alternatives. Another quality is listed for handrailing purposes, and this is lighter still.

Such flanges are procurable at a very low cost, and subsequent alterations involved are simple in character and easily made. In all instances it is worth while to take a light cut in the lathe equal to the gage of sheet over the face of flange and leave a central projecting portion. The hole in the sheet is thus made larger than the spindle to fit the projection on the flange.

It must be borne in mind that tube flanges take their size from the internal nominal diameter of the barrel they are made for. If a flange of the same nominal size as the spindle is used, the bushing will be of the same thickness as the tube. In the case of a damper spindle, a piece of screwed tube may be employed for the bushing; the nominal bore of the barrel will be right for the type of fit required.

Should it be necessary to support considerable weight in the case of thin gage material, sufficient rigidity can be obtained by the use of a doubling piece of some area riveted on in the location of the bearing. For all but heavy loads on thin material, it will be found that the flanges themselves provide the rigidity necessary. The area of the usual size flange is considerable compared with the size of spindle, while its diameter can be quickly reduced in the lathe when necessary or desirable.

Bearing area can be increased by increasing the length of the bushing, the excess amount projecting inwards. This can be made equal to the diameter of spindle inside the tank with advantage in many cases.

To obtain a flush interior to the job, the face side of flange, *i.e.*, next sheet, is countersunk, while the rivet holes in the sheet are the size of the rivet tail. In this way the head of the rivet draws a portion of the sheet into the countersink, giving a stronger attachment and leaving a flush face.

Fig. 1 shows the cheapest design. The bushing is a simple piece of barrel. This design is good enough for rough work and where the spindle is hand-actuated at intervals.

Fig. 2 shows a spindle with a cast iron or gun metal screwed bushing with hexagon end. The design shows the special method of riveting to leave a flush face on the interior.

When it is necessary to provide for the complete removal of the spindle, the flange is sawed down to make the gap shown in Fig. 3. The width of this is equal to the spindle diameter. When the bushing is unscrewed, the spindle may then be released and withdrawn upwards with its attachments complete. This design is for use at the upper end of the tank, and, for obvious reasons, with thin material a doubling plate is necessary. The sheet is cut to the shape of the flange; also the doubling plate. The easiest way of doing this is to locate the job with a cramp, having already drilled a hole in the doubling plate; the sheet can then be marked off from both sides. A slot can be marked off and the job prepared The rivet holes, if previously made in the doubling plate and flange, can be punched through the sheet. If the flange be chosen of correct and suitable size, it will be found that the bushing locks the spindle in perfectly. In spite of the gap, the job will be found perfectly rigid. If for reasonable thickness material, light load, and more especially where collars can be used on the spindle, the doubling plate may be omitted. Several sets made without a doubling plate are in use at the present time with satisfactory results, but the receptacles are semi-circular and not of great size. This particular design is believed to be absolutely novel, and it has solved a very troublesome problem for the writer in 20 S.W.G. material.

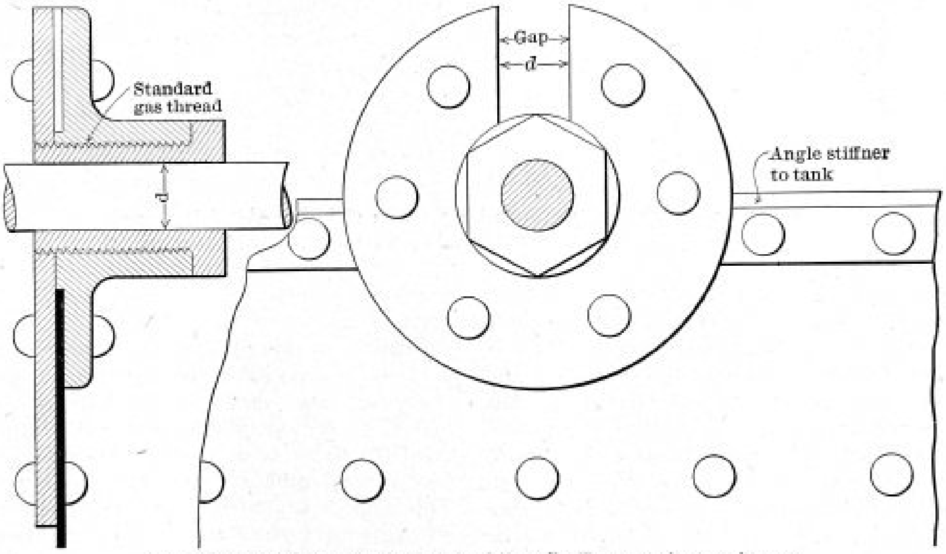


Fig. 3.—Gap Design for Removal of Spindle Entire with Attachments

Fig. 4 illustrates a bearing for a heavy load When the bearing is used at a level where it is necessary to provide a packed spindle tight against a standing or agitated liquid, the flange is used entire. The interior of the bushing is threaded and a threaded gland used. A doubling plate is shown. This design provides a perfectly tight spindle by the use of a small quantity of suitable packing.

Although the packing space is small and the design looks as though the spindle would cause the gland to loosen by allowing the interior diameter of the latter to be a trifle large, this difficulty is overcome. In any comparison with a usual type of gland, it must be borne in mind that the spindle turns—it does not reciprocate—and the gland needs only to be tight enough to prevent leakage. As a matter of fact, tightening by hand just to stop leakage is all that is necessary.

Although the sheet metal trade is not an artistic profession, there is something in making a proportionate and fitting job. These bearings certainly look the part when made; there is an inherent ugliness about the usual type

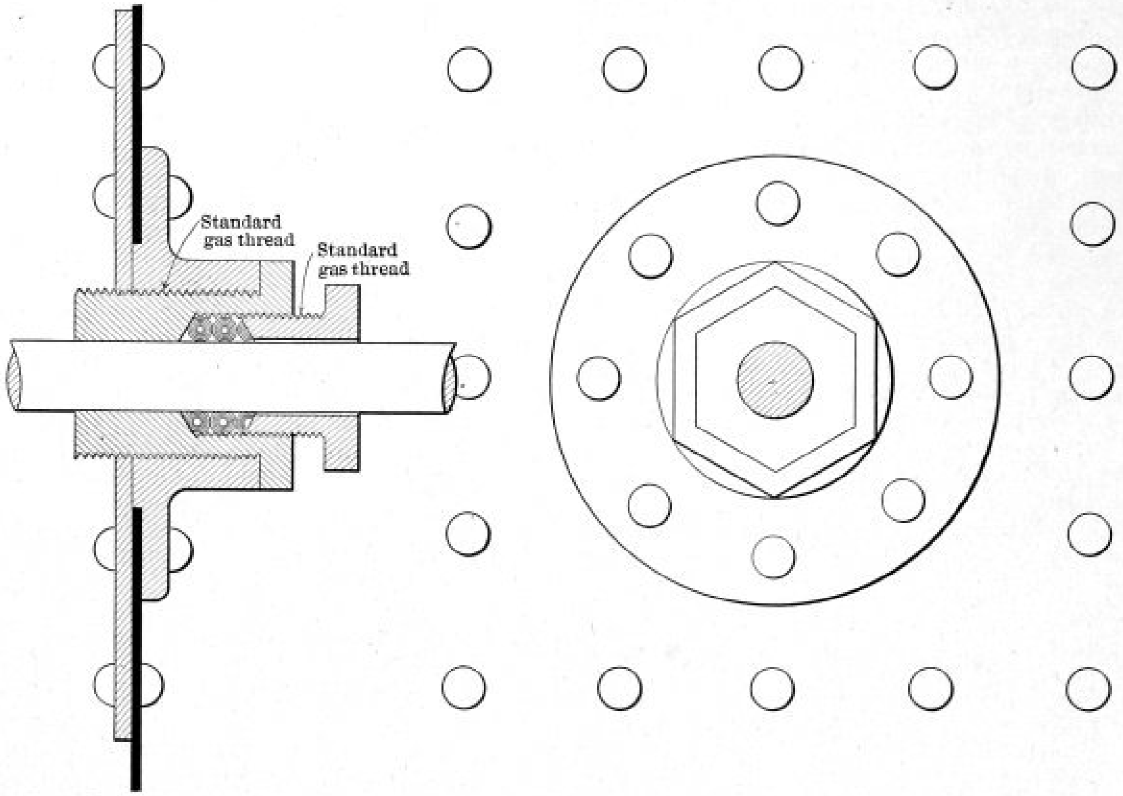


Fig. 4.—Design Showing Doubling Plate (Omitted in the Case of Heavy Material). Special Cast Iron Bushing to Take Hexagon Gland Bush for Packing Spindle Fluid Tight

of machinery bearing when applied to sheet metal. When, in addition, there is the further advantage of cheapness, nothing remains to be said on the subject of looks.

If it is intended to make up the article in the black and galvanize after, provision must be made that the threads are not filled. If the flanges are used entire, the thread can be easily tapped out. In the case of Fig. 3, the gapped design, this is not possible unless the gap is sawed through after galvanizing. This can be partially done before sending to the bath. The small area left bright can be trimmed with a soldering iron. If completed first, it will be necessary to cover the thread with a mixture of fire-clay and blacklead and remove this subsequently.

Finally, it is preferable in every instance to assemble spindle, screwed flanges and bushings complete to mark off the location of the rivets. In this wise due alinement of the spindle and an easy running fit are assured. A drilled hole in each case provides lubrication.

London, England A. L. HAAS.

Tapping Holes for Radial Stays

On looking over back files of THE BOILER MAKER recently, I happened to come across a communication entitled "A Word of Advice to the 'Youngsters,'" written by Mr. H J. Donnelly, of Millwood, Pa., in which he made reference to the tapping of holes as follows:

"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 not 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 pretty large."

Relative to this subject, may I suggest that there are a great many ways of overcoming this trouble? For instance, if the tap is too short for radial stays, procure a piece of pipe to fit the diameter of the end of the tap, allowing a good length on pipe, so that when the hole is tapped out on top and bottom the pipe will drop out of the said hole. This pipe must be inserted on the end of the tap in a solid manner, so as not to work out through any jar or movement of the tap. While going through the hole in the boiler, the pipe that is inserted on the short tap must equal the length of the regular tap required for such work.

Youngstown, Ohio. WILLIAM J. KELLY.

Trouble With Boilers

I feel that the trouble with boilers lies quite a bit with the engineers. There are some engineers who will not listen to a boiler maker under any consideration. They seem to think that all a boiler maker wants to do is to rob them and try to make bigger jobs on boilers than necessary. These engineers will order a boiler maker to make repairs, and when he arrives on the job they will tell him just how much they want done and *try* to tell him how to do it. The writer believes that this is one reason why there are so many boilers always in poor condition and constantly playing out, thus necessitating the calling in of a boiler maker at the plant so often. To mention an instance, an engineer sent for boiler makers to take out a number of flues here and there in a tubular boiler—probably fifteen or twenty—to pull through their own holes all scaled up and doing this to save expenses. Hardly a month goes by and again a boiler maker is called, this performance being kept up until the boiler has been retubed in the most expensive and inconvenient way.

This class of engineers certainly do not understand a boiler and are far from being first-class engineers. A first-class engineer will have a boiler maker look the boiler over first, and no doubt go with him while doing so, and then decide the best way to do the job, and that kind of a fellow generally gets a good job and has but very few boiler bills on his hands.

There are many causes for boilers giving out. Sometimes oil will accumulate in a boiler and cause the seams and flues to leak. I think that a great deal of the trouble lies in firing. As a general rule, you go into a plant and the boilers are being crowded with an overload of about 40 percent more than they are built for. There may be a poor grade of fuel on hand, and, if you notice, where there is poor coal there is a strong heat just over the grates and as far as the back end of the boiler. This strong heat will heat the boiler in one or two places to a hotter temperature than the material in the boiler will stand. This causes the boiler shell to expand or bulge over the grates, and in a short time causes the flues' beads to spring away from the boiler head and also causes the tubes to leak. On the other hand, should you go into another plant where the boilers are run with good fuel, that is, fuel that makes a long blast through the boiler and heats it more evenly, the boilers will carry an overload with less boiler trouble.

I noticed in The Boiler Maker some time ago a piece about compound making boilers leak. It does not seem to me that compound should be put in a new boiler, for I think it will work its way through the seams and cause the flues to leak if used too strong. For prevention of scale on a boiler, compound is a good thing, but the engineer should use his blow-off quite regularly, I believe, and, in a case where a plant only runs day times, the boilers should have a good blowing off every morning, because the water has been standing in the boiler over night and gives the compound a chance to soften the scale. They should be blown off during the day as well, although it does not seem possible for the compound to do its work while the boilers are evaporating the water and keeping the water circulating in the boiler as well as when the water is standing still.

When a boiler is due for boiler inspection, the engineer ought to see that it is cleaned out thoroughly, so that the inspector can get around the boiler without being smothered with soot, and the valves of the boiler should be closed tight to prevent the steam and hot water leaking into the boiler from the boilers alongside. I have seen inspectors go into boilers when the steam would be leaking in so badly that they could see nothing but their light. How can an inspector give good service under such conditions?

There are a great many places where a boiler inspector is not welcome, and after a boiler has been inspected they would not even show him where to get warm water to wash up. They seem to be afraid to see a boiler inspector come near their places. The concerns do not want state boiler laws and they fight it whenever it is brought up. Such places must be doubtful of their boilers or they would feel differently. They must know that their boilers are doing more work than is safe.

I do not see why there is any reason to be afraid of a boiler inspector, for he does more good than harm, and I would rather do work any time that has to be done to suit a boiler inspector than to do it to suit some engineers; for when you please the inspector you know the work is right.

I would like to see the state of Michigan have good boiler laws and as many boiler inspectors as they can find.

Bay City, Mich. Glenn Lacey.

Punching the Stock For Rings

"Bucker-up's" query in the December, 1918, issue of The Boiler Maker is an interesting one, and one that could be profitably discussed and studied by some of our "high brow" correspondents. However, as a common, everyday boiler maker, the writer ventures a reply to "Bucker-up."

As he mentions an outer and inner flange, and also speaks of punching the holes, it may be possible that he refers to channel iron rings. If such is the case, and he wishes to have the same number of holes in each flange, and also to have them correspond radially with each other,

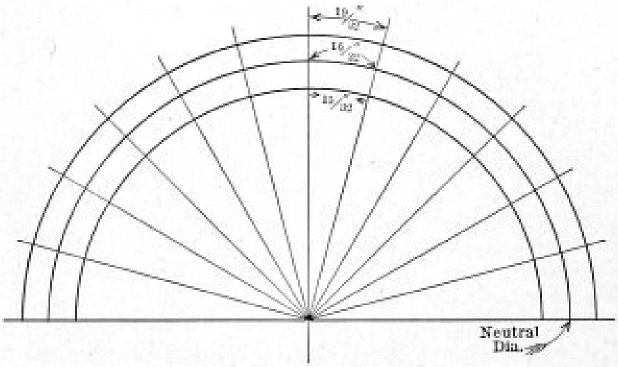


Fig. 1

his best plan would be to bend the ring first, then lay off the holes to the required pitch on one of the flanges. Now get a board the exact diameter of the inside of the ring, wedge it and locate the center of the ring on it. Lay the straight edge from this center to the flange where the holes are laid off and mark a line on the other flange from the straight edge.

Fig. 1 shows the difference in stretch and upset, assuming that the rings are bent at an even heat.

Fig. 2 shows the plan of a storage tank built so as to utilize all possible space in a place where space was de-

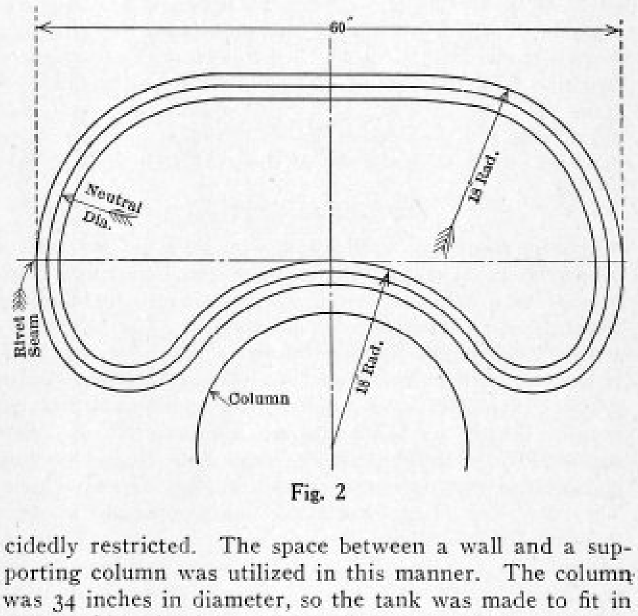


Fig. 2

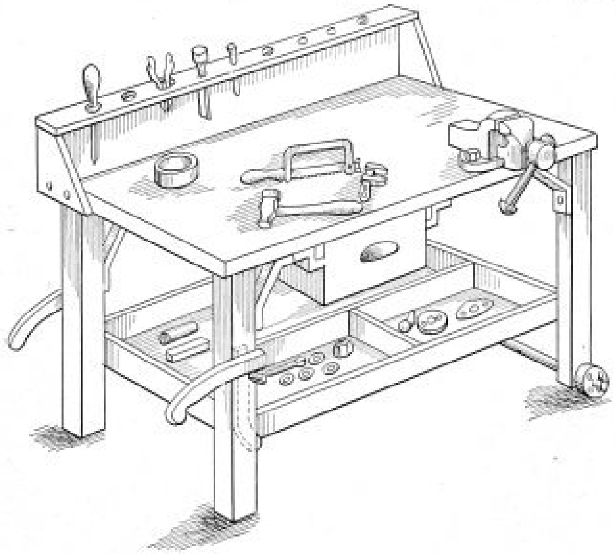
cidedly restricted. The space between a wall and a supporting column was utilized in this manner. The column was 34 inches in diameter, so the tank was made to fit in on one side. As the smaller radius was not a fixed radius, the plan of the tank was laid out on the floor, the small radius was drawn in, as shown, then a neutral line was drawn in. This line was carefully wheeled for length of plate to make the body of the tank in one piece.

Lorain, Ohio. Joseph Smith.

Handy Portable Work Bench

This home-made portable work bench is a labor and time saver, and well worth the time and material put into it. The time was odd hours when things were running well, and the material odds and ends about the plant.

The top planks are 1 inch thick, the legs 2 by 4 inches, and the shelf and compartment ½-inch stuff. The width of the bench is 2½ feet, the height 4 feet, and length 5 feet. This is just right for easy moving about. The handles swing down, as indicated in the dotted line, when not in use. The axe is a piece of ¾-inch cold-rolled stock. It passes through each forward leg of the bench in improvised bushings made of brass pipe.



Portable Work Bench

C. H. WILLEY.

Among Railroad Boiler Shops—VI

(*Concluded from page* 50.)

is shown in use in Fig. 5. The clip is shown at *T*, and the manner in which it engages the shear-strip *K* is plainly seen; also the manner in which the ends of clip *T* are bent down to hold the clip in place on the lower member of clamp *J*. The back strip *I* is also plainly shown by this engraving, and the manner in which this strip is placed to level up evenly with the top of shearing strip *K* is plainly visible.

A Vise Bench Truck

Among the very handy tools which the writer saw in use at the Texas and Pacific round house shops was a common truck, such as is used by roustabouts in handling freight, with a stout bench built upon it. The bench was a 3-inch oak plank about 18 inches wide and 2 feet long. It was mounted on the truck by a sort of bench-cupboard, two other planks having been used as vertical ends to support the top or bench plank. The plank at the front was mounted directly above the axle of the truck; the rear plank about two feet toward the handles of the vehicle. The lower end of the rear plank was pointed and allowed to pass down between the handles or rails of the truck and to form a third bearing for the truck to rest upon, the usual rear bracket-legs having been removed, so that all the weight of the truck and bench came upon the two wheels and the leg above described.

A very large and heavy vise was so placed upon the little bench that it overhung the front end. The bench and vise had been so disposed in regard to the axle of the truck that when the handles of the truck were raised to move the vise from one place to another, the weight of the vise and bench balanced almost "to a hair." Consequently very little weight rested on the handles during the act of transportation. Whenever heavy work was being done in the vise requiring more "tractive power," a few detached parts of a locomotive would be laid across the handles of the truck, so that there would be no question of the stability to the little vise bench.

A "Front-End" Staging

All the boiler work in this shop was necessarily done with the locomotives in the round-house stall. The men certainly had an effective and very simple way of building stagings for front-end work. They had made up several short ladders, about eight feet long, with stout rungs, made of 2-inch wooden pins, or, in some ladders, of 1½-inch steam pipe. Two of these ladders were used for each front-end stage. One ladder would be placed against the side of the round house after the locomotive had been run forward to the end of the pit track. A ladder was placed on either side of the boiler, fair with the cylinders; then a stout 2-inch plank was placed on top of the steam chest and pulled endwise through the ladder until the end of the plank touched the round house wall.

Some short planks—all kept for the purpose—were then placed across the two planks above described, pushed close against the end of the boiler and the "front-end" staging was complete.

Handling Locomotive Tenders

A good deal of locomotive tank work is done in these shops, and they have developed a clever way of demounting a tank when it needs the boiler man's attention. Some stout trestles, about 20 inches by 24 inches, are kept for that work. After the tender tank is pried up about five inches from the tender, two pieces of railroad iron are passed under the tank close to either end. Jacks are then set under the rails, which are jacked up clear of the tender. Four of the little trestles are then placed under the two rails, and blocking is built up from trestles to rails. The jacks are removed and the trestle pushed out from under the tender, which remains ready for the earnest attention of the boiler maker.

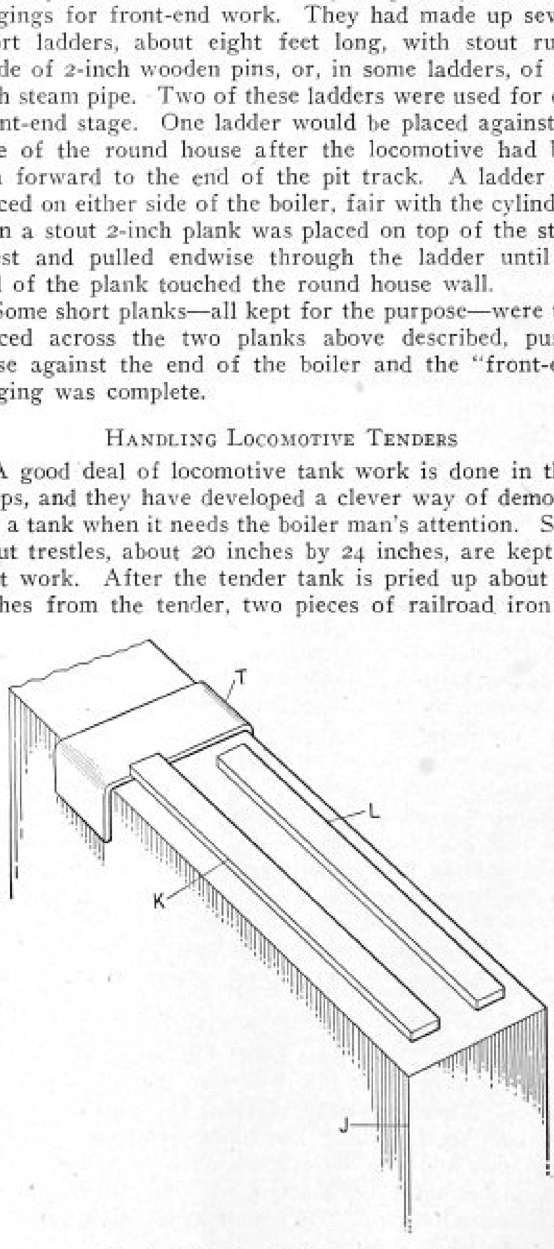


Fig. 5.—Clip for Holding Shear Strip

New Type of Firebox Construction

(Concluded from page 34.)

successive outer zones, the different zones being indicated by the wavy lines in the sketches "A" and "B." The outermost zone, in approximate contact with the firebox heating surface, may be considered as the effective flame-radiating surface, and the amount of heat radiated, as stated, will depend upon the temperature and area of this outer surface.

It is apparent that breaking the flame up into several channels by means of the syphons, as in "B," increases the flame-radiating surface, and that this increase in flame surface is practically equal to the increase in the firebox heating surface. A greater quantity of heat will therefore be radiated to the surfaces of firebox "B" than to firebox "A," the flame temperatures being the same.

The firebox "B," as shown above, evaporated approximately 5,000 pounds per hour more than firebox "A," and, while the shape of the flame passages in "B" would tend to increase the heat absorption from the hot gases by direct contact or convection, the amount of heat so absorbed would still be very small compared to the amount of radiant heat absorbed from the flames. For present purposes practically all the heat absorbed by the firebox can be considered as radiant heat; and the increase in the amount of heat radiated considered as proportional to the increase in firebox heating surface.

It was stated that the amount of heat radiated depends on the area of the flame surface and on the difference in temperature between the flames and the firebox sheet. Any increase in the temperature of the firebox sheets reduces the amount of heat radiated and absorbed and thereby reduces evaporation. Reducing the temperature of the firebox sheet increases the amount of heat radiated and absorbed and therefore increases evaporation.

At a boiler pressure of 200 pounds, the temperature of the steam and the water is 388 degrees, and it is manifestly impossible to reduce the temperature of the firebox sheet on the water side below this point. It is also evident that there will be a difference in temperature between the water-side and the fire-side of the sheet, as there must be a "head" of heat, or difference in temperature, to make heat flow through the sheet; but any increase on the water-side will result in an increased temperature on the fire-side and a consequent reduction in the heat radiated. It is important, therefore, that the sheet on the water-side be kept at a temperature approximating that of the water in the boiler. In order to do this it is necessary to keep the film of steam that forms on the surfaces of the sheets swept away and keep the water particles in intimate contact with the surface of the sheet. This can only be accomplished by a vigorous circulation of the water.

Water Circulation

The volume of water circulated through a pipe, such as an arch tube exposed to the high firebox temperatures, seems to be greatest when the volume of water and steam discharged at the outlet are about equal, and this condition prevails when high firebox temperatures are obtained. The ratio of the average cross-section area of the water passage of the syphon to the perimeter, or the heating surface, is practically the same as that of an arch tube, and it is reasonable to suppose that under similar conditions of temperature the proportion of water and steam discharged would be the same. Assuming, however, that under normal conditions of working and firebox temperatures the steam leaving the outlet of the syphon carries with it only half its volume of water, the circulation through the two syphons is found to be sufficient to cause all of the water in the boiler to pass through them every five minutes, and at the highest rate of working the velocity of circulation practically would be doubled.

With such high velocity of circulation as is here indicated, and with such large volume of water syphoned through the inlets in such a short space of time, it is apparent that no cold water could collect in the belly of the boiler, or remain there for any length of time.

Syphons Accelerate Circulation

The syphons are located so as to take advantage of the natural trend of circulation in the boiler and give greatly added velocity to it. The cold water fed in finds its way to the bottom of the boiler and slowly travels back towards the firebox. The syphons draw their water supply from this ordinarily cold zone at such a rapid rate that the cold water fed in is quickly drawn back to the throat and syphoned through the hottest zone of the firebox, where it is heated up to the temperatures of the steam and partly evaporated.

The water at steam temperature discharged from the top of the syphons travels forward toward the front flue sheet, thereby tending to draw the cold water up from the bottom of the side and back water legs.

Under such conditions of circulation the water is maintained at a nearly uniform temperature throughout the boiler, and this should result in a marked decrease in the prevalent boiler troubles due to the unequal contraction and expansion caused by wide variations in the temperature of the water in different parts of the boiler.

Summary

Engine 7615, equipped with the syphons, showed an actual fuel saving of 5,600 pounds per 100 locomotive miles while hauling 150 tons more than engine 7142. On a basis of 27,000 locomotive miles per year, this means a saving of 750 tons of coal per year per locomotive, or a saving of $3,000 per year with coal at $4 per ton on the tender. The same percentage of saving on a heavier and larger locomotive would, of course, result in a greater saving in tons of coal and in dollars and cents.

A considerable portion of the fuel consumed by locomotives is used in firing up, and, while no tests have yet been made, the indications are that locomotives equipped with the Nicholson thermic syphons will require less coal for firing up and can be brought up to the working boiler pressure much quicker than other locomotives of the same class.

The gross saving effected by the syphons will be reduced by a comparatively low cost of application and by a low maintenance cost that can be accurately determined only by experience. The simplicity of construction and method of application make the syphon an integral part of the firebox, that requires no more attention than any other part, and, when properly applied, it is practically fool-proof and accident-proof.

The indications are that the vigorous circulation obtained will result in keeping all parts of the boiler and firebox at a much more uniform temperature, and will reduce the troubles caused by unequal expansion and contraction both in the firebox and in the flues.

Three months of service has revealed no trouble from mud or scale. The high circulation through the syphons has resulted in keeping them swept clean at all times, and seemingly has thrown most of the mud and scale over into the back water leg, where it settles down to the bottom and is easily accessible for removal. Up to the present time there has been no evidence of scale in the syphons, nor leaks or trouble of any nature from seams or stays.

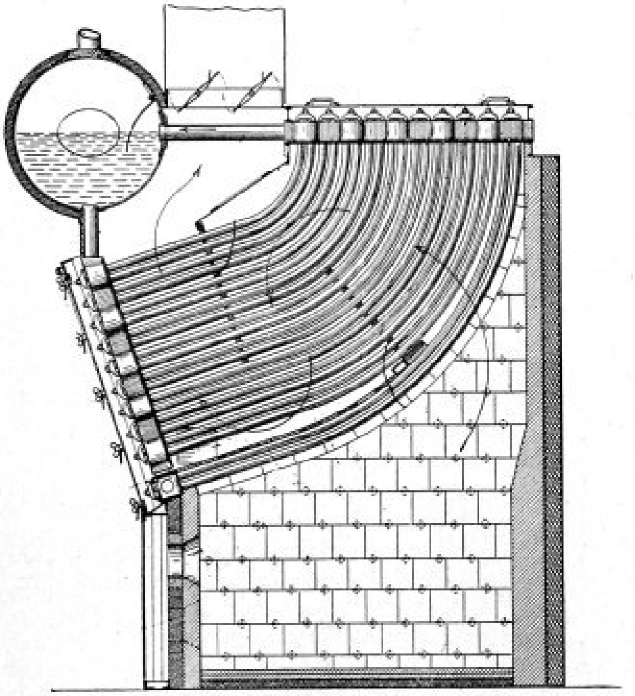
Selected Boiler Patents

Compiled by
GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,279,094. WATERTUBE BOILER. CHARLES W. DYSON, OF WASHINGTON, D. C.

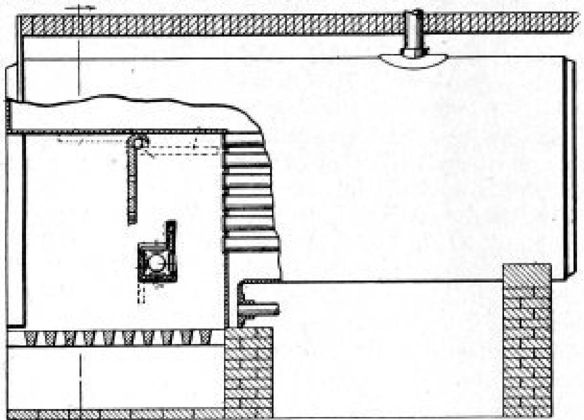
Claim 1.—A watertube boiler having a bank of generating tubes curved for at least a part of their length with their lower ends lying in a vertically extending plane and their upper ends lying in a horizontally extending plane, horizontally extending rear headers to which the upper ends of the generating tubes are connected, front headers to which the lower ends of the tubes are connected, a cross box connected to the lower



ends of the front headers, water tubes connecting said box with the rear headers, a transverse steam and water drum above the lower ends of the tubes, substantially horizontal nipples connecting the inner ends of the rear headers to the steam and water drum, a stack flue leading upwardly from the space between rear headers and the steam and water drum, and baffles to direct the flow of the gases over the tubes and through the nipples to the outlet. Three claims.

1,281,257. FURNACE. NORMAN W. ROBINSON, OF CHICAGO, ILL.

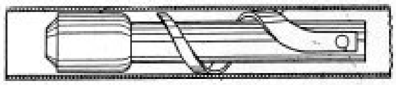
Claim 1.—The combination with a firebox having a grate and horizontal flues leading therefrom, of a perforated air box or tunnel extending across the firebox in front of and in the vicinity of the level of the lowermost flues, said air box or tunnel having a wall or flange ex-



tending upwardly past the lowermost flues, trunnions at the longitudinal axis of the air box or tunnel supporting the latter so as to permit it to rotate to carry said wall or flange downwardly below the lowermost flues, one of said trunnions being in the form of an open-ended tube connecting the interior of the air box or tunnel with the outside atmosphere. Six claims.

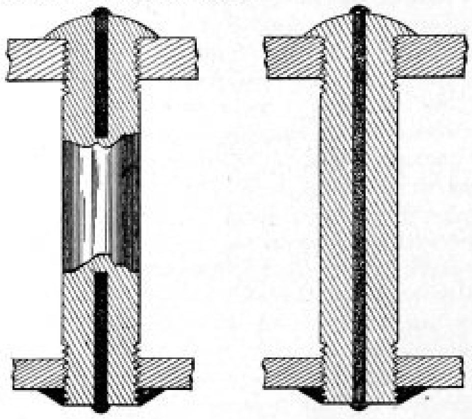
1,280,443. TUBE-CLEANING TOOL. CECIL M. GRIFFIN, OF NEWBURGH, N. Y.

Claim.—A tool adapted to be inserted in tubes or pipes for cleaning the same, comprising a central bar having an enlarged head on its rear end, a headed pin secured in the forward end of said bar, and a single



scraper blade having its forward end loosely mounted for sliding movement upon the shank of said pin, said blade being bent around said bar more than once to form rearwardly extending helical portions of a greater diameter than the diameter of the said enlarged head. One claim.

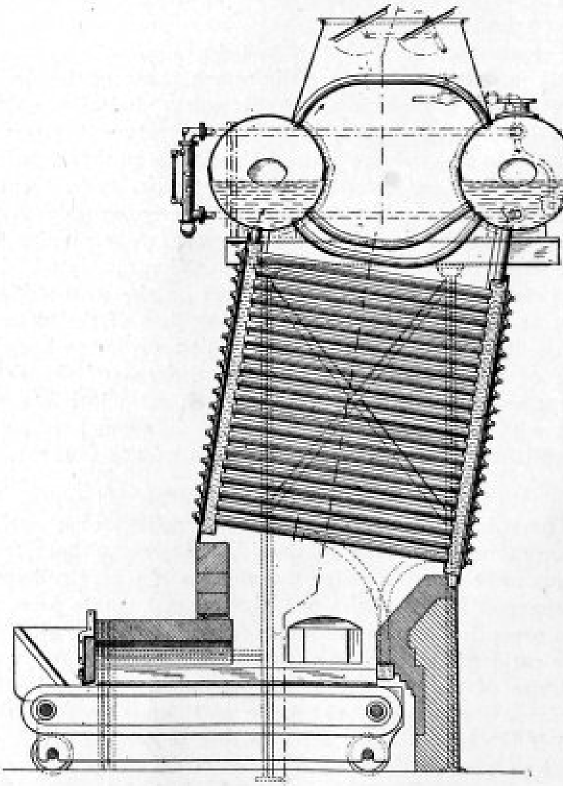
1,276,744. STAYBOLT STRUCTURE. JOHN ROGERS FLANNERY, OF PITTSBURGH, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.



Claim 1.—A staybolt for boilers having inclosed therein, a material which is sensitive to the action of water to denote the condition of the bolt. Five claims.

1,280,996. STEAM BOILER. ISAAC HARTER, JR., OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim.—A watertube boiler comprising a bank of generating tubes arranged in parallel rows at substantially equal distances apart and with the tubes of a given row staggered with respect to the tubes of adjacent rows, the number of tubes in the rows decreasing from the lowermost row toward the offtake flue, front and rear water legs to which the oppo-



site ends of all of the tubes are connected, side walls from the front to the rear water legs and conforming to the general form of the bank of tubes so as to cause the gases to flow through the boiler in one direction through a single decreasing flow area unobstructed by baffling, and drums connected to said water legs, said offtake flue being between said drums. One claim.

THE BOILER MAKER

MARCH, 1919

Boilers for Emergency Fleet Vessels

Description of Foster Type Marine Watertube Boilers Built by the Oil City Boiler Works for The Atlantic Corporation

When the United States Shipping Board entered upon its enormous shipbuilding programme for the war the requirements for boilers far exceeded the capacity of boiler shops which hitherto had specialized in building marine boilers. The facilities for supplying furnaces and for rolling the heavy shells of Scotch boilers were so limited that it was found necessary to use boilers of the watertube type on most of the vessels.

Many of the boiler shops throughout the country which hitherto had done little or no marine work were easily adapted to the production of marine watertube boilers, and contracts for work of this kind were immediately placed in shops in all sections of the country. A contract for thirty watertube boilers of the Foster marine type was placed with the Oil City Boiler Works, Oil City, Pa., for the vessels building by the Atlantic Corporation at their yard in Portsmouth, N. H. The details of the boilers are shown in the photographs, Figs. 1 and 3, and drawings reproduced on this and the following pages.

These boilers are of the continuous-header, cross-drum type designed for hand firing. They are built for a working pressure of 225 pounds per square inch, in accordance with the rules and regulations of the United States Steamboat Inspection Service, the American Bureau of Shipping, Lloyd's Survey and under the direction of the United States Shipping Board Emergency Fleet Corporation. Each boiler has a total heating surface of 3,050 square feet.

The first boiler built was erected complete with the casing in the builders' shop and subjected to thorough inspection and then dismantled and shipped to the contractors' works. The remaining boilers were carefully checked as to measurements, the main bank of the tubes assembled with the headers and the casings fabricated, using parts of the first casing as templets.

Steel of the following specifications is used in these boilers:

Marine steel, shell of drum, butt straps and drum heads.

Firebox steel, in plates for the headers.

Flanged steel, for the wrapper plates of the headers and for all pads and bolts.

Ordinary mill stock, for plates and shapes in the casing.

Cast steel, for the supporting cradle.

Wrought or annealed cast steel, for the supporting lugs.

The steam drum is 42 inches inside diameter. The shell plate is ¾ inch thick and 12 feet 7 inches long. It is continuous around the circumference of the drum. The longitudinal seam is double butt strapped, triple-riveted. Both of the butt straps are 9/16 inch thick.

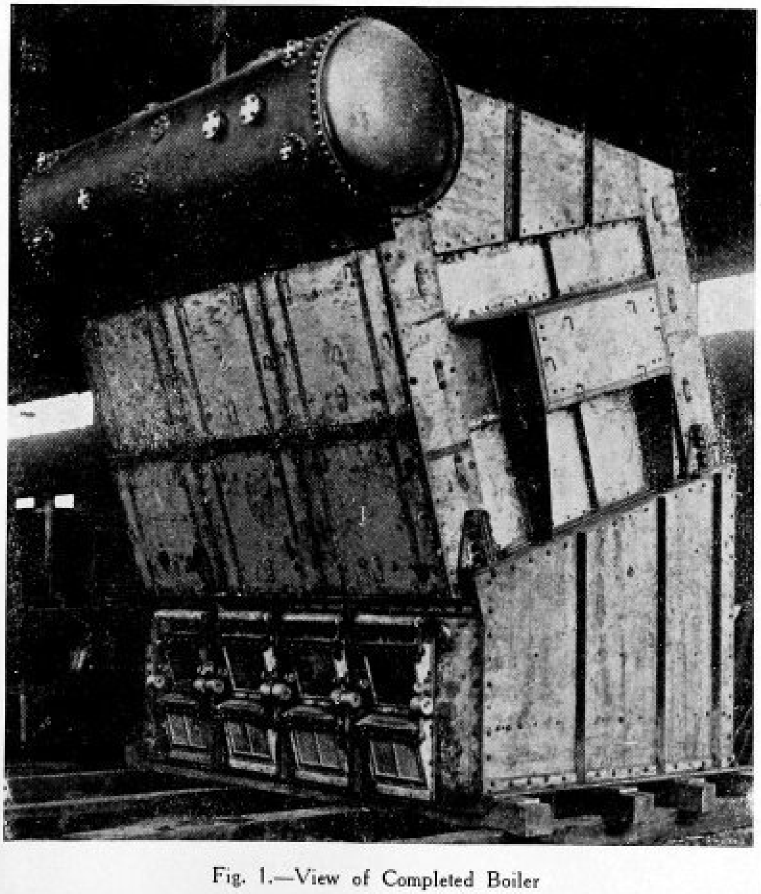


Fig. 1.—View of Completed Boiler

The main bank of tubes is made up of 444 tubes 8 feet long. The tubes are hot-rolled seamless steel 3 inches diameter and No. 10 gage. The tubes are expanded in the front and rear headers in the shop and project through the sheets not less than ¼ inch, nor more than ½ inch. As shown in the photograph, Fig. 3, the headers and main bank of tubes are shipped together.

As assembled, the width of each boiler over the casing is 12 feet 11⅝ inches. The height to the top of the casing is 14 feet 8½ inches. The lower end of the front header is 4 feet 2 inches above the base of the boiler, and the lower end of the back header 6 feet 9⅞ inches above the

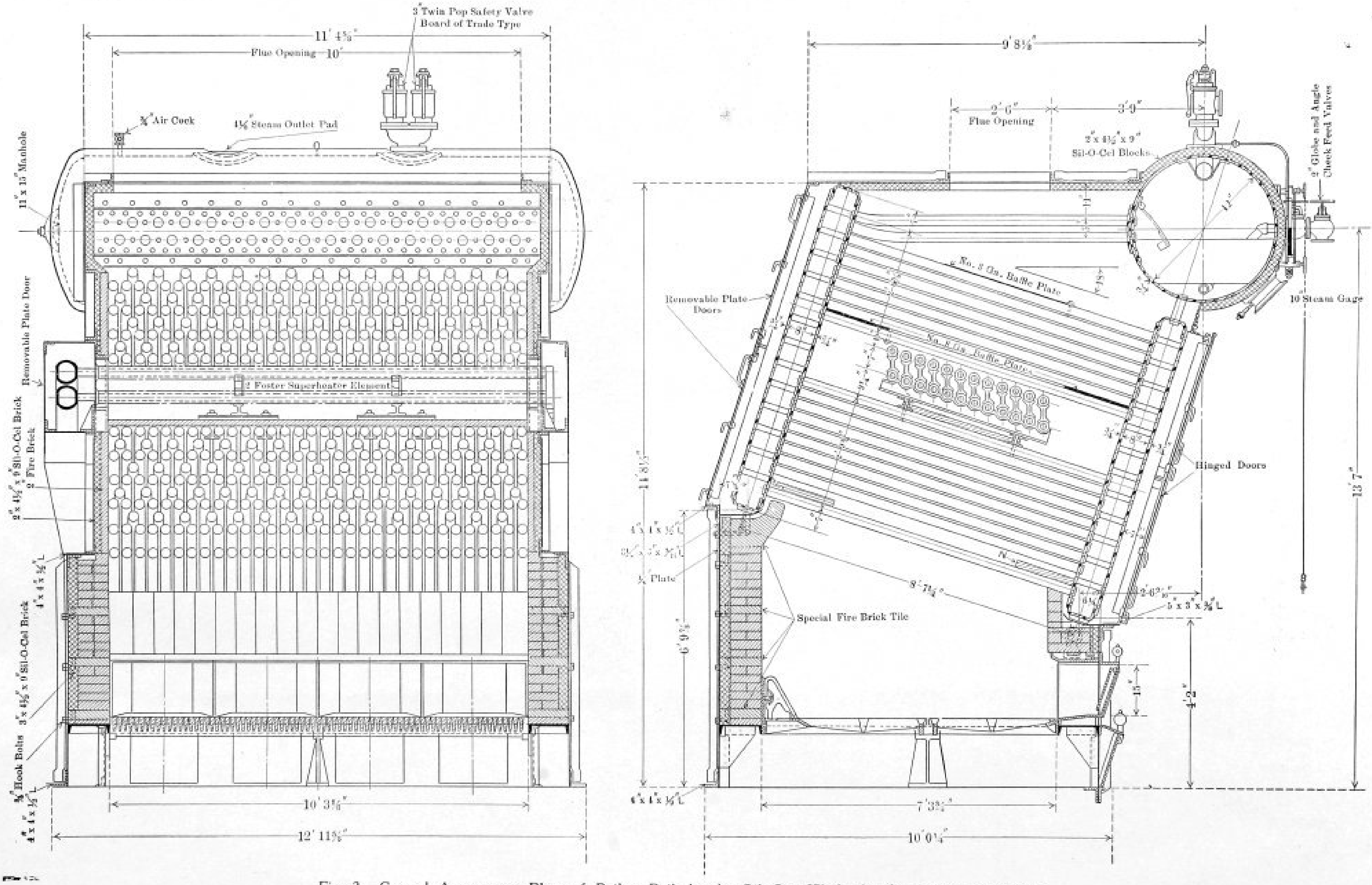


Fig. 2.—General Arrangement Plans of Boilers Built by the Oil City Works for the Atlantic Corporation

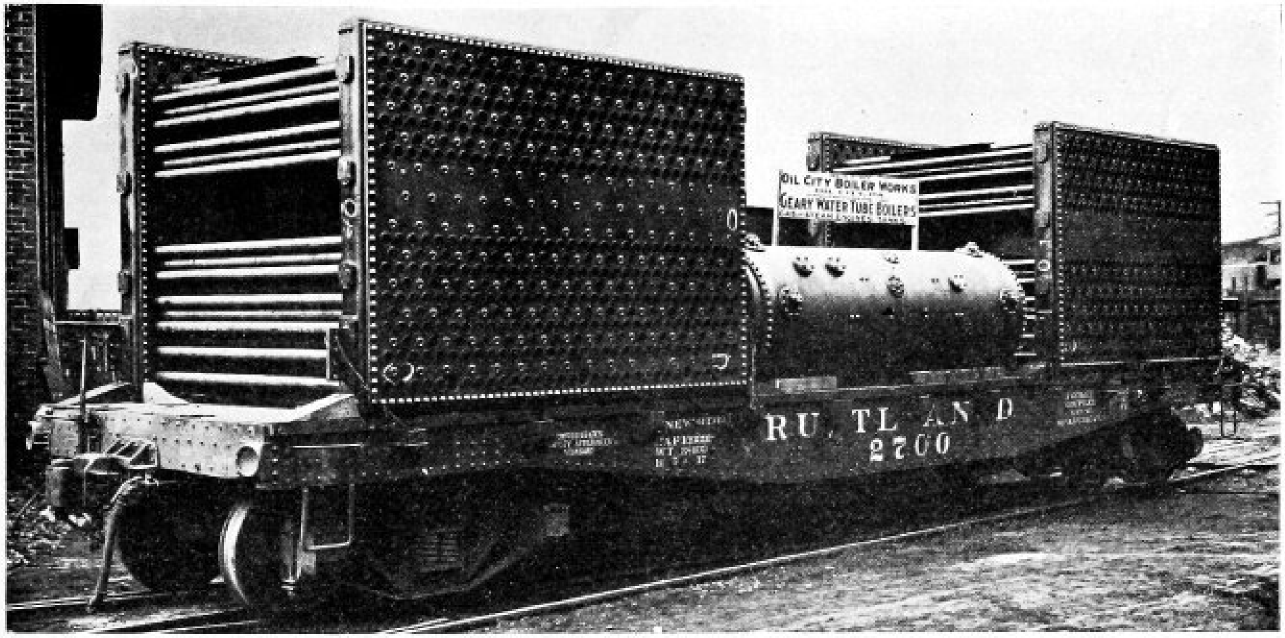


Fig. 3.—Boilers Assembled on Railroad Car for Shipment to Contractors' Works

base. The center of the steam drum is 13 feet 7 inches above the base. The furnace is 7 feet 3¾ inches deep and 10 feet 3⅛ inches wide.

The number and sizes of the tubes and the distribution of the heating surface are shown in the following table:

Data for One Boiler

Size of Tubes	Length of Tubes	Number of Tubes	Heating Surface, Square Feet
3-inch 10-gage	8 feet	444	2,725
3-inch 10-gage	6 feet 11⅞ inches	15	164
3-inch 10-gage	7 feet 1⅛ inches	16	164
3-inch 10-gage	7¾ inches	14	6
Drum and heater			155
Total heating surface, one boiler			3,050

The sheet steel casing consists of a box around the furnace, panels on the sides of the headers, a smokebox connecting to these side panels and supported by them, a gusset plate framework for carrying the superheater connecting to these side panels and to the furnace casing. This constitutes the framework of the casing.

The sides of the boiler are closed in by No. 8 plate flanged and attached by tap bolts to the framing. The header side panels are connected together by a tube door framing and plate arangement at the top and bottom of the headers.

The boiler is supported by a 4-inch by 4-inch by ½-inch angle frame around the edge of the casing panels on the sides of the furnace. A ¼-inch plate is placed underneath the boiler and the sides of the furnace casing are bolted to this plate with 4-inch by 4-inch by ½-inch angles.

The four header side panels are made from ¼-inch plate and are bolted to the boiler headers with studs. The plate is fitted around the wrought steel supporting lug, and at the bottom is bolted to the cast steel cradle, which in turn is bolted to the top angle of the furnace side panel. Along one side of the plate is riveted a No. 12 zee-bar, and along the other side a 3-inch by 3-inch by ⅜-inch angle iron.

The superheater framing is made up of gusset plates with angles and is attached to the zee-bar by angle iron clips. The zee-bar framing and the plate construction above and below the headers are attached to the 3-inch by 3-inch by ⅜-inch angles. At the top the plate is fitted around the drum head and is connected to the side smokebox panel.

The smokebox is made up of ¼-inch plate, the top side and stiffening angles being 3-inch by 3-inch by ⅜-inch. A No. 12 zee-bar is riveted to the bottom of the smokebox panel. The smoke outlet is made up of 3-inch by 3-inch by ⅜-inch angles supported by the side panels. Across the front of the boiler, between the drum and the member carrying the deep bars, is a channel fitted with doors, through which the soot on the circulating tubes can be brushed off.

The baffle on the lower row of tubes at the front of the boiler is made of 2-inch by 12-inch by 15-inch tile. For the rear baffle the tiles are special and held by a cast iron channel section, which in turn is held in place by a bolt passing through the lower row of hollow stays. The baffle below the superheater is made of 2-inch tile held in position by the superheater supports and clamps. The baffles above the superheater are made of three strips of No. 8 plate, which are bolted together after they are in position and are held by clamps, as shown in the drawing, Fig. 2. The top baffle is made in the same way.

The furnace lining is made of standard size firebrick laid up with special tile 11¾ inches by 2½ inches by 10 inches with a hole through which they can be attached to the casing by hook bolts. The bottoms of the headers are protected by special tile, as shown, attached to the casing by a square-headed bolt fitting into grooves at the side of the tile.

The lining of the floor of the furnace is made of standard-sized firebrick laid in two courses.

The insulating material is Sil-O-Cel brick and cement. The brick are laid with tight joints in mortar made of 85 percent Sil-O-Cel powder and 15 percent slaked lime. The bottom of the furnace is lined with brick 2 inches by 4½ inches by 9 inches, covered with mortar to take up any inequalities in the surface, on top of which is placed mill board ⅜-inch thick. The sides of the furnace are lined with brick 3 inches by 4½ inches by 9 inches. Above the furnace to a line even with the top tube, 2-inch by 4½-inch by 9-inch brick is used.

The smokebox is lined with 2-inch by 4½-inch by 9-inch brick held in position by expanded metal. The expanded metal is held by bars which are secured to the casing by bolts, one bolt being used for every square foot of surface. The expanded metal is covered over with ¼-inch of Sil-O-Cel hard-finished cement.

The shell of the drum is covered with brick 2 inches by 4½ inches by 9 inches, held in position by 2-inch mesh netting covered with ¼ inch of hard-finished cement. The drum heads are covered with a 2-inch thickness of plastic cement applied to netting suitably held in place and covered with a hard-finished cement.

The New "Old Man" Again

As Mr. Forbes will readily admit, 3/16-inch holes can be, and constantly are, drilled without the application of an "old man," even of juvenile character, especially where pneumatic or electric appliances are available.

Owing probably to some diversity of opinion as to the interpretation of my manuscript, my meaning is obscured by the substitution of "arm" for "stem" in the sentence inexplicable to Mr. Forbes. It should read, "Use a lock nut to fix the extension at top of *stem* and weld the arm, etc."

My criticism finds its validity seeing that the device was brought to the notice of boiler makers whose equipment has to be good enough to tackle a run of holes, including 1-inch diameter.

Before proceeding to discuss another aspect of the matter—for the question of strongbacks requires ventilation—it is worth pointing out that my criticism in the September issue is obscure in other ways, due again most probably to the aforesaid reason.

In the description of the very hefty strongback in the latter portion of the contribution, the term "bumps" is consistently used throughout; this should read "bungs." As barrels were in question, the substitution is perhaps not so misleading as its peculiar appearance would indicate, the word "bulges" refers to dents or inward protrusions.

Leaving the iniquities of the printer and getting back to strongbacks, termed "old men" in the vernacular. Since the article in the June issue appeared, several further ideas along the same line have suggested themselves. Lightness and rigidity being the ends desired, and taking Mr. Forbes' original description as a basis, suppose we take a piece of double extra strong tube 1¼ inches nominal size which is 1.66 inches outside diameter and .896 inch inside diameter, 5.214 pounds per foot run, screwing the same externally for 8 inches one end and one inch the other. Then take a piece of ⅝- or ¾-inch plate for the shelf and get the smith to form this into an edgewise shelf—say 1½ inches deep, the other end turned over as an eye, a free fit on the tube—the junction can be fuse welded. A couple of nuts top and bottom of this to thread on the tube give a rational resistance shelf, and, if the refinement is warranted, the eye in the plate can itself be threaded when only one locknut will be needed.

For a foot, another piece of edgewise plate made exactly as the old-time boiler maker made his candlesticks from hoop iron. This leaves a bolt slot, and attachment can be made by threading the edge of the foot adjacent to the tube being recessed to take the nut and leaving the foot flat underneath. The use of the welding torch would, of course, obviate the threading and nutting at the lower end of the stem. The adjustment of the shelf for height involves screwing at the upper end.

Such a strongback would retain all the features of Mr. Forbes' description in a more rational manner and a really efficient "old man," strong in wind and limb, would result. It is, moreover, within the capacity of any boiler shop to make, and the materials are all available at hand.

It differs essentially from the original form criticised by me in the September issue, in that there is no sacrifice of rigidity by a separate screw extension, the edgewise disposition of the plates used for the foot and shelf give lightness without sacrifice of strength, while a tubular stem retains the essential feature of the original scheme, but using tubing of adequate scantlings. Owing to the threading, the height is not so quickly adjusted as where a wedge or sap screw is used, but this drawback is very trivial, considering the abuse both means of attachment receive. Even the objection that damage to the external fine thread would result can be countered. If two short pieces of very thin *SO* tube, a free fit over the main stem, be welded by blow torch as an extension to the lock nuts or only to the upper nut (where one only is used), adequate protection is given without detriment.

The dimensions may be found wanting, but, as described, it would, in the writer's opinion, be adequate to drill a ¾-inch hole by ratchet brace at a radius of eight inches. But, while this is present belief, experiment may show otherwise. The design is justified by all precedent. The strength of a beam is as the square of the depth, and the center third of a solid cylinder has little effect upon its total strength or rigidity. The total weight completed, 18 inches high, 8-inch shelf, 10-inch foot; the shelf, of ¾-inch material, 1½ inches deep; the foot, of ⅝-inch material, 1½ inches deep, would approximate 18 pounds. Trussed constructions having a tie to the outer end of foot would sometimes be inconvenient to locate, but I am still of the opinion that it should be possible to overtruss the drilling shelf and overtruss the foot to stem, building the entire device of quite thin tube, in which case it should prove feasible to drill a 1-inch hole on a 10-inch radius without undue elasticity with a maximum weight of 10 pounds for the strongback. It needs experiment, that is all. The possibilities of Shelby or other *SO* tube of very thin type in a trussed construction would appear endless. Further, it would seem that the makers of small tools have an opportunity; for no man offered choice is going, for the sake of the past or any affection, to cling to the present "old man" who has to be manhandled too often to raise any false sentiments about his retention, if a more sprightly relative is available.

In conclusion, it is the writer's belief that pure destructive criticism is always unjustified unless the critic has a remedy, and, in this sense, the present article makes amends for the strictures in the last, it is believed, in a practical manner.

Wherever holes are drilled *in situ*, whether by hand, air or current, the "old man" in some shape or other will survive. So alter his anatomy and make him a less repulsive old gentleman. To ration his obesity and compel him to lose weight with advantage is of considerable moment to those who have to transport and locate him. He has survived far too long in his present dimensions and weight, and if Mr. Forbes and myself help on the good work we shall, I feel sure, be amply repaid by our mutual discussion. "Observer."

Area and surface are not the same, or equivalents. A piece of perfectly flat steel one foot square has an area of a square foot, but its surface may be much more than a square foot if corrugated. A Fox furnace has a greater surface than a plain flue of the same diameter, but no greater area.

Rivets and Riveting

Driving Cone, Button and Countersunk Rivet Heads —Pointers for Would-Be Hand Riveters—Calking

BY F. H. SWEET

The rivet is a small item. Nevertheless it is an important one, and the proper driving of it is easy—when you know how. The would-be riveter who has had only a casual acquaintance with this particular line of work will have difficulty. For a few days, at least, it can be safely prophesied that he will be troubled with a sore back. It is an utter impossibility to suddenly make a riveter or a calker out of a man who has not had at least a "bowing" acquaintance with the methods used in shipyards, structural work and boiler shops. For the man who has had some little experience in this line, it will be much easier.

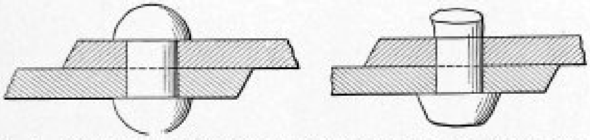


Fig. 1.—Showing the Buttonhead Rivet Properly and Badly Driven

Styles of Rivets Used

The different styles of rivets in general use throughout the country are the cone head, the button head, and the countersunk head rivets. The cone and countersunk are generally used on steam-, oil-, air- and watertight work.

To make a rivet tight, so that it will not cause a leak or loosen after the plates or structure has gone through the expanding and contracting process, it must be driven down straight into the hole, thereby completely filling the hole with metal. Whenever a rivet is not "plugged" straight into the hole, it is merely "clinched" and does more harm than good. It should at once be removed, since it will loosen and leak if left in. This clinching effect is the result of holding the pneumatic hammer at an angle to the parallel plane of the rivet. The hammer must be held strictly parallel to the rivet. Only practice will overcome the tendency of holding the "gun" at an angle.

Also, the rivet must not be too long or too short—just long enough to fill the die of the "gun." It is as bad a practice to drive rivets too long as too short; to get the edges down, one must roll the "gun" and hammer it long after the rivet has cooled. Since this "rolling" process often leaves a dent or groove around the rivet in the plate, such work is bad practice, as the riveter will find out when the foreman or inspector comes around. The head of a long rivet which has been hammered after cooling will often snap off; besides, it makes a poor-looking job. The lengths of the rivets are generally left to the judgment of the riveter. To those that may need information on the subject, however, a table follows:

Lengths of Cone Head Rivets

	Inches	Inches	Inches	Inches	Inches	Inches
Diameter....	5/8	3/4	7/8	1	1 1/8	1 1/4
Drive.......	1 1/8	1 1/4	1 1/4	1 3/8	1 1/2	1 5/8

By "drive" is meant the part of the rivet which visibly extends from the hole after the rivet has been inserted. For holes that are more than 1 inch long, or deep, add 1/8 inch, or add 1/8 of an inch for every inch over one inch deep. For button head rivets add 1/8 of an inch.

When estimating the length of the rivet for the countersunk head rivet, the depth of the countersunk hole, diameter of the countersink, and the length must be taken into consideration. The following table will give an idea as to the length of the countersunk head rivets:

Lengths of Countersunk Head Rivets

	Inches	Inches	Inches	Inches	Inches	Inches
Diameter....	5/8	3/4	7/8	1	1 1/8	1 1/4
Drive.......	5/8	3/4	3/4	7/8	7/8	1

Method for Riveting Circumferential Seams

In the riveting of circumferential seams, as well as longitudinal seams, it is good practice to "tack" the seams here and there with a few rivets, instead of starting at one end and terminating at the other. By the use of this method the "slack" of the plates will work ahead of the rivets. If this is not done, the plates separate and "buck" toward the end of termination. The "bucked" part becomes so rigid and inflexible that it cannot be hammered down cold; consequently, heating must then be resorted to. If rivets are driven where the plates are buckled, the rivets will snap off or break between the two plates as soon as they cool and contraction begins. It is customary to first "tack" alongside of the temporary construction bolts. These are then taken out, and the riveting up of the remaining holes accomplished. During the operation, care is taken to "lay up the sheet" from time to time, which means to hammer the plates together with a sledge.

Rivet-Holding Devices

Rivets are generally held with a "dolly bar"—a piece of round iron shafting about two feet long, weighing from twenty to fifty pounds, which is either held up by the "bucker up" or suspended from a small chain block. The "hook and sledge" method is also popular. The rivet is held by means of a sledge and a hook having a screw end; this is inserted through a rivet hole. A burr is then screwed on. The handle of the sledge is then placed in the hook, so that a good leverage is obtained, which reduces the chance of bucking up.

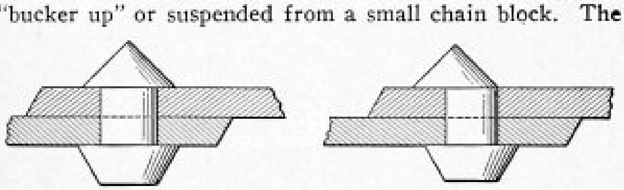


Fig. 2.—Showing the Conehead Rivet When Well Driven and the Disastrous Results of Poor Workmanship

Airjacks, airjams, wedge bars and latches are also used as rivet-holding devices.

Driving Countersunk Head Rivets

We will again turn our attention to countersunk head rivets. These are also driven with a "gun." A flat "snap" or slightly concave die is generally used, though sometimes these are driven by hand. The beginner may rest well assured that he will not be put on watertight hand-driven work. This work requires experience. Two men are necessary for hand riveting, each hitting quick alternate blows, not counting the "bucker up" and the rivet heater. The work of an inexperienced man on this work would, consequently, be most exasperating, since the seasoned riveter would have to "sneak" in with the riveting hammer to keep out of the way of the wild swings of a would-be riveter.

SPECIAL POINTERS FOR HAND RIVETERS

Here is where a few pointers may come in handy. If you are asked which hand you are, say that you are either right or left. There is no such "animule" as a man who

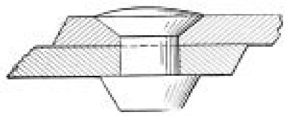


Fig. 3.—Showing Countersunk Rivet Carefully Driven

is both right- and left-handed. Few nowadays can use a hammer equally well with either hand. You may, perhaps, use either hand fairly well for a while, but you cannot keep it up. To work on the side that is not natural will quickly tire you out, unless you are an exception. If you are "shoulder" or "muscle bound," do not attempt hand riveting; nothing is more pitiful than to see a muscle-bound man trying to drive rivets where "ambi-dexterity" is required. Hand riveting used to be an "art"; some call it a "disease." There is very little of it nowadays.

For hydraulic or "bull" riveting, where the rivet is squeezed into the hole at a cherry-red heat, a portable air machine method is customary—the air hammer is the most widely used.

CALKING

Attention is now directed to the calking of seams and rivets. Calking is easy also, if you know how. But to do a good job, and do it quick, is another matter. Once the "hang" of it is acquired it will never be forgotten. The calking of seams and rivets is done either by hand or by air-actuated tools, a smaller air hammer being used than that employed in riveting. Calking tools are nothing more than blunt chisels, ground either round or flat, with a beveled surface.

For the calking of seams, a tool called a "fuller" is used, the end of which is ground to a radius of 3/16 of an

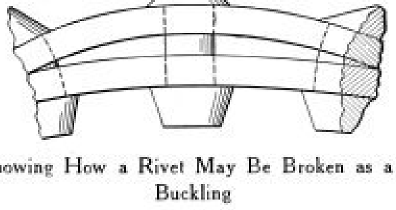


Fig. 4.—Showing How a Rivet May Be Broken as a Result of Buckling

inch. This is held on the beveled edge of the plate at an angle of about 30 degrees to the flat surface of the plate. After running over the seam with this, so as to fuller the edge down, a lighter fuller is then used to get the lower edge of the already fullered metal down to the underlying plate. This fuller is held at an angle of about 45 degrees. If a ragged edge forms under this light fuller, it is cut off with a hand chisel, care being taken not to touch the bottom plate. After this the smaller fuller is again run over the seam, care being taken not to calk too hard or too long in one place. Another method, but not so popular, is to use the large fuller first, then the flatly ground tool. If held properly at an angle of about 30 degrees to the flat surface of the plate, it will cut off its own ragged edge. This latter is called "square tool" calking, the other is "concave" calking.

Sometimes the edges of the plates are not beveled, consequently they must be chipped bevel. The easiest way to accomplish this is first to run the large fuller over the edge, holding it parallel to the plane of the surface of the plate, after which the upper extending corner of the edge is cut off with the air chisel.

Where two plates "butt" at the seams under the "butt strap," a cavity is formed at each end. Here a "dutchman" is inserted—a thin iron wedge, which is firmly driven into the space. The corners of the plates are then upset or fullered over the wedge, so as to make the cavity water-, oil-, air- or steam-tight, whichever may be necessary.

CALKING RIVETS

As for the calking of rivets, either a heavy fuller or a tool called a "Frenchman" is used. The latter is a tool having a flat surface the shape of a semi-circle, ground slightly bevel, so as to cut the edges of the rivet head into

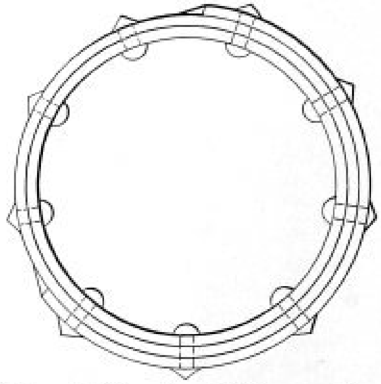


Fig. 5.—Tacking of Circumferential Seam to Prevent Buckling

the plate. Rivets are either calked by hand or with the air hammer. All air tools must be clean and well oiled. This is most important, since it is twice as hard to hold a dry hammer as one which is well oiled.

Selling Small Boiler Units Abroad

BY A. W. ALWYN-SCHMIDT

The art of exporting consists very often in nothing but offering to the market something that is required just then, and to make its purchase as easy as possible. Just now the new American markets require small power units, steam, electrical, and internal combustion. The boiler maker being interested principally in the steam end of the market, naturally will try to deflect the demand as much as possible in his direction. This can be done best by adapting the American offer to the conditions existing just now in the markets. We in the United States are mostly interested in the South American market, in Eastern Asia, and probably Australia and New Zealand. All these markets have undergone quite recently a very far-reaching economic development. From so-called buying countries they have changed, to a certain extent, into manufacturing countries. This does not mean that they have not manufactured already before this change took place, but that they have now taken up manufacturing in many industrial branches which were not found, as a rule, in nations of this class. This new industrial activity is a result of the war; and being still young, it has not had time to grow into big enterprises. The young industries, in fact, are represented principally by small and medium-sized establishments employing a small number of men only. The difficulty of equipping the new plants with power has been one of the main obstacles in the way of a more rapid growth.

NORMAL COMPETITION AGAIN

The war has now ended, and normal competition returns to the world's markets. The real problem now has arrived for the young industries, that of manufacturing as efficiently as its foreign competitors. This can only be done with the support of a good machine equipment and a reliable power source. But this power source must be of a character suitable to the earning possibilities of the enterprise. As this is very much limited by competition and the size of the market, the power source must be cheap in cost and operation. Such a power source can be provided by the small steam unit.

The American boiler makers have considerable practice in producing boiler for small and medium-size steam units, and they seem to be the only ones who can accept orders with a guarantee that they will supply according to stipulations. This business, therefore, can be handled very well in this country.

WHO GETS THE ORDERS?

But it is extremely difficult to get business of this character. When a new factory is founded in any country, the equipment of it is left, as a rule, to a consulting engineer who works out the whole plan and very frequently also supervises the installation. He naturally is the man who gives the orders. If he should happen to be an Englishman, the order will go to England in nine out of ten cases; and the same happened in pre-war times when German engineers were consulted. American consulting engineers are rarely found outside the United States. Often the manufacturer may make a trip to England and inspect a few plants of the character he desires to buy. In this case he will mostly order right on the spot. In recent years an increasing number of foreign manufacturers have come to this country, and the result has been a fairly active business in industrial equipment between this country and other markets, which has included also a great number of boilers.

This tendency in the foreign markets should be encouraged and supported by our manufacturers. If we want to sell boilers to other countries, we must let them know that we are able to supply them. There is no other way of doing this than by advertising. The proper mediums are not the foreign papers, because an advertising campaign in these is too costly, but rather the technical press at home. The consuls keep on file all journals which are sent to them, so that they may be consulted by prospective buyers. But our technical magazines are not found only at the consuls' offices; the American technical press has now subscribers all over the world. It is possibly the most widely read press of any country. Therefore, manufacturers who wish to sell abroad can do no better than make an extensive use of the advertising pages of our own press. In doing so they advertise, not only for the American market, but they stand an excellent chance to secure also a share of the foreign commerce of the nation.

CLASS OF BOILERS TO EXPORT

The question is now, how far the boiler makers in this country can make use of the present opportunity. It was mentioned already that the small and medium boiler unit stands the best chance. It is not only most in demand, but it is also most suitable for exporting, as it does not take much space and is of comparative light weight. Our manufacturers might find it worth their while to advertise just now these units and to add to their advertisements a wording to the effect that they are ready to arrange agencies wherever required. There is no doubt that in this way a representation can be secured in all the principal markets, and in this way the main point of the advertisement is gained. For the actual development of the business abroad, local representation is absolutely essential. Only the local representative can know the right moment when to make an offer. He will know when a new boiler installation has to be made in a local factory, and he can act before the news of the contemplated purchase has even reached this country.

As has already been pointed out, a boiler is rarely bought by itself, except in the case of a replacement. In most instances the boiler forms part of a larger order. The proper way of procedure in the selection of an agent, therefore, is to take a firm which is selling machinery and industrial equipment, or represents firms manufacturing these. The boiler agency fits well in with such a representation, and the boiler maker in this country knows that his agent has the kind of connection which most likely will be in want of boilers and boiler equipment. For the same reason, boiler manufacturers may find it of advantage to join one of the foreign trade combinations which are now formed under the provisions of the Webb Law. Any association of manufacturers exporting general industrial equipment is good company for a boiler maker, as their interests are practically identical.

An Emergency Job

Several weeks ago the push-plow, or butterfly, as it is called, struck a rock that had rolled down near the track, breaking out a piece on one corner about a foot square and cracking and bending the sheet badly.

A boiler maker and two helpers were sent out on the road to fix it. They took an ox-weld torch, one tank of acetylene, and two tanks of oxygen with them, besides sledges, bolts, rivets and other tools necessary to complete the job.

A piece about three feet b ytwo feet was cut out of the corner of the butterfly and a new piece of iron 3/8 inch thick fitted in and riveted in place by means of a butt strap on the back of the sheet. All rivet holes were burnt in the sheets with the torch.

It took six hours to complete the job, counting from the time the men started to unload their tools until they began to load them up again.

Denver, Col. ARTHUR MALET.

A young man who started to learn typewriting gave it up to work at the machinist's trade. When a shopmate wanted to scrape a joint he smeared a little Prussian blue over the surface; when the typewriter man had to scrape a joint he got an old typewriter ribbon and declared that it had "Prussian blue beaten a mile." But blue is rather the proper color for Prussia now!

Good steel must have proper temper. Men, likewise, require temper to do good work. There is good temper and bad temper in both men and steel. It is easier to draw the temper of steel if it is a little too high; not so with men. Both steel and men show what they are worth when put to hard work.

Repairs to Stationary Boilers

The following minute directions, which are issued by the Motive Power Department of the Baltimore and Ohio Railroad System, under the direction of J. H. Davis, to repairmen, cover work on horizontal stationary watertube boilers. These instructions have been prepared to assist those who are not entirely familiar with the methods of making such repairs, and accordingly contain very careful description of the tools required for this work. Although some of the points covered arise in all boiler repair shops and may be handled therefore according to standard practice, it may be possible that new and different features are outlined here.

The principal tool used in cutting out a tube or nipple—the ripping chisel—is made of a piece of ⅞-inch octagon tool steel about 14 inches long, flattened for half its length to about ¼ inch, the cutting end being ground concave, as shown in Fig. 1, but of a thickness equal to 5/16 inch for

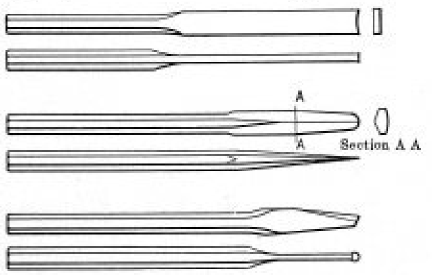


Fig. 1.—Ripping Chisel, Oyster Knife and Round-Nose Chisel—the Principal Cutting-Out Tools

clearance. The ripping chisel is used for cutting and slotting the tube. The oyster knife acts as a wedge for wedging the tube from the metal or seat into which it is expanded. The round nose chisel, about 14 inches long, is used for cutting purposes in the ordinary way.

Method of Removing and Replacing Tubes

Fig. 2 illustrates the method of loosening the tube from the seat into which it is expanded. The first move in

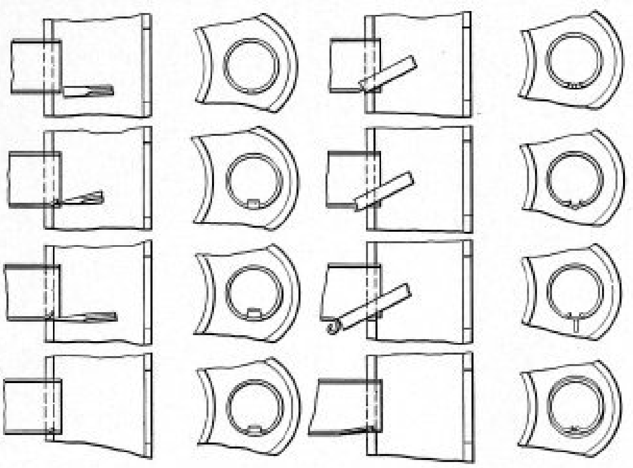


Fig. 2.—Showing Series of Operations in Cutting Out Tubes

cutting out the tube is to cut two slots or two cuts about ¾ inch apart on the bottom side of the tube, the cuts extending from the end of the tube to the tube seat. When the cuts are made the metal between the cuts should be lifted either by the use of a flat chisel or by knocking up the metal from the bottom side. When this is done it will be noted that a portion of the seat directly under the lip of the tube is exposed and, by the use of an oyster knife, this portion of the tube can be lifted from the seat. The lip is then broken off and the ripping chisel is used cutting the slot from the inside portion of the seat to about from 4 inches to 6 inches from the seat, keeping the ripper at the same angle. In cutting the slots there will be a burr, but the top side of the ripping chisel will cut this burr clean and flush with the outside surface of the tube, as shown. The bottom of the tube is now slotted from about 4 inches to 5 inches from the end. The sides of the slotted portion of the tube can be turned in. This will decrease the diameter of the tube and allow that portion of it where it was originally expanded to be taken out through the tube hole. Great care should be exercised in the cutting out of a tube or nipple so as not to injure the seat; that is, not to cut a groove or slot across the seat, but all cuts to be made clear of the seat. Both ends of the tubes should be cut in the same manner and the tube pulled out through the front header. Sometimes it is necessary to use a chain tackle in order to pull the tube out; other times the tube will come out freely, depending upon the amount of deposit on the outside of the tube.

After the tube is out the seat should be thoroughly cleaned and examined, making sure that it is not cut and the new tube should be placed by putting it through the front header through the baffle plates into the rear header. The ends of the tube should project the same distance from the seats both in front and rear headers, and this projection should not be less than ¼ inch, nor more than ½ inch. When the tube is set as outlined above it should be held at the rear end, so that when the mandrel is used in connection with the expanding of the front end the tube will not shift its position.

Expanding

One of the principal tools used is the steel expander, which is made up of six parts: (a) the collar, (b) the split guide ring, (c) the body, (d) the cap, (e) the rollers. The collar is a steel ring about 2¾ inches inside diameter, 5/16-inch thick, ½-inch wide. The split guide ring has a number of parallel V-shaped grooves machined on the inside for the purpose of adjustment. The body is made up of one piece of machined steel, having a neck at one end, the outside surface of which has parallel V-shaped grooves (identical to those on the inside of the split guide ring). The neck is bored out smooth to 1½ inches in diameter, this hole extending through to the bottom of the body. The lower part of the body is about 2 inches thick and 3½ inches outside diameter. This part contains three chambers about 1½ inches high and so shaped as to contain rollers. The cap is simply a disk 3½ inches in diameter and ½ inch thick with a hole in the center 1½ inches in diameter, and is secured to the bottom of the expander by three screws. The rollers are pieces of tool steel 1½ inches in diameter by 1½ inches long, with rounded edges, all of a hard temper. Three rollers are used, one in each chamber. There are two sets of rollers—one known as the "straight roller," whose sides are parallel and both ends of the same diameter, and one known as the "taper roller," which tapers from 1¼ inches diameter at one end to 1 3/16 inches diameter at the other end, and of the same length as the straight roller. The chambers in the expander body are so shaped and constructed as to allow the rollers to revolve freely, at the same time preventing them from dropping out.

Mandrels, as illustrated in Fig. 3, are used in connection with the expander. These are of three kinds, known as the straight mandrel, the single-jointed mandrel and the double-jointed mandrel. A mandrel is simply a tapered piece of steel, perfectly round in section and hardened. It is actuated by what is known as a turning pin, the latter being simply a ⅝-inch cold rolled steel rod

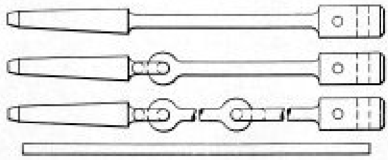


Fig. 3.—Straight, Single- and Double-Jointed Mandrels for Expanding Tubes. Turning Pin Is Also Shown

21 inches long, which is fitted into a hole at the head of the mandrel and acts as a lever to turn the mandrel.

The end of the tube projecting beyond the seat is called the lap, and in setting the expander for the tube this lap must be measured and the expander so adjusted that the top of the roller will project ¼ inch beyond the seat. For instance, if the lap of the tube is ½ inch, then the bottom of the guide ring should be adjusted that this ½ inch comes to a point ¼ inch below the top of the roller, as shown in Fig. 4, A. This adjustment is made by taking the collar from the guide ring and adjusting both halves of the guide ring, making them flush on the bottom and still come to the measurement, as stated above. The expander should then be placed in the front end of the tube

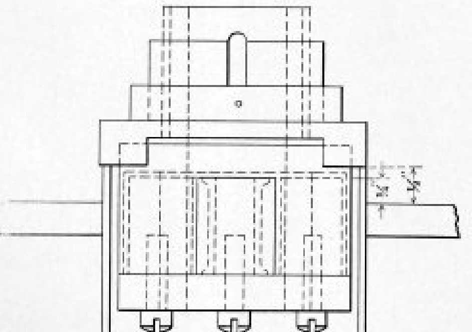


Fig. 4.—Showing Adjustments of Expanding Mandrel

and a straight mandrel inserted in the 1½-inch hole in the end of the expander. Two or three good blows are applied to the end of the mandrel, after which the mandrel is turned by the use of a turning pin revolving always in the same direction. When the mandrel becomes slightly loose a hammer should be applied to the end and the mandrel driven up, then turning pin used. Continue this process until the expander revolves evenly and there is an even tension of pull on the turning pin. If you think that the tube is rolled, take the mandrel out by quickly turning it from right to left and applying a hammer on the side of the mandrel at the same time. Take the expander out and examine the expanding. If the tube is fairly well rolled and impressions can be seen of the seat it can be assumed that the tube has been rolled enough. However, this is a matter of judgment entirely. After the front end has been rolled, then the rear end of the tube should be rolled in identically the same manner.

Expanding, as already stated, is simply a matter of judgment, common sense and experience. It is essential that the tube be not over-rolled, but be under-rolled, if anything. Then if, upon testing the expanding leaks, it may be re-rolled slightly, but if over-rolled the metal of the tube is hardened to such an extent that it will be difficult to make tight. The setting of the expander is identical with all tubes and nipples and it varies only when expanding the bottom end of a nipple from the top with taper rollers, as will be considered later.

Fig. 5, *A*, *B*, *C* and *D*, shows the manner in which the front nipples, connecting the bottom of the front cross-

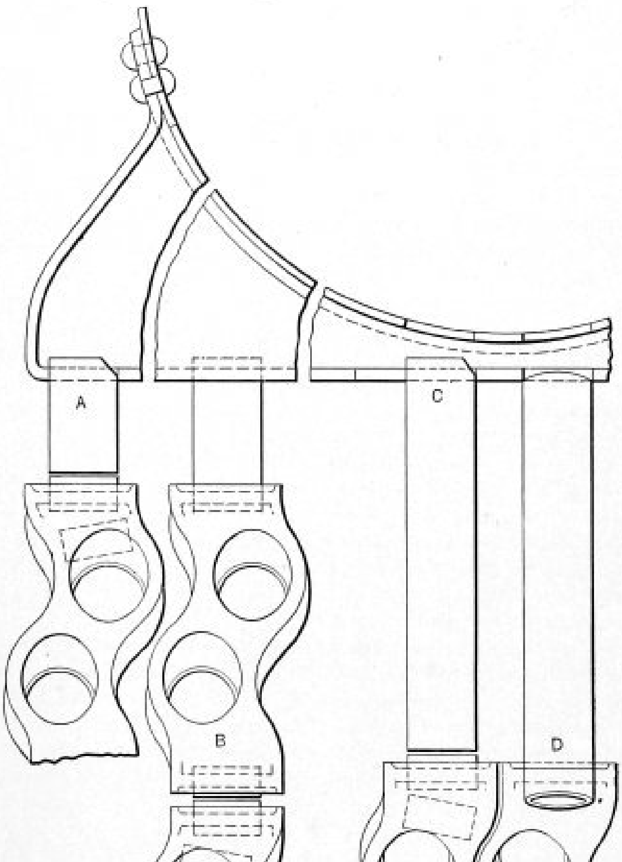


Fig. 5.—Showing Cutting of Front and Intermediate Nipples for Removal and Replacement

box with the top of the front headers and the intermediate nipples, used in double-deck boilers connecting the bottom of the top headers and the top of the bottom headers and the circulating tubes, are cut so that they can be removed and be replaced.

A shows the front cross box nipple connecting the top of the extreme side header. This nipple is cut at the top, the work of cutting being done from inside the drum. The top of the nipple is cut identically as the end of a tube, the oyster knife and ripping chisel are used, the nipple crimped at the top, decreasing its diameter. The other cut on this same nipple is made just above the top of the header. The ripping chisel is used and the nipple is cut in half. The lower portion of the nipple where expanded into the header is driven down through the seat by striking the top of this part of the nipple where it has been cut with a blunt tool. The lower part of the nipple is then removed from the top handhole. The upper part is either drawn up through the cross-box or taken out through the bottom of the cross-box. In replacing this nipple, it is put through the hole in the cross-box from the interior of the drum. Sometimes it is necessary to slightly flatten one side of the nipple at its top to clear the corner of the cross-box.

B shows the intermediate nipple connecting the double-deck section that connects the lower end of the top header with the top end of the lower header. This nipple is first cut in half with a ripping chisel, the cut being made between the headers. A steel wedge can be used, driven in this cut, forcing both halves apart; the top half of the nipple taken out through the lower handhole opening in the top header and the lower half taken out through the upper handhole opening in the bottom header. A new nipple can then be inserted from the handhole opening. If it is a rear nipple it should be put in position from the bottom handhole opening in the top header. If it is a front nipple, then it should be put in position from the top handhole opening of the bottom header. Before removing nipples which have been cut burrs should be removed, that the nipple will pass through the tube seats. The mud drum nipple, which is not shown, is removed similarly to an intermediate nipple. Where a man is skilled in this class of work, however, he will generally slot the nipple for its full length from the lower handhole opening in the rear header; close the nipple in to reduce its diameter, then remove it either from the mud drum or from the bottom handhole opening in the rear header.

C shows a circulating tube. The top end of the circulating tube expanded into the rear cross-box is cut like the top of the nipple expanded in the front cross-box. The bottom of the circulating tube is cut in two just above the top of the rear header. The lower part of the nipple is taken out through the top handhole opening of the rear header. The upper part of the circulating tube is removed from the rear cross-box by simply knocking it down until the top end is free from the cross-box, the bottom of the circulating tube just clearing the back face of the upper rear header. The tube is driven up from the bottom by use of a block and sledge until it clears the top of the rear header, when it is then brought down in place, as shown in *D*.

Expanding a Mud Drum Nipple

In the expanding of a mud drum nipple, the nipple must be so placed that the lap above the seat in the bottom of the header and the lap below the seat in the top of the mud drum will be the same; this lap should be divided up accordingly. When the nipple is adjusted a bolt should be placed in the bottom of the mud drum, the head on the bottom of the mud drum and the nut so adjusted on the threaded end as to hold the nipple in place.

Straight rollers are used in expanding the top end of this nipple to the seat in the bottom of the header, the expander adjusted so that the top of the roller will project ¼ inch above the top of the seat. The expander is placed in the nipple from the top end through the lower handhole opening, a single-jointed mandrel is used and is inserted through the second handhole plate from the bottom into the expander; a few sharp blows with a hammer on the end of the mandrel will be sufficient to spread the rollers stretching the nipple against the seat, after which the expander should be turned with a turning pin; the nipple should be watched so that the lap will be practically even all around the seat, and the expanding done in the regular way.

When the nipple is sufficiently expanded on the top, then the mandrel should be turned quickly from the right to left with the turning pin, after which the pin should be left in the end of the mandrel and a hammer brought to bear on the under side of the pin close to the mandrel head with an upward blow, so it will detach itself from the expander. In order to expand the lower part of the nipple into the seat at the top of the mud drum, taper rollers must be used, the big end of the taper toward the bottom of mud drum, the guide ring reversed, as shown in Fig. 4. Before the expander can be adjusted for rolling the lower end of this nipple, the nipple must be measured and the measurement of the lap from the lower end of the nipple to the bottom of the top seat of the mud drum should be measured and deducted from the length of the nipple. For instance, if the nipple is 4 inches long and extends through the bottom seat ½ inch the difference between the length of the nipple and this ½ inch at the bottom end will be 3½ inches. The expander should be so adjusted that 3½ inches will measure from the shoulder of the guide ring as reversed to ¼ inch or ⅜ inch above the bottom end of the roller, as illustrated. The single-jointed mandrel is used and is operated through the second handhole opening from the bottom of the header. When expanding the bottom end of a nipple from the top end of it, taper rollers should be used in every case, and by allowing the measurement taken from the shoulder of the guide ring as reversed to a point ¼ inch or ⅜ inch above the bottom of the roller, it allows the top of the roller to revolve clear of the bottom seat in the header. This is a matter that must be clearly observed and adhered to, otherwise if the top of the roller comes within ⅛ inch or ¼ inch below the upper seat it will tend to shear the metal of the nipple.

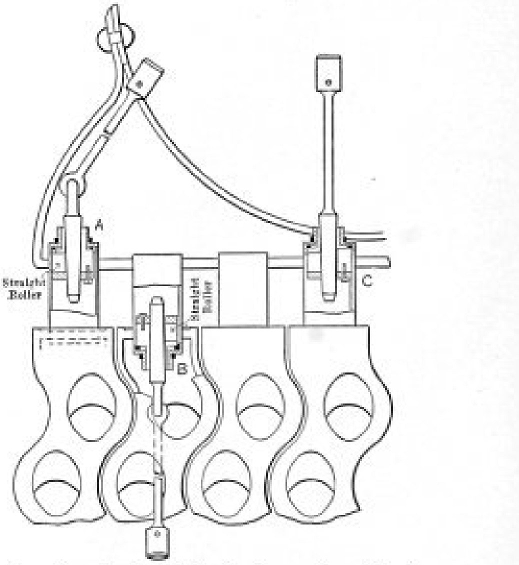


Fig. 6.—Showing Method of Expanding Nipples

Expanding of Front and Rear Nipples in Cross Box at Top Front Headers

Before replacing nipples that have been cut out, it is necessary to make sure that the seat is clean of rust and oil and void of any other imperfections. The lap of the tube must be evenly divided on the top and bottom so that it has the same projection through the top seat and bottom seat. Fig. 6 *A* shows the method of expanding the extreme end nipple in the cross-box, the expander being set identically as for expanding the end of a tube, the only difference being that a jointed mandrel is used for expanding the top of this nipple on account of its coming so close to the curve at the end of the cross-box. *B* shows the manner of expanding the lower end of this nipple into the seat in the top of the header. A jointed mandrel is also used in this operation, the expander being held in place, the mandrel inserted through the second handhole opening and driven up. A part of the mandrel will then bear on the bottom side of the handhole opening. Where this bearing occurs a piece of sheet copper should be used to prevent injuring the seat of the handhole opening. All the lower ends of these nipples are expanded in the same manner. The top ends, however, can be expanded with a straight mandrel, except the corner nipples, as explained above.

REPLACING HEADERS

In replacing cast iron headers of the vertical and inclined type, it is first necessary to detach any connection at the top of the header and at the bottom of the header. The header is then nicked on the sides of the handhole opening with a flat chisel, and by the use of wedges and wedge blocks the header is broken on a line running centrally from the center of the tube opening to the center of the handhole opening.

There are two sets of wedges used—one set in connection with the breaking of vertical cast iron headers and one set in connection with the breaking of inclined cast iron headers. The method of breaking both headers is identical; the wedges and wedge blocks are slightly different.

At the top of Fig. 7 is illustrated a wedge and two wedge blocks, also the manner in which the wedge blocks are placed in the handhole opening and the location of the wedge between the blocks. The lower half of Fig. 7 illustrates the wedge and wedge blocks for the breaking of inclined cast iron headers and shows the manner in which the wedge blocks and wedge are placed. The wedges and wedge blocks are shown in detail so there can be no mistake in the manner in which they are placed.

A bursting wedge and blocks in place is also shown in Fig. 8, the location of the crack running from the center of the top hole opening to the center of the top handhole opening. The broken portion is removed. The next handhole opening below is well nicked at the sides on a horizontal line with the center of the opening, the bursting wedges placed, and the wedge driven up with a maul until the break occurs, and in this same manner the header is

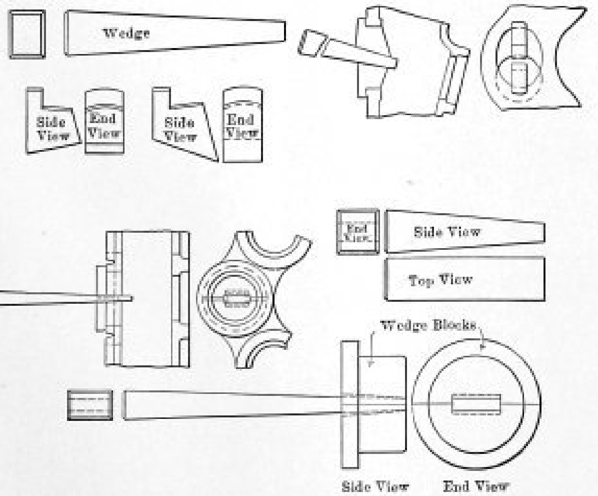


Fig. 7.—Showing Wedge Blocks and Manner of Bursting Cast Iron Headers

broken, each stage through each handhole opening to the bottom. When the portions of the broken header are removed it will be noted that the ends of the tubes are flared where they are expanded into the header. The next step is to heat the ends of these tubes. This is done either with a small hand forge for the purpose or by heating a cast iron plug to a bright red (the plug being slightly smaller than the internal diameter of the tube and about 4 inches long). Place this plug in the end of the tube and the heat radiation from this plug will heat the end of the tube to a cherry red; then a swage is used. A swage is made of a piece of steel one end of which is about 5 inches outside diameter and about 5 inches long; the other end of the swage turned or forged down to a diameter of 2 inches and about 18 inches long. The big end of the swage is turned down inside on a taper to a diameter at the end of about 4 3/16 inches, gradually tapering for 2 inches to a diameter of 4 inches, and from that point the inside is turned straight to a diameter of 4 inches for about 1 inch. When the end of the tube is hot, the swage is placed over the end and driven up until the end of the tube enters the

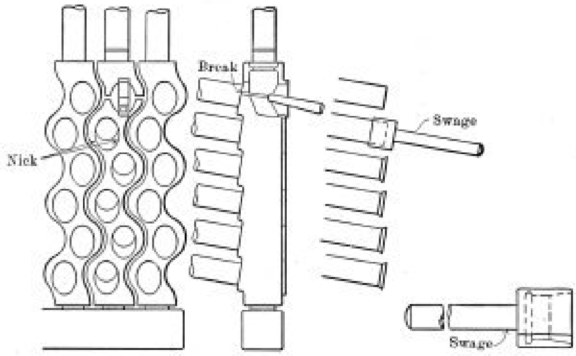


Fig. 8.—Showing Bursting Wedge and Blocks in Place

inside surface of the swage, which has been turned to an even diameter of 4 inches, when the swage is removed. It will then be noted that the outside diameter of the tube is 4 inches, which is the size of its original diameter. This same operation of heating the ends of the tubes and swaging them should be done to each end of each tube. When all the tubes have been swaged down to the proper diameter the header is put on by entering each tube through each tube hole in the header, after which the header is expanded off in the regular way. It should be noted that the swage is to be forced up just so far on the tube, otherwise when swaging the tube should the end of the tube be brought up solid it will loosen the tube at the other end where expanded into the front header and in such a case the tube should be forced back by applying a block and a maul at the other end, re-expanding the other end before expanding the end of the tube into the new header. Swaging of the tube applies in all cases where headers are removed. All cast iron headers are removed in the same general way. The only difference is in the design of the bursting wedge, which has already been explained.

REPLACING WROUGHT STEEL HEADERS

In the replacing of wrought steel headers, the tools used consist of a hand forge or a plug which can be heated and inserted in the tube, identically as used by some in the heating of a tube before the swaging is done, a crimping bar and strong backs, all of which are clearly illustrated in Fig. 9. Before attempting to remove the header, any connections to the top of the headers should be cut, and any connection to the bottom of the header should be cut, the header only held by the tubes. After this is done the first operation is to heat the ends of the tubes to a dull red either with a forge or with a plug, and by the use of a crimping bar the ends of the tubes can be crimped so as to decrease their diameter at the end. The work of crimping should be done quickly, and can be started first at the top end of a tube, second at the bottom, third at the right and left hand sides and then between the points, closing in the ends of the tube so as to bring it to the original diameter of 4 inches. This is done to each tube end, which is expanded into each seat in the header.

When all crimping has been done, then strong backs are used as illustrated; that is, the plugs in connection with these strong backs are turned down at one end so as to fit the internal diameter of the tube and turned at one end to a diameter equal to the outside diameter of the tube. The clamp is placed inside of the header against the handhole, and the bolt comprising the strong back is turned, forcing the header from the tube. These strong backs should be placed in every alternate group of two tubes, so that in pulling the header from the tubes it will be impossible for the header to turn one way or the other, but will pull straight from the tubes. When the header is removed then the tubes should be swaged, identically as described previously in connection with swaging tubes in the removal of cast iron headers. When the tubes are swaged to the proper diameter, the new header is put on by entering the ends of the tubes through the tube hole openings in the header. There are times when the ends of the tubes are a little full; that is, the diameter is a little over 4 inches. In those cases it will be necessary to jack the header in place by putting a jack at the handhole side of the header and forcing the header in position. The tubes are expanded in the regular way, the connecting tube or nipple made at the top and bottom of the header, the handhole plates attached and the job tested.

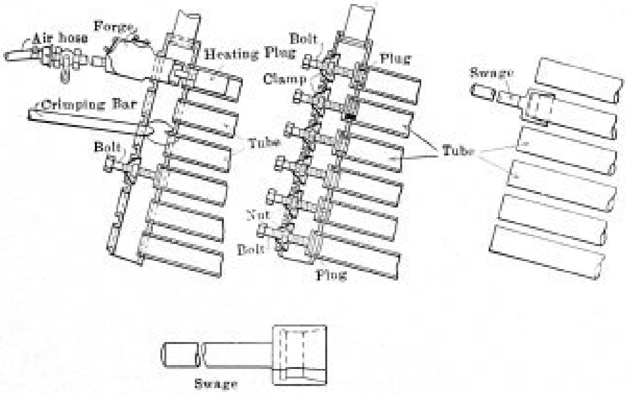


Fig. 9.—Tools Used for Replacing Wrought Steel Headers

Replacing Flame Bridges

In the Babcock & Wilcox type of boiler the groups of tubes are divided into three distinct parts by what is known as the flame bridges. The function of these flame bridges is to direct the passing of the gases from the furnace to the damper and flue. The flame bridges are made up of flame plates and tube brick. The flame plates are of cast iron about 3/8 inch thick and are so designed as to close in the space between the tubes. The tube brick, designed to close in the space between the tubes, at the same time act as a protector for the flame plates, which, in turn, act as a backing for the tube brick. In replacing a flame bridge the first thing necessary is to remove the tube brick, after which remove the flame plates. This is done by either breaking the brick in place with a piece of pipe or by prying the brick from the flame bridge and giving them a quarter turn, so that they will drop down in the diagonal space between the tubes. When the tube brick are out, the bolts securing the flame plates top and bottom should be taken out, the flame plates given a quarter turn and taken out of the diagonal space between the tubes, either from the top of the boiler over the top tubes under the drum, or from the furnace, or from the combustion chamber.

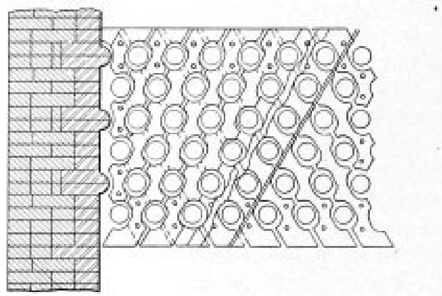


Fig. 10.—Method of Installing Flame Plates

There are two sets of flame plates—one placed diagonally in one direction and one placed diagonally in the opposite direction, both crossing each other and both secured at the top and bottom. When the tube brick and the flame plates have been removed, the first step is to install the new flame plates. The manner of installing these plates is shown in Fig. 10. The plates can either be installed from the top tubes or from the bottom tubes, or, if in a double-deck boiler, from the space between the upper and lower decks. It is necessary to install all the flame plates first that run in the same diagonal direction by inserting the plate into the diagonal space, and when its proper location is reached turning it so as to fill up the space. When all the plates in the same diagonal direction have been placed, then the plates in the opposite diagonal direction should be placed in identically the same manner, after which the plate should be secured with bolts at the top and bottom. At the top they will rest against a cast iron L-beam which extends across the top tubes, the ends of which are secured in the wall. At the bottom they will rest against a cast iron L-beam directly over the bridge wall, the ends of which are secured in the side wall. If a double-deck boiler, the bottom ends of the plates in the top deck and the upper ends of the plates in the bottom deck will rest against a T-beam placed between the decks in the same relative position as the cast iron L-beams, the ends of the T-beam being fastened in the wall.

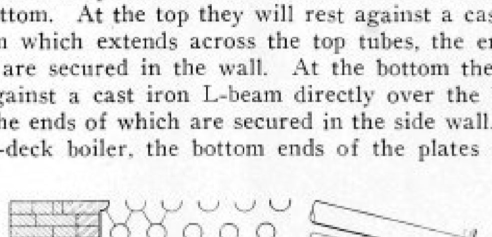


Fig. 11.—Tools and Method of Installing Tube Brick

Not only are the L- and T-beams used for backing up flame plates, but backing bars are used, some of them running in a diagonal direction and others running in a diagonal direction and others running in the same general direction as the L-beams. The ends of the backing bars, both horizontal and diagonal, are secured in the side walls, while other portions are held by a backing collar secured to the tubes. When the flame plates are in their right positions and secured, then the next step is to install the tube brick.

INSTALLATION OF TUBE BRICK

For the installation of tube brick there are three tools necessary. One tool is made up of a 1¼-inch square bar about 6 feet or 8 feet long; 10 inches from the end is a yoke so designed that a part of it passes through the hole in the bar and is secured to it with a nut. A second tool is made up of a 1¼-inch square bar with two pieces of 1-inch steel bent and secured to it, the centers of which are about 12 inches apart. The third tool is a specially designed pair of tongs used to handle tube brick. Fig. 11. *A*, shows the tool with the yoke. This tool is placed diagonally between the tubes and is brought into position, as shown, by twisting the end of the bar with a Stillson wrench. This spreads the tube in a horizontal position. Tool *B*, as already described, is inserted directly behind tool *A* and can be either turned in position, as shown, with a Stillson wrench or it can be brought from a position angular to the tube to a position right hand to the tube. These two tools are located about two feet from the flame plates and are used for springing the group of four tubes, as shown. The next operation is placing the tube brick in the space bounded by the four tubes that have been sprung from their original position. In placing the tube brick, the tongs *C* are used. The tongs are fastened to the tube brick as shown, the tube brick is inserted between bar *B* and the flame plates, is entered in the diagonal space between the tubes, either from the bottom or from the top of the boiler, whichever is the most convenient, and carried along, the flat sides of the brick parallel with the tubes, as shown. The brick is then given a quarter turn, and is then turned and knocked into place against the flame plates with the same tongs.

It is necessary to carry on this operation in the placing of each tube brick, and, provided the tubes are fairly straight, the brick can be readily placed. Fig. 11 also shows the manner in which the space between the side wall and the tube is closed, and in a great many cases when renewing tube brick it is not necessary to remove these tube brick that have already been placed and secured in the side wall.

Legal Decisions Affecting Boiler Makers

Anticipation of Patent—Its Bearing on Infringement Suits—Keeping Inventions Secret—Difficulties in Determining Prior Rights

BY JOHN SIMPSON

In a patent infringement suit, the plaintiff alleged that the defendant had deliberately concealed or suppressed the knowledge of his invention, thereby subordinating his claim—in accordance with the general policy of the law, in the protection of the public interest—to that of another and bona fide inventor. The latter, it was alleged, during the period of inaction and concealment, gave the benefit of the discovery to the public. The plaintiff cited the declaration of the Court of Appeals of the District of Columbia that, viewed in the light of the true policy of the patent laws, the later inventor in such a case is in reality the first to invent, and is therefore entitled to the reward. (*Dieckman vs. Breene, 37 App. D. C.*, 399.) The Federal District Court for the District of Maryland, in rendering decision, said that there was no doubt that an inventor who makes up his mind not to patent his invention at all, or not to patent it until he thinks someone else is about to invade his monopoly, forfeits all right to a patent. (*Macbeth-Evans Glass Co. vs. General Electric Co.*, 246 *Fed.* 695, 158 *C. C. A.*, 651.)

To whom does the benefit of the forfeiture inure—the public or a subsequent inventor? The question cannot arise unless the earlier inventor has kept his invention absolutely concealed until after the conception of it by the later inventor. If this were not the case, the second man would not be the inventor of something not before known or used in this country. This line of reasoning does not apply in cases in which inventions once made—even if to a limited extent, reduced to practice—are afterwards thrown aside and altogether abandoned. In such cases the United States Supreme Court has likened the reinvention to a rediscovery of an old art. (*Gayler vs. Wilder*, 10 *How.*, 477.)

In many cases there has been more or less doubt as to whether the invention in controversy had ever been perfected by the inventor who claimed to have been the first to make it. The evidence left doubt as to whether the invention had ever amounted to anything more than an unsatisfactory and abandoned experiment. The fact that it was used but for a short time, if at all, and was then relegated to the scrap heap or lumber room, suggested that it lacked some essential found in the second comer's creation. It may not have been possible from the testimony to discover precisely what was missing, but it was not improbable that it was something which made all the difference between failure and success and decided the fate of the invention.

Where the anticipating machines have, since being built, been in daily extensive and successful commercial operation, the question is: Were they so designedly hidden from the public knowledge that they cannot be said to have anticipated the subsequent invention? To find out the real truth in such matters is well nigh impossible. The second inventor may have himself forgotten, or never clearly appreciated, the real source of his idea; and yet it may well have been due to something said or suggested by one who, all unknown to the inventor, had some information of the earlier device. So far as concerns inventions which are clearly anticipations and which have been in continuous use, the court is of the opinion that if any exception exists to the letter of the statute—which forbids the patenting of anything before known or used by others in this country—it is limited to certain cases. In these instances the first inventor has deliberately made up his mind to practice his invention secretly, because he thinks he can make more out of such a monopoly than he could obtain from one legally given by the patent laws, and that it has been proved that his efforts to keep the invention secret have been absolutely successful. (*E. W. Bliss Co. vs. Southern Can Co.*, 251 *Fed.*, 903.)

Marine Boiler Standardization

BY C. A. SELEY

THE tremendous programme of the United States Shipping Board in its shipbuilding activities has developed latent powers in production of boilers in this great country of ours. One would hardly think of going to Battle Creek, Mich., Chattanooga, Tenn., Springfield, Ill., or any one of a score or more of inland towns for marine boilers, yet it has been done and the boilers have been produced.

These boilers are for ships in the proposed merchant marine, for which the Scotch type of boiler has heretofore had preference. Our country, however, had not developed Scotch boiler building facilities to the extent to meet the quick requirements for thousands of boiler horsepower, and the Emergency Fleet Corporation was compelled to design a type of boiler that could be built by inland shop facilities and shipped on standard freight cars to the seaboard to supplement the work of shops more advantageously located as to water shipping facilities.

This article is not to enter into the details of this production, but to note the fact and to call attention to the influence of this great lot of boilers on the marine boiler engineering of the future. It is certainly an impressive lesson on standardization and its advantages in large production and installation. In addition there are those lessons of the future in operation and maintenance to be learned.

Reasons for Standardization

Many hundreds of boilers are similar in details that may need renewals, and there is the double advantage of similarity of parts and of tools and appliances to make repairs. It also greatly simplifies the operating problem in the methods of instruction and acquaintance of the men handling and responsible for steam production to have similarity of equipment and not find a new type or variation on every ship, especially as there are to be "ships, ships and more ships," as the slogan has called for. This all seems even more emphasized by the recent statement of intention on the part of the Shipping Board to effect a world organization to forward the work of administering this country's shipping facilities, which, for the thousands needed to replenish and complete the number of ships necessary will require several thousands of marine boilers.

Advantages and Disadvantages of Scotch Boilers

Adverting to types, the Scotch boiler has certain advantages. Its best, perhaps, is that of long acquaintance. It is accessible for inspection and repair, is integral and self-contained and in a way more fool-proof. Owing to the bulk of water contained, it is less sensitive in maintaining the water level, and particularly so as to effect of salt in the feed-water, if in any amount. It is analogous to the return tubular type of boiler used in land stationary practice, now generally displaced by the watertube type in large plants, where economy of space and costs of operation are ruling factors. It is possible that the same logic of events that has changed land practice in boiler engineering may, as it already has in our navy practice, affect that for the merchant marine.

The marked disadvantages of the Scotch type of boiler are weight and cost per boiler horsepower as compared with those of the watertube type, amounting to ratios between two and three times as against the Scotch. The weight affects displacement and cargo space, the lower efficiency affects coal costs and space. They must be built adjacent to water transportation and handling facilities. Shops must be equipped with special tools and facilities not required for other classes of boiler work. Conservation of steel has been a great need during the war and is still with us and is an important consideration in boiler design.

Cause of Lower Efficiency

Lower efficiency has been mentioned—and the reason is simple. The design of the Scotch boiler does not lend itself well to air admission. This is proven by the amount of smoke from such boilers, denoting incomplete combustion in the furnaces, due to lack or improper admixture of air. Combustion is a chemical process and a proper proportion of air is as essential as to a human being. The so-called combustion chambers are not of much aid in combustion except in the case of long-flaming fuel. We are told that there is no radiation from gases beyond the flaming stage, and on this theory the furnaces of locomotive type boilers have been given greatly increased volume and surfaces more fully to utilize the radiant heat and heat of conduction; and the combustion must be complete before passing into the tubes, as the flame will not pass into small tubes, and their value as heating surface is to extract the heat by convection or contact as the gases pass through them. This is the reason for the great number and small size of boiler tubes, so as to gain a great amount of surface for contact of gases. It is well known that a square foot of heating surface in the furnace is many times more efficient than in the tubes, and that is because the furnace gases are not only hotter, but radiate and conduct heat, whereas, the same gases when they reach the tubes can only heat by contact.

Combustion chambers have been added to locomotive boilers to increase the volume for combustion and additional heating surface to utilize resulting heat in such boilers. These, however, are an extension or part of the furnace permitting a more complete mixture of air and gases and to aid more fully in their combustion at the high rate common in locomotive service.

Combustion in the Scotch Boiler

In Scotch boilers, however, the air admixture and combustion are probably as fully completed as they will be while in the furnace and the function of the chambers is mainly as a passage for the gases from the furnaces to the tubes, absorbing some heat, it is true, though mainly from convection or contact and not to the extent ordinarily supposed. If the area of cross section is sufficient to pass the gases, an increase is not of the proportional value as is the heating surface, which has the benefit of radiant and conducted heat.

It is not at all likely that Scotch boilers will lose favor with many engineers, but will continue to be built for many ships, and for this reason it is believed that some features of standardization and conservation may be timely. In many designs the water-ways at the back and sides of the combustion chambers are made tapering, for which there seems to be no good reason, and in fact a waste of the sheet material, time in laying out and no opportunity for standardized staybolts.

It is assumed that the main reason for the taper is the theory that it assists in water circulation, but it is very doubtful if such is actually the case. As has been pointed out, the combustion chamber walls are not very active heating surface and the water circulation is very sluggish as compared with that in the water legs of a locomotive type boiler of which we have some data as to rate.

Circulation in a Locomotive Boiler

Some years ago, during some locomotive boiler tests on boilers having 58 square feet of grate surface 9 feet

1¾ inches long by 6 feet 4¼ inches wide, carrying 200-220 pounds steam pressure and working to high capacity, it was found that the movement of the mass of water was comparatively slow, being broken by violent local agitations and cross-currents. The average velocity, as noted in a large number of tests, was about one foot per second, with a maximum of not over two feet. The velocity of the steam bubbles through the water was found to be in line with that of free air bubbles rising in water which can be observed independent of boiler operation, but in these tests averaged about 12 feet per second. As the water spaces in this case were less than those usually found in Scotch boilers and the rates of service were approximately 1,000 horsepower, it is believed that the circulation of the mass of water greatly exceeded any possibility in Scotch boiler water-ways and there must have been a vastly greater amount of steam bubbles to accommodate.

Making water-ways straight in Scotch boilers saves time in layout and loss of material in shaping the combustion chamber side sheets at once a simplification and conservation. It will also simplify the staybolting, as with tapered water courses the length of each row increases from the bottom row upward, making as many lengths as there are rows in many cases.

Standardization of Staybolts

Many shops accept these conditions on the theory that there is a certain amount of variation in assembly of the boiler parts, and some amount of variation is essential in the staybolts, and in fact easiest to meet in that way. The thousands of staybolts in watertube marine boilers, all of one set of dimensions and lengths, are an example of standardization that at least might suggest some economies in that line in Scotch boiler practice. Indeed one very large shop on the Pacific coast has standardized such bolts, making them complete, threaded and tell-tale hole drilled, ready for application, arranged in bins in ¼-inch variables as to length to meet assembly variations which cannot be readily overcome. These are mainly due to sheet buckling, following the flanging of back heads of the boiler and of the combustion chambers. The total range, however, need not exceed 1 inch, and ¼-inch variations call for only five lengths instead of sixteen or more with tapered water course at the back.

At the sides of combustion chambers there need not be as much variation as at the back, if good work and care in the assembly of the parts are insisted upon. There seems to be no good reason for taper of the side water-ways, as it does not seem materially to assist in tube arrangement nor in circulation. Some designs were noted wherein the centers for striking the sides of combustion chambers were so located as to make the water-ways closer at the top corners than on the horizontal centerline, directly contrary to the circulation theory. Some designs locate the shell seams so that staybolts have to pass through butt-straps, which, if avoided, lessens complication and cost and gives the staybolts a better chance in standardization and service and does not impede circulation.

Iron Versus Steel Staybolts

The drilling of tell-tale holes in the outer ends of staybolts, after application, is a difficult and expensive operation and is entirely overcome by the use of standardized bolts. It is, of course, necessary to apply such bolts with a stud nut or driver, which has been very successfully adopted, instead of using a projecting square, which has to be cut off and wasted.

The use of steel for staybolts in marine boilers is questionable, as it is not borne out in locomotive boiler practice. There is not a locomotive running in this country using steel for staybolts. It has been tried with dead soft and with alloy steels of best quality, as would be imagined from laboratory tests, but did not long survive in service. This is no doubt due to the respective structures of iron and steel. Staybolt iron is built up and has not only slag layers between the sections but in the sections themselves, interposing walls against the progress of a fracture originating in the outer fibers and interrupting the progress of the fracture. Steel is homogeneous in structure, without these slag walls, and a check once started is liable to traverse the whole section. Under these conditions steel staybolts in locomotives were found to break in bunches, so to speak, instead of here and there, and therein lay the danger in their use.

A staybolt with smooth body between sheets has several advantages. It is a conservation of material and time in manufacture and in application and reduces boiler weight without loss of efficiency. It does not offer as good a lodging place for scale as a fully threaded bolt and facilitates washing-out.

The rules of the Inspecting Bureau permit upsetting of boiler stays which would include staybolts and in the case of steel there seems to be no objection on the score of the structure to obtain a smooth body. With iron, however, the case is different, and upsetting drives back and interrupts the continuity of the structure as originally built and found desirable to withstand the stresses to which staybolts are peculiarly subjected. A smooth body can be obtained by forging down or rolling the body, maintaining the structure, conserving material and other advantages. This is believed better practice than threading bolts full length or threading and then turning off the threads between sheets. These practices waste time and material and give a surface not so good as the skin of the iron removed.

Type of Thread Desirable

While a fair fit of the staybolt threads in the sheets is desirable, it is believed that such tight fit as to require heavy wrenching is bad practice. It is manifestly impossible to make straight threads steam-tight, and as the threads are relatively fine, heavy wrenching often tears them and subsequent heading up does not fill them out and secure the close contact and fit of threads essential to continued tightness of the staybolts. Good threads on bolt and in sheets, maintained in application by light wrench fits and proper heading over, will give desired results.

Standardization should also be extended to the threads of stays and boiler fittings. The sharp V thread quite extensively used in boiler practice provides sharp corners at the bottom of threads that invite fracture. Engineering practice has learned to abhor a sharp corner as an incipient break, and in the case of threads to use the Whitworth with rounded tops and bottoms, or the U. S. Standard, with flat tops and bottoms. Either of these contributes much in maintaining good threads in application, as the sharp V threads are more liable to catch and tear.

There are many other points, both in design and in shop practice, in which standardization would be of advantage in Scotch boiler production, and in view of the large questions that a growing merchant marine brings up there is an opportunity for getting together the best minds of the marine engineers and naval architects on this important branch of boiler engineering.

Bobbie and Jimmie Take the Professor Down to the Shop and Make Some Discoveries

Bobbie Points Out the Advantage of a Technical Education—Jimmie Tries an Experiment and Demonstrates the Advantage of a Practical Mind

BY W. D. FORBES

In the matter of economy the various mechanical concerns of the country will be found to be somewhat like the leopard—that is, spotted as to how they attempt to economize. A concern may have a superintendent who bends all his energies towards saving oil. Any man found wasting this very important article loses favor in the superintendent's sight. Yet he will say nothing if a man is careless in handling taps or reamers, punches or dies, even if the carelessness amounts to abuse. Saving oil is his "spot." Another man will go literally wild if a rivet boy overheats a few rivets or if rivets are found lying on the floor or benches. Yet this particular man will say nothing if a plate is sheared wrong or improperly drilled. A third man will buy his coal on analysis, paying only for B. t. u.'s contained therein, and insist upon the greatest care in firing, yet he will neglect seriously the matter of feed water heaters or the steam pipe insulation.

Professor Rumsey was thinking on these lines as he walked up to the boarding house where our young men were, and Bob was astonished to see the professor standing in the door when Jimmie opened it in response to a knock. Bob introduced Jimmie to the professor, who, after shaking hands, looked around the cosy room and at the comfortable fire, and said:

"I had an idea, Mr. Kelly, that boiler makers were not much given to aesthetic inclinations, but judging from your room with the dainty curtains at the windows, good pictures on the wall, books and magazines on the table, in your case at least I was mistaken."

Jimmie turned red and Bob chuckled, but the professor didn't notice this and continued:

"Carey, when I got my figures together over at the works I saw at once that there was something wrong, and on investigation the information given me by the superintendent showed from past tests that something was all out, and it proved that since the tests I speak of were made that the pipe and feed water conditions had been entirely changed. So I shall have to make some further tests and will require three tanks. The superintendent told me to come to Mr. McClaren's shop to get these tanks made, and I hope, Mr. Kelly, that you can undertake the work for me to-morrow."

"Well," answered Jimmy, "I guess I can fix you up, but what is the work?"

The professor took from his pocket some sketches, and Jimmie saw that the work was simple and that he could undertake it. "But, Professor," he said, "I'll have to get you to change those decimals into vulgar fractions, as the boys are not used to decimals at all."

"That," replied the professor, "is something I cannot understand, but it is a fact that most workmen do not like decimals, except in the machine trade, and it is more surprising because the men use decimals when it comes to their pay. Twenty-five cents is, of course, a quarter; fifty cents is half a dollar. They would never think of putting down \$12.25 as \$12¼. Then decimals are so much easier to handle."

"Well," said Jimmie, "our rules and scales are not divided into tenths and hundredths. Anyway, if you want that work got out, you had better change the decimals."

This the professor did quite reluctantly. He then asked: "As I came in, Mr. Kelly, you had your hat in your hand. Were you going out?"

"Yes," broke in Bob, "we thought we would take a walk down to the works."

"That," replied the professor, "would just suit me, so I'll go along. But, by the way, do you think I could get a room here for to-night and to-morrow? I have brought my grip along with me."

This was very easily arranged, and the three men were soon on the way to the boiler shop. Bob looked with satisfaction on the various changes Jimmie had made in the shop and arrangements of the work, and they finally reached the smithy. Jimmie picked up from the floor a piece of formed steel and said:

"Bob, I am in an awful hole on this. I took a lot of these to make and got out a form and punch to use in the steam hammer, but you see I can't do it that way. See here"—and he pointed to a crack in the under side of the forging—"they all come that way, and the blacksmith says it's on account of the steel, but we can't change that, as all the steel was furnished us by our customer. We were trying to experiment when we shut down Saturday. Here are the dies in the hammer now."

Bob looked at the dies, and after a short time said: "Have we got enough steam to let me try one, Jimmy?"

"If we haven't, we can get it in a few minutes. I'll ask the watchman to shake up the fire," said Jimmy.

In a very short time they had 80 pounds pressure, and Bob put one of the plates on the fire and put on the blast. He got Jimmy to hold the plate in the die, brought the punch down slowly onto the hot metal, then opened the throttle and squeezed the plate down as far as the pressure would send it. Then he gave it a few light taps slowly, then a few smart blows, and Jimmy took the piece out and turned it over. To his great delight he found it had not cracked. A few more plates were tried with always the same result.

"By Cracky," said Jimmy, "that's great. How did you tumble?"

Bob laughed and answered: "You remember we once went to a show where a man did a lot of stunts breaking chain and ropes with nothing but his hands?"

Jimmy nodded.

"Then," continued Bob, "he took a piece of stick about 18 inches long and ¼-inch square and laid the stick on a couple of sherry glasses and taking a sword broke the stick and both wine glasses by hitting the stick. Then he took another stick and some more glasses, whirled the sword around very fast and hit the stick in the middle and broke it without breaking the glasses?"

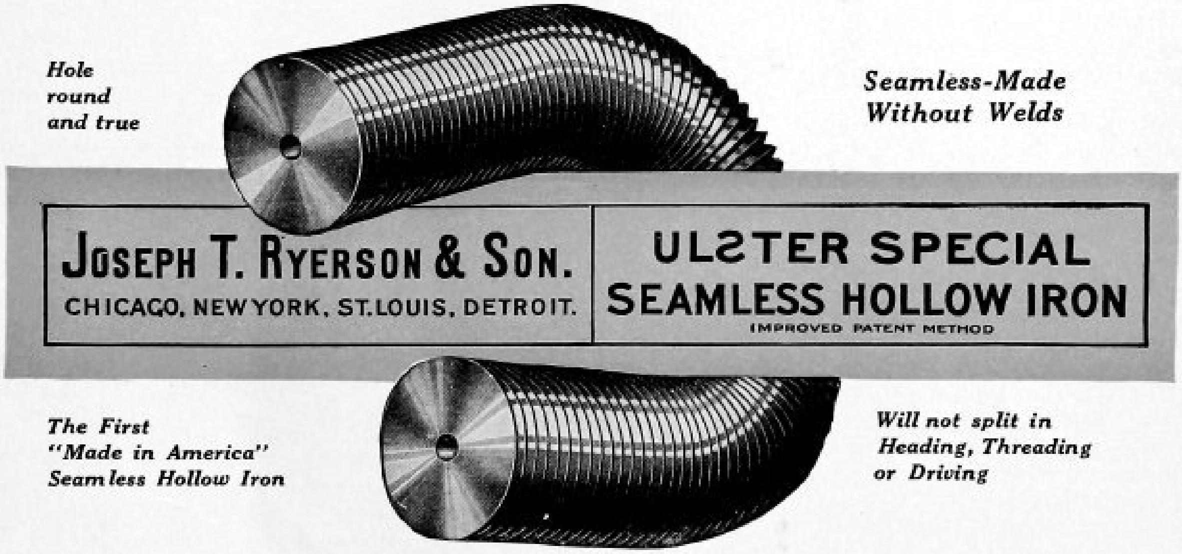
"Yes," said Jimmie, "I remember all that, but what has that got to do with forming up these pieces?"

(Continued on page 85.)

Something New in Hollow Staybolt Iron

Hole round and true

Seamless-Made Without Welds



The First "Made in America" Seamless Hollow Iron

Will not split in Heading, Threading or Driving

Seamless—the only hollow iron without sections longitudinally welded to secure the hollow feature.

Every bolt length guaranteed not to split in heading, threading or driving, increases boiler shop output, reduces shop cost.

All made from solid finished bar of identical Ulster Special that is standard for staybolts on majority of leading railroads.

Manufactured from finished bar without further heating or working, a tough, ductile and uniformly dependable iron insured.

Locomotive time lost in the shop is costly—one protection is seamless hollow stay bolt iron.

Exact staybolt lengths furnished—saves cost of cutting, eliminates waste, facilitates handling.

Sizes in stock for your rush requirements, without extra charge; manufacturing facilities insure prompt shipment.

Specify seamless hollow iron—insist on Ulster Special—there is no other hollow iron that is seamless.

Further information, price, delivery, etc., will be furnished on request.

JOSEPH T. RYERSON & SON

CHICAGO NEW YORK ST. LOUIS DETROIT

How to Design and Lay Out a Boiler—V

Covering the Design of the Longitudinal Joint—Three Elementary Methods of Failure—Investigation of Method

BY WILLIAM C. STROTT*

Let the two spring balances shown in Fig. 15 be suspended from a point and their lower hooks attached to a beam, as shown. If now a weight W is fastened to the center of the beam the two spring balances will be stretched until the whole system comes to equilibrium. It will be found that the scales will each register one-half of the weight W. In the figure, the small circles at

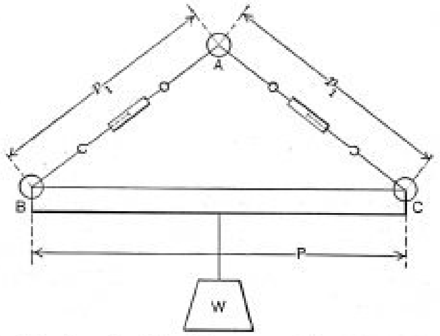


Fig. 15.—Showing Combined Stress on Two Diagonal Sections

A, B and C may be likened to rivets of Fig. 15; the scales may be likened to the diagonals p_1, and the beam which carries the weight or load is similar to the net plate section through P.

Having convinced ourselves of the foregoing truth, it would appear on first impressions that the only requirement necessary to meet this condition is to have at least one-half as much metal through sections p as we have through P. From a study of Fig. 15, however, the student should see that the pull through the diagonal is not in the same direction as that in the horizontal. In other words, the stress through p is of a pure sheering nature, while in P it is entirely a tensile stress. The shearing strength of steel plate is comparatively low (between 35,000 and 40,000 pounds per square inch) compared with its resistance to tension. Thus a very obvious reason has been advanced for this method of failure.

The excess of metal required in the diagonal sections has been demonstrated by extensive tests to be a factor of the angularity. That is, as the angularity ϕ, Fig. 14, is increased, a certain percentage increase of metal is necessary in the diagonals to render them at least as strong as the horizontals. If angle ϕ is 30 degrees, an excess of 20 percent is required, and it is on this basis that the A. S. M. E. Code has established its requirements, because 30 degrees represents the usual arrangements met with in practice. It should, however, be understood that the Code has not determined the angularity to which we must place the rivets, but that we provide at least 20 percent more metal in the combined plate sections through p than we have in P. In practice, it is not convenient to work with angles when laying out riveted joints, so we provide for the foregoing requirements by fixing the back pitches as X, y and z, as in Fig. 12. The least dimension allowed for X may be found direct by means of the following formula:

(3) $x = C\sqrt{0.11p^2 + 0.48pd + 0.16d^2}$.

Substituting, we have:

$$x = \sqrt{0.11 \times 3.8 \times 3.8 + .48 \times 3.8 \times 1 + 0.16 \times 1 \times 1}.$$

Solving gives:

$$x = \sqrt{3.57}, \text{ or } 1.89 \text{ inches, say } 1\ 15/16 \text{ inches.}$$

To eliminate the possibility of interference with adjacent rivets during erection, the Code specifically states that the back pitch shall never be less than two rivet-hole diameters. Although formula (3) gives the 20 percent excess required, the rule of not less than 2 times d, or 2 inches, must prevail.

For back pitch y, the following formula may be employed:

(4) $y = \sqrt{0.0275 \times (2p)^2 + 0.6 \times 2pd + d^2}$;

whence, substituting, we have:

$$y = \sqrt{0.0275 \times 7.6 \times 7.6 + 0.6 \times 2 \times 3.8 \times 1 + 1 \times 1},$$

and solving gives:

$$y = \sqrt{6.15}, \text{ or approximately } 2\tfrac{1}{2} \text{ inches.}$$

This figure must further be checked up with a certain minimum requirement, as follows: A reference to Fig. 12 shows that we have the lap dimension L to begin with, and then there must be a clearance of about ¼ inch between the edge of the plate to the edge of the rivet heads to facilitate driving and calking. Lap L we know to be 1½ inches, and adding ¼ inch to this gives 1¾ inches. For the student's convenience, Fig. 16 (a) to (c) gives the proportion of standard rivet heads.

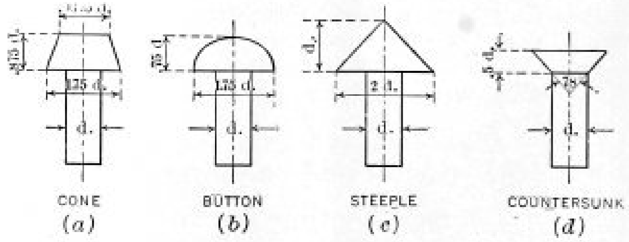


Fig. 16.—Proportion of Standard Rivet Heads

The cone and buttonhead rivets are largely superseding the steeple head, which, in addition to permitting of more compact spacing due to their smaller heads, also have greater strength and are more adaptable to calking. For either of these two forms the heads are 1¾ times the diameter of the rivet shank. Now, putting all calculations for back pitch to one side for the present, dimension y must at the outset be not less than $1.5d + \frac{1}{4}$ inch $+ .875d$, or $1.5 \times 1 + .25 + .875 \times 1 = 2.625$ inches, which is ⅛ inch more than found by formula (4). Therefore, 2⅝ inches must prevail, and in most boiler shops this would in all probability be increased to a nominal dimension of 2¾ inches. Formula (4) is also applicable to triple-riveted butt joints with straps of unequal width, illustrated in Fig. 18, providing that the last-named conditions for lap and clearance are complied with.

Nothing is stated in the A. S. M. E. Code concerning the requirements for back pitch z, other than that it

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

should not be less than twice the diameter of rivet hole. It is advisable, however, that the sum of the two diagonals p_2 be somewhat greater than the horizontal, or maximum pitch, P. Formula (5) has been devised to give this result direct.

(5) $$z = \sqrt{0.5\ Pd + .25d^2}.$$

Substituting, we have:

$$z = \sqrt{0.5 \times 15.25 \times 1 + .25 \times 1 \times 1}.$$

Solving gives:

$z = \sqrt{7.875}$, or 2.8, for which 2¾ inches would be satisfactory.

This completes the design of our longitudinal joint, and the student should have no difficulty in detailing it for the boiler shop.

In addition to the quadruple riveted butt joint, there are several other forms of this type to which reference will now be made. The triple-riveted has three rows of rivets on each side of the joint, a unit length of which is illustrated in Fig. 17. In this case the maximum pitch is twice the calking pitch.

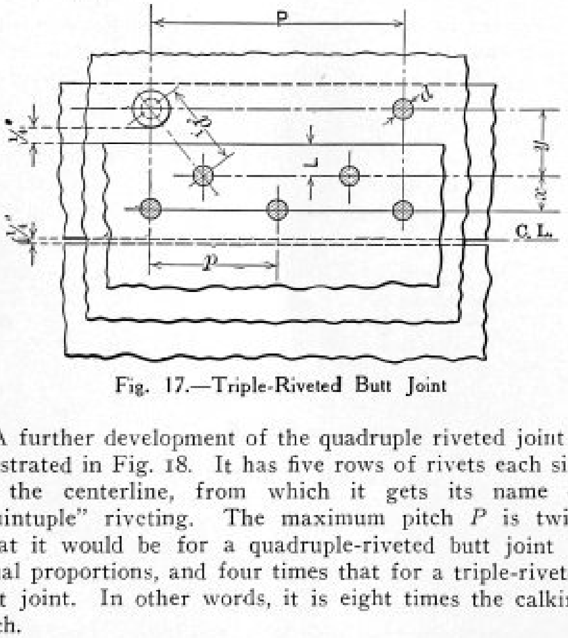


Fig. 17.—Triple-Riveted Butt Joint

A further development of the quadruple riveted joint is illustrated in Fig. 18. It has five rows of rivets each side of the centerline, from which it gets its name of "quintuple" riveting. The maximum pitch P is twice what it would be for a quadruple-riveted butt joint of equal proportions, and four times that for a triple-riveted butt joint. In other words, it is eight times the calking pitch.

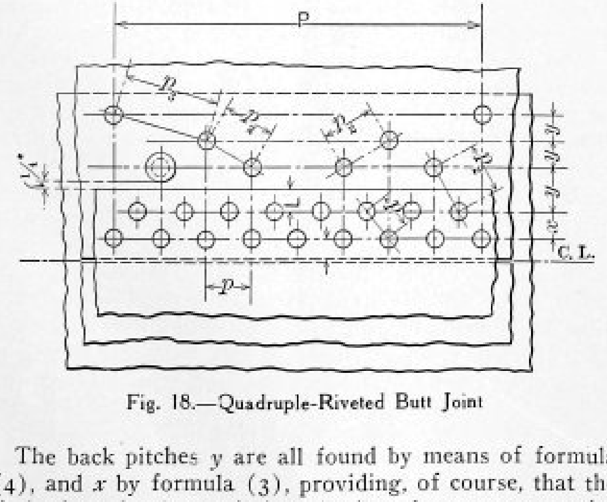


Fig. 18.—Quadruple-Riveted Butt Joint

The back pitches y are all found by means of formula (4), and x by formula (3), providing, of course, that the limitations for lap and rivet-driving clearance are maintained.

It is evident that this process of widening the inside butt straps and adding a row of rivets along the outside might be continued indefinitely, producing sextuple (six rows), and even higher combinations. Due to their extreme width, however, longitudinal joints above quadruple riveting are practically unknown in even the largest commercial boilers, but they are extensively employed in very large tanks and standpipes, where, on account of their increased efficiency, considerable material may be saved by way of shell plate thickness.

A more recent type of longitudinal joint with which it might be well to acquaint the student is illustrated in Fig. 19. It is frequently termed a "double-shear" joint because all the rivets are in double shear. The more common name for it, however, and the usual one employed, is "saw-tooth," on account of the serrations on the edges of the outside butt strap. Although giving efficiencies considerably less than the ordinary unequal-strapped double butt joint, it finds extensive use in large internally-fired boilers, particularly of the Scotch marine type, where, on account of the shell not being subject to the products of combustion, there are no limitations placed on the shell plate thickness, probably having run as high as 1½ inches in actual installation. Therefore, if a joint of the unequal inside and outside strap variety were to be employed, the size of rivets required would be beyond the usual facilities available for driving them, and, further, none would result in impracticable strap widths. In the saw-tooth joint, twice as many rivets may be grouped in a given space, and, also being in double shear, it is possible to get four times the rivet strength that would be available in an unequal strapped joint having a similar number of rows.

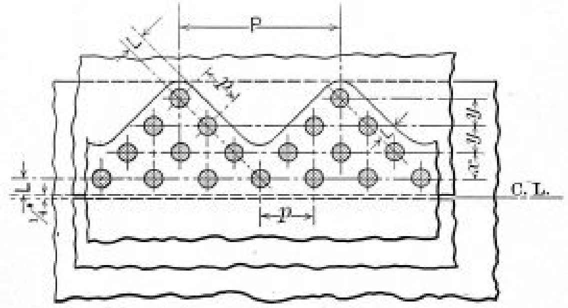


Fig. 19.—A Recent Type of Longitudinal Joint

Calculating the efficiency of a saw-tooth joint offers no worse complications than any lap-riveted joint. In fact, we have but the three elementary methods of failure, S, Sh and Cr, to deal with. Each, of course, acts singly.

If the student has thoroughly understood all of the foregoing work covering the design of the longitudinal joint for one boiler, he should have no difficulty in handling any other type. By commencing at the outside row of rivets and using a common-sense method of reasoning, he should ask himself just how each part of a joint will fail, and investigate that method to see whether there is any thing else that would have to fail with it.

(To be continued.)

Re-Tubing Locomotive Boilers

The cost of re-tubing locomotive boilers depends almost entirely upon the equipment of the shop with modern tools. Where tools are designed especially for this work the cost is not excessive or the job a difficult one.

As the subscriber who inquires as to the best method of doing this work does not say how he is equipped, I assume that he is lacking in power tools, and so will endeavor to show how this work can be done by hand in a very simple and easy way—one that the writer, as outside or traveling repair man, has used for many years on road work.

Let us assume that the steam pipes, nozzle box, diaphragm, etc., have been removed from the front end and the grate bars from the firebox, so that a platform can be made to allow the workman good standing room. You are now ready to work. With a chisel of the side-set kind, Fig. 1, cut off the beads in the firebox. This should

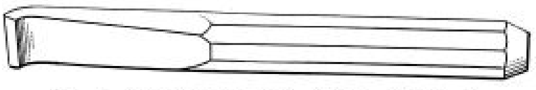


Fig. 1.—Side-Set Chisel for Cutting Off Beads

be done carefully and as close to the sheet as possible without cutting or marring the sheet. Having cut off all the beads, take a ripper, Fig. 2, and rip the tube to any

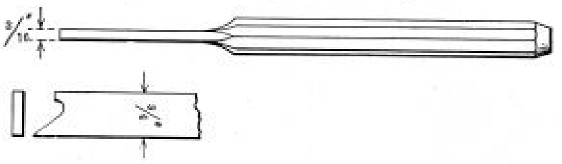


Fig. 2.—Hand Ripper

desired length suitable for safe ending, so that the tube will loosen up easily when the operation of oyster knifing is begun. The ripper should be applied as in Fig. 3.

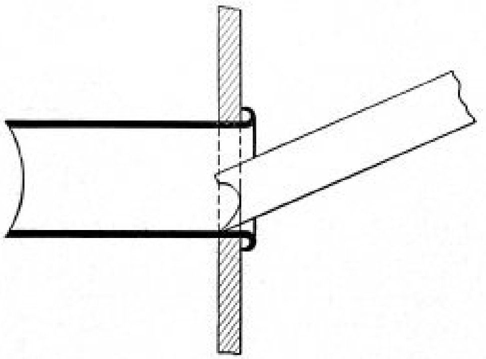


Fig. 3.—Applying Ripper

After the tubes are ripped there still remains a portion of the tube on the flue sheet, so that it is necessary to cut away this small portion of the tube without cutting through the copper ferrule into the sheet. This can be done with a good, sharp flat chisel. Now apply the oyster knife, Fig. 4, to that portion of the tube which has been

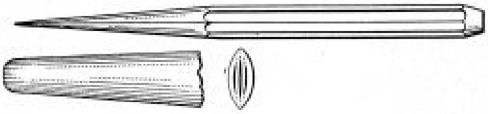


Fig. 4.—Oyster Knife

ripped and split by carefully driving this tool between the copper ferrule and the tube. The cut end of the tube will be bent inwards. Repeat this operation on the other side and both ends will be turned in so that the tube is loose. To remove the copper ferrule, take a thin fine chisel, drawn out to a feather edge at the point, and insert it between the copper ferrule and the tube sheet; when the copper ferrule is raised up about ¼ inch or ⅜ inch, cut it in two, and, with the chisel, back it out from around the tube. The tube will then move freely in the hole. Repeat on all tubes until all are loose.

At the smokebox end, should there be any beads on the tubes, remove them carefully (without turning the ends in, if possible,) and with the backing out bar, Fig. 5, back a tube in the middle row at any convenient height. Enlarge this hole either by cutting or rolling, so as to allow the tubes free passage through. Withdraw the first tube that you have driven back into the firebox, and if the hole is not large enough take the tube back out of the way and enlarge the hole again; now back out the tubes in the center row, *above* the large hole, then take alternate rows to right and left until all the tubes in line with the large holes are removed. Work downwards, taking the top tubes in each row and maintaining the angle formed by the rows of tubes, until all the tubes are removed.

In working the tubes towards the large hole, the writer, when it was possible, used two old files (half round are the best). Insert the end of the file through the nearest hole in the tube sheet into the tube to be removed and work it over to the large hole. Then your assistant in the firebox pushes it forward into the hole and it is easily withdrawn.

In order to adapt the above-mentioned hand tools for use in air hammers all that is necessary will be the altering of some of the old tools to the required shape and to substitute a tube cutter for the backing out bar.

With modern tools, the tubes are not split or closed in at the firebox end, and all that is required there is the cutting off of the heads. After the cutter has done its work at the front end, the burrs, or ends of the tubes re-

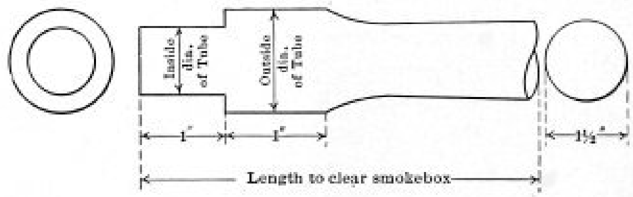


Fig. 5.—Backing Out Bar

maining in the tube sheet, are easily removed and the tubes are withdrawn through the large hole previously described.

The backing out bar should be made with the outside diameter of the head equal to the outside diameter of the tube to be drawn out, so that in following the tube through the sheet it will clear, as shown in Fig. 5. The head, to render good service, should be of good tool steel tempered to withstand the hard knocks. If the steam pipes are still in position, as is often the case in repair work, the bar must be bent so as to clear the pipes in order to reach the tubes behind them.

Referring to Fig. 2, it will be noticed that the blade of the ripper is the same thickness, unlike the ordinary ripper which is beveled. This allows the tool to be withdrawn with greater ease. Should it go right through the tube as it often does, in order to make a good oyster knife take a round gage and flatten it down to a nice oval shape and grind to suit. A ripper of this kind can be ground from one of the ordinary designs. The chisel for cutting off heads can be ground from an ordinary flat chisel. The object gained by using a chisel is that it clears the hand better and cuts the head off much cleaner. With a good temper, a chisel of this kind should last a long time without breaking.

There are other ways of cutting out a set of tubes, but the above describes the simplest of them all where hand power is the only means at hand.

Wilkesbarre, Pa. FLEX IBLE.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY, INC.
6 East 39th Street, - - - - New York
8 Bouverie St., London, E. C.

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor.

Branch Office
Boston, Mass., 294 Washington street, S. I. CARPENTER.

Boiler manufacturers who did their duty during the war and are now finding it difficult to get their money from the Government may be interested to learn that the Court of Claims at Washington has just adjusted a case involving a claim submitted at the close of the Civil War. It is only fifty-four years since the Civil War ended!

Railway boiler makers who are in Chicago during the week beginning March 16 will have an opportunity to visit the exhibit of railway appliances and devices of the National Railway Appliances' Association at the Coliseum, which will be opened to visitors on Monday, March 17. This exhibition is being held during the week in which the American Railway Engineering Association holds its annual convention at the Congress Hotel in Chicago. Naturally many of the exhibits at this exhibition will be of interest to boiler makers.

According to figures made public by the Director-General of the Railroads, there were 2,622 locomotives shipped to railroads under Federal control for the year ended December 31, 1918. Of this number, 744 were constructed under orders of the Railroad Administration, while 1,410 were contracted for prior to the Government's operation of the transportation facilities.

In the total were 200 Russian decopods constructed for the Russian Government, but, owing to the situation which arose in that country, necessitating a change in plans, the locomotives were never delivered.

Of the total number of locomotives delivered during the calendar year 1918, 540 were assigned to the Allegheny region, 375 to the Central Western region, 902 to the Eastern region, 236 to the Northwestern region, 105 to the Pocahontas region, and 103 to the Southwestern region.

An article in reference to the repair of bagged and ruptured tubes in watertube boilers, which appeared in a recent issue of an electric railway journal, appears to have received rather wide publicity. It has recently been quoted in a letter sent out by W. G. Williams, district engineer of the Mid-Continent Division of the United States Fuel Administration, evidently with the intent of conserving tube material. The article follows:

"In the boiler rooms of the Doherty properties in Toledo, Ohio, all bagged and leaking boiler tubes are being welded by the oxy-acetylene process. William Long, superintendent of production, states that as many as fourteen welds have been made on one tube before it was discarded. The process is first to heat the bag on the tube with the torch, using a slow heat until the bag is a bright cherry red. The bag is then driven back, beginning at the outer edge and working in toward the center. In case there is a hole in the bag, this is first welded shut. Boiler tubes are also being reclaimed by welding sections of tubes onto damaged tubes that have been removed. The cost of welding is approximately 75 cents per single weld, including all labor, material and cost of setting up the apparatus. When several welds are made on one boiler the cost is less.

"Crystallized boiler tubes are also being successfully annealed by use of the oxy-acetylene process. The two ends are heated to a bright cherry red and allowed to cool, after which they are re-rolled and given a hammer test. After treatment, the tubes are found to be as soft as new ones.

"The Toledo Railways and Light Company reports that by use of these methods a great saving is being made in boiler tube costs. The process is another illustration of the extent to which modern welding is being applied in all technical fields."

The boiler insurance engineers believe that any general introduction of the methods of tube repair proposed in this article cannot help but increase the already too numerous accidents caused by tube failures in the watertube type of boiler, and the Steam Boiler and Fly-Wheel Service Bureau, New York, comments on the situation as follows:

There is a class of tube accident occurring in connection with watertube boilers with more or less frequency, which is produced by the blowing out of a piece of the tube. While it is very difficult to assign a definite cause for this class of accident, it may be most logically explained as being produced by repeated local heating and cooling of the section. It would appear that in a structure as rigid as the ordinary boiler tube, the proposed method of welding and driving up small bags, as practiced by the Toledo Railways and Light Company, might contribute to this class of accident, due to severe internal stresses that may be produced by local heating.

The welds made in the manufacture of the welded type of boiler tube are frequently the cause of tube accidents. The best engineering practice requires the use of seamless tubes for watertube boilers, or, at least, that the first few rows of tubes which are exposed to the products of combustion and which are generally the ones concerned in tube failures should be of the seamless drawn type.

Owing to the fact that tube accidents are often accompanied by a loss of life or the very serious personal injury of the attendants, as well as large property damage, it is believed that only the best material should be used for tubes, especially in boilers of the watertube type.

Tube failures are of such frequent occurrence that the engineers of the companies doing steam boiler insurance business feel that the danger should not be increased by this practice of heating and welding.

Questions and Answers for Boiler Makers

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

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *6 East 39th street, New York City.*

Boiler Rules

Q. 1.—What rule will give the correct working pressure for a stationary (upright) boiler that has been pitted from poor iron or corrosion of the iron in the shell or firebox sheets?

2. Give rule for the proper amount of stays a boiler (stationary upright) should have (stays or braces).

3. What is the shortest and best rule for finding out what pressure a watertube boiler should carry?

4. What rule applies to the strength of single and double riveted seams?

A.—(1) To determine the maximum allowable working pressure on any type of boiler that has plates or other parts so corroded as to reduce plate thickness, diameter of stays, etc., it is necessary to ascertain, first, the plate thickness or diameter of the corroded parts, then use the rules on boiler designing to find the strength of each weakened part. From the strength of the weakest section, the allowable working pressure is based.

On existing installations the A. S. M. E. Code gives the following rule on maximum allowable working pressure on a shell or drum.

The maximum allowable working pressure on the shell of a boiler or drum shall be determined by the strength of the weakest course, computed from the thickness of the plate, the tensile strength of the plate, the efficiency of the longitudinal joint, the inside diameter of the course and the factor of safety allowed by these rules:

$$\frac{TS \times t \times E}{R \times FS} = \text{maximum allowable working pressure, pounds per square inch, where}$$

TS = ultimate tensile strength of shell plates, pounds per square inch

t = thickness of shell plate, in weakest course, inches

E = efficiency of longitudinal joint, method of determining which is given in par. 181 of these rules

R = inside radius of the weakest course of the shell or drum, inches

FS = factor of safety allowed by these rules

Boilers in service one year after these rules become effective shall be operated with a factor of safety of at least 4 by the formula, par. 378. Five years after these Rules become effective, the factor of safety shall be at least 4.5. In no case shall the maximum allowable working pressure on old boilers be increased, unless they are being operated at a lesser pressure than would be allowable for new boilers, in which case the changed pressure shall not exceed that allowable for new boilers of the same construction.

(2) To answer this question, it would be necessary to know plate thickness of furnace, its length from center of rivets in flange of water leg to center of rivets in the furnace tube sheet.

According to the A. S. M. E. Rules: A plain cylindrical furnace exceeding 38 inches in diameter shall be stayed in accordance with the rules governing flat surfaces.

(3) To determine what maximum working pressure a given size boiler would carry, it is necessary to consider the features relative to its design and construction, and then apply the rules governing its design to determine its weakest part, from which the maximum allowable pressure would be based.

(4) In figuring the efficiency of a riveted joint, consider the number of ways the joint may fail. The strength of a riveted joint is based on its weakest part. Its efficiency depends on several factors, as the pitch and arrangement of rivets, their driven size and shearing strength, plate thickness and its tensile strength. In January's issue of THE BOILER MAKER, a single-riveted joint was explained. We would advise that you secure a good treatise on boiler designing and the A. S. M. E. Rules.

Annealing Boiler Tubes

Q.—I recently had an argument over annealing new tubes from the factory. The man I had the argument with said that it was not customary in large union shops to anneal tubes from the factory; I contended that annealing new tubes was safeguarding against trouble when putting them in the boiler. I have been a boiler maker for seven years, and when I first started my apprenticeship I was taught to anneal all tubes. Now I would like an explanation of the *best* practice in large union shops, as I want to know who is right in annealing new tubes.

R. W. E.

A.—To anneal or not to anneal the new tubes has always been a troublesome question in boiler shops because of the difference of opinion making the answer both yes and no. Most manufacturers of boiler tubes say that annealing is unnecessary and they do not recommend it. On the other hand, in many cases, the men in the shop and the makers of boiler tools recommend annealing. The annealing consists of a heat treatment of 1,600 degrees F., which gives a very soft and tough metal.

High grade boiler tubes are manufactured in several different ways and of different metals. These variations account in part for the difference of opinions about the need for annealing.

Hydrostatic Tests

Q.—Kindly volunteer the information on how to conduct the hydrostatic test on locomotives. I am required to test engines here, and I never have tested for hydrostatic. I have made other tests in regard to staybolts, rivets, etc. Your information will be appreciated.

A.—The hydrostatic test is made by filling the boiler with water, then with the use of a special pump pressure is applied to meet the test requirements. Usually the hydrostatic pressure test is made to $1\frac{1}{2}$ times the maximum pressure the boiler will carry. In filling the boiler with water, one of the boiler openings, preferably at the top, should be left open to allow the air within the boiler to escape. This precaution is necessary, as a boiler containing air and subjected to water pressure might in bursting cause some damage.

The A. S. M. E. rule 330, on testing new boilers, requires that during a hydrostatic test the safety valve or valves shall be removed or each valve disk shall be held to its seat by means of a testing clamp and not by screwing down the compression screw upon the spring.

In applying the pressure, it should be done slowly, so that the boiler is not subjected to sudden stresses, which might cause a permanent distortion in the metal. The test gage must be watched to see that the pressure is not allowed to run above that required for the test.

Certain tests are imposed in the A. S. M. E. Boiler

Code, and most any new tubes will stand these tests without special annealing. The same is true with the standard test for locomotive tubes by the American Society of Testing Materials. Most of the tube manufacturers and the inspectors are fully satisfied that the special annealing is unnecessary, while many of the boiler makers, tool makers and repair men claim the need of it to make the tubes work better. Therefore, both parties have good reasons for their opinions.

There does not seem to be any fixed rule in practice, as some shops anneal the tubes, while others using the same make do not, depending upon the condition of the metal when received. If they are seamless drawn steel tubes, some of the manufacturers themselves recommend special annealing; but not so if they are knobbled charcoal iron or spellerized steel tubes.

Bobbie and Jimmie Take the Professor Down to the Shop and Make Some Discoveries

(*Continued from page 78.*)

"Just this," answered Bob, "a blow broke the stick without breaking the glasses because of its great velocity. It did not transmit the strain to the glasses. Now, I just reversed this idea and said to myself, if I bend the metal down slowly and give it a chance to flow first and then give some light blows and then a big smash when it is almost formed up, the steel will not crack, and you see I was right."

Jimmie pondered a moment and then replied: "That's all right, but you did not have to go to a technical school to find that out. You got that in a show."

"No," broke in the professor, "you are wrong, Mr. Kelly. It was the mental training that Carey got at the institute which resulted in his making the deduction that he did. You saw the exhibition as well as Carey, but your mind had not been trained to make deductions. Of course, if Carey had not gone to the institute, with his natural bent of mind he might still have arrived at the conclusion he did. Your blacksmith laid the trouble on the steel, but, as you see, it was in the handling entirely."

The professor and the two men then wandered into the drawing room. Jimmie was quiet for a time, evidently thinking deeply while the professor and Bob were looking over some blueprints of the boilers being made in the shop. Jimmie finally asked Bob: "What was it all about —the big boiler you got out of the shop that wouldn't go out of the door?"

"Oh," answered Jimmie, "I didn't tell you about that. It was funny, but it wasn't a boiler. It was a tank. You see we got an order for a tank and the boss measured up the door and found we had two inches to spare so the tank would go out all right. The day after we got the order the boss had to stay home a week with an attack of rheumatism, and next day a letter came in telling us to make the tank eight inches larger in diameter and to charge up the extra cost. The old man forgot to tell the boss about it, and I started in and got the tank all finished up without knowing anything about the change in size; so there we were, and the boss and the old man were as mad as wet hens when they found it would cost $150 to take the girder down and the bricks above it and put them back again.

"While they were chewing the rag, I came along. Well, I was surprised and couldn't understand how the boss had measured up the door wrong. Then I got an idea and went and laid out a template and tried an experiment. Going to the old man I told him I could get the tank out without taking down the girder, and he said, 'If you can do that, it's $25 in your pocket,' and I said 'all right.'

"That was Thursday. Saturday, when the men had knocked off, I took a couple of rousterbouts and had them lift the flooring up from between the rails. You know the railroad tracks go right through the shop. I got a man to come over from Wrights with an adze, and, laying the template across the rails, I had the man dub off the sleepers wherever the template showed that the boiler, when lowered onto the rails, would touch the sleepers.

"This did not take very long. Then I hooked onto the tank with a crane and lowered it down to the rails, first slushing them way outside the shop with grease. I got a sling around the tank and drew it through the door without having more than a quarter inch to spare, but we came out all right.

"This was about six o'clock, and I phoned the old man that the tank was outside the shop. He was down at the works bright and early Monday morning and handed me out my twenty-five dollars. I gave each of the rousterbouts a couple of dollars extra, so we were all happy."

The professor smiled and said: "We are generally told to look up in the world, but you have shown that it sometimes pays to look down."

"Yes," answered Jimmie, "but I got my idea out of a book that told about when they tried to get an obelisk through one of the gates of Rome and they couldn't do it because the gate wasn't high enough. A poor young engineer offered to get it through, and did so by digging down the street through the gate. The Pope, or somebody, made him a king or a knight or something. I remembered what I had read and did practically the same thing."

(*To be continued.*)

News Items

A meeting of the executive board of the Master Boiler Makers' Association will be held at 10:30 A. M. on March 22 at the Hotel Sherman, Chicago, for transaction of important business relating to the annual convention to be held May 26 to 29, inclusive, at the Hotel Sherman.

Owing to the inability of C. L. Hempel to serve as chairman of the committee to report on topic No. 6 at the annual convention of the Master Boiler Makers' Association, L. M. Stewart has been appointed chairman of the committee.

H. B. Nelson, foreman boiler maker of the Missouri-Pacific Railroad, Sedalia, Mo., has been appointed member of the committee on topic No. 3, which is to report at the forthcoming convention of the Master Boiler Makers' Association in Chicago.

The Scully Steel & Iron Company, Chicago, has just issued special literature showing different types of riveting sets and staybolt headers for pneumatic hammers. This company has also issued special literature covering pneumatic chisel blanks, chisels, forged flanges, high-speed chain hoists, blow-off valves, I-beam travelers, rivet forges, staybolt taps and staybolts.

Two hundred and eighty-nine boilers were manufactured by the Willamette Iron & Steel Works, of Portland, Ore., in 1918. Of this number, 138 were standard Scotch marine boilers and 151 were logging-engine boilers for use in the spruce and logging camps of the Northwest.

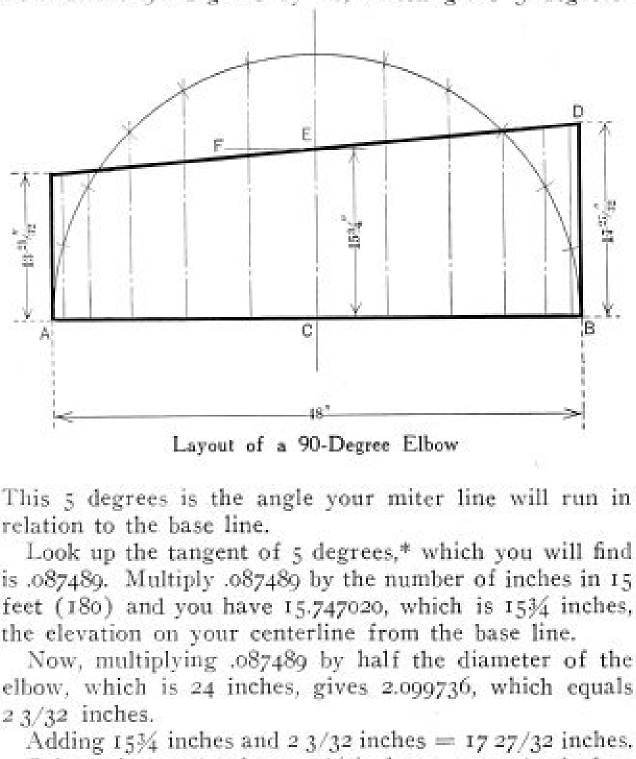
Letters from Practical Boiler Makers

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

Layout of Elbow With Large Radius

Probably a good many readers of THE BOILER MAKER have run up against the job of laying out an elbow on a large radius. The tram sticks were too short and had to be spliced and you had to use a chalk line and block-up plates on horses and barrels to get something to work on. It would take you three or four hours before you had your outline ready so that you could go ahead and accomplish anything. Here is a method that is quick and easy.

Lay out a 90-degree elbow 48 inches in diameter, 15 feet 0 inches radius on the centerline. First determine the number of sections you want in the elbow, which, we will say, is 10. This gives two half sections for the end pieces and eight full sections. Multiplying 8 by 2 = 16, and adding the two half sections to 16 = 18. This is the number of sections there really are in a 10-piece elbow. Now divide 90 degrees by 18, which gives 5 degrees.



Layout of a 90-Degree Elbow

This 5 degrees is the angle your miter line will run in relation to the base line.

Look up the tangent of 5 degrees,* which you will find is .087489. Multiply .087489 by the number of inches in 15 feet (180) and you have 15.747020, which is 15¾ inches, the elevation on your centerline from the base line.

Now, multiplying .087489 by half the diameter of the elbow, which is 24 inches, gives 2.099736, which equals 2 3/32 inches.

Adding 15¾ inches and 2 3/32 inches = 17 27/32 inches.
Subtracting 2 3/32 from 15¾ inches = 13 21/32 inches.

Having now found all the dimensions which you need, draw a base line 48 inches long; mark your point *A*, *C*, *B*; from point *A* set off the distance 13 21/32 inches and mark *F*; from point *C* set off 15¾ inches and mark *E*; from point *B* set off 17 27/32 inches and mark *D*.

Through points *D*, *E* and *F*, draw the miter line. Draw your semi-circle and divide into an equal number of parts. Project these points to the base and miter line and you are ready to develop the stretchout.

This method can be used for any radius, any number of pieces, and for any degree of a circle. You will also find that it is much quicker on large work and takes up less room than the old method.

McGill, Nev. F. E. JAMESON,
Boiler shop foreman.

* You will need a table of natural sines and tangents, which can be found in any cheap handbook or pocket companion.

Hand Versus Power Riveting

In the September, 1918, issue of THE BOILER MAKER, Mr. Haas pays the writer a very nice compliment and, at the same time, bears out conviction that hand rivets can be made tight. Now I would like to refer once more to that part of Mr. James Francis' letter of May, 1917, which gave rise to this controversy, in which he says: "Not much like hand work is good pneumatic riveting."

The writer has many times cut off hand-driven rivets and had the body of the rivets fall out of the hole as soon as the head was removed. This is not so, however, with pneumatic or hydraulic rivet driving. There, as in brazing, each and every part of the rivet hole is fully filled with the metal which flows like wax under the rapid blows of the "gun" which drives them.

The difference between hand-driven seams and those driven by air is apparent at once, even during the testing of the boiler, for with hand riveting it used to be necessary to calk the entire boiler—tighten this seam, that rivet, then this one, as the water pressure sought out the defective riveting. With modern pneumatic work the boiler shop foreman is apt to "talk Dutch" to a gang which has driven the seams of a boiler in which he finds more than two or three leaky rivets at the test, and these are usually at the laps where three sheets meet.

When the writer differed with Mr. James Francis there was no thought in his mind about the pressure carried, be it high or low; neither was there any thought of thickness of material used; but what "got my goat" was the fact that a writer in this magazine had said that a hand-driven rivet could not be made tight when the evidence of my experience is that they can and were driven tight. This was done on a Scotch marine boiler with shells of material 1 inch thick in a certain marine boiler shop in Barrow-in-Furness, England, as far back as 1880. Later, right here in Pittsburgh, Pa., boilers of the steamboat, two-flue type were hand-driven and were made absolutely tight, since it was impossible to calk a leaky flue, the flues being too small for a man to crawl into. In driving rivets on this kind of work the stake was used to buck up, and all rivets had to be *driven fair in the hole* to insure good work; but it took *two men* to do the work, and not as it does to-day—a "hunky behind the gun."

I am glad that the experience of Mr. Haas is the same as that of the writer—that hand-driven rivets can be made tight and that he has seen such work. There are very few places better than the scrap yard to illustrate this fact, for here boilers of all ages are cut up; and all kinds of tools were formerly used in doing this work, and the men engaged in this kind of work knew quite well that they had no soft snap in cutting apart boilers of the hand-driven kind.

In defining a leaky rivet as one that shows moisture under hydraulic test, Mr. Haas again bears witness to my contention in THE BOILER MAKER of November, 1917, in which the statement was made: "Let us see what constitutes a leaky rivet; it is not necessary that a rivet be loose in the hole and the water squirting all over the shop to signify a leaky rivet. A rivet that weeps, or sweats, or shows a drop of water, is a leaky rivet to all intents and purposes and will not pass muster until it is made dry. Therefore, I say that a boiler that *weeps or sweats* all over is *leaking all over* and requires calking."

Now there is another point in this controversy that has not been touched upon so far, and that is, what does it cost to calk a leaky rivet? The writer well remembers working in a shop (some twenty-two years ago) building a watertube boiler of a type very like the Sterling boiler. The drums of this boiler had to be calked before the tubes were put in, and, in order to accomplish this, wooden plugs were driven into the tube sheet from the inside. After the manhead was in position the water was turned into the drums and the plug, after soaking, became fairly tight, thus allowing a fairly even pressure to be maintained by the injector.

In those days all the rivets had to be calked, not because the water was squirting out of the rivets or the seams, but because they were sweating. Possibly they would not leak when in service, but the manufacturer was not taking any chances, but required the drums to be tight, for, as he (the manufacturer) told the writer, it was cheaper to make a good job while in the shop than it would be after the boiler was installed. A leak that could be stopped with a light application of the calking tool in the shop might cost him $25 to stop after installation.

This fact was very forcibly brought home to the writer some years later when he was sent away to stop a leaky rivet in a locomotive boiler, the rivet being directly behind the frame on the wrapper sheet. All kinds of bent tools were used to try and reach the leak, but to no purpose, and the only alternative was to take the frame off in order to reach the rivet.

The readers of this journal who are familiar with locomotive work have some idea of the cost of such an undertaking when the work is done in the shop, where there are tools of every kind at hand to do such a job; but what is their idea of such a job being undertaken away in the country, where tools are scarce and jacking up the engine has to be done by hand? Here, then, lies the expense or cost (to the manufacturer) of a leaky rivet. He alone is able to tell what the actual cost is. There is no doubt, however, in the present writer's mind but that much of this trouble could be avoided. Modern machinery is powerful enough to do the work right, and a rivet driven by hydraulic pressure, if not absolutely tight, should be nearly so.

In the writer's opinion, if more attention were given in all departments to the various operations, hydraulic riveting included, there would be a very fair chance that better work would result and reputations for good work would not be at stake. From the very start the fitting up should be of the most careful kind and by the most experienced workmen. We cannot expect good riveting to result from bad fitting, especially for piece work, premium, or individual merit, for the men engaged are going to make out somehow even if it is at the cost of bad work.

Bolts should be applied about every seventh or eighth hole in good fitting up, and the work drawn up as close as possible. This takes up the slack uniformly all over and gives the hydraulic riveter a chance to tack or stitch his work properly, thus avoiding, to a large extent, the formation of a collar between the sheets and the *riveter*, instead of giving the rivets *one squeeze* and getting off the rivet as quick as possible. While the rivet is red hot, holding the pressure for a few seconds—say six or seven—helps the rivet to contract, thus avoiding much future trouble.

In shops, however, that have a regular test system, that is, where men are paid piece work on the testing floor, the riveters become indifferent to the condition of their rivets. Recently the writer saw a man driving rivets with the pneumatic hammer on boiler braces and leaving them a bright red. When asked if he were not afraid of the rivets, he shrugged his shoulders and replied that it was "up to the testers."

It is a fact that boilers are calked by piece work, and that the price paid varies from 1 cent to 4½ cents per rivet, and this does not fully cover the cost of leaking rivets, for sometimes, when it requires three or four applications of the test pressure, the cost far exceeds this. This is a monetary matter, but what of the reputation of firms doing work of this kind? Surely Mr. Haas is right when he says there is room here for missionary work.

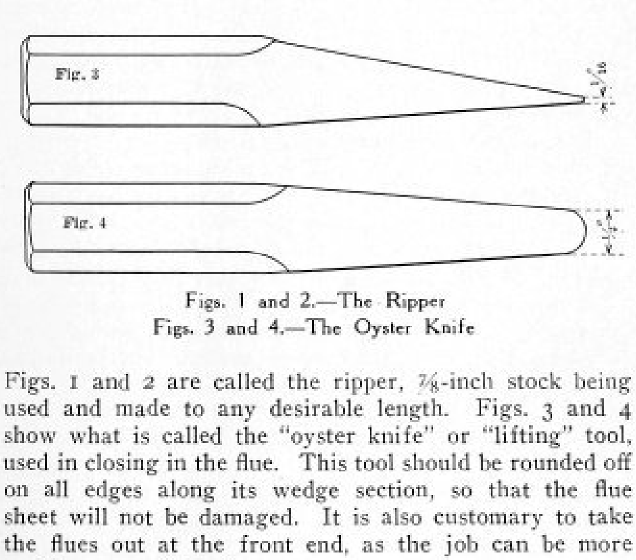
I am truly loath to continue this controversy, but, knowing conditions and methods of working, both past and present, I cannot stand by and see the old-time *hand-driven rivet knocked.*

Modern machinery handles the work quicker than before its introduction, but we are not getting the results that we should get, and there is no reason why, after installing powerful machinery and making a shop up-to-date, the manufacturer should depart from his old tradition of good work and good workmen, for one job rejected on account of bad riveting costs more in the loss of reputation than the actual money loss.

Wilkinsburg, Pa. G. H. HARRISON.

Tools for Removing Flues From Locomotive Boilers

In your November, 1918, issue, in answer to a query relative to the removal of flues from locomotive boilers, you give sketches of tools to be used. May I say, as one who has had twenty-five years at the business, that the tools so described appear rather awkward in design. The tools shown in the accompanying illustrations represent the general shape of tools used for cutting flues by hand.



Figs. 1 and 2.—The Ripper
Figs. 3 and 4.—The Oyster Knife

Figs. 1 and 2 are called the ripper, ⅞-inch stock being used and made to any desirable length. Figs. 3 and 4 show what is called the "oyster knife" or "lifting" tool, used in closing in the flue. This tool should be rounded off on all edges along its wedge section, so that the flue sheet will not be damaged. It is also customary to take the flues out at the front end, as the job can be more rapidly accomplished.

In answer to "J. B." in the same issue, you give the layout for section of a smokestack, stating that it is not necessary to lay out the pattern as for conical work. As I have learned practically all that I know about laying out from the pages of THE BOILER MAKER and have built quite a few stacks, I venture to disagree with you. Be the taper of a course ever so slight, it is necessary to find the camber if we are to have a perfectly straight stack.

For a hurry-up job we can use the method described in Fig. 5. Set out the circumference for large and small end; at center set up elevation of section desired, as shown by lines *A-A* and *B-B*. Then set square at line

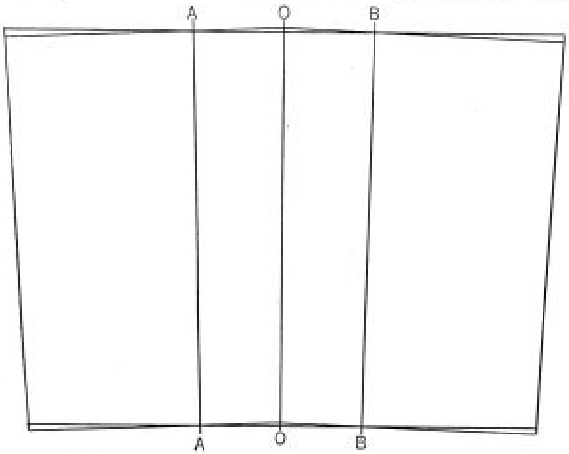


Fig. 5.—Layout of Section of a Smokestack

A-A, touching point *A*, and draw in the line where the square touches the centerline. Repeat at line *B-B*. This shows the camber at center; turn square over on line *B-B* and mark the line to end of the circumference. Repeat at line *A-A*.

The same procedure will give us the camber on the bottom edge. The rivet holes can be spaced off along the lines found, and, with proper punching, a fairly straight job is assured.

Lorain, Ohio. JOSEPH SMITH.

Welded Patches

A few months ago an engine came into the back-shop for repairs. There was a patch about forty-eight inches long on the knuckle of the flue sheet. After the flues were removed it was found the patch had a crack twenty inches long, on the inside, in the knuckle. The flue sheet was warped very badly and in poor condition, but as there was no iron on hand to make a new one, and not wanting to keep the engine out of service while waiting for the iron, it was decided to put on another patch.

The old patch was riveted on and the new patch was to be welded on. After cutting off the rivet heads in the old patch with the oxy-acetylene torch they were backed out. Then the knuckle of the flue sheet just at the lower edge of the rivet holes was burnt out. In order to make a good job, one more flue hole had to be cut out than was taken out by the old patch, making a total of twenty flues less than was in the boiler when the sheet was new.

The sheet was then chipped to about a forty-five degree angle. Three holes were drilled in the top of the patch, and after the crown sheet was heated and straightened, the patch was bolted up. (The acetylene torch was also used to heat the crown sheet.) After the patch was bolted up, the flue sheet being bulged so badly, a strong-back had to be put on it to pull it back even with the patch in the center of the sheet.

Two welding operators welded the patch, changing off. It took about four hours to weld the patch into place.

As soon as the sheet had cooled off, the holes in the top were drilled through the holes in the crown sheet from the inside of the boiler, and countersunk on the firebox side. The rivets were then driven and the sheet chipped and calked both inside and out.

The flue sheet was bulged so badly there were twelve different lengths of flues. After the flues were finished a test pressure of two hundred and sixty-five pounds water pressure was applied and there were no leaks.

This engine has been in service now for two months and has showed no leaks so far. There are about six other engines running here with welded flue sheet patches, and twelve with patches welded on the mud-ring corners, but this is the largest put on so far. One flue sheet patch gave some trouble in leaking, but it was finally calked up and has given no more trouble. One of the mud-ring patches failed when the engine was backing out of the round-house about an hour and a half before it was to take a train out. The weld had cracked the entire length. This was chipped out and rewelded. This engine has been running over six months since the patch was rewelded and has given no further trouble.

The torch used in the welding of all the patches was an ox-weld.

Denver, Colo. ARTHUR MALET.

Taking Account of One's Personal Stock

The advice in the editorial columns of the October issue of THE BOILER MAKER, to sit down in the "silence" and take account of one's personal stock, is as sound as the proverbial nut. There are two kinds of advice, usually speaking, that a publication like this gives. One may be called detailed advice, the other suggestive advice. The first is the size of rivets proper for a job or the layout of an uptake; the second is for the thinking man.

In the poem of "The Deserted Village" these lines are found: "Past experience proves on every soil that those who think must govern those who toil." The responsibility of governing, or perhaps directing, is great and not always appreciated as it should be.

Financial returns are looked for by those who have invested money in the enterprise, and those who toil look for consideration in their work. Are you doing fairly to both, Mr. Thinker? is a question which is not easy to solve. It is easy to place blame on the employees for failure to make a good financial showing, but it is the man who directs who is responsible for loss and who, by wise forethought, will prevent it.

It is in these silent moments that a man may find that he is the one at fault. Unfortunately, most musers, not thinkers, resort to a cut in wages in order to show a profit. No more common mistake is made than this, and it is a natural one, as it is something directly under the control of the thinker. His thoughts rarely turn to cutting his own pay. Let him consider how much of an incentive lower wages would be to a gang to finish up a boiler. There is the foreman to blame. That is easy. "He is making the work cost too much. It is his fault." Just think of his work—not from the office end, but from the shop end. There, all the riveting has stopped. You can't make a boiler without making a noise. Why has the riveting as I had no overhead gear to get the plates to the and see. "Yes," says the foreman, "I had to stop the riveting as I had no overhead gear to get the plates to the rolls, and they are heavy; the lumpers could not handle them." Now, Mr. Thinker, had you thought of that as the cause for the high cost of work? Here you have skilled men doing lumpers' work. Did you ever happen to think that it is poor policy to have a gang of riveters come in the morning and start to build a staging which should have been all ready for them so that they could get to work at their legitimate work?

Did you ever consider how much it cost you to have a man hunt all over the shop for a couple of bolts that, when found, had to be put in a vise and an eighteen monkey wrench used to run the nut down on it? Again, did you ever think how a few pieces of blocking might prevent a boiler from rolling over on the men? Or that taps, drills and wrenches do not hold their size or last forever? Perhaps you will say that this is a part of the foreman's work. That may be true, but have you forgotten that every time the foreman asks for anything you look as black as a thunder cloud and talk about economy? Are you really so close to the foreman that he is ready to tell you all that goes on in the shop?

Just change your line of thought, Mr. Thinker, and bring it right down to yourself. Look closely to your own shortcomings. You are the man to see that the shop is provided with the facilities for doing the work before you start to blame anyone for its not coming out. Consider carefully your position and see if you are doing real thinking and not just musing.

New London, Conn. W. D. Forbes.

Position Drilling Versus Separate Drilling

Many years ago, when the iron ship first came into general use, it was found that there were many failures in the plates and that plates had to be renewed long before the life of the plate was passed, on account of the failure of the edges cracking into the rivet holes. To overcome this, the British Admiralty ordered that all plates should be cut from the solid sheet, leaving a larger crop end, and, at the same time, experiments were made with punched and drilled holes to ascertain the difference between the two methods.

As shown in The Boiler Maker some time ago, that difference was so small, especially where punched holes and the plates annealed afterwards were used, that there are many boiler makers who still believe that the punched holes are equal to a drilled hole. As a compromise, they have come to punch a small hole while the sheet is in the flat and ream out to size after bending. This, they claim removes any cracks (invisible to the naked eye) caused by punching. This method has given entire satisfaction, and boilers built from plates done in this manner have passed the requirements of our best insurance companies. Yet a hole drilled on the flat should relieve the mind of both builder and purchaser, knowing, as they do, that every precaution has been taken to overcome the failure of the sheet at the edges. In many years' experience, the writer has had but one batch of plates fail at the edges from rolling, and those were rejected when the first failure was discovered.

In England, position drilling is almost a general practice, for there the board of trade looks after such things, and when there is a boiler explosion there is also a rigid investigation and the blame is placed where it belongs. Hence the British manufacturer is compelled to use every care possible to avoid all accidents, and, with the use of the best of material and modern methods, they do avoid many accidents. We in this country are coming to the same conclusion, slowly but surely. Drilled holes have been used in many shops for many years; position drilling in a few. Now here is a question that has occurred to the writer: What is position drilling—or, rather, are all the holes in a boiler to be drilled after the boiler is rolled? Recently the writer has seen some position drilling done, but there were holes punched in the sheets while flat, so that the covering strips (butt straps) and heads could be bottled up and held in position while being drilled. After the other holes were drilled the tack holes were reamed out to size.

Another thing the writer noticed was the match of the holes that were punched. No doubt they were carefully laid out, but, as is well known to the practical boiler maker, the slip of the center punch will throw a hole out a little, and should this occur on all of the plates, which finally must be bolted together, the result is bad holes. This is a small matter, but small things count when the whole thing is considered. Then, again, the rolling of plates for boiler shells and the inside and outside covering strips should be perfectly bent to the various radii. To do this on the shell of a boiler and get the butting edges true is out of the question on any rolls, and some other method must be used.

Some up-to-date shops have formers (male and female) to fit into their hydraulic riveters. After rolling, the shell is slung up at the "bull" and the formers take out the flat place left at the butting edges of the sheets when they first enter the rolls. But, notwithstanding all the care taken, the job that the writer has in mind was far from a good one, for the inside strips stood off from the shell fully ¼ inch, which allowed the *cuttings from the drill* to get between the sheets, and they were bolted up in this manner. Now here is a case where the covering strips should have been removed and the cuttings blown out. The writer watched this particular piece of work being done and followed it through its course from the drill press to the testing block, and regrets to say that the result (to him) was far from satisfactory, for, although a bone dry job was expected at the test, the truth is every rivet had to be calked.

Another question, and one that is all-important to manufacturers, is: Is it worth while to install expensive machinery that can drill but one hole at a time (in position drilling) and one that will take up so much valuable space as the one described by Mr. Lawrence McCarthy, of St. Louis, in The Boiler Maker of November, 1918? Not being a manufacturer, I cannot answer this question, but from my knowledge of such things that occur in the boiler shop, and the difficulty of obtaining less expensive machinery which increases the output, I am of the opinion that it would not pay them. Single-hole drilling is too slow for these days. Gang drills of a dozen or more drills might meet with better success, but, if a hole drilled in the flat will meet all requirements of the present code, why the extra cost of position drilling?

If the results obtained from boilers, tanks, etc., that have been positioned drilled were such that the cost of production was reduced, there is a possibility that some manufacturers would be led to make the change.

The writer always has been in favor of drilled holes at all times and cannot see that the distortion (if any) caused by the bending of the plates is in any way detrimental to good work. Knowing that boilers that have holes punched in the flat and reamed in position have stood the ravages of twenty years and more without showing bad results, it is a sure bet that drilled holes will stand the test of that length of time or more.

Any boiler that has been in service constantly, regardless of its makes, should be retired from further service, for there are few boilers that are not crystallized badly long before they are ten years old. The writer is of the opinion that all boilers that have done duty for nine years should have all plates subjected to an analytical test.

Wilkinsburg, Pa. Flex Ible.

Selected Boiler Patents

Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney,

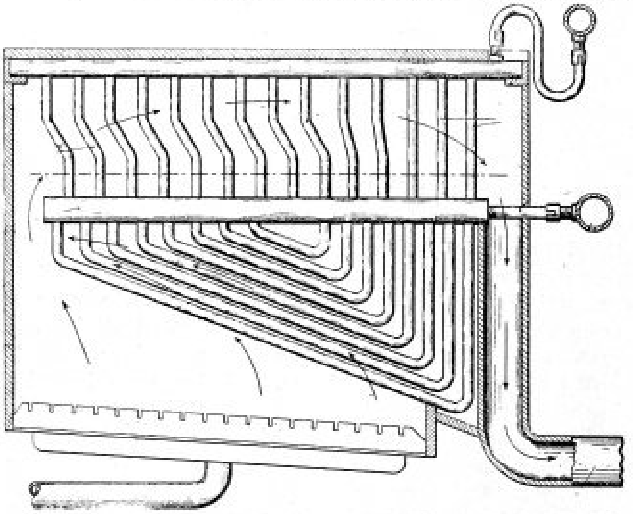
Washington Loan and Trust Building,

Washington, D. C.

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

1,284,015. BOILER. WILLIAM H. WINSLOW, OF CHICAGO, ILL., ASSIGNOR TO THE STEAM POWER DEVICES COMPANY, OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

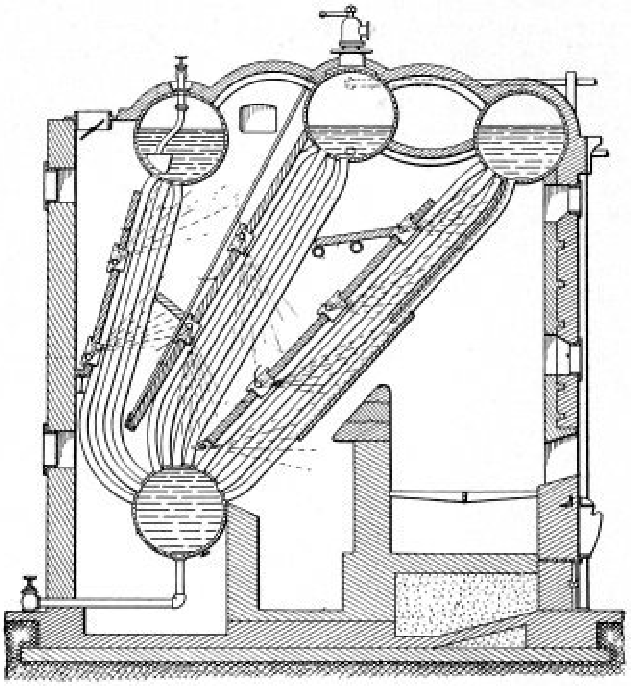
Claim 1.—A boiler comprising a pair of headers, a plurality of tubes extending between said headers, one of said headers being provided with



a tube permitting water circulation through said last-mentioned header, said tube having both ends thereof terminating in said header, said other header being disposed above the normal water level. Eighteen claims.

1,283,048. SOOT BLOWER FOR WATERTUBE BOILERS. JOHN E. BELL, OF NEW YORK, N. Y.

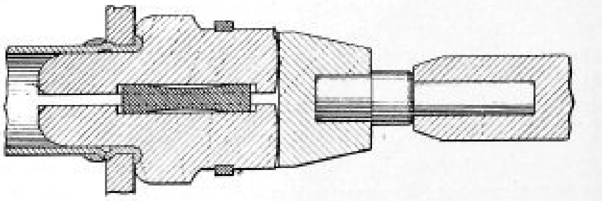
Claim 1.—In a watertube boiler, the combination with a plurality of spaced apart watertubes, of a series of metallic bodies arranged in end to end relation to each other transversely of said tubes, each of said bodies having elongated surfaces extending longitudinally of the tubes and shaped to contact throughout their length with the walls of adjacent



tubes and to span the space between said tubes, and a blower pipe extending transversely of the water tubes and supported and incased by said bodies, whereby such heat as the metallic bodies absorb is rapidly conducted through the walls of the tubes to the water in the interior of the latter and the bodies are thus maintained approximately at the temperature of the tubes. Eight claims.

1,283,799. BEADING TOOL FOR BOILERTUBES AND THE LIKE. WILLIAM KERR OF CLINTON, IOWA, ASSIGNOR TO THE COLLIS COMPANY, OF CLINTON, IOWA, A CORPORATION OF IOWA.

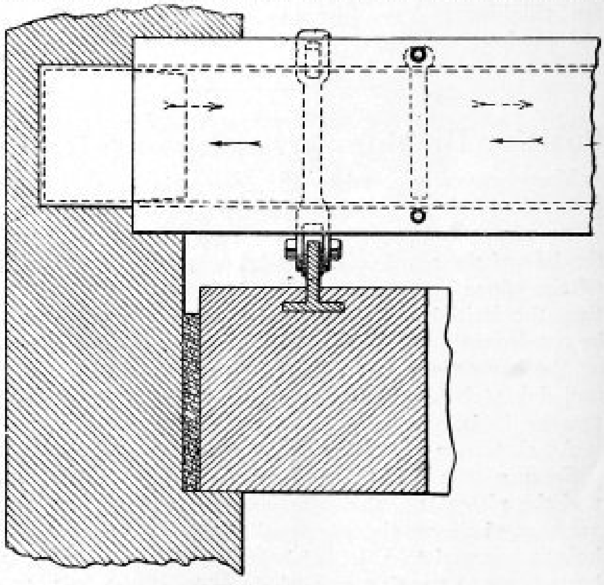
Claim.—A beading tool for boiler tubes and the like, comprising in combination a body member of circular cross section having on one end a central socket for the accommodation of a hammer pin or the like and having in its other end a transverse slot for the accommodation of a pair of flanging wings, and also having adjacent to said end a peripheral groove, a pair of flanging wings within said slot, each of said wings



having an arcuate end portion for seating against the bottom of said transverse slot and also having a protruding working end portion adapted to project beyond said slot, central facing recesses on said wings, a block of resilient material seated within said recesses and between said wings, and of sufficient width to normally maintain said wings separated from each other, and thereby cause their edge portions to project beyond the outside face of the body portion, and a band of resilient material seated within the peripheral groove aforesaid and drawing the wings toward each other. One claim.

1,284,066. FURNACE CONSTRUCTION. MYRON H. DETRICK, OF CHICAGO, ILL., ASSIGNOR TO M. H. DETRICK CO., OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

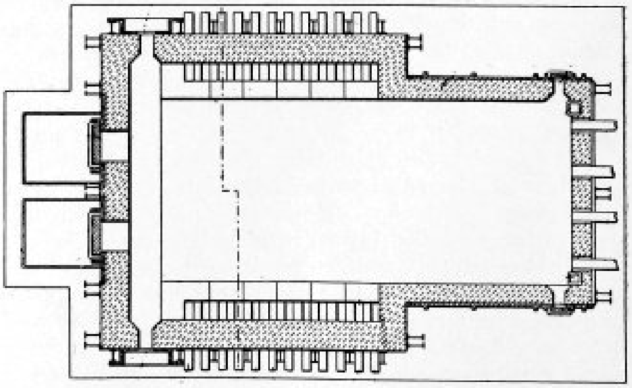
Claim 1.—In a furnace, a girder comprising bars arranged in spaced relation to each other having longitudinally extending flanges on their



outer sides, cover plates secured against said flanges to form air flues throughout their length, and means at one end of the girder connecting the said flues. Ten claims.

1,279,889. HEATING FURNACE. CHARLES W. LUMMIS, OF WORCESTER, MASS., ASSIGNOR TO MORGAN CONSTRUCTION COMPANY, OF WORCESTER, MASS., A CORPORATION OF MASSACHUSETTS.

Claim 1.—In a heating furnace, a heating chamber, a plurality of partitions carried by the walls of said heating chamber to divide the same into a plurality of similar passageways, each partition being spaced above



the floor of said chamber, means for advancing a row of billets through said chamber transversely of said passageways, and means for directing products of combustion through said chamber longitudinally of said passageways. Six claims.

The Boiler Maker

APRIL, 1919

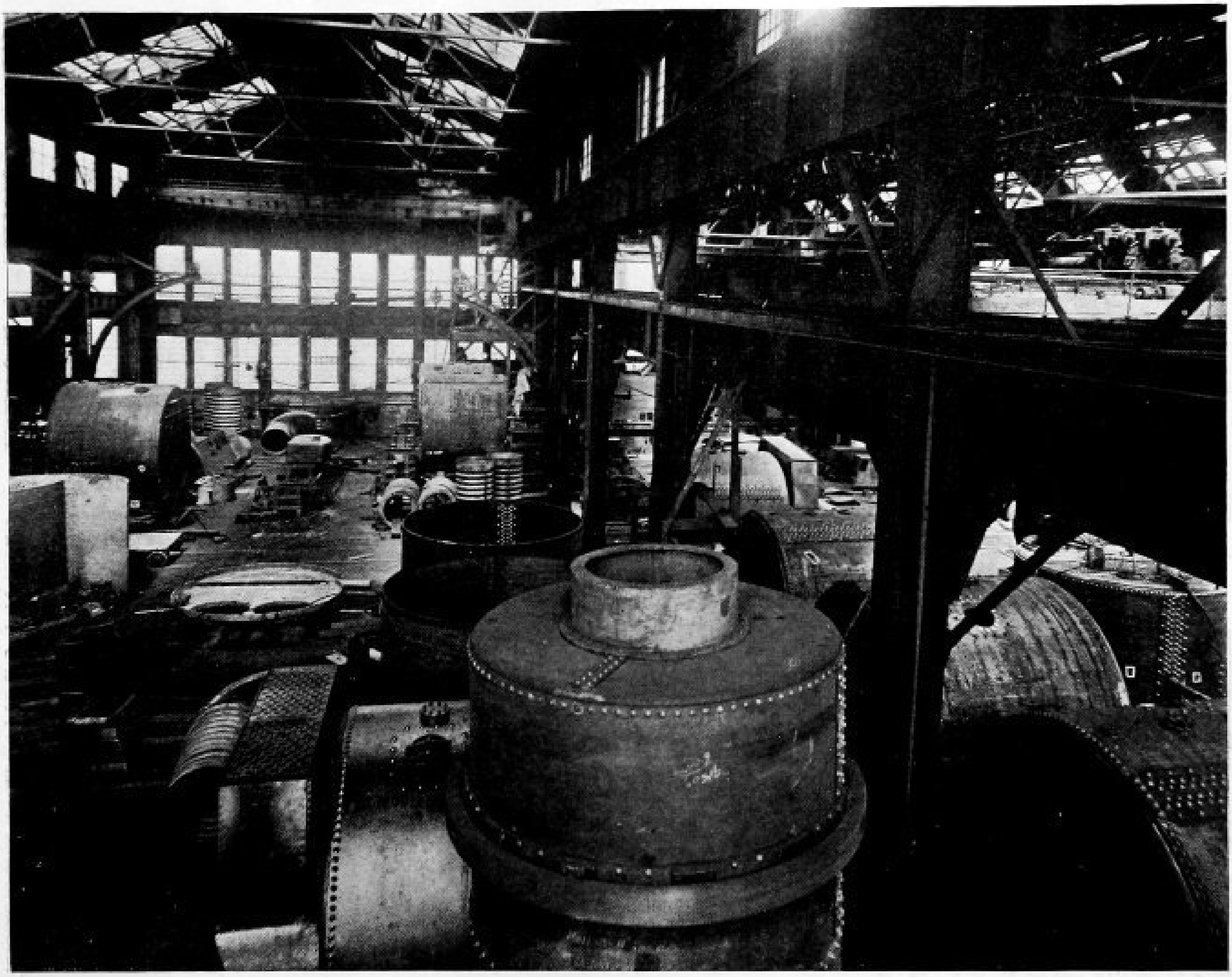


Fig. 1.—Interior of Manitowoc Boiler Shop, Showing Variety of Work Handled

Marine Boiler Shop on the Great Lakes

Boiler Making Department of the Manitowoc Shipbuilding Company, Manitowoc, Wis.—Capacity of Shop, Two Boilers a Week

On this and the following page are shown views of the boiler shop of the Manitowoc Shipbuilding Company, Manitowoc, Wis., which is one of the largest shops on the Great Lakes for building Scotch marine boilers. The boiler shop is situated about one mile down the Manitowoc River from the shipyard and is equipped for handling a variety of heavy plate work, such as paper-making machinery, digesters, tanks, etc., in addition to Scotch boilers. The shop, which is 180 feet long by 250 feet wide, is divided into three bays, with a fourth bay at right angles to the main shop.

The shop is thoroughly equipped with heavy machinery and overhead cranes capable of handling the large boilers fitted on Great Lakes steamers. During the war the shop was turning out an average of two 500-horsepower boilers a week; each boiler is 14 feet 6 inches diameter by 11 feet long outside the heads, equipped with three furnaces and separate combustion chambers. The boilers weigh about 55 tons apiece and are placed on board the vessels by a set of shear legs at the waterfront capable of handling weights up to 75 tons. J. J. Norris is superintendent of the shop.

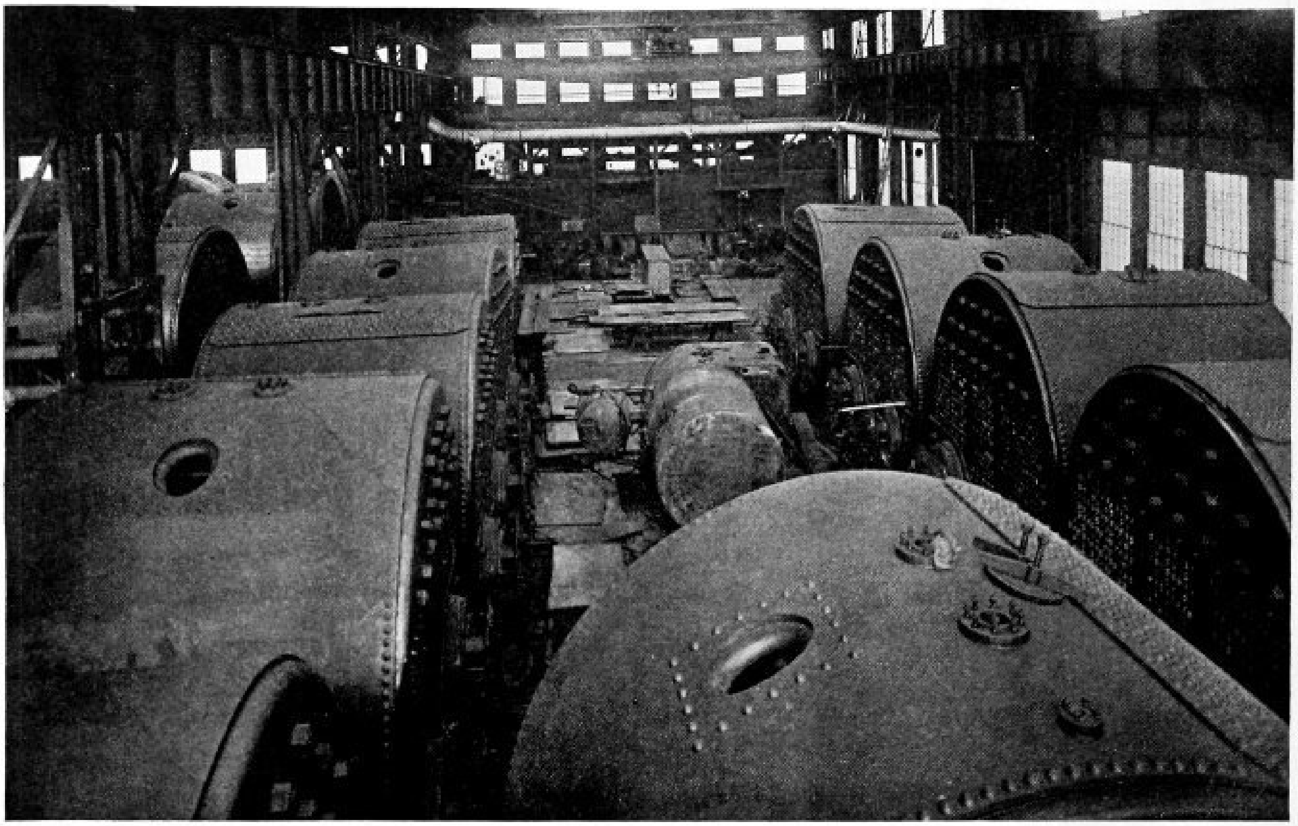


Fig. 2.—Erection Floor of Manitowoc Boiler Shop

Fig. 3.—Central Bay of Manitowoc Boiler Shop

A Problem in Piping Layout

Piping Too Large to be Laid Out on Shop Floor—Angles and Lengths of Lines Computed by Mathematics

BY JAMES LESLIE LANE

Some weeks ago the layerout brought the following problem to the office for solution. As it happened, the dimensions were not large and he had been able to lay it out on the shop floor. A large plate was handy, and, by drawing it full size, the angle and length of the tangent line required were found with sufficient accuracy. However, as he happens to be one of those who want to know the "why of things," he was curious to know how to obtain the same results mathematically. In the present instance a graphical method was plenty good enough, but, as he said, an occasion might sometime arise where the factors were so large that laying it out on a small scale would run the risk of having errors greater than would be permissible.

Thinking that the problem may interest some of the readers of THE BOILER MAKER, it is presented here, with the solution:

The point E is the center of a 20-foot diameter hot stove about which is to pass the gas main whose center line is Y, C, D, Z. The center lines YW and WZ, where the piping makes straight runs, will, if extended, cross at the point W at an angle of 90 degrees. The portion of the pipe YC is on an arc of a circle of 12 feet 1½ inches radius, whose center is at the center of the stove E. The portion DQ is on an arc of a smaller circle of 36 inches radius, whose center is at F, 14 feet below the center of the stove and 4 feet 7 inches to the left. The problem is to find the length of the tangent line CD and the angle (A) that it makes with the line YW.

The first step is to find the length of the line EF which joins the centers of the two circles.

$$EF = \sqrt{\overline{FG}^2 + \overline{EG}^2} = 176.774 \text{ inches.}$$

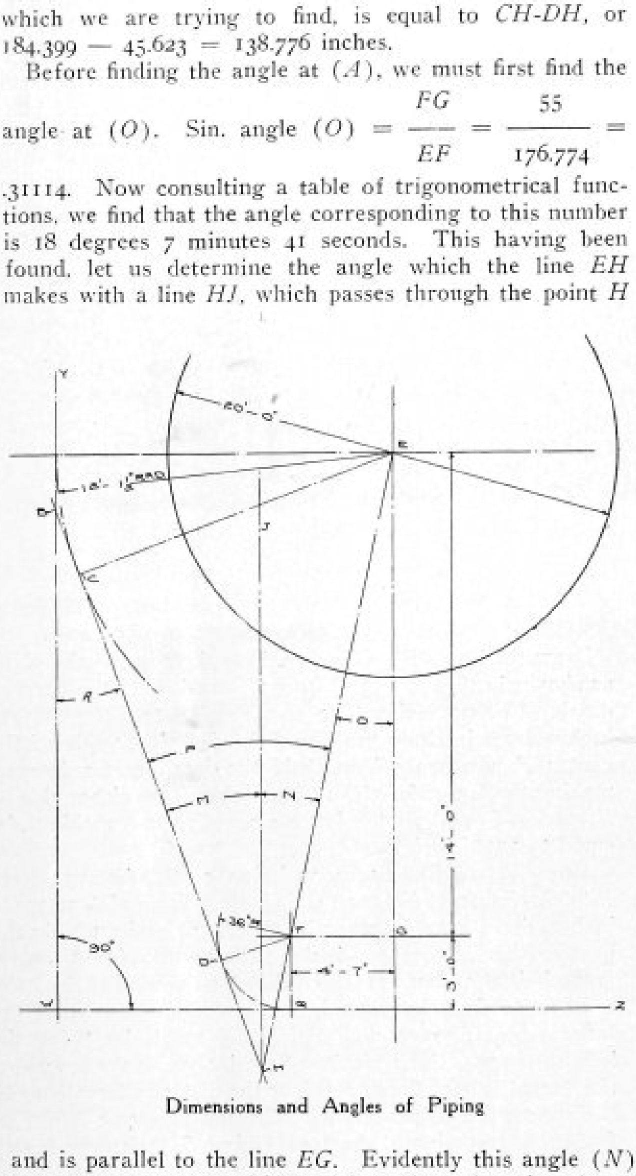
The second step is to find the length of the line EH, where H is the point of intersection of EF continued, and the line CD, which is tangent to the two circles. True, we do not as yet know anything, in a mathematical sense, concerning the position of this tangent. If we did there would be no problem. However, supposing it to have been drawn, we know that $EH = \dfrac{EF \times EY}{Ey - Fd}$. This is from a general geometric problem where we have to determine the distance from the center of a circle to a point where a tangent to this circle and to a smaller one crosses the centerline of the two circles produced. Substituting our values in the above equation, we have:

$$EH = \frac{176.774 \times 145.5}{145.5 - 36} = 234.89 \text{ inches.}$$ Then from this,

$FH = Eh - EF$, or $234.89 - 176.774 = 58.116$ inches.

The next step, finding the length of the line CH, is simple, since EC and CH are at right angles to each other—a radius of a circle always being perpendicular to the tangent to the circle at that point. Then $CH = \sqrt{\overline{EH}^2 - \overline{EC}^2} = 184.399$ inches. Similarly, $DH = \sqrt{\overline{FH}^2 - \overline{DF}^2} = \sqrt{58.116^2 - 36^2} = 45.623$ inches. From this we see that the length of the tangent line CD, which we are trying to find, is equal to CH-DH, or $184.399 - 45.623 = 138.776$ inches.

Before finding the angle at (A), we must first find the angle at (O). Sin. angle $(O) = \dfrac{FG}{EF} = \dfrac{55}{176.774} = .31114$. Now consulting a table of trigonometrical functions, we find that the angle corresponding to this number is 18 degrees 7 minutes 41 seconds. This having been found, let us determine the angle which the line EH makes with a line HJ, which passes through the point H and is parallel to the line EG. Evidently this angle (N) is equal to the angle (O) which we have just found, and is therefore 18 degrees 7 minutes and 41 seconds.



Dimensions and Angles of Piping

Having previously determined the lengths of all the sides of the triangle ECH, we are enabled to solve for the angle (P) at the intersection of CH and EH. To do this, we proceed as before. Sin. of angle $(P) = \dfrac{EC}{EH} = \dfrac{145.5}{234.89} = .6194$. Consulting our table, we find the value of this angle to be 38 degrees 16 minutes 21 seconds.

Now the angle (P) is equal to angle (M) plus angle (N); therefore, angle (A) is equal to angle (P) minus angle (N), or 38 degrees 16 minutes 21 seconds minus 18 degrees 7 minutes 41 seconds, which is 20 degrees 8 minutes 40 seconds, since it is equal to angle (M), which we have just determined.

Laying Out Envelop for Slightly Tapering Conical Frustum

BY H. J. RAPS

Let it be required to build a steel stack 48 inches inside diameter at the smallest diameter by 81 feet 7¼ inches long of seventeen plates ¼ inch by 60 inches by 155¼ inches.

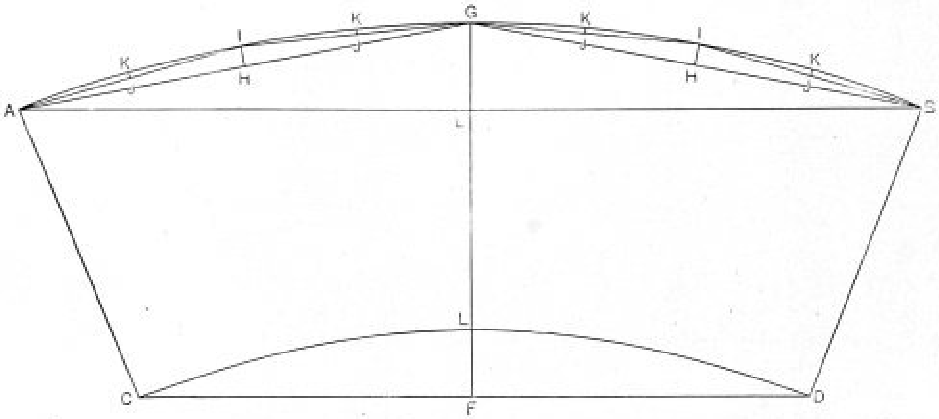
Adding the thickness of the plate, or ¼ inch, to the inside diameter, we have 48¼ inches for the mean diameter of the small end. For its circumference we have 48¼ × 3.1416 = 151 9/16 inches. For the circumference of the large end we will add 7¼ times the thickness of plate. 151 9/16 + (7¼ × ¼) = 151 9/16 + 1 13/16 = 153⅜ inches.

of *EG*, or one-fourth of 0.6043, which equals 0.151 inch, and mark off from *H* to *I*.

Connect *AI*, *IG*, *GI* and *IB*, and bisect at *J*. For the versed sine of the arc, divide *EG*, or 0.6043 inch, by 16 or divide *HI*, or 0.151 inch, by 4, which equals 0.0377 inch. Mark off this distance from *J* to *K* at the four points so marked and draw the curve *AGB* through the points that have been located.

Parallel to *AGB*, and 57½ inches from it, draw the arc *CLD*. Connect the points *AC* and *BD*, completing the lines on which the rivet holes are to be layed out. Locate the holes and add the lap, completing the pattern.

To simplify the calculations, we will group them together:



Pattern for Slightly Tapering Conical Frustum

Draw the line *AB* 1 13/16 inches from the edge of the plate, as shown in the sketch. Bisect *AB* and erect the perpendicular *EF*, extending it to *G*. Parallel to *AB* and 57½ inches from it, draw the line *CD*. On either side of the center *F* measure off one-half the small circumference, making the length of *CD* 151 9/16 inches. On either side of *E* mark off one-half the large circumference, making *AB* equal to 153⅜ inches.

We will now find the versed sine, or the distance from *E* to *G*. Subtract *CD*, or 151 9/16 inches, from *AB*, or 153⅜ inches, divide 153⅜ inches by the result and multiply the quotient by *EF*, or 57½ inches; the result, 4886.8 inches, is the height of cone of which the stack section is the base.

Then to find the versed sine, we square one-half the large circumference and divide the result by twice the height of cone. The result, 0.6043 inches, is the length of the versed sine of the arc *AG*, or the distance from *E* to *G*.

Connect the points *AG* and *GB* and bisect at *HH*. To find the versed sine of the arcs *AI* and *GI*, take one-fourth

$H = C \div (C - c)\, h = 153.375 \div (153.375 - 151.5625) \times 57.5 = 153.375 \div 1.8125 \times 57.5 = 84.62 \times 57.5 = 4865.65.$

$VS = (C \div 2)^2 \div (2 \times H) = (153.375 \div 2)^2 \div (2 \times 4865.65) = (76.6875)^2 \div (4865.65 \times 2) = 5880.97 \div 9731.3 = 0.6043.$

Where

H = height of cone.
C = large circumference.
c = small circumference.
h = height of frustum.
VS = versed sine = distance from E to G.

In making the calculations, it is not advisable to extend them beyond a reasonable limit; for instance, instead of squaring 76.6875, simply square 76.68, or, to get a closer approximation, multiply 76.69 by 76.68.

The sketch has been drawn out of proportion to make the demonstration clearer.

Bob and the "Boss" Settle Some Difficulties

Threatened Strike Averted by Equitable Distribution of Increased Profits Among Workers and Employers—Wages Raised and Shop Improved

BY W. D. FORBES

The end of March was drawing near. The work in the shop was going on very well—much better, in fact, than Bob had expected or hoped—yet he was troubled. He had worried over the plate shed, as it was an old wooden building on the north side of the shop and in bad repair. In fact, it was beyond repair, and something had to be done with it at once.

In order to get the plates into it, they had to be lifted with the overhead crane onto a truck, rolled to a turntable, then along a track to the shed. This took time, and to get the plates out the operation had to be reversed; some of the boiler makers had to lend a hand at each move so as to help the "lumpers," and this added to the labor cost of the boilers.

This condition was not, however, the real cause of Bob's trouble. He had, with the help of Howland, got out a very good cost account system, and it showed a very much larger profit on all the work turned out and in hand. At least three times the hoped-for profits was actually proved.

Saturday afternoon Bob sat smoking his pipe, with his feet up on the radiator, in the office looking over his cost sheet with satisfaction, yet trouble was clearly shown on his face when Mr. Rogers came in.

Mr. Rogers drew up a chair, and, after looking at Bob for a few moments, said: "What's the trouble, Bobbie?" It was the first time he had ever called Bob by this name.

"Well," Bob answered, slowly, "I am young and I am up against it hard, as I lack experience."

"Tell me about it. I may be able to help you out. What is it?" said Mr. Rogers.

"There is going to be a strike," answered Bob with a choke in his voice.

"Oh," said Mr. Rogers, "I was afraid it was some money matters of your own."

"I wish that was it. But what are we going to do, Mr. Rogers?"

Mr. Rogers was silent for a few moments before he answered, and then said: "I cannot settle the labor question, I know, but we can settle it for our particular case, I think, and on the only basis on which it can or ought to be settled—that is, on what is fair. No other is possible, to my mind.

"Now, what are our conditions? Just these: Under your system, coupled with the very hearty co-operation of the men, this company has made more money than it expected. We have a fine lot of men—not just machines. Without this joint work, nothing could be accomplished as far as I can see. It is, therefore, only a matter of justice that as one side is a gainer the other should also profit. Not only is this fair, but it is a wise course to take, as you can see, as it makes towards a continuance of the same conditions, and that is what we all want."

Bob's face beamed as he exclaimed: "Mr. Rogers, that is just the way I look at it. To break up our gang would cost us a lot of money, and even if we did hold the men down to the scale of pay they now get they would not work as well as now. They would not give the present output and all would have a grouch."

Mr. Rogers acknowledged this, and Bob continued: "Then all we have to do is to have Mr. Anderson put up a notice."

"Wait," said Mr. Rogers, "not quite so fast. What advance do the men ask?"

"Why," said Bob, "fifteen percent is what they ask, but I think they would be glad to take ten and not have a strike."

Mr. Rogers shook his head, and, much to his listener's surprise, said: "No, that is not the way to look at it. It is a question of are the men entitled to what they ask? If they are, they should not be asked, or made, to take less. We can afford to give them this advance, so, my boy, we will do it. But to post a notice just from the management of this shop would not answer at all."

"Why not?" exclaimed Bob in great surprise. "They would be getting all they asked."

"Yes, they would be getting all that they asked for, but there are others to be considered," answered Mr. Rogers.

Bob was bewildered.

"You know George Mann, the business agent of the boiler makers?" said Mr. Rogers. "Well, he is a mighty fine fellow and has saved the men and the bosses much trouble and loss in the past two years. I know him well, and he is broad-minded at all times. If we had to deal with men like him there would be few, if any, labor troubles. But that organizer, Wall, is quite another type and no end of a trouble maker."

"Yes," said Bob, "he is no good and our men don't like him."

"Well, he has to be reckoned with in our case as well as Mann," said Mr. Rogers. "You must see these men and we can post a notice about like this:

"This company, after conferring with Mr. George Mann and Mr. Henry Wall, representing the boiler makers' union, have agreed to advance the wages of all our workmen fifteen percent, after next Saturday. We believe this action shows our appreciation far better than words, yet we are glad to say that we do appreciate the way in which all our workmen have aided us in making our business pay, and we hope to have the pleasant relations continue.

"There," said Mr. Rogers, rising, "see these two men as soon as you can, but see Mann first and let that shouter talk. It will make him feel good and do no harm to you."

All this plan was carried out by Bob, but not without some fear on his part of making a mistake of some kind. All went well, however. The men, of course, were pleased and Bob was greatly relieved.

After the wages question had been settled, Mr. Rogers saw a good deal of Bob, as the matter of the plate shed had to be settled. Finally it was settled just as Bob wanted it—that is, by adding three bays to the west end of the shop. The shop was of steel and brick. Its end had, however, never been bricked in, as the idea of an extension had been in mind when it was built.

"You see," Mr. Rogers," said Bob, "by having the new track come at the west end we can lift the plates with the crane right into the racks. These will all be to the westward of the new tracks, so there will be no danger of hurting anybody in shifting the plates, as there was when we had to carry them the entire length of the shop and over all the men. Now the plates will be taken to the rolls, or to be laid out, or to the drill presses, then further on to be assembled, and at last, when the boiler is all done, it will be loaded onto the car at the east end of the shop. That makes a continuous performance. We will save the cost of the extra crane track and extension and other outlay in less than a year. Then taking down the old shed will give a lot more light.

Mr. Rogers agreed, by a nod, then said: "Bob, why don't you get married? I know you are engaged to a very fine girl."

Bob blushed and answered, "I want to get a little more ahead. That's prudent, is it not, Mr. Rogers?"

"How much," was the query, "do you want to get ahead?"

"Well, answered Bob, "I think I should have about two thousand dollars to fall back on, but I have only about half that amount as yet."

"That is not bad, but you need not be without two or three thousands more any day," was Mr. Rogers' answer.

This surprised Bob, indeed, and he said, "I don't see how I am to get those amounts, unless someone gives them to me, and that is not likely."

"No, perhaps not," answered Mr. Rogers, "but you can go and buy the sums (just as you can a loaf of bread) at any insurance company."

"Why," answered Bob, "you have to die to win in that game."

"Not at all," was Mr. Rogers' quick answer, "get that idea out of your head at once. Go and get a twenty-payment policy for, say, three thousand dollars. As soon as you are accepted and have paid your premium you have an estate of that amount, and if you die the next day your wife would be paid the sum in a few days. It would be just as sure as the bank. Then if you could not keep up the payments you do not lose what you have put in, as you can get a paid-up policy for the sum you have paid or a certain amount of the cash that you have handed over to the company. At your age and with your present pay you will not find the payments a burden, unless you take out too large a policy. That is often done, and it is a grave mistake to load up with more than you can well carry. Go and get figures from several companies, but let me see them before you settle just what you are to do. And tell the agent that you will make up your mind and let him know if you will take what he offers or not, but you do not want him to call on you unless sent for. The insurance men make a big mistake by trying to force a man. They get to be a burden, and often lose out in that way.

"Now just look into this matter at once and get married. By the way, your salary goes up twenty-five dollars a month; I forgot to tell you that."

With a laugh Mr. Rogers shook hands with Bob and left him very much bewildered, but very much elated.

(To be continued.)

A Plea for the Apprentice

System of Apprenticeship in British Shops Needs Revision—Where the Weakness Lies and How It May Be Remedied

The training and technical education of the average engine fitter and boiler maker sadly require attention from employers. A boy eager to become an engineer enters a marine engineering shop—probably he is bound for five years' apprenticeship, which means that his employers are to teach him the trade of fitting, while he must serve them during the named period. His first interview is with the timekeeper, who initiates him into the hours of work and the penalties of any lapse of discipline. He is passed on to the foreman of generally the nearest shop, who promptly looks around for a machine man requiring a mate. The writer well remembers being taken over to a machine for turning the taper in the bossing of a propeller and the foreman's instructions to keep a note book and sketch.

So far, so good; but is this good enough? What impression does the young engineer get of his future work? Generally it is a poor one and he feels anything but happy. *En passant* I will be forever grateful to my first machine man, who gave me the soundest advice I have ever received. He told me never to funk a job. If you can't see even the first step—well, take your coat off or get out a file. Do something and the rest will come, and I have found this true.

Conditions the Apprentice Has to Meet

My article is not a complaint, but a plea for a more careful consideration of the training of the apprentice in marine and boiler shops. If the boy, who by now probably is bored to death with the machine and gets into trouble because he will wander around other machines, asks for a move, he may get it or he may have to desert and risk a row; but, as a rule, he has to move on his own initiative. He then gains some experience as a fitters' mate, either in the form of an older apprentice or a journeyman. This is good if his mate is good, but he is not always good.

After two years of this casual training a boy in the lathe shop wants a move, and a chance opens for a boy in the fitting shops. A lucky one gets it and leaves several unlucky comrades behind, and so the tale of chance goes on. Granted it is that a boy with a good purpose can get around and learn, but it is generally no fault of the employer if he does so.

The writer knows within his personal experience of an apprentice who desired to learn lathe work, and, failing to be moved, he disappeared out of the fitting shop and was found in the lathe shop, from which he refused to move; so the foreman of the fitting shop went to the foreman of the lathe shop and damned the boy's character. Such was the result of ambition.

Generally three or more apprentices are required in the boiler shop to fit mountings and repair the machinery of the shop, but there is no roster kept enabling all the apprentices to learn this necessary work, and the writer had to follow the step of the boy who wanted to go to the lathe shop before he could gain this experience, and this method, although serving its purpose, is not good for the discipline of the shop or the apprentices.

Knowledge of Boiler Construction Essential

The construction of boilers is a very essential knowledge to the engineer, yet how few of the apprentices are given the opportunity of actually working on boilers, fitting the mountings or actually running the boiler on the test. The marking-off table requires only one apprentice to act as mate; but is there any need that once an apprentice has learned the job he should be kept there because the journeyman is too lazy to teach another boy? For an apprentice to become efficient at any job, such as fitting boiler mountings, marking-off, turning or erecting, generally signs his death warrant so far as having opportunities of learning other sides of engineering. Apprentices come and go, and it seems as if every one is happy so long as there are plenty of mates to work with the journeymen.

Comparisons are odious, but why is it that apprentices in locomotive shops are guided through the different grades and not so apprentices in marine and boiler shops? Again, let us consider the technical training of our young engineers. Is it not quite recently that an apprentice is allowed to lie in on the morning after night classes? But not yet is it a universal practice to encourage practically the attaining of technical distinction. To allow a few hours' extra in bed after night classes and not to insist on results of the classes is only, in a majority of cases, breeding laziness. The writer has had some experience of night class lectures, and the classes are generally made up of two kinds of boys—those willing to learn, and the others who attend in order to have this class card initialed and so earn a few hours' sleep next day. Beyond this privilege mentioned, there is nothing to encourage night study except ambition, which, in most cases, is dormant until a boy reaches, say, eighteen years or even more.

There are too many poor and medium fitters and an insufficient number of well-trained engineers; and the blame lies mostly with the head of boiler making and engineering establishments. It is as easy for a good working scheme to be thought out and put into practice as to "carry on" in the present slipshod fashion. It will benefit the employer in the long run, for, instead of having a crowd of so-called fitters hanging around his door waiting to be taken on, he can have a group of regularly employed engineers and boiler makers inside the shop.

It is my experience, and I ask the employer to believe me as a late apprentice, that these casual fitters run up the cost of a job about thirty percent. Is there any doubt that a good, well-trained fitter or boiler maker is worth two semi-trained men? I do not think so. Again, does not *esprit de corps* play another part in a good workman's life? Is it not worth money to the employer—yet, who can expect such a spirit from the man who knows he downs tools when the job is done?

Combine these two, a well-trained fitter or boiler maker and a man with a keen sense of *esprit de corps,* and surely he can compare with at least two casual fitters.

In France, during the last four years, millions of men have faced death for one word and what it means—"honor." Cannot this word be introduced into the engineering shop, or is it for the battlefield only? A boy wandering and drifting through a boiler or fitting shop never hears or sees the word, and, consequently, what are the works to him? He knows that as soon as his apprenticeship is finished his firm will perhaps offer him a pound a week, but they do not mind whether he stays or goes. They themselves place a value on their own training of an apprentice, and it amounts to nothing.

Minor Improvements

If I am asking too much for a drastic change in the system of apprenticeship, there are several smaller alterations that would mean big improvements. Why cannot there be practical tests each year with suitable encouragement to the apprentice and such places as the drawing office and marking-off table or boiler fitting shop open to the best apprentices? The boy who can use a lathe well is just the one to teach how a boiler is made and how a safety valve is made and mounted, and the boy will then be an all-round fitter.

The drawing office should be the reward of four years' hard studying—not a mere chance, as it generally is. When the writer served his apprenticeship he never saw one boiler maker apprenticeship in the drawing office, and yet his firm made marine boilers. In several big firms the sons of well-to-do men can, for a certain sum of money, ensure a good training in the different shops, but it is very rare that a poorer man's sons can do so. They must be content to stay in one shop. It does not make any difference how clever they may be.

The want of all-round trained artisans has been revealed in this war. There have been plenty of men who could do special fitting jobs, such work as they had been used to for years; but if a particular lathe man became ill the lathe was out of use until another lathe man was sent up. Yet these so-called fitters had served an apprenticeship in shops where lathes were used.

So much for the practical side of an apprentice's training; but what about the commercial side? Does he ever see inside a cost office or the estimating department except to take an occasional message? How many apprentices can tell you what the working expense of the firm is or how the file that he uses is bought and paid for? I often wonder if he ever realizes that a file or chisel cost money. It is doubtful, and yet if he knew that the more jobs a file is used on the cheaper will be the different jobs, and, consequently, the more ultimate business for the firm, surely his knowledge will be a gain to the firm.

This article has dealt mostly with the result to the firm, but it is the same with the apprentice—commercial knowledge is essential to-day. I notice constantly articles in The Boiler Maker on how to make a boiler-making firm pay. Surely this subject should be a part of the apprentice's education. It is quite as important for a man to know how an order is taken, sized up and estimated as how to carry it out. The other day an American engineer was brought over to England to manage one of our railways, and a certain English lord bemoaned the fact that this should be necessary and he wondered why. Let him go to any engineering firm, select any of the apprentices who have worked their way into the drawing office and ask them to tell him how the counting house or cost office is run. He will be surprised at their ignorance, yet these are important parts of a modern engineering firm, and the general manager has to know before he can attain this position.

Weaknesses Realized Too Late

Not many apprentices realize the weakness of their training until they become journeymen and they have ambitions towards higher jobs. Then they have to look around for books to teach them what they should have learned years ago, and, as a consequence, their time is taken up in acquiring general knowledge instead of specializing.

Now is the time for changes. Let this subject be on the list of consideration. Ten minutes' thought will be sufficient to reveal its necessity, and very little time is required to put into action a working scheme. Some firms, very few, have done so more or less; yet even they have not done all they can. Surely a big firm can afford an apprentice master whose time and energy are to be spent in controlling the teaching and training of the apprentice. Such a man should be one capable of lecturing at the night classes so that he is in touch with the apprentices during the evening as well as the day. His work in the shops need not clash with the foreman, for he is simply there to see that each apprentice goes through the different departments and that any ability developed is used accordingly. The good can be separated from the bad much better by this master than any one foreman, and the apprentices themselves will realize the importance attached to their training.

The technical committees of different towns do their best to train the apprentice theoretically, but there is at present no means of keeping a direct connection between the committee and the firms employing the boys during the day. The possibilities of good to be done by employing a qualified apprentice master are enormous, and the money invested would yield a high interest in years to come, and I should like to read of other opinions on the matter. M. T.

Supply Trade Notes.—The Badenhausen Company, Philadelphia, Pa., announces the opening of additional sales offices at 311 Jenkins building, Pittsburgh, under the management of A. D. Neeld, Jr., and also at 1225 Marquette building, Chicago, under the management of J. F. O. Stratton.

The Chicago Pneumatic Tool Company, Chicago, Ill., announces the discontinuance of its office at Wichita, Kan., and the transfer of stock to Eldorado, Kan., where an office and warehouse have been established. The company also announces the opening of a new office at 313 Richards building, Tulsa, Okla., with warehouses at 102 North Cheyenne street.

Flues

Methods Employed in Installing Flues in Stationary and Locomotive Boilers

BY GEORGE L. PRICE

In the articles published in THE BOILER MAKER from time to time regarding flues and the different methods employed in the installation of same, I have noticed the differences of opinion as to how to tell when the flue is rolled tight enough by the sound or the drive of the roller pin. According to the drift of this discussion, I am taking it for granted that these writers are talking about rolling flues in stationary boilers, as our present-day methods in locomotive work call for the use of pneumatic tools.

Taking up the question of rolling or expanding flues in stationary boilers first, I will state that when applying flues in watertube boilers that have forged steel headers it is advisable to use precaution when rolling the flues. I am of the opinion that no one but a competent mechanic should attempt this class of work, because watching for the scale to form around the flue on the sheet in this case would not be advisable.

It has been my experience when applying tubes in forged steel headers to take into consideration the ring of the flue pin when being driven into the rolls and the amount of strength required to turn the rolls; also the crease produced by the rolls, the latter, however, to apply only when the ends of the flues are not visible, as when applying the short 6- or 8-inch flues that connect the mud drum. A mechanic may also determine the proper amount of rolling to give a flue by watching the working or expanding process that the end of the flue is undergoing while he is rolling it.

When applying flues on new work, we know that all the flue holes are uniform, and I am of the opinion that the first flue should be rolled by hand. This first flue should be the gage, and, after the flue is rolled in the proper manner, set a stop on your pin and roll all the others in the same manner. This process will insure a uniformity in the flue holes that will be of great aid to the person who puts in the second set, and may possibly save the reaming out of the flue holes when making the second application. And I am sure it will have a tendency to equalize the compression upon the flue sheet bridges, which will give longer life to same.

What cracks our flue sheet bridges? Crystalization. What produces crystalization? The excessive condensation of the molecules in the steel from different causes, as blows of a hammer, variations in temperature, pressure from flue rolls or expanders and other abusive methods which are permitted to exist. Whenever you find a cracked bridge, measure the flue hole adjacent to same and note if it has not been enlarged by the flue rolls or some other agent. I am of the opinion that uniformity should be applied in all cases, or, in other words, we should adopt a standard practice in our work and constantly apply same.

When rolling flues on new work in stationary boilers with steel heads it is often the practice in many shops to have a boiler-maker helper roll the front end while the boiler maker is beading the back end. In this case, I would again advise the use of the stop on the flue pin, said stop, however, to be set by the boiler maker. This method will not permit excessive rolling by the inexperienced man. Flues in all classes of boilers should be shimmed tight in the proper manner before they are rolled. A flue that is loose in the hole when it is being rolled will only thin out and possibly burst in the seam.

I do not think it is good policy for the flue ends to protrude out of the sheet over ½ inch when they are not beaded. The end to be beaded should not protrude out of the sheet more than 3/16 inch, and up to 5/16 inch the length for bead is generally regulated by the style and size of the cavity of the beading tool. Flues in firetube boilers are generally beaded, while flues in watertube boilers are not.

The question is often asked why do we bead the fire end of the tube and not the other? Generally on stationary boilers of the horizontal type both ends are beaded, but on a vertical boiler the flues are generally beaded on the fire end only. They are beaded on the fire end to protect the ends of the flues, as the excessive heat from the hot gases strikes them very forcibly upon entering the flue in its passage to the front end. The wear and tear of this constant force upon an unprotected flue end would soon cause considerable trouble. On the other hand, at the front end of the tube the hot gases, in departing from the tube ends, do not have the same forcible effect on account of their reduced temperature and their travel out of the tubes.

When rolling tubes by air the self-feeding expanders should be used with a stop on the p'n. However, I do not think it is advisable to roll flues from 2½ to 4 inches with air, as this operation necessitates the use of a high-powered machine, which is very heavy to handle and also dangerous. When using the self-feeding rolls with an air machine the stop on the pin will pull the pin automatically when the pin reaches the proper point of contact on the stop. This operation saves the workman the time and trouble of reversing his air machine on every flue.

It is very good practice to have both sides of the flue hole chamfered off slightly when the flues are to be prossered, thereby eliminating the sharp edge of the flue hole, which will have a tendency to shear the flue when it is worked. When the flues are to be expanded with the roller expander the flue hole should be chamfered off on the side of the sheet where the flues are to be beaded. I also believe in a driving fit for all flues wherever it is possible.

LOCOMOTIVE WORK

In locomotive work the flues are generally rolled or expanded with air tools in the front end and not prossered. I consider a flue that protrudes ¼ inch outside of the front flue sheet the proper length and the most convenient to work, for when we get a flue that protrudes from ½ inch to 1 inch outside the sheet, and especially when the holes are worn large, they are liable to split when they are pinned out.

All flues are generally shimmed in the front end with iron shims. The use of copper shims has been abandoned by the railroads for some time, and I do not think copper shims are necessary when sheet iron answers the purpose just as well. On new work, when the sheets are new, some railroads do not use shims in the front end. They enlarge the flue ends at the flue fire so that they fit into the front tube sheet snugly. This method is good practice and should be adopted whenever possible, providing the front flue sheet holes are not too large.

All flues in locomotive work are rolled with self-feeding rollers, and, while some operators use a stop on the roller pin, others do not. I prefer the stop wherever it is convenient to use same. I also notice quite a discussion about the proper size of the flue holes in the front flue sheet. I think that the front tube holes should be 1/8 inch larger than the outside diameter of the flue.

Just a few days ago a case came to my attention where it would have been impossible to install a set of flues with the holes smaller than 2 1/8 inches. We had a set of 2-inch flues to put in, and the front flue sheet was warped and distorted so badly that the flues could not be shoved straight in at right angles with the sheet. We had about 25 or 30 flues in the center of the sheet that had to be shoved in with the alinement of the distorted flue hole instead of at right angles with the sheet. The flues varied in length in this set from 1 inch to 1 1/4 inches, due to this warped sheet. This sheet, however, has possibly had ten or twelve sets of flues, and the flue holes have been rolled and re-rolled until they caused distortion of the sheet. This fact alone has convinced me that the proper size of the front flue sheet holes should be 1/8 inch larger than the outside diameter of the flue. Railroad companies do not spend the time in having flue sheets straightened nowadays as they used to. I have seen four and five lengths in a set of flues quite often.

Many boiler makers have the idea that flues enlarged to fit the front flue sheet holes thin out until they become unfit for use in the interests of safety. I will agree with them should they attempt to enlarge old flues in this manner, but I think this process can be used with new flues and old flues alike, providing they are 1/8 inch in thickness and the flue hole just 1/8 inch larger in diameter than the flue. I have noticed that "Flex Ible" states it is apparent to any right-thinking man that in reducing the flue end by belling it out to fit a flue hole that is 1/8 inch larger than the tube the tubes are practically cut in half; or, in other words, a No. 11 B. W. G. tube which is 1/8 inch in thickness with the outside diameter of 2 inches enlarged on the end to fit a 2 1/8-inch hole is reduced in thickness to 1/16 inch. I will agree with "Flex Ible" that it is logical to *think* that the tube will thin out to 1/16 inch in thickness, but, practically speaking, I do not think that it will, because I believe the tube can be stretched 1/16 inch before it will be reduced 1/16 inch in thickness. Somebody might try this and settle the argument.

"Flex Ible" also states that some twenty-five years ago the Master Mechanics' Association came to the conclusion that the best way to finish a flue was to bead it before rolling, and that it has been proved by demonstration that the beading of the flue after rolling loosened the flue from its seating. With due respect to the Master Mechanics' Association, twenty-five years ago they were right, but from a practical standpoint and our present-day methods I think they are wrong. When flues were applied twenty-five years ago I do not think the prosser was used. They were expanded or rolled into the hole by the roller expander, then turned over with a hand hammer and beaded by hand. To-day a job like that would be just half completed, for the reason that we have to add an additional operation, and that operation is prossering with a big air gun. So for this reason I do not think that the beading of the flue after it has been rolled, belled out and prossered will loosen it from its seat, especially if the beading tool is held in the proper position during the beading operation.

(*To be continued.*)

Keeping Account of Each Piece of Work

BY EDWIN L. SEABROOK

A simple bookkeeping system for boiler makers can be adopted which will show the status of each contract or price of work when it is completed.

Such a system has been devised and is in daily use by a boiler maker. This system was developed to meet the needs of a varied line of work done by this boiler maker. He separates his business into several classes and is therefore able to determine which part of his business yields the most profit.

Each contract or piece of work, whether it is $1.00 or $1,000, is entered under its proper classification. A columnar book is used. When the contract or piece of work is completed, the line on which it is entered will show the price received, the cost of time in performing it, cost of material, overhead expense, and net profit.

A single transaction, an actual contract, taken from the records, will illustrate the system used:

REPAIRING

Name or No.	Total	Time	Material	Overhead	Profit	Remarks
	$63.60	$26.54	$15.14	$12.91	$9.01	

From the above it will be seen that an accurate account can be kept with every piece of work performed, and when it is completed the result shows just how profitable it has been. It should be particularly noted that this method permits of keeping each class of work separate. One page can be given to repairs, another to new work, and the entire business can be separated into as many divisions as may be desired. At the end of the year it can be readily ascertained which particular part of the business has been the most profitable. Of course it is necessary that an accurate account of the time and material of each piece of work be kept. It is also quite essential that each workman accurately record daily the amount of time on each piece of work which can be designated either by name or number.

This same boiler maker keeps his cost of conducting business, or overhead, in what he terms an "Expense Distribution Book." The columnar style is also used, each expense item is placed on a separate page and the amount expended for each item is entered under it. At the close of the year the total of these expenditures for each item is carried to the Expense Account. The overhead expense is listed under the following items:

Automobile.—Divided into repairs, tires, sundries, gas and oil.

Advertising.—Divided into general and help wanted.

Insurance.—Fire, liability.

Rent, stable, telephone, hauling, machinery, stationery, postage, printing, carfare, light and heat, and yard account.

This boiler maker also has a "Come Back" account. This is to take care of work that has been completed, gone through the books, but through some defect required further attention and could not be charged for as a separate item.

Lastly, there is the Miscellaneous Expense account, which takes care of expense items that cannot be listed in any of the regular expense accounts.

This system is extremely simple, there is nothing complicated about it, and it can be kept by any boiler maker who will give the necessary details the proper attention.

The columnar sheets come bound in book form, or they can be secured separately and used in loose-leaf binders.

Jim and Fergus Visit a Boiler Shop

New and Useful Kinks Found in a Modern Up-to-Date Plant That Is Rapidly Increasing Its Business

BY JAMES FRANCIS

THINGS are pretty well "up in the air" in Indianapolis at this time—railroads, the gas company and the boiler shops. The railroads are "up" because of the elevation of grade crossings throughout all parts of the city. The gas company has "gone up" because of the blowing up, very recently, by the city public service commission. They have been "blown up" to the height of paying $100 a day forfeit to the city for not furnishing gas of standard 600 B. t. u. per cubic foot.

And, what do you think? Fergus says that some of the engineer sharps have figured out that the gas company saved over $500 per day by furnishing poor gas, and that they laugh in their sleeves while paying $100 daily and still have over $400 profit left from furnishing poor gas. That's why the gas company is "up in the air," for most of their gas seems to be air! See? Fergus says he does. But the boiler shops; they are "up in the air" for the very simple reason that they, to the recollection of either Fergus or myself, have never been underground!

"Up in the Air"

WALKING AND PROGRESSING

Last February we had a chance to visit a very progressive shop in Indianapolis—The Indiana Tank and Boiler Works, 1123 East Maryland street. This vigorous shop is only about four years old. It is a child of the National Dry Kiln and the National Boiler and Sheet Iron Works just across the street at 1118 East Maryland. Fergus says the new boiler concern seems to have had *not* "poor, but worthy parents." Still, in spite of that, the new boiler company was not born with a "silver spoon in its mouth"—not by a good deal. If it had anything at all in its mouth when born it was a cold chisel or a drift; but the new shop is now a lusty lad about four years old and has had its clothes enlarged twice already and is now being "put into short pants" by the construction of a third addition to the shop buildings.

The parent companies decided to quit boilers and make only dry kilns, so Mr. E. Bossingham, the manager of the old boiler company, together with Mr. E. A. Craig as vice-president and Mr. R. R. Bossingham as secretary, formed the new Indiana Tank and Boiler Company and took over the boiler business of the parent company, with Mr. E. Bossingham as president and general manager.

But Fergus says I am getting ahead of my story, for we haven't even got to the shop yet. That is so, and it is a task to get there, too, for the Indianapolis Street Railway Company is also "up in the air," so we-uns have to walk—part of the way at least. The old Virgina avenue viaduct seems to have become tired of waiting for track elevation, so one day a girder let go and all us "South Siders" have to walk across the old viaduct, then take a dinky shuttle car, which doesn't even shuttle but runs around three corner lots, turns once upon a "Y" and waits at the far end of the viaduct until another "shuttle" car rattles into view. Then the car at the bridge slips away, even if you may have one foot in the air ready to step aboard—"up in the air," too! See?

NEW TOOLS, TOO

The boiler shop is to have a lot of new tools, as well as a lot more floor space. When the original building was erected about four years ago the I-beam track for the overhead crane extended out of doors 30 feet or so, and the new and heavier construction will enclose this crane track, adjacent to which the heavier tools, punches, shears and new rotary shear, etc., are to be located. Four new motors—one of them pretty large, too—are to be installed to drive most of the machine tools individually, thus getting rid of the line shaft which now extends, post-hung, along one side of the old shop.

But, Fergus got ahead of his story this time. Just after we left the East Washington street car to walk a few blocks in nice Maryland (street) mud, we passed a barber shop and Fergus spied upon the window the legend in bold letters:

MARION'S
SHAVES

I really thought at the time that we would have to give the boiler shop a job on Fergus, where he nearly strained the gusset seams of his coat tails as I dragged him out, just as he was disappearing into that barber shop to find out whether "Marion" wore corsets or suspenders!

When the boiler shop first went into business they put in an air compressor, driven by an independent motor, and both machines placed on a pair of timbers half buried in the shop cement floor. Some nice open channels were left for the air pipes, below the floor level and out of the way, and the "boy" of the new shop paved the channels with nice brick, pointed smooth in nice cement mortar. Next week the air pipes all froze up, and Oh! what a time they did have digging out those bricks to thaw out the pipes! There is not a sign of concrete around those pipes now, but a larger compressor is on the way to be set in place of the outgrown smaller one.

Tool Protection

I saw Fergus looking at the upturned flat surface of a small "brake," upon which had been neatly lettered with white paint: Do not use this brake only to bend No. 16 or lighter. And such caution is needed, too, for there seems always to be some man in a shop who will jamb a sheet into a tool, no matter whether the machine is suitable for the work or not. The caution is well-timed, and more of it should be in use around boilers shops—and enforced, too.

The heavy shear with 12-inch blades was fitted with a handle which enabled the machine operator to control the cut even across a pretty wide sheet. An extension about five feet long had been attached to the lever, which started the machine into operation. The extension was made of a piece of 2-inch steam pipe, with one end forged to fit the end of the starting lever. The pipe was driven over the end of the starting lever and "stuck out like a sore thumb" in front of the machine, just where the operator needed to have the machine control located.

Marion's Shaves

Each tool and machine in the shop was well protected by thin sheet metal, some of the sheets being merely set in place, others being fastened where they would do the most good. But every gear and belt had its protective metal guards, which rendered the machines safe for the workmen.

A Novel Building Arrangement

When this shop was built it consisted of a long frame structure with a lean-to shed. Later more land was acquired, a big old barn was purchased and another frame building, similar to the first, was erected alongside of the shed. These frame buildings both have pitch roofs. Now the space between the two frame buildings has been covered with a high flat roof, after which the lean-to roof was torn out, leaving a building which appeared symmetrical outside, and which contained a whole lot of room inside, with three fine bents, each without a post in them.

I saw Fergus out in the shop yard looking very closely at a device made evidently for shop heating purposes a year ago, when the mercury played ground hog and went down out of sight. Fergus said he had never before seen such a big "bucket," or one with legs, and as leaky as this! The shell was about 3 feet high and 22 inches in diameter. The legs, riveted on, were four in number, of 1/4-inch by 2-inch black steel. Six holes had been knocked through the shell about two inches above its lower edge. These holes had evidently originally been punched.

Then the holes had been split open with a cold chisel and the cut edges of the 1/8-inch sheet driven back until a piece of 3/4-inch pipe would pass through two of the holes, all of which, so Fergus said, looked as though they had been "hammered out between thunder and a rock." A short piece of 3/4-inch pipe was thrust through the two middle holes, then other pieces put through the holes on either side of the middle pipe. This brought three pieces of pipe through the heater shell parallel with each other. On top of these pipes was thrown a bit of 1/8-inch tank steel, with the corner sheared off roughly so the piece of steel would go into the heater shell.

A lot of holes had been punched in the piece of steel plate, which did duty as a bottom, or grate, upon which the coal fire was built in the heater. A handle, or "bale," bent into holes near the top of the device, added greatly to its resemblance to an immense bucket or "pail." For a time I did not know but what Fergus would run and hide, just as Pat did in the Charleston (Mass.) Navy Yard the first time he ever saw an old-time sheet anchor, the kind that are pictured in the books. Pat's eyes popped out, he looked all around, ready to run at an instant's notice.

"What's the matter, Pat?" some one asked, and Pat replied: "Faith, an' I'm skeered," and, pointing to the anchor, he said, "I'd hate to be afther meeting the man who uses that *pick!*"

A branch track from the railroad runs past the shop about 50 feet distant. The track runs lengthwise with the buildings, thus leaving a fine loading yard between the track and shop. A derrick, made in the shop, has been erected close beside the track. The device has a capacity of about five tons, although the crab which forms the winding part of the device can handle about seven tons. The derrick was built up from steel shapes and stands upon a pivot rendered ice-proof, and which in turn is carried upon a concrete foundation.

A platform, built out from the mast and revolving with it, served as a standing place for the men who operated the crab. Five guy cables were attached to the top of the derrick, and the method of their attachment was most simple and effective. A circular plate of boiler steel was drilled to slip over the top pin or gudgeon of the derrick, then a row of holes was punched around the edge of the 20-inch disk. The five guy cables were fastened into such of the holes in the disk as came fair with the guy cables in question.

Leading out from the shop, at right angles thereto and to the railroad track, was a light track, probably "industrial," of about 36 inches gage. On this track was a steel transfer car, same as used in the dry kilns of the company across the street. The car could be pushed from the shop to the railroad directly into the circle commanded by the derrick, thus making loading and unloading quite easy, especially of the many dredge buckets which came to the shop for repairs.

The amount of activity in enlarging the shop and acquiring new machinery means that somebody is very optimistic regarding a large volume of new business in the immediate future. I left Fergus tracing out the pipes which led *somewhere* from a little 6-inch rotary pump on the ground right behind the power punch, while I went

On the Way to the Shop

into the office with Mr. Bossingham and he showed me what he proposed to do in the immediate future.

It very soon developed that the work he was fitting the shop for was the making of tanks—"hydro-pneumatic" pressure tanks for water systems in isolated houses where water is used under pressure obtained by forcing water from a well or pond into steel tanks against the pressure of the contained air. These tanks, some of them, weigh as much as 3,800 pounds. Most of them are smaller, and they are usually made of tank steel from 1/8 to 1/4 inch in thickness. This class of work seems good to the writer—light, clean, not too heavy, and easy to lay out and set up.

Lay-Out Templets

A considerable number of lay-out templets were observed in the shop. They were made from thin sheet metal, about No. 14, apparently from strips four to six inches wide, the end joints put together with "gusset pieces." A templet thus made for each standard shell to be turned out certainly reduced laying out to its lowest terms.

Just then Fergus came along and said: "Say, Jim, what is that chap trying to do over there by that vertical boiler shell? He takes one of those 5-foot boiler tubes between his knees with one end resting on the ground and the other end against the shell of the boiler, which is lying horizontal and which the tubes are to go into. With the tube thus held, he files off the burr at the end and also files off the scale, when there is any, for six inches at the end.

"As soon as one end has been filed, he goes for the other end of the tube, and there he is working away with a file by hand when two emery wheels are standing idle within twenty feet of him. He says the tubes must go inside of ferrules, so he smooths up both ends of the 102 tubes in that boiler by hand. Why in creation doesn't he do that work with the grinding wheel and save nearly all the time spent and *all* of the files he uses up?" And Fergus went off, shaking his head and wondering about the ways of a boiler maker with files and flues.

"Overhead" and Estimating

While Fergus was puzzling over hand and machine work, Mr. Bossingham was relating some interesting experiences in calculating the cost of work and the making of estimates. He remarked that very few boiler makers, even some of those owning or operating the larger shops, seemed to have a comprehensive idea of fixed charges, or "the overhead," in general. He told how this worked out in competitive bidding, where some shop owners had evidently added nothing whatever for the "overhead" and all too little for profit; also nothing for the time of the superintendent or manager of the shop.

"When they do this, or don't do it," Mr. Bossingham added, "their figures make me look foolish, while all the time they are foolish for giving in such figures as will allow them absolutely no profit. I find it necessary to add at least 75 percent of the labor cost for "overhead," and then there must be 10 or 15 percent profit added, or what's the use of doing business?

"Here's another way in which some shops lose out," continued Mr. Bossingham. "They don't charge for the capital invested or for the salary of their manager. Now, with $10,000 tied up in a shop and tools, that amount would bring in 4¼ percent if put into Liberty Bonds, so why should it be a liability in a boiler shop? It is, but too many shops don't figure it or include their own compensation. That method makes my bids seem high. I lose business and they do it at a loss or with no profits. Why will they not "come to life" and make estimates right?"

"Hey, Jim," yelled Fergus, "let's go back along the

A Case of Mistaken Identity

railroad track and we can skip all the mud and go past the brewery, too. Gee! but I wish the windows weren't all boarded up. I used to like to look in and see the big engines and *other things* in there. But things sure are dry and lonesome around the breweries now!"

How to Design and Lay Out a Boiler—VI

Why the Longitudinal Seam Must Be Stronger Than the Circumferential Seam—Formulas for Finding Strength of Boiler Shell

BY WILLIAM C. STROTT*

The next phase of design covers the circumferential joints, or "girth seams," of which, in our boiler, there are three, viz., at the juncture of the two courses of plate at the center, and their connections to the two heads or tube sheets.

These girth seams may be single-lap riveted for reasons which shall now be thoroughly explained.

During the author's apprenticeship in the boiler shop drafting room he used to wonder why the joints "around" the boiler were so much more simple than the complicated longitudinal joints. To make matters worse, the "checker" in that particular "engineering" department enlightened him with the information that the *ring seams were always twice as strong as the longitudinal seams!* This statement will sound like sheer ignorance to the technically trained man, but, strange to say, other men, supposedly well up in the field of boiler construction, have been heard to make this identical remark—probably not because they did not understand the theory but rather that, from years of misuse, it has become a "word of mouth" expression. What is really meant is this:

The stress in the longitudinal joint of a cylindrical shell when subjected to internal pressure is twice the stress in the circumferential joint. Suppose we consider a seamless hollow cylinder with ¼-inch thick walls of the dimensions shown in Fig. 20 and under an internal pressure of 100 pounds per square inch. By 100 pounds per square inch

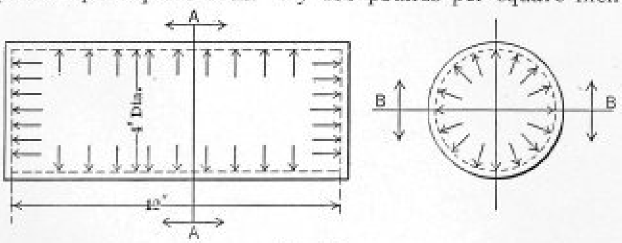


Fig. 20

is meant that the fluid—be it steam, air, gas or liquid—is acting with a force equal to a weight of 100 pounds against every square inch of the internal surface of the vessel. This force acts equally and opposite in every direction, at right angles to the surfaces, as indicated by the small arrows in Fig. 20. The term "pressure" to which we always refer in calculations of this kind is known as gage pressure, i.e., the actual pressure existing within the vessel, as determined by a pressure gage.

In scientific work the term "absolute pressure" is encountered. Although an understanding of the meaning of this term is not essential to the boiler designer (in so far as the actual design of the boiler from a standpoint of safety is concerned) it might nevertheless be well for him to become conversant with its application, so as to enable him to speak intelligently should the occasion arise.

If a vessel under a pressure of, say, 10 pounds were placed in a perfect vacuum, the steam gage would then read 10 pounds + 14.7 pounds, or 24.7 pounds, because the neutralizing of effect of the atmospheric pressure (14.7 pounds per square inch) has been removed. Hence, whenever the absolute pressure is spoken of the designer will know that it is the gage pressure plus the atmospheric pressure.

Referring now to Fig. 20, the student should first understand that pressure against the heads tends to tear the cylinder into two parts across its diameter, as indicated by line *A-A*. This force is resisted by the ring of plate, in this case 4 inches in diameter and ¼ inch thick. The area of metal thus resisting is 3.1416 × 4.25 inches × 0.25 inch, or 3.338 square inches.

The force tending to break this ring of metal is known as the end thrust of the heads. It is found by multiplying the area of the head in square inches by the pressure on the surface of the head in pounds per square inch. In this case it is $(4)^2 \times .7854 \times 100$ pounds, or 1,256.6 pounds. The student is probably inclined to believe that the force on both heads should be considered, or 2,513.2 pounds. This assumption is not correct, as will be deduced from Sir Isaac Newton's "Third Law of Force and Motion," viz., "To every action there is an equal and opposite reaction." In other words, if one head is pulling with a force of 1,256.6 pounds, the other head is resisting this through the medium of the shell plate with an equal and opposite force, or "reaction," also of 1,256.6 pounds.

Now, since a ring of metal having a cross-sectional area of 3.338 square inches is subjected to a stress or "pull" of 1,256.6 pounds, then each square inch will be stressed to $\frac{1,256.6}{3.338}$, or approximately 372 pounds. This value is known as the "unit-tensile stress" in the circumference of the cylinder.

We next wish to find the unit-tensile stress in the plate in a direction at right angles to the circumference of the cylinder, or, in other words, the direction in which the two semi-circle would go if the cylinder were to rupture through line *B-B* (see end view, Fig. 20). This is termed the "hoop stress," and the action is similar to the "stretch" in an ordinary top balloon when inflated. To find the total force tending to cause such rupture, we multiply the diameter of the cylinder by its length, thus finding the area on which the internal pressure acts. The student may be considerably "at sea" on this point also—in fact, many will wonder why we do not consider the area of the inside surface of the cylinder, as it will be remembered we said the pressure acts on every square inch of the internal surface. So it does, but the chief point of the law should be also remembered, for it was pointed out that the force acts *equally and in opposite directions.* Notice how the "force arrows" indicated on the end view of Fig. 20 all radiate from the center of the cylinder, and by projecting any pair of *opposite* arrows, which will always be through the diameter of the cylinder, we get each time a line as *B-B*. If the student wishes, he may consider line *B-B* as an imaginary partition plate as per Fig. 21. It can be understood with very little effort that a pressure over the surface of the partition will be equally resisted by the walls of the cylinder at *t-t*.

Getting back to our calculations, we find that the area

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

of the plane through line B-B = 12 inches $\times$ 4 inches, or 48 square inches; and with a pressure on each square inch equal to 100 pounds, the total force tending to tear the cylinder into two semicircles, as in Fig. 21, becomes 48 $\times$

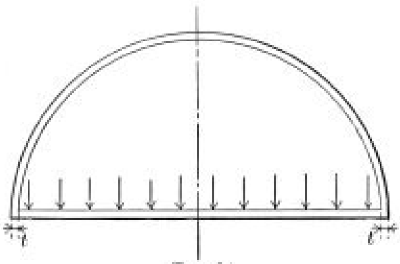


Fig. 21

100 pounds, or 4,800 pounds. There are two thicknesses of metal resisting this force as at t-t, and each thickness is equal in length to that of the cylinder, or 12 inches. Hence the total cross-sectional area of metal in tension longitudinally is 2 $\times$ 12 inches $\times$ 0.25 inch, or 6 square inches. From this we find the unit tensile stress to be $\frac{4{,}800}{6}$, or 800 pounds, thereby proving beyond doubt that the stresses set up in the longitudinal seams of a cylindrical vessel when under internal pressure are approximately twice those in the circumferential seams—2.15 times as much, if we wish to be exact.

Having convinced ourselves of the truth of this scientific principle, it should be obvious that the girth seams require but half the strength of the longitudinal seams.

In the foregoing method of reasoning concerning the longitudinal stresses tending to rupture the shell at t-t, Fig. 21, we have the following equation:

(a) $$2 \times R \times L \times P = F,$$

in which the diameter of the cylinder is denoted by $2 \times R$ (which means 2 times the radius); the pressure in pounds per square inch by P; the length of the cylinder by L, and the 4,800-pound force by F.

We know of something else that F also equals. It is the resistance of the cross-sectional area of the cylinder walls at t-t.

(b) $$F = 2 \times t \times L \times T_s.$$

Substituting this term for F in equation (a), we then have:

(c) $$2 \times R \times L \times P = 2 \times t \times L \times T_s.$$

We may cancel out the length of the cylinder L, since it appears on both sides of the equation. The same is also true of the figure 2. Canceling, we get:

(d) $$R \times P = t \times T_s.$$

Transposing for t, we have:

(e) $$t = \frac{R \times P}{T_s},$$

which, in words, simply means that if we multiply the radius of a cylinder by the internal pressure in pounds per square inch and divide the product so obtained by the unit tensile strength of the material of which the cylinder is made, we find the thickness of plate necessary to withstand that pressure. Thus have we in the most simplified manner possible developed the fundamental formula pertaining to stresses in pressure vessels.

Formula (e) will give the theoretical bursting pressure of a seamless cylindrical shell; in other words, of a vessel having a 100 percent "joint." The first thing we must do to this formula is to provide for joint efficiency. Let us call it E. Remember that it was also called E in formula (1) at the beginning of this treatise. We multiply T_s by E in formula (e) because, due to the joint, we do not get the full strength of the plate. The formula now takes the form:

(f) $$t = \frac{R \times P}{T_s \times E}.$$

Formula (f) might be applied to any practical problem, except that the resulting value for t would be just sufficient to resist rupture. What we must provide for now is to prevent the stresses from reaching the elastic limit or yield point of the material as previously explained, and at the same time provide against that "factor of ignorance." In short, we now "inject" the factor of safety into the formula. Denoting this factor by F as before, the formula is finally arranged thus:

(g) $$t = \frac{R \times P \times F}{T_s \times E}.$$

By transposing formula (g) it is possible to find any one unknown quantity when all the other quantities are either known or assumed. For instance, if we wish to figure what the safe working pressure would be for a given boiler, we arrange the formula as follows:

$$P = \frac{T_s \times t \times E}{R \times F}$$ (which proves to be formula [1] given at the outset of this treatise).

For convenience of those who are not sufficiently far advanced in mathematics to be able to transpose and arrange formulæ for any unknown quantity, we shall further arrange formula (1) as follows:

To find tensile strength, T_s:

(1_a) $$T_s = \frac{P \times R \times F}{t \times E}.$$

To find radius of shell, R:

(1_b) $$R = \frac{T_s \times t \times E}{P \times F}.$$

To find efficiency of longitudinal joint, E:

(1_c) $$E = \frac{P \times R \times F}{T_s \times t}.$$

To find the factor of safety, F:

(1_d) $$F = \frac{T_s \times t \times E}{P \times R}.$$

Our purpose in carrying through the above work leading to formula (1) was to demonstrate to the student the value of all engineering formulæ, and how, through a system of analyzing scientific laws, such formulæ are developed. As we proceed with the course, other formulæ will be encountered and their derivation also explained.

We will occasionally come across what are termed "Empirical Formulæ." "Empirical" means "based on experience or experiment" and are just what the definition implies. Such formulæ are developed whenever the nature of the problem in hand is so complex that no one basic scientific law can be wholly applied thereto. In that case the scientists or engineers engaged in research work build up a formulæ as near as can be devised from scientific analysis. Experiments or tests are then carried out based on these original deductions, during the course of which (sometimes extending through a period of many years) the shortcomings in their formulæ are discovered, and constants added until finally the formula is in shape for general use. For instance, the formula for the rivet gage (centerline of rivet to edge of plate), which is two times the driven diameter of the rivet, may be said to be empirical for

practice has proven this to be the most satisfactory proportion.

The ratio of the comparative strength of longitudinal to girth seams holds good in actual practice only when both joints are proportionately so designed, for it would be possible to produce so poor a ring seam that its efficiency might be much less than half that of the longitudinal seam. Therefore, we should always endeavor to design girth seams with this fact in mind, because the A. S. M. E. Code especially lays down two rules covering the efficiency of circumferential joints. Simplified, these rules are as follows:

(1) When the head of a boiler is not stayed, meaning when there is nothing but the ring seam resisting the full internal pressure against blowing the heads from the shell, the ring seam must be at least 50 percent as strong as the longitudinal seam.

Th's condition exists chiefly in watertube boilers in connection with which there are steam and mud drums of comparatively small diameter having dished heads without bracing. (Design of dished heads will be treated later under "Steam Drums and Domes.")

(2) When 50 percent or more of the boiler head is stayed against internal pressure, thus putting but half or less of the full load on the circumferential joint, the efficiency of the ring seam may be as low as 35 percent of the efficiency of the longitudinal. The bracing considered is that due to diagonal or through stays, and also that proportion of bracing afforded by the boiler tubes when same are expanded into the heads.

The circumferential joints of our boiler evidently come under the second ruling, because the boiler heads being flat they shall require bracing both above and below the tubes to prevent these flat surfaces from being "bulged out" under pressure. Considering, therefore, the large surface of each head which is to be acquired by the tubes, and, in addition, the area which will be supported by the regular braces, we can safely assume that approximately 50 percent of the total pressure on the heads will be carried by the bracing, and not be transmitted to the circumferential seams.

Recalling that the efficiency of the longitudinal joint was 92.4 percent, the girth joints may have an efficiency as low as $.35 \times 92.6$, or 32.4 percent.

Referring again to standard rivet pitches (Table 2), the maximum pitch for single riveting in ½-inch plate is given as 2¼ inches. The rivets, as before, will be ⅞-inch diameter, or 15/16-inch diameter after driving. The spacing will have to be in even pitches throughout the seam, and, for convenience in "laying out" (to which any progressive "layer out" will testify and gladly explain), the number of pitches should be exactly divisible by 4.

(To be continued.)

Boiler Power Versus Tractive Power—I

Increased Boiler Efficiency Necessary in Modern Locomotive Boilers—Formulas for Deriving the Tractive Power for Single-Expansion Locomotives

BY WILLIAM N. ALLMAN

In supplying the demand for locomotives having capacity for handling heavy tonnage, it has meant a continual development in the design of boilers to bring about the greatest efficiency. From 1900 up to the present time there has been a marked advance in the size and capacity of locomotive boilers, and for the purpose of increasing their efficiency very noticeable results have been obtained through the installation of superheaters, stokers, arch tubes, brick arches and feed water heaters.

The development of the steam locomotive in the United States has been quite extensive. As an illustration of the development, Table 1 shows the gradual increase in size and capacity, and, as the backbone of the machine, or source of power, is the boiler, we can appreciate the increasing demand that is being made on the boiler and the necessity for general improvements in design.

It has been found by the application of superheaters that there has been a saving of about 25 percent in fuel and a saving of 30 percent per indicated horsepower in steam consumption. Through the use of superheated steam the same cylinder power is developed at a lower boiler pressure, and, consequently, a lower steam-producing rate.

TABLE I
STATISTICS OF STEAM LOCOMOTIVES IN THE UNITED STATES—1902-1914

Year	Total No. Locomotives.			Average Tractive Power—Lbs.			Average Heating Surface Sq. Ft.			Average Grate Area Sq. Ft.			Av. Weight On Drivers—Tons.			Average Weight—Total Tons.		
	Single Expansion.	4-Cyl. Comp'd.	2 Cyl. Comp'd.	Single Expansion.	4-Cyl. Comp'd.	2-Cyl. Comp'd.	Single Expansion.	4 Cyl. Comp'd.	2 Cyl. Comp'd.	Single Expansion.	4-Cyl. Comp'd.	2-Cyl. Comp'd.	Single Expansion.	4-Cyl. Comp'd.	2 Cyl. Comp'd.	Single Expansion.	4-Cyl. Comp'd.	2-Cyl. Comp'd.
1902	35228	1175	1113	19946	29031	28515	1507	2556	2252	25	43	38	44	67	63	55	85	75
1903	40443	1953	849	21156	30551	31379	1590	2702	2551	27	50	37	46	70	68	57	99	82
1904	43246	1968	932	22206	31896	31335	1681	2843	2549	29	48	37	49	73	69	60	93	83
1905	45033	1793	870	23178	32326	31056	1759	2941	2569	30	47	38	51	73	69	62	95	83
1906	48300	1767	887	24307	33168	31561	1862	3070	2596	31	47	38	54	75	70	66	98	84
1907	51891	1727	945	25439	34345	31335	1952	3169	2578	33	48	39	56	76	70	68	101	83
1908	54230	1714	923	25088	35288	31378	2005	3268	2592	34	49	39	57	79	70	69	104	84
1909	53977	1603	888	26300	35173	31509	2041	3297	2614	34	47	39	58	78	71	71	105	85
1910	55867	1511	862	26891	39440	31326	2107	3489	2549	35	49	39	59	87	71	72	112	84
1911	57963	1407	792	27771	32928	32157	2167	3266	2615	37	46	40	61	73	72	75	102	86
1912	58842	1418	750	28482	33024	32282	2231	3279	2615	37	46	40	63	74	72	77	104	85
1913	60131	1373	707	29595	33038	32339	2235	3329	2603	39	47	40	65	74	72	80	105	86
1914	61518	1333	659	30346	33086	31931	2401	3340	2583	39	47	40	67	74	73	82	105	86

There has been much written on the subject of the ratio between the heating surface and cylinder volume of locomotives, and this ratio is still used as a factor of comparison. However, the basis of using the cylinder horsepower is now accepted as the correct one on account of the great change which the locomotive boiler has undergone; for example, the material increase in the length of tubes and other changes in design.

Recommendations were made back in 1897 by the Master Mechanics' Association concerning the ratio of heating surface to cylinder volume, and Table 2 was then considered correct proportions, but, due to the development of the locomotive, it soon became apparent that these proportions needed some change.

TABLE 2

Ratio of Heating Surface to Cylinder Volume (Two Cylinders)

180	for large anthracite coal
200	for small anthracite coal
200	for bituminous coal

A little later on in 1902 it was brought out that the ratios covered in the 1897 report contained only one factor, i.e., the working force; but, after combining with the speed, it formed a more logical basis.

Again, in 1916, or about fourteen years later than the previous report, the general advance in locomotive design brought about an entirely different method of proportioning based on cylinder horsepower. Notwithstanding this, a few still adhere to the older method as contained in the 1897 Master Mechanics' report, increasing the ratios on account of the heavy demand on modern equipment, and the figures in Table 2 have therefore been increased about 35 percent.

While the figures in Table 1 show a gradual increase in power, they do not reveal the exceptions, as there have been, during the past few years, a large number of locomotives placed in service whose tractive power has been more than double that shown in this table, which naturally raises the general average. As the tractive power is based entirely upon the capacity of the cylinders, it is therefore evident that the maximum effort is available at starting, decreasing as the speed of the locomotive increases. The horsepower, however, increases with the speed.

The formula which is now generally accepted for deriving the tractive power or single-expansion locomotives is:

$$T.P. = \frac{.85\, P d^2 s}{D}. \qquad \text{(Formula 1)}$$

in which

P = boiler pressure.
d = diameter of cylinder in inches.
s = stroke in inches.
D = diameter of drivers in inches.

It may be of interest to some readers to know that Formula 1 is derived from the following formula (No. 2), which, when written out in full, is:

$$T.P. = \frac{d^2 \times .7854 \times 2 \times s \times 2 \times P \times .85}{D \times 3.1416}, \qquad \text{(Formula 2)}$$

in which the letters have the same meaning as in Formula 1. This formula logically constructed is: Area of cylinder multiplied by twice the stroke, multiplied by the mean effective pressure ($.85 \times P$), divided by circumference of the driving wheels. This formula after process of cancellation finally becomes as shown by Formula 1.

We also have the two-cylinder and four-cylinder compound locomotives as well as the "Shay" geared-type of locomotive, and certain formulas have been recommended and generally used for these types of locomotives, there being some difference of opinion on the compound formulas by the different authorities.

Formula for Two-Cylinder or Cross-Compound Locomotive

Assuming that the work done on the two sides is equal, it is only necessary to consider the high-pressure cylinder in the calculations, allowing a sufficient decrease in boiler pressure to compensate for the necessary back pressure. The formula generally used and the one given by the Baldwin Locomotive Works is:

$$T.P. = \frac{C^2 \times s \times \frac{2}{3} P}{D}, \qquad \text{(Formula 3)}$$

where

$T.P.$ = tractive power.
C = diameter high-pressure cylinder.
s = stroke in inches.
P = boiler pressure.
D = diameter drivers.

For the Mallet four-cylinder compound locomotives various formulas have been proposed from time to time, the results of which differ materially. The two formulas that are generally used are those suggested by the American Locomotive Company and the Baldwin Locomotive Works. While each of these formulas has points of merit, yet the results vary.

American Locomotive Company Formula

$$T.P. = \frac{C^2 \times s \times P \times t}{d}, \qquad \text{(Formula 4)}$$

in which

$T.P.$ = tractive power.
C = diameter of low-pressure cylinder.
s = stroke in inches.
P = boiler pressure.
t = constant = .52.
d = diameter of drivers in inches.

With reference to the constant t in this formula, it may not be out of order to state that the tractive power of a compound locomotive of two or more stages of expansion is determined by taking the total average pressure of the steam used transferred to the last or low-pressure cylinder. The first or high-pressure cylinder simply forms a measurement of the steam to be used, giving so many expansions. The total work of the engine would not be greatly affected by quite a considerable change in the cylinder proportions, but it does affect the efficiency and the distribution of the work between the two engines. The greater the number of expansions, the higher the efficiency, which, of course, has to be limited so that there is sufficient final pressure to fan the fire. It has, therefore, been considered not practical to make the cylinder ratios more than 1 to 2½ with adjusted cut-off to get equal work in both cylinders, making about 83 percent in the high-pressure and 89 percent in the low-pressure cylinders, or a maximum of about three expansions with saturated steam. For equal distribution of work, it has been found that the constant for average pressure came in the vicinity of .52, which, however, was exceeded by delaying the cut-off in the high-pressure cylinder, with a consequent increase of power in the low-pressure cylinder. This practice has been avoided as much as possible and the factor of .52 adopted as permanent.

With superheated steam this condition is somewhat altered, due to the shorter expanding quality of the steam, and a cut-off volume of 1 to 2.35 in the two cylinders proved to give the best combination of power and distribution. This gave a cut-off in the high-pressure cylinder of 89 percent and 83 percent in the low-pressure cylinder, which is the reverse of that of saturated steam. With the same cylinder ratio of 1 to 2.5, and with the average superheat of 100 degrees, it was found that the constant came very close to .52 also. This, of course, varies somewhat with the variation in the degrees of superheat, a flexibility that would be impossible to meet with any constant. It is, therefore, considered that the constant of .52 is as nearly correct as it is possible to obtain.

Baldwin Locomotive Works Formula

The Baldwin Locomotive Works states after a careful study of the situation, and by comparison, that it has adopted the following formula (No. 5), which is based on the assumption that equal power is being developed in the high- and low-pressure cylinders and that the total mean effective pressure is 85 percent of the boiler pressure. It is claimed to be a safe formula to use for calculating the maximum tractive force that can be developed by a Mallet locomotive of modern design, using superheated steam and working compound at slow speeds; and it is, therefore, recommended for general adoption:

$$T.P. = \frac{C^2 \times s \times 1.7\,P}{(R+1) \times D}, \qquad \text{(Formula 5)}$$

in which

$T.P.$ = tractive power.
C = diameter of low-pressure cylinders in inches.
P = boiler pressure in pounds per square inch.
R = ratio of cylinder volumes.
D = diameter of drivers in inches.

Shay Geared-Type Locomotive

(Lima Locomotive Works, Inc.)

$$T.P. = \frac{d^2 \times s \times 1.5 \times P \times G}{D \times P_1}, \qquad \text{(Formula 6)}$$

in which

$T.P.$ = tractive power.
d = diameter of cylinders.
s = length of stroke in inches.
P = mean effective pressure.
G = number of teeth in gear run.
D = diameter driving wheels in inches.
P_1 = number of teeth in pinion.

In this formula the Lima Locomotive Works recommends for the value of P, or the mean effective pressure, 75 percent of the boiler pressure.

It will be observed that this formula is simlar to that for the simple rod locomotive, with the exception of the constant 1.5 (which is introduced because there are three cylinders used and the geared ratio, which for the Shay locomotive is about 2 to 1).

There is one thing to be noted as regards the tractive power of a locomotive; that is, as the engine grows older in service it becomes stronger, due to the wear on the tires and cylinders, the former becoming smaller and the latter larger all the time, and, when applying these two factors in the formulas, it will be readily seen why this condition exists. Such increases, however, often cause slipping, due to the engine being what would be generally termed "over-cylindered," caused by insufficient adhesion on account of too light weight.

It is therefore evident that the adhesion at the rails fixes the economical tractive effort of the locomotive, and the main parts, such as the boiler and cylinders, are therefore limited. From a number of tests that have been made from time to time it has been found that as high as 28 to 30 percent of the weight on drivers may be utilized as tractive effort; this occurs only under first-class conditions and on well-sanded rails. In ordinary practive this percentage usually approximates 22 to 25 percent of the weight on the drivers. The tractive effort is, of course, maximum at starting and up to a piston speed of about 250 feet per minute; at higher piston speeds, and due to shorter cut-off, the mean effective pressure is reduced. Therefore, as the speed increases the tractive power decreases.

(To be continued.)

New Type of Firebox Construction

I have read in your very interesting paper (February issue) a description of the locomotive firebox construction with the Nicholson thermic syphons welded therein. According to the tests, it is apparent that the increased firebox heating surface shows how valuable it is, no matter in what form it is put into the firebox, whether it be in the shape of shallow corrugations or otherwise.

Commenting on the design, it is apparent that some 150 staybolts have been added to the firebox in this arrangement, besides the welding of these side sheets into the crown of the firebox and carried down to the water leg. This plan offers considerable obstruction in the firebox to the men working at the tubes, or for repairs on the tube plate; it might be considered that the firebox of the locomotive has been made *more rigid* by this application than it was. Is it desirable? It has always occurred to me that the trouble in locomotive fireboxes, as constructed, is that they are altogether too rigid, hence we have to apply so many forms of stays to prevent them from breaking, and with the same idea of preventing the plates from cracking, distorting, etc., which is usual in locomotive fireboxes of the regular type.

It appears that they have gained by this construction fifty-three square feet of heating surface. Undoubtedly fifty-three square feet is of great value in a firebox; and if this could be gained without this complicated construction, it seems to me that its value would be untold if applied to the number of engines working on the railroads in the United States.

I had occasion to make considerable inquiries into the question of locomotive fireboxes; my attention had been called to the corrugated firebox designed by William H. Wood, engineer, of Media, Pa., the drawings of which were made from a Pacific type of locomotive. In it the gain of surface by the shallow corrugations was fifty-four square feet. The reduction of stays was about 729, their absence being due to the extra strength of the corrugations.

Taking the two fireboxes, from an engineering standpoint, in the Nicholson system the firebox has been made more rigid, as well as the tube plate, whereas in the Wood boiler it has been made more flexible—and is not that *what is required* and acknowledged by all mechanical engineers in the construction of locomotive fireboxes? However ingenious the construction may be as devised in the Nicholson plan, it would be subjected to a greater expense for upkeep over that of the corrupated boiler referred to. I presume that Mr. Nicholson is a railroad man and therefore has the advantage of the railroad combination over that of an outside engineer.

This is an important question, and one which concerns the saving of repairs, as well as fuel. Both the Nicholson and Wood systems of firebox construction prove the advantages of extra firebox heating surface, but apparently the cost of upkeep for the Nicholson type of construction has not yet been determined, whereas the results of a four-year test of the Wood firebox are available, showing the savings in upkeep that are possible with this system.

Reading, Pa. John H. Bickley, M. E.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY, INC.
6 East 39th Street, - - - - New York
8 Bouverie St., London, E. C.

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor.

Branch Office
Boston, Mass., 294 Washington street, S. I. CARPENTER.

Reports from the office of the secretary of the Master Boiler Makers' Association indicate that the forthcoming convention of the association at the Hotel Sherman in Chicago on May 26, 27, 28 and 29 will be the largest ever held by the association. During the war, meetings of the association were suspended and there is a lot of lost ground to be covered. All those who formerly were active in the affairs of the association are renewing their interests, and at the convention will be given opportunities for renewing old acquaintances, making new ones and in general gaining much information regarding recent developments in boiler making. Not only have most of the men who in former years made it a point to attend the convention signified their intention of attending the convention this year, but, in addition to that, a large number of applications have been received for membership in the association. All indications point not only to a big and enthusiastic convention, but also an unprecedented increase in the membership of the association.

It is too early to judge the effects of the price reduction in steel schedules, as agreed upon by a committee of the American Iron and Steel Institute and the Industrial Board of the Department of Commerce. There are certain obvious facts, however, which ought to be considered. The Steel Corporation and other large steel companies are more or less apart from the ordinary business of the country. Their size makes it possible to do things which would not be possible in other industries. The reductions agreed upon range from 10 to 14 percent, with a possible average of 12 percent. When one considers the volume of business which the Steel Corporation does, and its relation to taxation, the reduction amounts to comparatively little. Further, the amount of money lost through price reduction is, to a considerable extent, offset in other ways, which would not apply to smaller manufacturers.

Assume that the steel companies' sales were a billion dollars this year. A 10 percent reduction would mean a loss of about $100,000,000. That $100,000,000 would, if accumulated as profits, be taxed at the peak point, and practically 80 percent of it would be paid out. Therefore, the net loss might be figured as low as $20,000,000, or 2 percent. We do not suggest that a reduction of 10 percent means nothing to the purchaser, but it means little to the Steel Corporation. In smaller industries, however, a reduction of 10 percent from the gross profits may mean a heavy loss, at least while war labor prices and resulting inefficiency maintain production costs at the present high level.

Although it has not been officially stated, it is rumored that the steel people submitted alternative propositions to the Industrial Board. One proposition covered approximately what has been decided upon—a reduction of 10 to 14 percent, with no reduction in labor cost. The other contemplated a reduction of 25 percent, with a proportionate reduction in wages. The Industrial Board, it is said, did not consider for a moment the higher reduction with a proportionate scaling down of wages. Apparently what the Board expects is price concessions with no reduction in production costs. Such an expectation is absolutely inequitable and will not be stimulating to lagging industries.

Showing the plight of smaller firms is the statement of the Board that "the price reductions may involve the necessity of some high cost plants either shutting down temporarily or running at a loss for a period, but it is expected that with an increased volume of business soon to be developed a reasonable return to the average profits will be afforded." This is at once illuminating as to results but hazy in its prophecy. If you compel a manufacturer to shut down through forcing cuts in prices which he cannot stand, and permit no corresponding reductions in production cost, how will he develop the increased volume of business which is supposed to cure his condition?

At a meeting at the Engineering Societies Building, New York city, on February 13, representatives of blow-off valve manufacturers discussed the standardization of boiler blow-off valves, with a view of simplifying their manufacture and the elimination of unnecessary sizes and varieties of valves. As a result of the meeting, the following recommendations were made:

(1) That bottom boiler blow-off valves be manufactured in the following sizes: 1 inch, 1½ inches, 2 inches and 2½ inches; these are the sizes recommended by the A. S. M. E. Boiler Code.

(2) That blow-off valves for use on boilers operating at pressures up to 250 pounds per square inch be made extra heavy pattern only and that the 1-inch sizes have screwed connections, the 1½-inch and 2-inch sizes screwed or flanged, and the 2½-inch size flanged only. It is also recommended that flanged connections be preferred for the 1½- and 2-inch sizes.

(3) That the manufacturers reduce the variety of styles to the smallest number of types possible in the interests of conservation and economy.

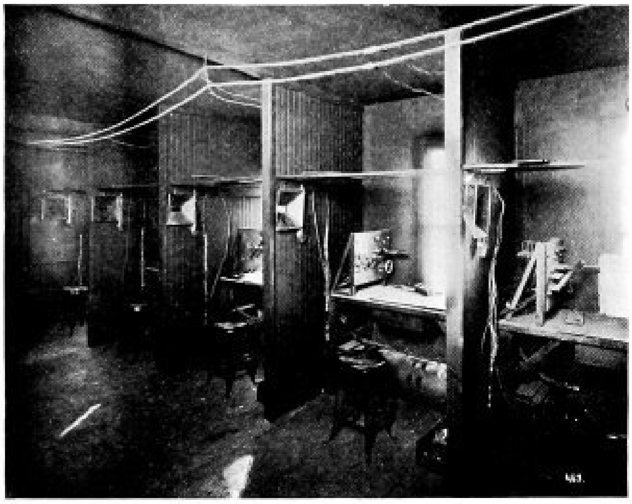
As soon as all the blow-off valve manufacturers agree as to the types and sizes that good engineering requires, their recommendations will be submitted for approval and adoption to the Industry Committee on Valves and Pipe Fittings, which has succeeded the War Service Committee.

Engineering Specialties for Boiler Making

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

School of Electric Arc Welding

When rapid production became a pressing necessity, the Emergency Fleet Corporation established several schools for teaching men to operate the electric arc welder. As is well known, electric welding came into prominent use in connection with the repair of the German liners and in the manufacture of new ships, where it was used for welding a great number of pieces which hitherto had been riveted at much higher cost and with much greater delay. One of these welding schools was conducted under the supervision of The Lincoln Electric Company, Cleveland, Ohio, and gave a complete course, which enabled an entirely green man to learn the fundamentals of electric arc welding in a short time.



Electric Welding School of the Lincoln Electric Company

Now that the war is over The Lincoln Electric Company is continuing this same school and putting its service at the disposal of any manufacturer who desires to teach his men the art of electric arc welding. Men can come to the school and be instructed in any phase of the operation by thoroughly competent instructors. A view of one section of the welding school, showing the operating sets and switchboards for the operator's use, is shown on this page.

Discovery Used to Treat Burns

In line with the utilization of successful war discoveries for peaceful pursuits is the adaptation of "Ambrine," a new surgical dressing, to the needs of American industry, and in that connection, American shipyards. This dressing, which has been perfected by Dr. Barthe de Sandfort, a retired surgeon of the French army, is composed of certain paraffins and resinous gums scientifically combined to serve as a sealing poultice on burns. Dr. William O'Neill Sherman, chief surgeon of the Carnegie Steel Company, of Pittsburgh, was much impressed with the value of the dressing when he visited the Allied hospital at Issy-les-Moulineaux, where the treatment is used. The preparation has been adopted by the British Admiralty and army, the Belgian and Italian armies, all the French organizations handling the medical war situation, and by the United States army.

In application the material is heated to a temperature of less than 150 degrees F., and the viscous mass applied to the lacerated surface to cover the delicate exposed nerve ends. The exclusion of air, of paramount importance in dealing with all types of skin and flesh wounds, is thus accomplished by the forming of a semi-flexible surface over the burned parts. Usually a supplementary dressing of medicated absorbent cotton is applied for purposes of convenience, through which heat can be imparted to the tissue. Repair is thus carried on by nature, unaided.

Actual results obtained by the use of the process are shown in the accompanying photographs. The first photograph shows the very serious condition; the case was termed "burning in the second degree." The second gives the result of the treatment after thirty-five days. The Ambrine Laboratories, 347 Madison avenue, New York City, are placing the product commercially on the market.

New Wallace Bench Machine

The Wallace bench saw, which is being put on the market by J. D. Wallace & Company, 1407 West Jackson Boulevard, Chicago, Ill., is a portable bench tool designed to be operated by ordinary electric light current. It has

Fig. 1.—Ambrine Kit

Fig. 2.—Workman Suffering from Burn in the Second Degree

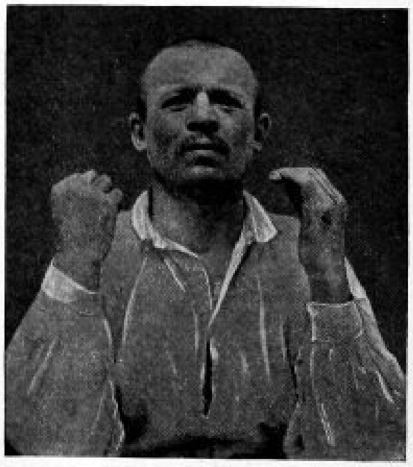
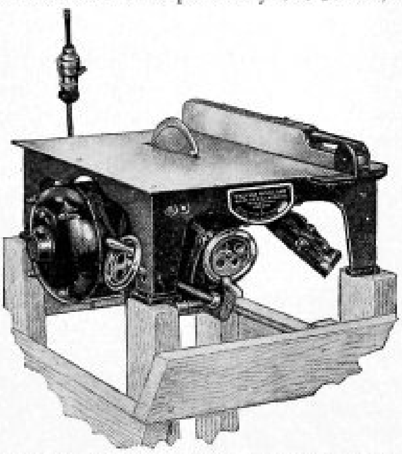


Fig. 3.—The Patient After 35-Days' Treatment

ample power to take a full 2-inch cut through the hardest wood, making it possible to use this machine for at least 80 percent of the work generally done by hand or on the big circular saw in the pattern shop. For angle cutting the saw itself is tilted, consequently the operator is always working on a table which is in a horizontal position. By a handwheel mounted on a perfectly cut screw, acting in a



Portable Bench Tool Operated by Electric Current

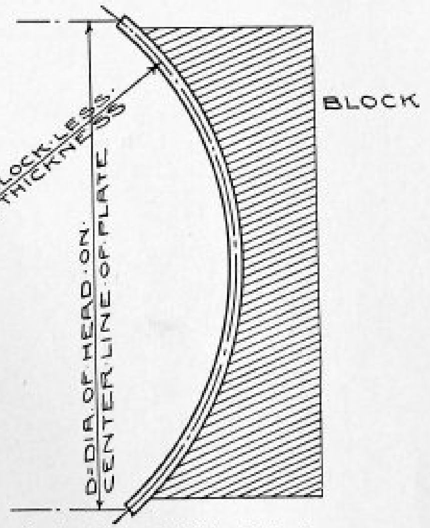
swiveled nut, the saw may be set at an exact angle. This mechanism swings the cradle in which the motor-driving mechanism and saw are mounted.

The Wallace saw is provided with a shutter saw guard built into the machine to protect the operator's hands and to prevent the catching of the end of the stock in the back of the saw or the catching of the waste stock in the teeth of the saw.

A Formula for Dished Heads

BY JAMES LESLIE LANE

As a rule the allowances for flanging and dishing given in boiler makers' handbooks are sufficiently close for



Section Through Dished Head

medium-sized work. Where the finished heads are not above sixty inches in diameter, any slight variation can be made up by increasing or decreasing the rivet line off on the flange.

Where the heads are for large storage tanks or digesters, it becomes necessary to know what sized blank to order for a required head within close limits. Oftentimes an increase of half an inch in diameter will make the plate so large that it takes a mill extra in price, which might have been saved if the foreman had been sure that the smaller one would have done. Especially is this true in cases where the head is to be simply dished and secured to a drum by the electric or gas welding process. Here there is no chance to make correction by changing the rivet line off. Either the blank produces a head of just the right size or it is too large; in which case the surplus metal must be trimmed off with the shears.

This involves a double waste, for this excess plate (which was ordered at a base price plus extras for width and cutting to circles) must be sold as scrap, in addition to the time and labor in trimming.

The following formula, worked out and used by the writer, will prevent such faulty ordering, if the proper corrections are made. These corrections, as will be explained later, are due to the manner of performing the dishing operation. In addition, it is applicable to heads of any radius of dish, regardless of whether or not they are standard.

The formula is as follows:

$$D = 2\sqrt{R^2 - \left(R - \frac{A}{2\pi R}\right)^2}, \text{ where}$$

D = diameter of head after dishing, measured on the centerline of the plate. (See Fig. 1.)
A = area of the blank head in square inches.
R = radius of dishing block minus one-half of the plate thickness in inches.
$\pi = 3.1416$.

Let us suppose, for example, that we have a blank head 7/16 inch thick and 56 inches diameter. It is to be dished in a block whose radius is 48 inches. What will be the diameter of the finished head measured across the center line of the plate?

D = diameter to be found.
A = 2,463 square inches (area of a 56-inch diameter circle).
$R = 48 - .22 = 47.78$ inches.

Substituting in the above formula, we have:

$$D = 2\sqrt{47.78^2 - \left(47.78 - \frac{A \text{ or } 2{,}463}{2 \times 3.1416 \times 47.78}\right)^2} = 53.6 \text{ inches.}$$

Of course if we had given the finished diameter of the head and wished to know what size blank to order, the formula would read as follows:

$$53.6 = 2\sqrt{47.78^2 - \left(47.78 - \frac{A}{2 \times 3.1416 \times 47.78}\right)}$$

Solving, A equals 2.463 square inches. From this we see, if we consult a table of areas, that the diameter of blank required is 56 inches.

This formula is based on the supposition that the head is not decreased in thickness during the dishing operation. In other words, the superficial area of the head, after dishing, is supposed to be equal to the area of the blank. For heads dished under a press, where all the metal is brought down to shape at the same time, this will be found to be substantially the case. However, where such heads are forced into shape with a ram and block, a slight decrease in thickness results, the amount depending upon the temperature of the plate during the operation, the curvature, thickness of head, and skill of the workman. This, of course, means that a blank slightly smaller in diameter will be required, and, as the amount of this variation depends on equipment and other local factors, the foreman must be guided accordingly when ordering stock for this work.

Questions and Answers for Boiler Makers

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

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *6 East 39th street, New York City.*

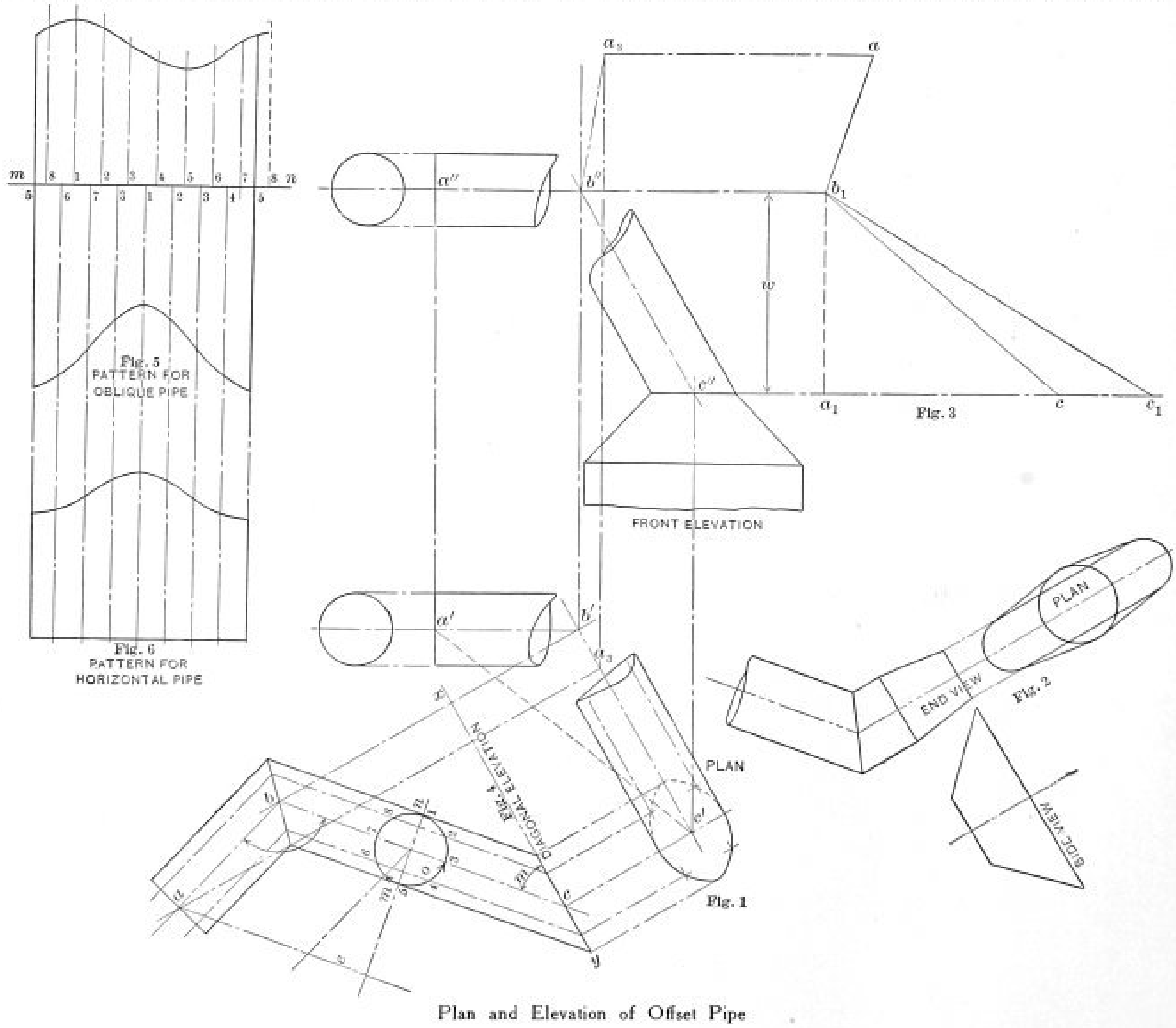
Oblique Pipe Development

Q.—I would like a solution of a pipe connection shown in the accompanying sketches. It is a connection between a horizontal pipe and an oblique pipe which joins a transition piece. Assumed angle of pipes in plan and elevation is 30 degrees. H. R. D.

A.—The plan and elevations show an offset pipe making an angle to all the planes of projection, which will be as shown in the plan view. A better connection would be as shown in Fig. 2, in which case a vertical pipe is mitered to the oblique pipe and also joins the transition piece.

CONSTRUCTION

Lay off the axes of the pipes in a plan and front elevation. Then determine the true angle between them, as shown to the left of the plan, as follows: From point b', and at right angles to $b'c'$, the axis of the oblique pipe shown in the plan, draw the line b-b'. From x draw the base line xy. Line xc equals $b'c'$. The distance xb equals the vertical distance between points b and c of the elevation shown at w. Connect b and c with a straight line. Its length is the true length of the axis of the oblique pipe, and the angle m is the true angle the pipe makes



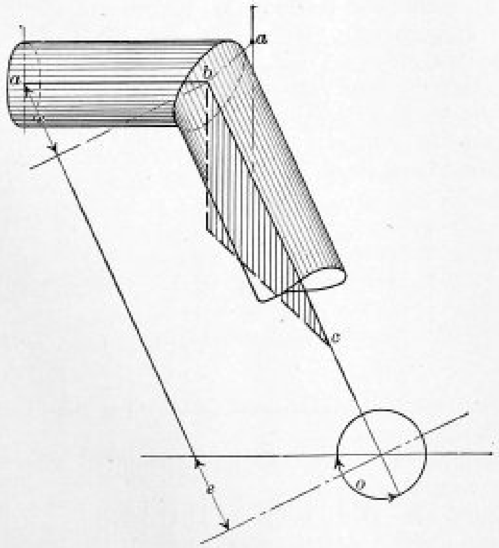
Plan and Elevation of Offset Pipe

understood from the accompanying perspective. It joins a horizontal pipe and a transition piece at the lower connection. In Fig. 1 the miter between the pipe and transition piece lies in a horizontal plane, which causes the opening in the oblique pipe on this plane to be elliptical, with the horizontal plane. The perspective illustrates this angle clearly. The view constructed shows the pipe as viewed at right angles to the line $b'c'$ of the plan. The next step is to determine the angle between the horizontal pipe and oblique pipe. First find the true length of the diagonal distance between points $a'c'$ of the plan, as follows: Transfer $a'c'$ to Fig. 3 and lay off a_1c_1 on the horizontal line. a_1b_1 equals the distance w. Connect b_1 and c_1, which is the required true length of the diagonal. With this length and point c in Fig. 4 as a center, describe an arc. With $a'b'$ the length of horizontal pipe's axis and b as a center, draw an arc intersecting the arc previously drawn at a. Angle abc is the true angle between the pipes.

If the oblique pipe is cut by a horizontal plane, xy, as in Fig. 4, the pipe section on this plane is elliptical, and its connection with the transition piece having such a base is fixed. Therefore, the other pipe connection must be revolved to bring it into a horizontal position shown by its projections. The pipes in Fig. 4 lie in the same plane, and, if turned about xy until xb is in a vertical position, the projections of the axes will appear as shown at $c'b'a_3$ in the plan, and $a_3b''c''$ in the elevation. Now imagine the oblique pipe in Fig. 4 to be cut along m-n; then the upper part can be turned until the axis a-b lies in a horizontal position. The arc length that this section is revolved is equal to the arc length o shown in the perspective. The construction of an end view at right angles to the axis b-c, Fig. 4, is required to determine this arc length, which will be used in developing the pattern. Distance c in this view indicates the length point a is above point b measured at right angles to the axis bc. Note the position of corresponding triangles in the perspective, which will bring out this fact. In developing the pattern for the oblique pipe, it will not be made in two sections, but the part above m-n will be turned a length equal to the arc length o in the development, which will bring the two pipes in their proper relationship and position when assembled.

PATTERNS

Fig. 5 is the development of the pattern for the oblique pipe. The distance o is laid off from the center, bringing the point l around to its proper position for the twist. From point l the remaining distances are spaced off. In the lower part of the pattern point l is directly on the center, and from this point equal spaces are laid off and



Perspective View of Pipe Connection

parallel lines drawn. With the compasses or trammels, set off the measuring lines directly from Fig. 4 to the pattern. Allow for laps on connecting edges. Fig. 6 shows the construction of the pattern for the other branch. The development is simple, and by writing the reference figures in the views the work should be easily followed.

Layout of Tapering Ring

Q.—Please give a method for laying out a taper ring which has only a slight taper.

A.—Fig. 1 shows a plan and elevation of a frustum of a cone in which the taper from the lower to upper base is small. The pattern layout may be developed in several ways; the accurate method would require *triangulation,*

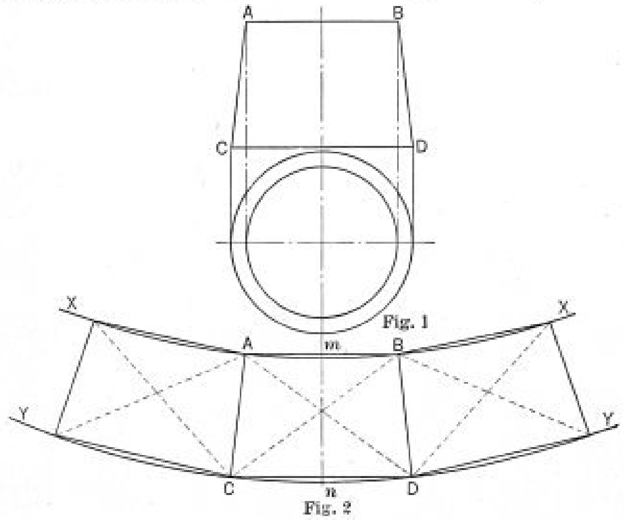


Fig. 1.—Plan and Elevation of a Frustum of a Cone.
Fig. 2.—Method of Laying Out

but approximations are usually employed, which are close enough for most purposes.

In Fig. 2 is shown an approximate method which is very simple and easily applied. The elevation *ABCD,* as in Fig. 1, is drawn about m-n, Fig. 2. About this diagram two other sections are assembled as indicated. *Ay* and *CX* equal *AD*. *AX* equals *AB*, and *CY* equals *CD*. When the three sections are assembled, the camber lines are drawn in at top and base, as through the points *Y-C-D-Y* at the base, and *X-A-B-X* at top. These curves may be drawn with the aid of some pliable strip of material that can be bent to the desired curvature. From m-n, space off the required length of the arcs for the stretchout. A graduated traveling wheel is a good instrument for such a purpose.

The third edition on "Laying Out for Boiler Makers" has been revised and contains many solutions to problems of this kind and many other practical layouts met with.

Boiler Tubes and Flues

Q.—How are the best steel boiler tubes made, and please state the difference between a tube and a flue? What other metals are used for tubes? T. P.

A.—Cold drawn, seamless steel tubes are extensively used; the metal for such tubes must be of good quality and ductile. Steel having a high tensile strength and a smooth surface withstands considerable use. The process of cold drawing produces a uniform tube of great strength and practically round throughout its length. The metal thickness remains constant, and the tubes are rolled true to gage. Considerable discussion by the trade as to the relative merits of steel and iron tubes has been made. Both kinds of tubes have their good points.

Iron, copper and brass are used in tube making. Copper tubes are used in England and other European countries, but not to any great extent in the United States or Canada. Copper withstands corroding elements and resists pitting better than *iron* and *steel*. Copper is more ductile than steel or iron, but has a lower tensile strength.

Letters from Practical Boiler Makers

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

Re-Tubing Locomotive Boilers

In my last letter on the above subject a simple method of removing tubes from boilers was described. In this letter is given a simple way to remove scale from locomotive boilers—that is, from all parts accessible.

After the tubes, dome cap, dry pipe, etc., are removed from the boiler, the barrel of the boiler can be entered. If compressed air and a pneumatic chipping hammer are available, have a tool made like Fig. 1, and with this in

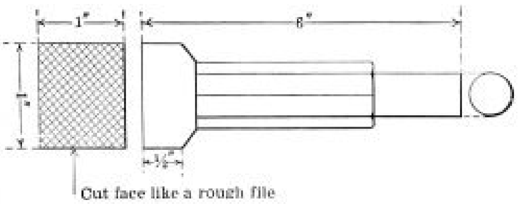


Fig. 1.—Scaling Tool Made to Fit Pneumatic Chipping Hammer

the air hammer attack the scale on the sheets and you will be surprised to see how quickly the scale will be removed.

There are many other tools that can be used for this purpose, such as a heavy fuller for thick scale and a light fuller for thin scale and close quarters, and many other tools can be used after you once get hold of the idea; but the best way to remove scale is to remove it before it enters the boiler. One of the simplest ways of doing this is by the use of common washing soda—½ pound to about every 500 gallons of feed water. Throw the soda into the tank and let it feed into the boiler, and make frequent use of the blow-off cock. Wash the boiler out every week. This remedy may not be a cure-all, but in many cases it will do the trick, and it has the advantage of not attacking the boiler plates.

If compressed air is not available and one has to resort to hand power, make a hammer like Fig. 2. With this tool the scale can be easily removed. To remove scale from the tubes, place them in the rattler until thoroughly

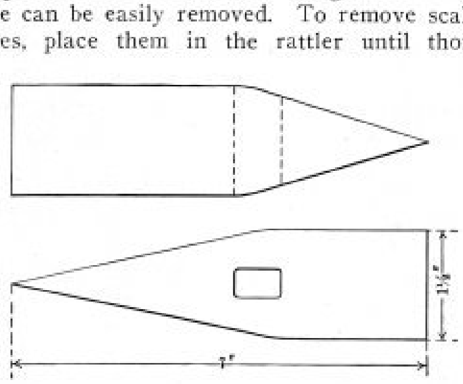


Fig. 2.—Hand Scaling Hammer

cleaned. If there is no rattler at hand, place the tubes on two wooden horses, and with an old file, used edgeways, strike the scaly tubes a few sharp blows and the scale will fly off. Continue this all over each tube until all are cleaned.

Now the writer merely gives this way of cleaning tubes for the well-known reason that there are shops so situated that they do not have the tools to do the work, and yet they are frequently called upon to change tubes.

When the tubes are thoroughly cleaned, cut off one end just clear of the damaged part, giving enough margin to get the required length after welding. Safe ends come in various lengths from the mill—6, 8, 10 or more inches. Now take the safe end and scarf one end so that it will fit inside the end of the tubes to be welded. To make this possible the tube end is first heated and is then driven on a mandrel. To bell-mouth the end enough to take the safe end (see Fig. 3), insert the safe end and draw the heat and weld under your welding machine.

Again, it may be possible that it is required to do this by hand; if so, it can be done easily in two ways—first, by

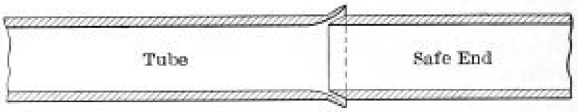


Fig. 3.—Showing How to Bell-Mouth the Safe End

proceeding as follows: Make a very light hammer with iron handle, as shown in Fig. 4, and, when the heat comes to the welding point, apply the hammer lightly but quickly, at the same time turning the tube until the whole joint is welded; then quickly remove to the anvil and swage to size.

Another way is to remove the tube when at the required heat to the mandrel placed in the anvil, then with your helper, each provided with a light hammer, close the weld as quickly as possible; then swage, of course. These ways of doing work are old ways, but still they come in handy once in a while, and apply to-day just as forcibly as they did thirty years ago, for, as stated above, there are places that are still compelled to do lots of work by the good old "armstrong" way.

There are good machines on the market for doing this work quite cheaply, but they are often like Paddy's anchor. Now Paddy was a sailor, and when at sea he was caught in a terrible storm on a lee shore, and, overhearing his captain say he wished he had an anchor, Paddy approached his superior and said:

"Sir, I have an anchor!"

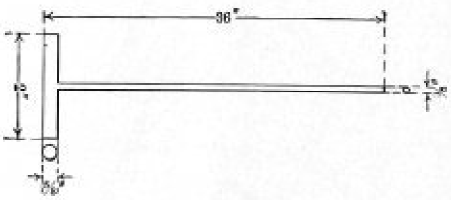


Fig. 4.—Light Hammer for Welding Safe End

Turning to Paddy the captain inquired where his anchor was.

"Sure, sir," said Paddy, "it is at home."

Like Paddy's anchor, good tools on the market are of no use to the man compelled to do the work by hand.

Applying the Copper Ferrules

After welding out all tubes to the required length, we have found it good practice to allow 3/16 inch for the firebox end and ¼ inch for the smokebox end. Apply the copper ferrules, either with the boss rolls or with the sectional expander, being careful to keep the ferrules flush, if not a little inside the sheet, thus allowing for the stretch of the ferrule when rolled. In doing this, see to it that the coppers are not rolled too heavy, or the fit will be a poor one.

The fit between the tube end and the copper ferrule should be a driving fit. In flue setting the writer always uses the following system: After all copper ferrules are in place, stuff in all the tubes in the front end. When all are in position and with the helper in the smokebox end, provided with a bar, Fig. 5, lift up and steer the end tube in the *top* row, the man in the firebox catching it with the handle of his hammer and guiding it into the

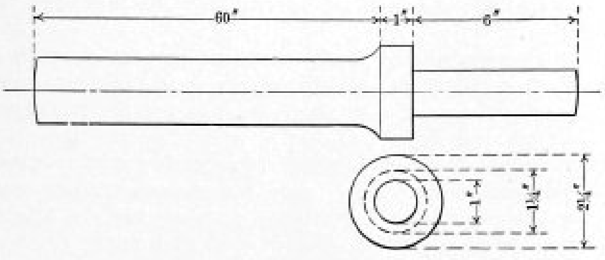


Fig. 5.—Tubing Bar

copper ferrule. Then the helper, with his bar point resting in the tube, gives the tube a few sharp blows on the end, driving it into the copper ferrule. When the required 3/16 inch for bead is through, the man in the firebox knocks the bead, or bell-mouths the tube end, at the same time that the helper is bearing down and drawing back on his bar to prevent it being drawn too far at the firebox end.

Now take the next tube in the *top* row and continue this until the entire set of tubes are knocked over in the firebox. If this is carried out properly, it will be quite impossible to get the tubes crossed. The reason why the writer always knocks the bead all around the tubes (instead of merely knocking a lip on the tubes to hold it in position) is because it is so much *easier* and *quicker* to do it before the tube is fastened in the tube sheet than it is afterwards.

Now take your sectional expander (prosser) and starting, say, in the center of the tube sheet at the bottom, work upwards (right or left) diagonally, taking two rows of tubes at the same time. When this is done you will have formed a V-shape. Then start again at the bottom and work up to the middle of the tube sheet to the top. Starting at either corner, right- or left-hand bottom, work up towards the top center. The reason for doing the work in this manner is to prevent as much as possible the distortion of the tube sheet, which usually takes place in the top corners of the tube sheet and leads to the breaking of the bridge between the tube holes and making the tube holes egg-shape.

Use of the Sectional Expander

The writer has recently removed a tube sheet of this kind. In using the sectional expander, great care should be used. It is not wise to drive this tool into a tube either with a maul or a long-stroke air hammer until the mandrel is solid and depend entirely upon the expander to do the work. We are well aware that it is the practice in many of our shops to dispense with the roller-expander in the firebox, but the writer has always used the sectional expander with moderation, knowing the evil resulting from its excessive use; in fact, he has never used it for any other purpose than to *fasten* the tube in the sheet. As a fastening tool it is all right, and, where the tube is a tight fit in the copper ferrule, a slight application of this tool is all that is required. If possible, use the dudgeon rolls for the front end. In beading the tubes, use your own judgment as to doing this before or after rolling; but it has always been the writer's practice to bead after prossering and before rolling. If you have air motors, follow as closely as possible the foregoing.

If every detail explained above is followed out closely, there is very little doubt but that a good and satisfactory job can be accomplished.

Wilkinsburg, Pa. Flex Ible.

Leaky Flues

Referring to the letter on leaky flues on page 26 of the January issue of The Boiler Maker, in which the writer, Mr. F. Amesbury, of Bridgeburg, Ontario, wished to hear from some of the readers regarding his unfortunate trouble in keeping the flues tight in this particular engine. There is something radically wrong here, and I am very much interested. Flue failures, throughout different railroad roundhouses, have become a very rare thing in these days.

There are several causes of flue failure: First, hard water conditions, which have been reduced to 90 percent by the process of welding the flues after they have been properly inserted; second, the improper setting of copper ferrules and the improper prossering of the flues and leaving them with a large bead; third, flues over 16 feet in length are more apt to give trouble, due to vibration when operating the locomotive; fourth, the practice of welding back tube sheets when bridges are found cracked from one tube hole to the other and increasing the metal to over a half-inch thickness will surely result in failure, and very often this welding will not stand the contraction and expansion of the tube sheet.

Welding of Fire Cracks

Electric welding of fire cracks and at the rivet holes and building up of wasted flanges in the back tube sheet can be successfully accomplished, and I would suggest that if this engine had been filled up with welds in the flue area and new flues inserted, it would be a good idea, in order to get the mileage out of the flues, to have the flues properly prossered and beaded and the sheet properly cleaned off around the beads and have them electric welded. This will keep the engine in service until the next shopping of locomotive, and then at this time he may apply a new back tube sheet. This will not take this engine out of service over two days. I would also suggest that a brick arch be applied to this engine, if it is not already equipped with one.

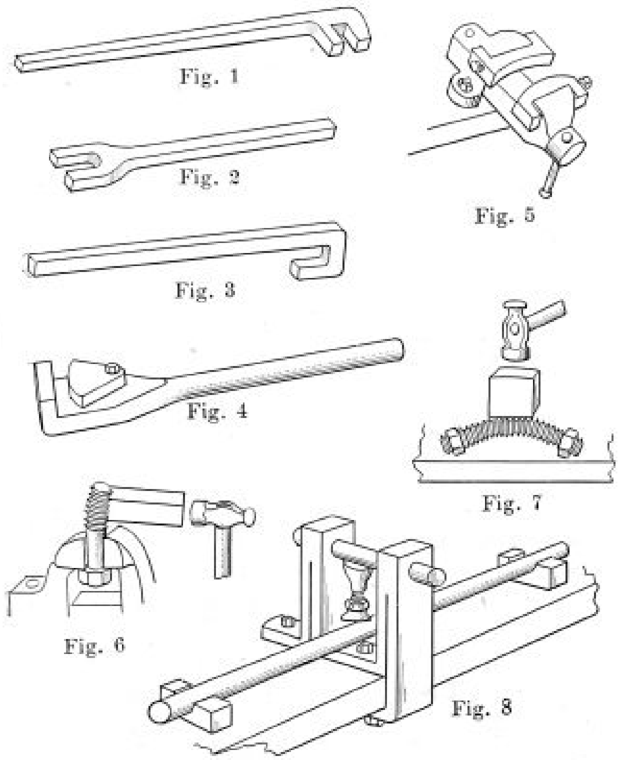
It must not be forgotten that a poor fireman and engineer can very easily start a set of flues leaking. From my experience in roundhouse work, I have had locomotives that run as much as a hundred thousand miles showing no leaks in flues at the back tube sheets, and other engines on the same division and of the same type doing the same work, but making only from 50,000 to 60,000 miles. The flues had been worked so that it was necessary to reset the new set of flues, this plainly showing the difference of engineers and firemen. Then it was necessary to shop the engine for a new set of flues. While I was in a hard water district on the Santa Fe in Colorado during 1906, in our passenger engines it was necessary to renew the flues once every 90 days in order to keep the engine in service.

Kearny, N. J. Harry A. Lacerda,
United States Shipping Board
Emergency Fleet Corporation
Boiler Inspector.

Straightening Tools

During a recent trip to a small shop where a considerable amount of salvaged machinery was repaired, I noticed that they had a lot of straightening to do, and to make the work easier they had contrived to make a lot of home-made devices that seemed to me worthy of passing along for others to use. The tongs or wrenches, Figs. 1 to 4, were used to take the twists or bends out of plates, angle iron, channel, and T-bars.

Fig. 5 shows a very handy pair of jaws that can be made to attach to the bench vise that enables the power of the screw to be used to straighten small bars and pipe, etc.



Home-Made Devices for Straightening Tools

Figs. 6 and 7 show correct ways of straightening studs and bolts.

Fig. 8 shows how they constructed from ¾ by 4 inches flat stock a powerful little straightening press for use on the bench. It is made from one long strip bent to give double strength. A round bar with a small jack complete the rig. Vee-blocks are used along the bench to hold the work being straightened. Machinist.

Improvements in Planer Design

The question raised by J. T. Gardham on page 28, January issue, does not lack interest, for the apparent wastage of time and energy on the reverse stroke of a plane must have struck every mechanical mind. The metal planing machine dates from about 1830, and the drawbacks cited have exercised many minds. The alteration in design, by having two duplicate cross rails either side of the housings, is possibly better than fitting other tool boxes at the back of the present cross rail, while on a modern planer four tool boxes—two on the cross rail and two side boxes—is a very usual arrangement. The trouble begins if the multiple boxes on the cross rails are to be employed on the one plane surface, for it is almost an impossibility to secure a finished surface free from joins at (in the best case) imperceptible differences of level.

With the present acceleration of reversal speed there is less time lost than is at first apparent. Reversal is now at 75 to 100 feet per minute. Taking the cutting speed at 20 feet per minute, with reversal at 80 feet, 960 feet of cut are passed per hour; 1,200 feet is the maximum possible if the cutting were continuous, the forfeiture of the maximum being 20 percent only; with a reversal speed of 100 feet per minute and cutting speed 20 feet per minute, the loss is 17 percent. Assuming an extra loss of two feet travel due to the double rail on housings, and a 10-foot job at 20 feet per minute with an 80-foot reverse speed—all practical figures, without overstatement—the gain due to the "improvement" is just over four percent; if the reversal speed is 100 feet per minute this vanishes altogether.

To prove this is fairly easy, 10 feet at 20 feet per minute occupies 30 seconds, 10 feet at 100 feet per minute occupies 6 seconds—total, 36 seconds for the round trip. The converse case is 24 feet at 20 feet per minute—total, 72 seconds divided by 2 equals 36 seconds per 10 feet cut.

It must be remembered that, for obvious reasons, housings two feet only in depth are unusual, and the loss can easily be three feet in place of two, each cut.

To place duplicate tool boxes on the back of the present cross rail would involve over a foot at each reversal, and total re-design of the planer housings would be needed; these would have to be doubled to take the necessary tool thrust, and it would be more difficult to provide for side boxes. At present the tool boxes on cross rail have to travel to the extreme width of housing, so that it is possible to mount and traverse a job full width of opening in housing. If the boxes can only travel to the inside width of the housing the extreme size of the planer for a given weight is minimized.

Methods of Planing

Broadly, there are two methods of planing—one in which the work reciprocates, the other in which the tool travels. Increased output in the moving bed planer is obtained by multiplication of tool boxes, every modern machine having four, which frequently are in operation simultaneously, reversal speeds being much higher than the cutting speeds, while complete electric control with absence of inertia stresses is the result of such an alteration in drive.

The boiler shop is most interested in the plate edge planer, in which the work is stationary and the tool reciprocates, a screw-actuated carriage carrying a broad-nose tool at an inclination to the surface of the plate and machining the complete edge at each pass. This type of planer, by reason of its greater simplicity, allows machinery on both forward and reverse strokes by means of a turnover revolving tool box. This can be automatic or thrown over by hand. Such machines are commonplace in every good boiler shop.

In discussing this matter of planer improvement, the first idea which comes to mind is that by clamping two tools back to back cutting on both strokes can be done; but it is essential to lift on the return stroke, hence the clapper box, which allows the tool to lift.

This fitment—the reversible tool box—has been mooted for planer application, because no clapper is then needed, cutting taking place on every stroke; whether it is applicable to the mooring bed machine or not, it can be applied to the traveling tool, the difficulty in practice being the registration of cut on reversal. The plate edge planer does work of a distinctly rough and ready character. It needs neither exactitude nor precision; it is required to remove the sheared metal at edge of plate and give a suitable angularity for fullering.

To return to planing as generally understood in the machine shop. Other rivals have arisen; and while planing is the most perfect means of getting an approximate plane surface, plano-type milling machines using cutters having numerous single-point tools clamped in revolving heads are favored in many connections. There is usually reason for the particular manner in which machines follow an evolutionary path. The fact that reversible tool holders on the normal planer are now in evidence points to the fact that their drawbacks overset their advantages. It would, of course, be folly to assume that the latest up-to-date planer cannot be improved; too many earlier abortive alterations become possible after a lapse of time.

Mr. Gardham has been thinking critically—always an intellectual stimulant. It is here my privilege to put the reverse case, to which I am free to admit I had hitherto given small consideration, although the reversible planer tool box gets suggested periodically. Milling was to have superseded planing; but it has done nothing of the kind, and the modern electrically-driven and electrically-controlled planing machine is a mechanical work of art, fascinating to watch, which still plays a yeoman part in machine-shop economy.

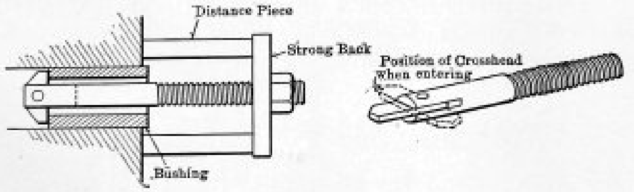
Finally, plate edge planing is the cheapest of all rectilinear metal machining; it is insisted upon by all good specifications, and preferred by every competent boiler authority. It really saves its cost by making fullering of plate edges more certain and expeditious, and a boiler having this refinement does look a much more finished article.

It is really to advocate the practice of plate edge planing in a universal sense that leads me to reply thus fully to the provocative critique already cited.

London, England. A. L. HAAS.

Ferrule or Bushing Puller

There are many different types of bushing or ferrule extractors to be found in the different shops and plants, but I will risk saying that there is none that can be made



Ferrule or Bushing Extractor

as quickly, easily or cheaply as the simple, efficient type shown in the sketches.

It consists of a suitable size bolt. This has its head cut off and a slot cut in it to take a flat piece of stock for a crosshead, the slot being of sufficient length to allow the crosshead to be turned into it on the pivot, as shown. The sketches will make plain its use and construction.

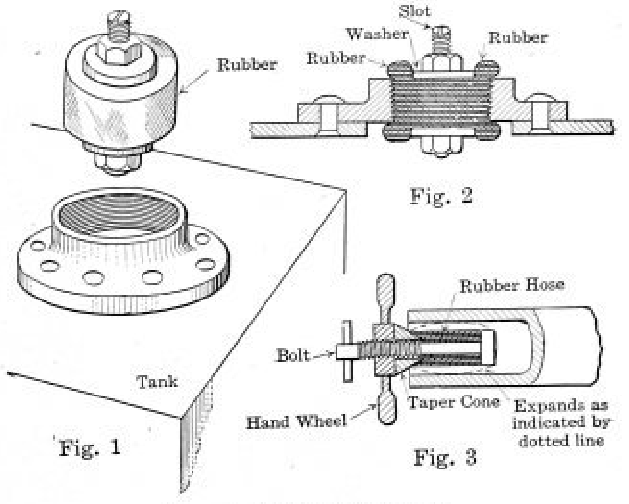
C. H. WILLEY.

Adjustable Test Plugs of Rubber

During a stop over in a small town, I visited a tank shop and picked up a couple of kinks in the form of improvised rubber test plugs. I have copied these into the sketch book and pass them along for what interest they may have.

The plug shown in Figs. 1 and 2 was improvised to plug up the threaded hole of a gasoline tank flange. These tanks have caps that screw in the holes, but the caps are vented and the threads of the holes are special. When it was desired to test the repaired tank with 10 pounds pressure, the shop man made this plug of rubber, and the bolt and washers. The idea may be used for other work.

Fig. 3 shows a scheme that they employ for plugging tube and pipe ends quickly while testing for leaks. It consists of a bolt with a large round thread. On this is



Improvised Rubber Test Plugs

slipped a section of rubber hose or round rubber bushing. A threaded hand wheel is turned against a cone collar, while the bolt is held from turning by the T-handle. The cone feeding in makes the rubber expand, as indicated by the dotted lines.

C. H.

Suggestions from a Boiler Inspector

I have read the January issue of THE BOILER MAKER with much interest, for I have been a reader of this journal for a good many years, and I gladly recommend it very highly to every boiler maker who wishes to know what others are doing in their line of work. For some time past I have been looking for articles from practical boiler makers as well as boiler inspectors regarding the quality of workmanship of the riveting and calking of the present time—work which would not have been accepted a few years past.

For the past four years I have been engaged as a boiler inspector for new construction of locomotive boilers, and I have been in every locomotive plant in the United States. I have had the inspection of 3,563 locomotive boilers which were built for various railroads in this country as well as for foreign railroads—boilers of most every design used throughout the world for railroads. At present I am with the United States Emergency Fleet Corporation as a boiler inspector at the Federal Shipyard, Kearny, N. J. I wish to state that I have a whole lot to write up concerning the difficulties which I have met with throughout the various plants to obtain the quality of workmanship due to the lack of practical boiler makers.

In these times the majority of the boiler maker foremen are ready to pass "the bull" when their attention is called by the boiler inspector to poor workmanship, as well as to laminated materials, which very often do not meet with the requirements of the law. They often feel that the boiler inspectors take up a lot of their time and practically pay no attention to them. This usually winds up that the boilers are often rejected until these instructions are complied with according to law. This usually results in a large expense to the manufacturer.

It is always a good policy for the general foreman of the shop not to uphold their assistants or the assistants not to uphold the workmen to any bad workmanship, which very often is the case at these times. The thing should be corrected as soon as possible and the trouble is over.

In future issues I would like to see some articles, together with sketches, showing the proper size of calking tools for different thicknesses of firebox sheets and boiler shells up to 1⅝ inches thickness. I will also recommend to the younger boiler makers that the practice of split calking on boiler work is not very practical and will be rejected by the boiler inspectors even though the foremen often see no harm in doing it.

SHOP HINTS

The older boiler makers are in some cases getting careless with their work just simply because in lots of cases the younger boiler makers try to pass "the bull." For instance, if you are riveting boiler heads or back tube sheets and don't find the work properly bolted up in place, don't drive the rivets, but call your foreman's attention to the matter. In doing this you will be doing justice to your foreman as well as showing your good faith toward your employers.

Don't get careless with your work, whether it be riveting, calking or fitting up, just because the other fellow does not know any better. Show him how to do it. That is the way to get his good will. You must remember that he does not need to learn what you did when your father taught you. To hold a job nowadays as a boiler maker he only needs to learn one thing, because he knows he will get the same money that you are getting.

Boiler making nowadays is much different from what it used to be. The acetylene and electric welding are doing 75 percent of your repair work and 55 percent of your new work—even beveling your plates so that you will have no chipping to do with your calking.

It's a good practice at all times when driving rivets with a pneumatic hammer to drop back on the rivets whether they are "double-gunned" or head-on with the air holder on. There is but very little drawing on 1⅜-inch rivets in 1⅝-inch plate driven with the pneumatic hammer.

There are many boiler foremen who do not believe in double-gun riveting—the upsetting of the rivet on both sides of the sheet. No better method can be adopted. Every boiler maker foreman should agree to double-gun riveting, especially on firebox work and on mud rings, if he intends to be up to date. The double driving of rigid staybolts is not always a good practice, but I have seen good double-gun staybolt driving by men who are very familiar with the method.

INFORMATION WANTED

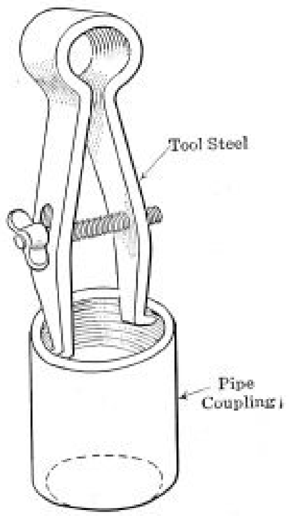
I would appreciate information from any of the readers of THE BOILER MAKER regarding the service of the enormous number of locomotive boilers which were built for the Allies and for the Chinese Government. These locomotives were practically of the same design as our American Pacific type. They had copper fireboxes with back flue sheets 1¼-inch thickness at the flue holes, and the flanges milled off to ½ inch. The staybolts were of bronze material, and the flues with a copper safe end were brazed to the steel flue.

The information that I am asking for is, how they manage to keep the flues tight at the firebox end with a sheet 1¼ inches thick at the flue hole. As to my experience in our locomotive boilers, the thickness of this sheet to be applied on our American locomotives, considering our hard water problem, would prove a failure—½ inch being our standard for the back flue sheet.

Jersey City, N. J. HARRY A. LACERDA.

Thread Cleaning Tool

There is nothing more aggravating than to try to screw on a nut or pipe fitting that has the first few threads crossed, burred or dirty; you get all out of patience and finally go hunting after the right size tap to retap the threads. I have made a little tool, as shown in the sketch, from a piece of flat tool spring steel. As may be seen, it is in the form of an adjustable caliper. The feet of the tool are bent at right angles and filed up to standard V-thread shape, so that the cutting edges of each foot will come right when the tool is revolved.



Pipe-Fitting Thread Chaser

The tool can be made to answer for a wide range of sizes. In using it to chase out crossed threads, tighten up the adjusting screw so that the feet will readily enter the hole; then release the nut and let the feet bottom in the good threads; then unscrew the coupling or nut, and the feet will clean and cut out the burrs.

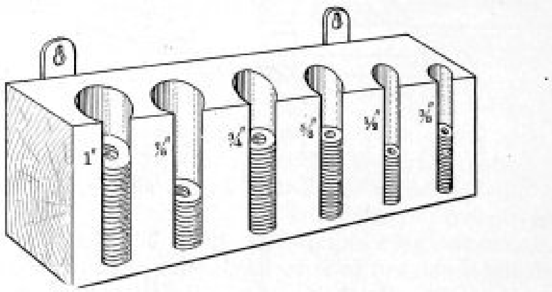
H.

Washer Rack

This idea is one that certainly proved pretty popular, for, after I made myself a washer rack and hung it on the wall near the drill press that I was operating, it was not long before the rest of the boys copied the idea and had similar washer racks hanging near their machines.

The rack is patterned after the familiar poker-chip holder, in that the holes that hold the washers are open at one side, making it very easy to slip in or out several washers at a time.

To make it requires but a few minutes' work. A piece of suitable wood is obtained and a series of different-sized washer holes are bored in it in a line, leaving a space between each hole. (Bore the holes to within an inch of the bottom.) Then cut through the length of the block with a saw, cutting through the outside edge of each washer hole. Put two metal lugs on the back by which to hang it up. Paint the block black, and then with white paint print the size of each washer next to the hole, as shown.



Round Washer Rack for Various Size Washers

C. H. WILLEY.

Have you ever tried using a check valve one size larger than the pipe? It will astonish you how the annoying check disappears and how much easier the pump works. Think it over.

Selected Boiler Patents

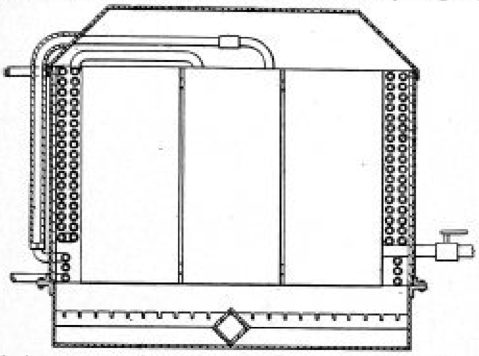
Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,289,340. BOILER. WILLIAM H. WINSLOW, OF CHICAGO, ILL., ASSIGNOR TO WINSLOW SAFETY HIGH-PRESSURE BOILER COMPANY.

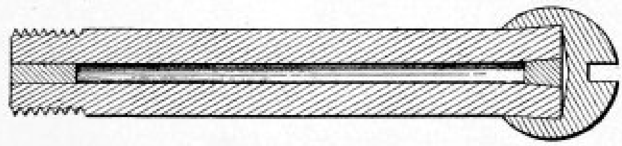
Claim.—In a boiler, the combination of a casing, a boiler unit disposed therein, a header communicating with said boiler unit, an inner coil surrounding said boiler unit, said inner coil comprising a plurality



of convolutions separated to allow the fire gases to pass therethrough, said inner coil communicating with said header, an outer coil comprising a plurality of convolutions disposed substantially in contact with each other to form a continuous wall between the casing and the inner coil, said outer coil communicating with said inner coil, and a water supply connection communicating with said outer coil. One claim.

1,285,097. STAYBOLT FOR BOILERS. JOHN ROGERS FLANNERY, BENJAMIN E. D. STAFFORD, AND ETHAN I. DODDS, OF PITTSBURGH, PA., ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

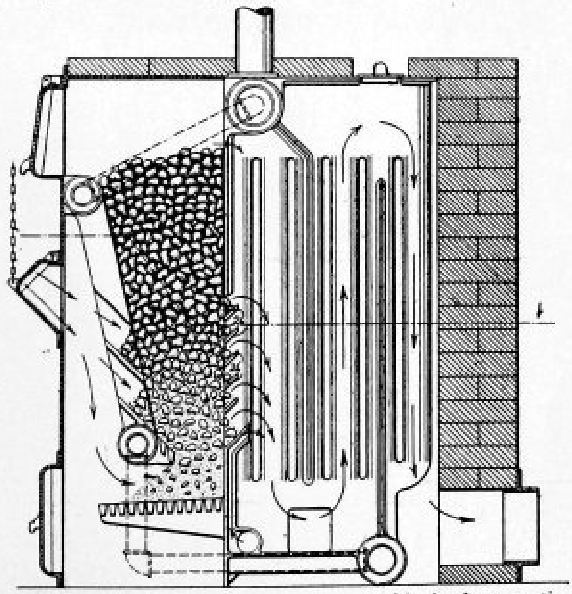
Claim 1.—A staybolt for boilers, comprising a body portion having an expanded end portion, and a head having a socket receiving the ex-



panded end portion of the body, and said head being rigidly secured on said expanded end portion of the body of the bolt. Four claims.

1,283,668. BOILER. LESTER A. CHERRY, OF BUFFALO, N. Y., ASSIGNOR TO THOMPSON HEATER CORPORATION, OF BUFFALO, N. Y., A CORPORATION OF NEW YORK.

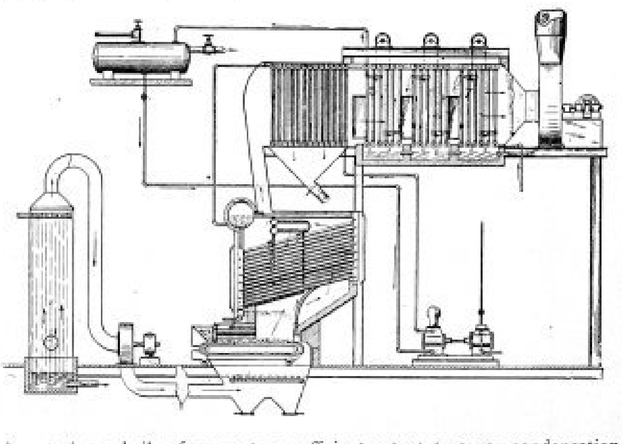
Claim 1.—The combination of a boiler comprising a plurality of vertically arranged sections, and a furnace for heating said boiler sections separably united therewith, each boiler section comprising a downwardly



extending rib which starts from and connects with the front portion of the boiler section and extends toward the bottom and in front of the flue opening in the furnace portion, the ribs of adjacent sections being in contact, one with the other, to form flues for the products of combustion, whereby the products of combustion from the furnace are directed downwardly. Three claims.

1,285,201. METHOD OF OPERATING STEAM-BOILER ECONOMIZERS. DAVID S. JACOBUS, OF JERSEY CITY, N. J., AND HERMAN C. HEATON, OF CHICAGO, ILL., ASSIGNORS TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

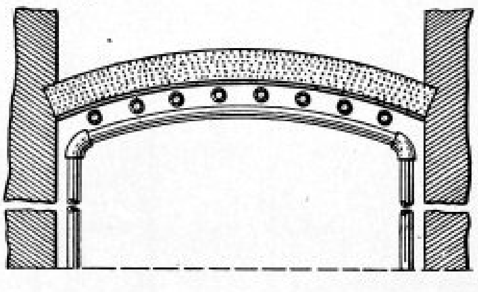
Claim 1.—In the operation of a power plant the steps consisting of supplying moisture, heated by waste heat from said power plant, to the



air entering a boiler furnace to a sufficient extent to cause condensation of at least a portion of said moisture on an economizer, and then passing the flue gases over an economizer in the waste flue, feeding water through said economizer to the boiler, and cooling the gases down to a point where at least a portion of the introduced moisture will be condensed on the economizer tubes. Three claims.

1,288,015. METHOD OF CONSTRUCTING FIRE-BRICK ARCHES. FRANK JUDSON JEWELL, OF ROME, N. Y., ASSIGNOR TO FRANK JUDSON JEWELL AND NELSON ADAMS, BOTH OF ROME, N. Y., TRADING UNDER THE FIRM NAME OF BETSON PLASTIC FIRE BRICK COMPANY.

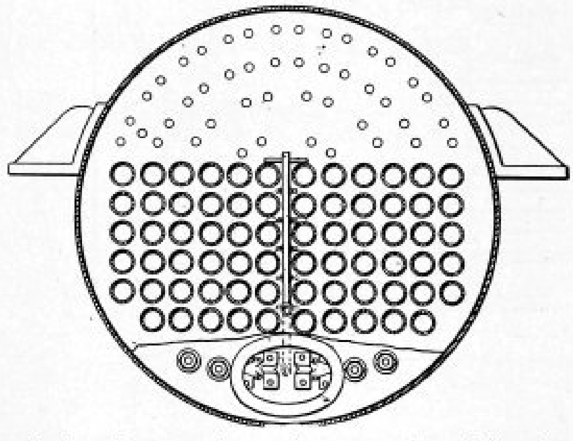
Claim.—The method of constructing a one-piece fire-brick arch, which consists in building a knockdown false work structure of metal bars or



pipes supporting a thin metal sheet having the arched form desired for the bottom of the arch, compacting a mass of unburned plastic fire-brick material on said arched plate in the form of the desired arch, heating the false work and the arch formed upon it until the fire-brick material is converted into fire-brick and then removing the false work. One claim.

1,288,586. BOILER-WASHING DEVICE. JOSEPH E. HIXON, OF CHICAGO, ILL.

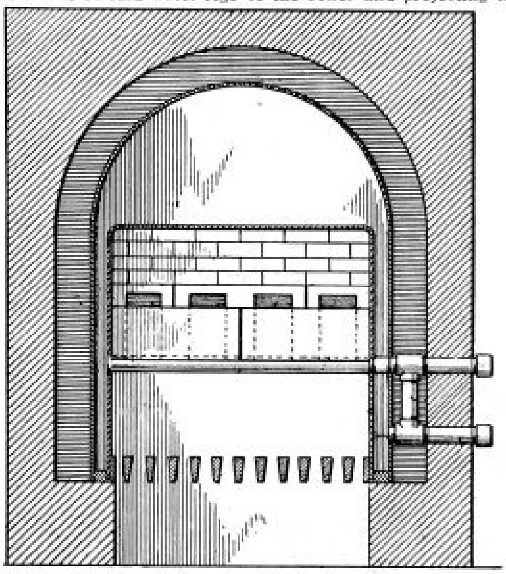
Claim 1.—A boiler washer comprising a water supply pipe, a crosshead contiguous to one end thereof adapted to ride upon a pair of boiler flues to support said pipe, a plurality of diametrically opposed pairs of discharge nozzles mounted in said pipe for directing streams of



water horizontally over and upon the upper surfaces of flues disposed at different elevations below the flues from which the pipe is suspended, said crosshead provided with water discharge openings adapted to discharge water over the flues upon which the washer is supported, and means for connecting said supply pipe with a source of water under pressure. Three claims.

1,287,081. FURNACE. ANDREW NILSON, OF CHICAGO, ILL., ASSIGNOR TO THE EUREKA SMOKELESS FURNACE COMPANY, OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

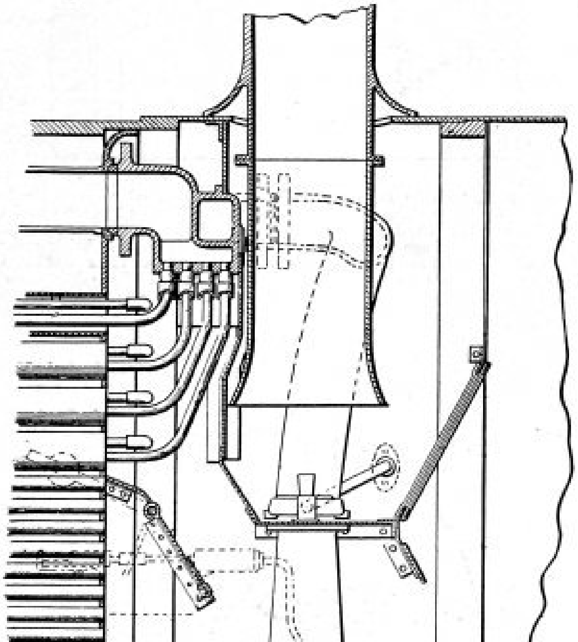
Claim 1.—In a boiler having water legs, a tubular support for a baffle wall or similar structure, consisting of a tube connected to the inner wall of one of said water legs of the boiler and projecting through



the other water leg, the interior of said tube at said connection with the inner wall aforesaid communicating thereat with the interior of the boiler, and said tube at its projection through the said other water leg having a watertight connection with the two walls of said other water leg, a second tube secured to the outer wall of the second water leg, and a connecting tube between said second tube and the projecting portion of the first aforesaid tube. Three claims.

1,285,656. DRAFT-REGULATING DEVICE FOR LOCOMOTIVE FRONT ENDS. THAYER B. FARRINGTON, OF LOUISVILLE, KY.

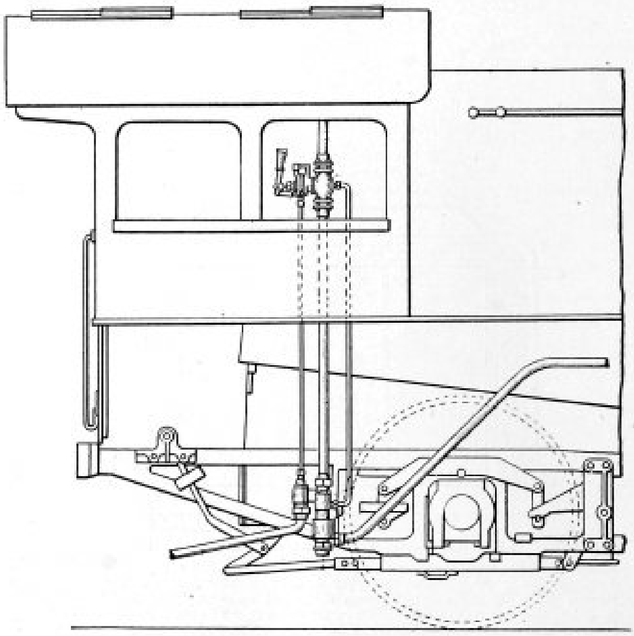
Claim 1.—In a locomotive boiler, a set of upper flues containing superheating coils, a set of lower flues having unimpeded passages, a smokebox common to both sets of tubes, a cinder screen in said smokebox, a smoke-arch positioned between said cinder screen and the flues of the



upper set and also the uppermost flues of the lower set, and a deflector secured within said smokebox and extended downwardly to project into the path of the direct draft between approximately all of the flues of the lower set and the lowermost point of the smokebox, and thereby impede or restrict the flow of gases through substantially all of said lower flues and cause an increased draft through the flues of the upper set, said deflector being pivoted at its upper edge to enable it to serve as a damper to close the passageway between the flue sheet and said smokearch. Four claims.

1,282,601. BOILER-FEED APPARATUS. WILLIAM L. LEONARD AND NORMAN SUHRIE, OF ALTOONA, AND CLARENCE D. DOUTY, OF BARREE, PA.

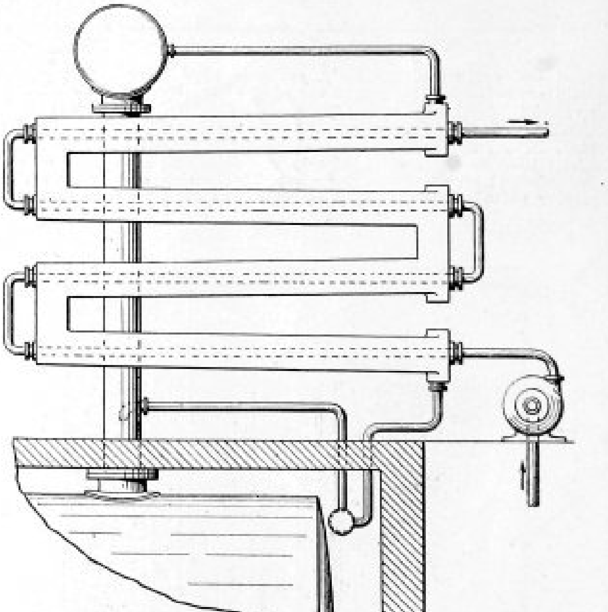
Claim 1.—In boiler-feed apparatus the combination of an injector having a water conducting valve, a steam supply device having direct connections with said injector and said valve and provided with means



for controlling and operating said connections, including a manually actuable member, said member mounted in said device for dissimilar directional movement during the controlling of said connections by said means, and a water indicating device associated with said member and capable of indicating water flow during movement of said member in one direction. Nineteen claims.

1,288,162. BOILER FEED-WATER HEATER. JOSEPH A. PERSICHETTI, OF PHILADELPHIA, PA.

Claim 1.—A boiler feed-water heater comprising the combination of a boiler, a double-pipe heat exchanger for heating feed water, a steam generator exposed in the flue passage of the boiler, and a closed pipe



system for passing live steam from the boiler to the steam pipe of the exchanger and for returning the water of condensation of that steam from the exchanger through the steam generator and thence, as steam, back to the boiler. Two claims.

1,288,014. METHOD OF FORMING BAFFLE WALLS FOR BOILERS. FRANK JUDSON JEWELL, OF ROME, N. Y., ASSIGNOR TO FRANK JUDSON JEWELL AND NELSON ADAMS, BOTH OF ROME, N. Y., TRADING UNDER THE FIRM NAME OF BETSON PLASTIC FIRE BRICK COMPANY.

Claim 1.—The method of forming baffle walls of refractory material for tubular boilers, which consists in inclosing a space to be filled by such material by walls, charging repeated portions of plastic unburned firebrick material into said space and tamping it to insure its filling its portion of the space and its union with previously tamped portions and finally subjecting the completed baffle wall to heat to give it hardness and permanency. Four claims.

THE BOILER MAKER

MAY, 1919

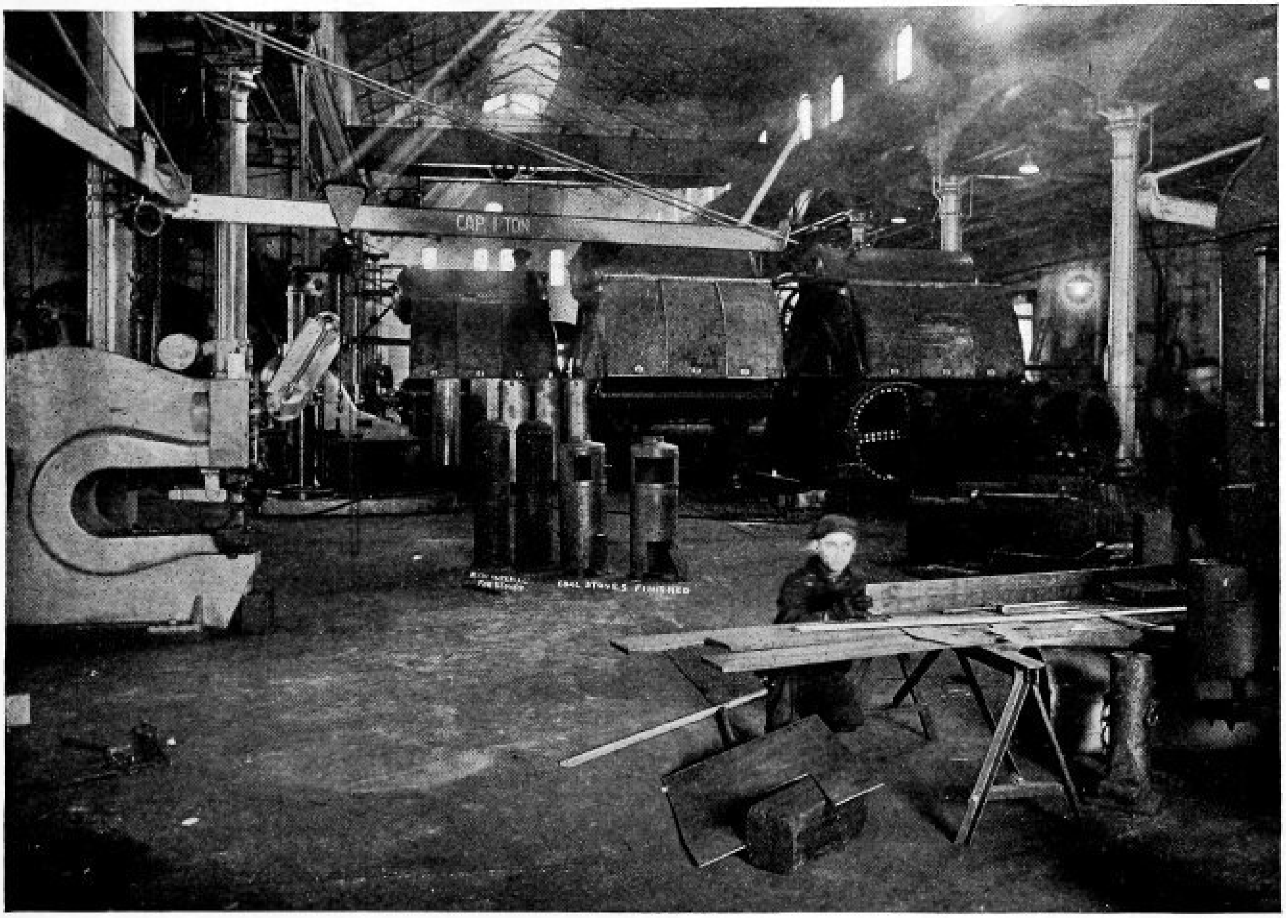


Fig. 1.—Converting Discarded Air Tanks Into Coal Stoves at League Island Navy Yard Boiler Shop

Government Savings from the Scrap Pile

Boiler Shop at Philadelphia Navy Yard Manufactures Coal Stoves from Discarded Air Tanks Found in Scrap Pile

BY THOMAS P. O'CONNOR*

About the middle of February the boiler shop at the Navy Yard, Philadelphia, Pa., received an order to manufacture thirty coal-burning stoves of a type and size suitable for the care and preservation of boilers and machinery of vessels to be placed out of commission upon being released from active war service. These stoves are principally used for the preservation of boilers by taking up the moisture in the boiler and in the boiler compartment.

Inquiries were made by the Navy Yard of several commercial establishments, and the best offer was by one firm who submitted an estimate of $41 for each stove of the type and size mentioned, with delivery thirty days from date. Owing to the immediate need for the stoves, one of the progressman-boiler makers inspected the scrap yard and found twenty-four seamless air tanks (cylindrical in shape) that had previously been discarded as of no further Government use except as scrap metal. It was found that they were of the proper size for the purpose required and they were immediately converted into coal-burning stoves, as shown in the photographs.

The cost for completion for each one was slightly less than $7, or a total saving to the Government of $716. This is only one of the many instances in which scrap

* Master boiler maker, Navy Yard, Philadelphia, Pa.

Fig. 2.—Completed Coal Stoves. Raw Material, in Shape of Discarded Air Tanks, Shown at the Left

metal has been utilized in this boiler shop during the period of the war to effect economy, and shows that the scrap pile can be utilized in the saving of considerable money to the Government or to the private plant concerned and should never be neglected. Undoubtedly many other cases could be cited where scrap is profitably utilized.

Modern Management in Boiler Manufacturing

Improved System of Manufacture Possible with Standard Product—Relations Between Employer and Employee—Avoiding Labor Troubles

BY CHARLES M. HORTON

Any system of manufacturing that is worth the name must have as a fundamental desideratum continuity in the operations when developing the product. By that I mean that the operations necessary to turning out the product must have a machine-like sequence and move with machine-like regularity and evenness one to another. Almost any system which has ever been conceived will serve in the manufacture of screws, for instance, or a standard line of valves of governors or pumps—even jitneys. The product is uniform and so susceptible in its manufacture to system. There is a continuity—or should be—in the process. System is a matter of straight lines, anyway—some call it a process of straight thinking, or common sense or horse sense—and, lacking a "straight line" in the manufacture of the product, no system will prevail to a satisfactory extent—satisfactory to the manufacturer, that is.

The manufacture of boilers, and especially of contract boilers, usually is grievously lacking in continuous process. You make up your order according to contract and specifications and you deliver it. And then you make another type of boiler and you deliver that. And so on to a third and a fourth. There is no continuity in your product, no straight line of operations continuous day in and day out. You are a jobbing manufacturer and must suffer the irregularities in the work of all jobbing manufacturers. That is your punishment for not taking up a standard line of manufacture.

But when it comes to a single type of boiler made up in quantities for a long period of time, there is a word to be said for system. System is possible in this kind of manufacture, even for a boiler maker, and it should begin, and does begin, in the up-to-date shops with the storage of plate. I need not describe these storage yards. The plate is stacked in racks according to gage, and when wanted is usually found readily. But from that point on, in most shops, there is chaos. The work proceeds from the layout man down through to the painters in a sort of haphazard fashion which cannot but spell loss, and needless loss, to the management.

It will be admitted that plate is less susceptible of easy handling than is a machine screw—to hark back to a former parallel. Therefore, likewise, it is less susceptible to the workings of a system. Nevertheless, the process, the movement of a single plate from gang to gang, is practically the same. Each gang of workmen does its little bit toward completing a boiler, just as each tool in a turret lathe performs its particular stint in the manufacture of a screw. The big idea, then, is to harmonize the operations in the making of boilers, to sort of blend them one into another, to the end that there will be a minimum of wasted effort. This is not done in many shops because, principally, of the layout of the shop, the relation, or lack of proximity, of one tool or gang of men to another. Most shops were laid out before the advent of systematizers, or efficiency men, which in part accounts for the disruption in the process and progress of the work. And to change it over now—like adopting the metric system—would mean the outlay of a lot of money. So the bad work goes on.

Any new shop, therefore, will ever have an advantage over the old shops. This subject of modern management is gripping all thinking men. Newcomers in the field are bringing with them new ideas. Many of these ideas have to do with systems. These ideas along system lines are put into working practice by these newcomers, and not the least of the ideas has to do with an arrangement of tools and working spaces which will give the most returns for the outlay of money. Any practical boiler maker knows what this arrangement ought to be. A systematizer need not be brought in at all. It is just a matter of common sense—straight-line thinking—and more people are blessed with that gift than is generally realized. The difficulty lies—and this is the why of this paper—in getting the management to spend the money necessary for securing the direct—as opposed to the indirect—line of manufacture. When that is done the rest is easy. A study of the laws of graphics would prove helpful, though this is not necessary. All one has to do is call in the boss of the shop and have a candid talk with him. He will show how it can be done.

Improved system in manufacture, however, is but one side of this subject of modern management. Let us look at some of the others. One of the most important, if not *the* most important, is the one of industrial relations. There is a relation between employer and employee, and it is a very close one, although heretofore it has not generally been recognized. Group a number of men together for a period of eight or nine or ten hours at a stretch every working day—year in and year out—and there cannot but be a very close relation. True, one man may be separated from his next "relative" by the thickness of a partition; yet the relation is there, nevertheless.

In a word, you and your employees are one big family. I know that is trite, but it will bear repeating. Your major interests are common—the earning of a living. For six days a week, or some fifty-four hours, year on end, you are practically cheek by jowl with your workmen, and the continuous contact is bound to tell upon you. Indeed, you see more of Jack Deming, your foreman, than you do of your own family. You may think more of your family than you do of Jack; but that is beside the point. The intimate relationship is there.

Men in high places everywhere, with the possible exception of boiler manufacturers, are beginning to realize all these truths. The realization in many quarters is taking tangible form, too. There is creeping over industry evidence of this, in the mutual regard with which men occupying all stations in industry affect toward one another, a genuine feeling of camraderie, and the result will mean more to the manufacturer in actual dollars and cents than would the workings of a system in the manufacture of his product. Manufacturers to-day cannot probably lay their hands upon it as yet. But the results will presently appear, will make themselves apparent, and in many diverse ways. Any man has but to look within himself and about him for evidence that this is a working law as natural and as true as that two and two summed up make four. The writer personally has tried it out, and has seen it work, and then has deliberately essayed the reverse venture—an ignominious and perverse performance—and has seen this kind of bread boomerang unto him, winging him in the neck. The thing is a law, I say, and manufacturers are beginning to realize that it is, and that it possesses wonderful powers for good to themselves in their business.

So look you, Mr. Boiler Manufacturer, to the good in all its manifestations in your plant. A welfare committee of workmen, and shop elections for petty bosses, and dentisty, and recreation periods, and loan associations, and the care of workmen who are ill, and their families cared for during the period of illness, and proper lighting and heating and ventilation, and machines that machine and tools that tool—any one of the hundred and one innovations being put into effect everywhere through the country to-day, and, indeed, throughout the civilized world. There is money in it for you, if you will but see it. It is bread cast upon the waters. Manufacturers in other lines are finding this out, and it behooves you to go and do likewise. It is part and parcel, the very backbone, of modern management, this attending to the men in your employ. You are the stronger in some ways; you hold the upper hand. It is no evidence of weakness—rather is it evidence of strength—to bend to service for those who cannot well serve themselves in these things. Nor let them have to ask for it; give it yourself, first, and freely and without stint. You will think better of yourself, and will feel better, for having done this thing.

"I've been with this company going on seven years," said a foreman boiler maker one day in his tiny office rigged apart and made bomb-proof—at least, sound-proof—in order that he might concentrate upon his daily problems without the usual interruptions that are necessary to boiler making. "They've had their periods of business depression, just the same as other shops. But never in all that time have I known them to lay off a man because there was not enough work. They kept the organization together, even though at times it must have been hard for them to do it." He was moodily silent.

I asked him the reason for this outburst on his part, since the subject up to this time had been of the work. He smiled and continued to gaze thoughtfully out through the tiny glass partition.

"It's this," he finally replied. "I was thinking about these things that are holding the interest of executives to-day everywhere in the country. What they are just waking up to, apparently, has been known and practiced by this company ever since I've been here. They don't—and never did—treat the men rough. And there isn't a man on the payroll but what would go to hell for Wyatt, the manager, and Tripper, the president. We have never had any labor trouble and we never will. Other shops in this burgh have been tied up more than once because of a dispute of some kind or another. But not this shop. And it's all because the owners are men who can see a little beyond immediate overhead expense and the growing wage scale. They are in business as a business, just the same as any other man. But where they were wise beyond the average was that they saw that it was good business never to antagonize the source of their income, which means not only the buyers from other houses using their product but also the men inside who make their product. That's all. You'll excuse me for that busting out, I take it. What made me think of it was the figure of Wyatt out there now taking a tool out the hands of one of the apprentice boys and showing him how to make the proper use of it."

I certainly excused him for his "busting out," as he called it, because it was in line with my own thinking—and I had worked for the concern myself, as a draftsman, some ten years ago, and was but retracing old ground on new ventures. One of these ventures was by way of being an inquest into the manner in which certain phases of modern management were being received by executives and owners and workmen.

I was learning much. One of the things I was discovering was that boiler manufacturers are loath to accept these modern tendencies in industry. Perhaps presently they will take forward steps along these lines.

Among Mississippi Boiler Shops

Some Wall-Pockets—A "Grounded" Electric Motor—Curing the Trouble—Making a Stack Ring—Working Without Boiler Makers

BY JAMES FRANCIS

This day, the twentieth of February, I came across a little boiler shop in Vicksburg, Miss., almost upon the banks of the Mississippi River, and the very first thing noticed was a line of "feed boxes"—for they looked all the world like the places where they feed horses in livery stables—built all along one of the side walls of the shop and filled with rivets, bolts, steam fittings and all the numerous articles of small size which must be kept "somewhere" in a boiler shop which does not have a store room.

The walls of the shop were made of corrugated steel, which was nailed vertically upon shingle strips spaced 16 to 24 inches apart, as shown at *I* and *J*, Fig. 1. The storage boxes were built right against the sill *B*, which in turn rested upon the concrete foundation *A*. Three tiers or rows of boxes had been built as shown at *C*, *D* and *E*.

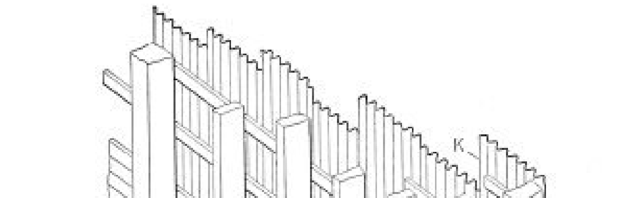


Fig. 1.—Side Wall Storage in Shop

The boxes were attached to the studs by means of the heads *F*, *G* and *H*, and the shingle strips were placed close together back of the boxes, as shown below *I*. The outside corrugated steel covering is shown at *K*, and it will be noted that the storage space, which is very large, there being three rows of boxes, does not use one particle of the floor space of the shop, but is carried entirely upon the side wall. The front side of each box was utilized for marking thereon, with neat black letters or figures, the name or dimension of the article to be found inside each compartment.

In this shop there is a fine little grinding machine with double wheels, one on either end of a mandrel, and with an electric motor in between the wheels and well enclosed from dust, making an ideal grinding machine for the boiler shop, particularly for the finer class of work, there being a larger and rougher set of wheels, belt-driven, elsewhere in the shop. This little machine carried a motor wound for 350 volts. It carried that particular pressure because it was the voltage required by the large motor which drove the rest of the shop machinery; therefore, the little grinder motor was for 350 volts, too.

A current of 350 volts will shake up a man pretty well when it gets through his hands and leaves by way of the feet; and, while perhaps not dangerous, it sure makes a man look "high, wide and lively" four ways for Sunday when it gets loose in his anatomy!

Somehow, that grinding machine had become completely charged with "the juice," and the men were all leery about doing work on the little machine, for, as the foreman said, "It would sure shake a man some once in a while!" And nobody seemed able to tell when the machine would "behave shockingly," or when it would be good.

Curing the Trouble

The writer then showed the shop foreman how to grind without getting a dose of the "juice." The machine stood directly upon the dirt floor of the shop, and when a man touched the machine, either with fingers or with a tool, after current had been turned on, that man was pretty apt to dance an unexpected jig.

A little platform, made of dry pine boards about two feet long, was nailed up, the grain being crossed, making the platform about two feet square. This was placed on the ground in front of the machine, and while standing upon the little platform a man could grind a tool without getting a shock. The platform was placed to one side when an uninitiated man went to grind, or to "ride the goat," as the boys called grinding with that machine.

The foreman was also advised to have an electrician overhaul the machine a bit, and while so doing he would probably find that the insulation of one of the wires had become worn, letting the wire bear directly against the metal of some part of the motor, thus "grounding" the circuit and charging the motor. Such a condition is not at all desirable in any motor-driven machine, for, with one of the wires grounded in the machine, should the other wire chance to ground also, then there would be more fireworks than was at all desirable or comfortable, hence the immediate necessity of having grounded motors attended to at once.

Does a Large Variety of Work

From the appearance of the shop it was judged that six or eight men might be employed upon outside work, for there was a fine radial drill in the shop, a set of light ten-foot bending rolls, a fine combined punch and shear, together with a flanging forge and a whole lot of smaller tools, bending rolls, clamps, etc., for doing light sheet metal work.

The writer was surprised when the shop foreman informed him that they had more than forty men on the payroll and were hiring every boiler maker they could get hold of! It appeared that the little shop not only did a large amount of stationary work, but that steamboat work was their "middle name," and also they did all the bridge work which they could get hold of!

After leaving the shop, the writer passed the office of the concern and was surprised to find that it was as large, if not larger than the shop! And that circumstance brought forcibly to mind a statement made by the foreman of the little shop in question, who said: "You can't most always tell from the looks of a shop how many men they are working on outside jobs!"

Hoping They Won't Get the Contract!

Just now this shop is waiting the acceptance of their bid on a job which they hope they won't get! Rather a queer situation that, but the figuring was done and the bid made some time ago upon a bridge over 800 feet long—a steel bridge—and since the tender was made prices have gone up so much that the shop management sincerely hopes their competitor will be awarded the contract!

On the floor of the shop was a small vertical boiler, with the remains of a fire underneath it, but there were no grates under the boiler, the fire having been built directly upon some pieces of sheet steel which had been laid on the dirt floor of the shop and the boiler placed upon the sheets. A rubber hose had been connected between the boiler blow-off and the city water plug of the shop.

"Say!" remarked the writer to the shop foreman, "that boiler business surely was a good way of keeping the shop warm during the cold weather you had last winter, but can't you let up on the shop heater business now that the roses are in bloom?"

"'Spose we can," remarked the foreman, "but the thermometer stood at 32 degrees on February 19 in the morning, roses or no roses!

"I didn't have that boiler on the floor last winter, but 'bet your boots' I wish I had, and it would have been fired for all it was worth! You see it is this way. Have just put a 'dough-patch' on the inside of the water-leg of that boiler and I was afraid there might be a few little leaks in the work; and I knew the people who own that boiler, and if there had shown the slightest 'weep' anywhere around that patch, then back would have come the boiler again for another 'once over.'

Stopping the "Weeps!"

"So I just 'put one over' on those people. I sent down to the river and got a barrel of Mississippi River water, filled the boiler with it and fired her up. There were half a dozen wet places around and under that patch, but inside of half a day 'Mississippi mud' got in its work, and now, you see, with city water pressure in the boiler there is not even a sign of dampness anywhere around that patch.

"Anybody knows that little leaks in new work will 'take-up' as soon as a boiler goes to work—No! not everybody knows that, for that customer who owns the boiler can't be made to see it, much less to know, so I have learned better than to take any chances with such people, but I just 'camouflage the leaks' with a little heat and Mississippi mud, and everything is lovely and not a kick coming!"

Making a Stack Ring

Having thus expressed himself, the shop foreman, with two colored helpers, proceeded to make up some stack bands to go around the upper end of sections of wire netting, said sections being designed to top out the smokestack of "gin mills" in the neighborhood. Now, let it be understood that a "gin mill" in the South is very much different from its namesake in the North. There it means where liquors are sold and drunk. In the South it means a place where cotton fiber is removed from the seeds and pods of the plant—in other words, a "cotton gin."

It is necessary to screen the tops of "gin" stacks in order to prevent fires from the sparks likely to be thrown from the open stack, hence the six-foot sections of 1/4-inch wire cloth with which each "gin stack" is topped out. The manner in which stack-bands were made in this shop was to lay off, punch and cut the band, then one colored laborer held one end of the strip of black steel over the top bending roll while another dusky man hit it with a sledge until the end was formed to about the proper radius.

The bending was continued by taking a pry between two of the rolls and pulling down upon the long end of the bar, advancing the bar a bit between pulls. As soon as the circle was closed up so it could be barely removed from the roll the band was removed to the anvil, placed across the corner at the root of the "beak" and inside blows from a sledge quickly closed the band to a smaller diameter than was required.

The foreman then took the band in hand and finished it while the helpers were working other bands. The foreman placed the band flat upon the handy-hole end of the anvil, and with light blows from a hand-hammer opened the band, rounding it up while increasing its diameter, but keeping the ends close-lapped all the time.

In far less time than it has taken to tell the story he had rounded that ring so nicely that the eye could detect no irregularity in its circumference, had opened it until the two end holes were fair with each other and had slipped the band over the end of a screen section and was drifting holes in the wire-cloth, through which the colored helper placed small bolts and, eventually, drove washered rivets. By keeping the ends of the band at all times clamping together while opening and rounding the band, the foreman made easy work of the job.

Working Without Boiler Makers

"Yes," said the foreman, "we hire about every boiler maker who comes along, and we very seldom let a good one get away from us. We find it pays to keep them puttering around even at a loss when work is slack, for in our business we never know when we are going to be rushed to death. The work doesn't send out any advance agent to bill the town before it gets to us. Just 'biff,' and then we are working night and day on some large steamboat job, and that is where that big radial drill comes into use.

"Some shops seem able to get along without boiler makers, but we can't. There is that large railroad shop down street a couple of blocks. They have another larger shop at McComb, this state. In 1912 they had a big strike and all the boiler makers, about 275 of them, quit work. We hired everyone from this shop and some from the other, and then we couldn't get men enough to handle the work we had on hand at that time.

"And the queer thing about it is that those two shops, which used to employ 275 boiler makers, have never had 75 between them since the strike! And it is there that they do work without boiler makers, as I said we couldn't seem to do. Why, the foreman of one of those railroad boiler shops told me only a few days ago that during 1917 his shop had removed eleven fireboxes from locomotive boilers, replaced the old with new ones and had used only two boiler makers in doing all that work!

"What men did he use? Why, farmers, young men from the country, that they can manage to get hold of and keep. And the foreman also told me that in his shop where those two boiler makers were working they had twelve boiler apprentices! So it looks as though they would have boiler makers again some time, if those two journeymen boiler makers are not worked to death between making fireboxes and teaching apprentices!

Didn't Like Oxy-Acetylene

"No, sir, we haven't got an oxy-acetylene outfit in the shop yet. I would like a cutting torch, for I think they are fine, but I am afraid of oxy-acetylene welds on boiler work. I will tell you why. One day I was sent out to repair a job which a welder had tried to do and had fallen down on. There were seven small leaks—cracks, most of them—in a boiler and they had all been welded. As soon as the last one was done and they looked the work over they found each weld to be cracked right along in the middle of the weld again.

"The welder went over all those welds two or three times, and there would be that crack right in the middle of the weld again as soon as he got away from the work. I tell you, sir, that made me sure afraid of the oxy-acetylene welding, and I had to patch every one of those cracks before they could use that boiler again."

The writer explained to the foreman how the welder did not understand the laws of expansion and contraction, and that he had evidently built metal on top of the crack instead of burning away the metal until the weld could be started at the bottom of the crack. The value of arc welding and its lack of hardening or carbonizing the sheets were also explained, but for all of the talk there is one foreman boiler maker in the state of Mississippi who will never trust welding, not at least until he may be gradually converted to its value through use of the cutting torch and then the increasing use of the oxy-acetylene flame for simple welds at first.

Boilers of Merchant Ships

To the casual observer it may seem strange that, while the watertube boiler is now exclusively employed for warships, it has made practically no impression on the mercantile marine. There are indeed notable exceptions. Belleville boilers have been extensively adopted in the vessels of the Messageries Maritimes. In this country (England) a few shipowners have broken away from the tradition of the tank boiler, while in Germany a very big departure was made in fitting boilers of the Yarrow type to the large transatlantic steamer *Imperator* and two sister vessels. The results in the *Imperator* were stated to be entirely satisfactory in the few months that elapsed between the passing of this vessel into regular service and the outbreak of war, when the intervention of the British fleet made further practical experience at sea impossible.

Judging by the number of ships fitted with Scotch boilers, the opinion of shipowners is still very strongly in favor of that type. During the war a certain number of vessels have been fitted with watertube boilers, but this change must be construed as a bowing to necessity, due to shortage of capacity for the manufacture of Scotch boilers rather than to a weakening in the affection for them. Much of this feeling is no doubt pure and unalloyed conservatism. The strenuous fighting to retain the Scotch boiler in the navy is still fresh in the memory of most of us. One may speculate as to what would have been the course of events had the watertube boiler been first established and the Scotch boiler introduced as an innovation. A storm of criticism would in all probability have been directed against it for its contravention of the canons of mechanical science. The evils of flat surfaces exposed both to pressure and heat would have been emphasized, the racking strains due to variations in temperature in a structure so lacking in symmetry, and many other objections would have been urged against so daring a departure from existing practice, while the rules by which the thicknesses of flat plates and the diameters and pitches of stays are calculated would have been stigmatized as conforming to no known principles of applied machines. In short, had the tank boiler been born into a world already accustomed to the watertube boiler, it would probably have been regarded as entirely illogical with no *raison d'etre*. The Scotch boiler has, however, a great weight of accumulated experience behind it, and it must be admitted that, in spite of its obvious limitations, it has, on service, proved itself to be reliable and fairly efficient, with the added advantage of a long life if properly looked after. The watertube boiler has no such accumulated experience in the mercantile marine, but from the experience in warships there is no reason to suppose that either its reliability or its durability, at least in the simpler types, is any less than that of the Scotch boiler. It is on the score of efficiency that the watertube boiler is most open to criticism, and it must be admitted that its performance is uneven; or, put in another way, its curve of efficiency under varying rates of steaming is not so flat as that of the Scotch boiler. At the highest rate of evaporation the efficiency of a modern watertube boiler of any of the types most in use is at least equal to that of the Scotch boiler. At low rates of evaporation high efficiencies have also been obtained on carefully conducted trials on shore, but these results have not as a rule been maintained under service conditions at sea. Several factors combine in the watertube boiler to make the realization of high efficiency difficult at low rates of evaporation. It is not so easy to maintain a proper covering of the wide grate, and there is in consequence a greater tendency to loss by excess air than with the narrow grates of the Scotch boiler. The relatively low speed of the gases and their straight path render mixing more uncertain. Radiant heat, which bears a greater proportion to the total when fires are thin, is also much better utilized when the heating surface is nearer the grate—that is, in the tank boiler. The quantity of water contained in the boiler must also have some influence in improving efficiency by steadying the rate of evaporation during the fluctuations in the generation of heat which occur when firing. The magnitude of these factors steadily decreases as the rate of evaporation is increased, and in the cylindrical furnace the advantage of nearness of its heating surface to the fire becomes a disadvantage after a certain point, when the furnace becomes filled with flame and the heat is transmitted nearly wholly by direct contact of the heated gases, the cooling of which must result in a certain amount of incomplete combustion.

We may conclude, then, that the solution of the problem of constructing a watertube boiler which shall be as efficient at low as at high rates of evaporation, suitable for merchant ships which have to vary their speed to suit their itinerary, must be sought in some form of compromise. For mail steamers on a fixed route, which always require to run at their maximum speed, the adoption of the watertube boiler with its many advantages should not, it appears, be much longer delayed. We may see established in the near future passenger services by air, and, although the volume of this traffic will be limited, it will undoubtedly exercise an influence on the liner by creating a demand for faster passages.—*The Engineer.*

To Lay Out an Ellipse by Circular Arcs

By Arthur Malet

Fig. 1 shows how to lay out an ellipse by circular arcs. Although not an exact method, it is very convenient for many purposes.

First draw *AB* the long diameter or major axis, and *CD*, the short diameter or minor axis, intersecting at right angles to each other in the center *E*, so that *AE* equals *EB*, and *DE* equals *EC*.

On the major axis *AB*, set off *Aa*, which equals *CD*, the minor axis; then divide *aB* into three equal parts. With *E* as a center, and a radius equal to the length of two of these parts, draw arcs cutting *AB* in *b* and *c*.

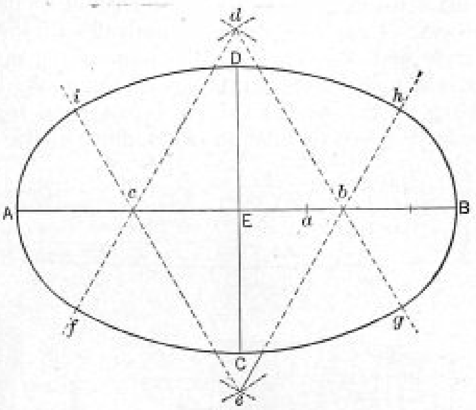


Fig. 1

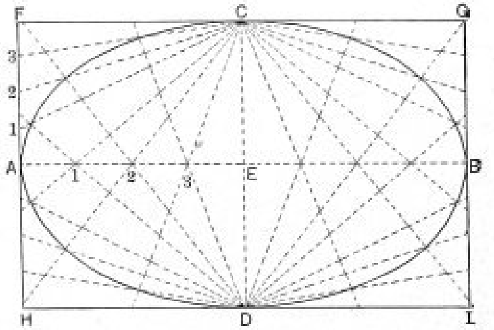


Fig. 2

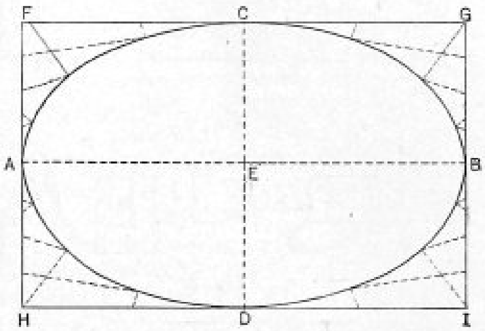


Fig. 3

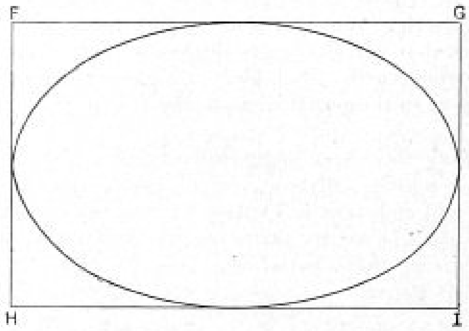


Fig. 4

With *b* and *c* as centers and any convenient radius, draw arcs cutting each other at *d* and *e*; then construct two equilateral triangles *ceb* and *cdb*.

With *b* and *c* as centers and any convenient radius, arc *fCg*. With the same radius and *e* as a center, draw the arc *iDh*. With *c* as a center and *cA* as a radius, draw the arc *iAf*, connecting *iDh* and *fCg* at *i* and *f*. With the same radius and *b* as a center, draw the arc *gBh*, connecting *iDh* and *fCg* at *h* and *g*, completing the ellipse.

To Lay Out an Ellipse Within a Given Rectangle

Figs. 2, 3 and 4 show an ellipse drawn within a rectangle. This is an exact method and can be used when the sheet on which the ellipse is to be drawn is equal to, or but slightly exceeds, the rectangle.

To lay out the ellipse, draw the rectangle *FG*, *HI* equal to the major axis, and *FH*, *GI* equal to the minor axis. Draw the centerlines *AB* and *CD*, which are the axes of the ellipse, and be sure they divide the rectangle into four equal parts.

Divide the lines *AF*, *AH*, *GB*, *BI*, *AE* and *EB* into the same number of equal parts, as *A*-1, 1-2, etc. The larger the number of parts made, the larger will be the number of points through which the ellipse passes.

From the point *C* draw lines to the points of division on *AF*, as in Fig. 2. From the point *D* draw lines through the points on the line *AE*, producing them until they intersect the lines drawn from *C*.

Where the lines meet will be points on the ellipse—that is, where the line *DI* meets the line *CI* will be a point on the ellipse, etc.

The other three-quarters of the triangle are to be treated in the same manner, thus locating all the points of the ellipse, see Fig. 2.

Then with a steady hand or a strip of light iron bent to the required curve, draw the ellipse.

Examinations for Applicants for Positions as Locomotive Inspectors to Be Held on May 21 and 22

Inspectors of locomotives, at $3,000 a year, are called for by the United States Civil Service Commission, and examinations will be held on May 21 and 22 to fill vacancies under the Interstate Commerce Commission. Applicants must have reached their twenty-fifth but not their fifty-fifth birthday on the date of the examination, and must have not less than three years' railroad experience in the capacity of master mechanic, road foreman of engines, locomotive boiler maker, locomotive boiler inspector, roundhouse foreman, shop foreman, locomotive machinist, or locomotive engineer; not less than five years as locomotive inspector or locomotive fireman; and must have been within three years next preceding the date of application in active service in any such capacity or in the capacity of inspector of locomotive equipment under the government of the United States or of a state or territory.

Flues—II

Kinds of Tools Used on Flue Work and Reasons for Using the Tools

BY GEORGE L. PRICE

While we are discussing the flue question, I would like to see each month in THE BOILER MAKER sketches and drawings of beading tools and gages with explanations as to why different styles of tools and gages are favored; also experiences with different styles of tools, describing their merits and defective qualities alike. Discussion of the following questions will also be helpful:

Topics for Discussion

What style and kind of beads are preferred for locomotive flues? Is a large bead or a small bead preferable and why? Do you prosser your flues with a large air hammer? If so, what kind of a rigging do you use in the firebox to support the air hammer? What kind of expander do you use? What kind of mandrel pins do you use in your expanders? Give your ideas as to why you think your style of tool is the best.

It would be very interesting and educational to the readers of THE BOILER MAKER to see the different kinds of tools in use throughout the country and hear the opinions in regard to the good and bad qualities of each particular style. It may result in bringing out tools and appliances that will be nearly perfect as far as their missions are concerned. Shop kinks are also very interesting, especially so to the practical man who is using the hammer daily.

In making the above suggestions I hope I have started something which will continue for some time; for example, I will endeavor to explain with words and sketches the kind of tools we are using on flue work; also my reasons for using these particular tools.

Mandrels

Our expander mandrel pins are the "flatted" type, as shown in Fig. 1. The flat surfaces are ideal for holding high pressures, and they are made octagonal with a taper. This will permit the turning of the expander more readily and gives each expanding segment a flat bearing upon the entire base area, which will greatly increase the life of the tool. The wear on the pin is much less and the wear on the base of the sections is so slight that new sections may be applied at any time without special fitting. I am also of the opinion that the octagonal mandrel is less dangerous to the workman, as it is not likely to fly out as often as the round pin.

Expanders

Our expanders are of the sectional type (see Fig. 2). I consider the maintenance expense very slight on this style of expander; also the distribution of pressure is more equally divided. We use this expander with the rubber retaining ring. There are eight sections to each expander. All sections are interchangeable.

This style of sectional expander enlarges the flue diameter on both sides of the flue sheet, thus making the flue act as a brace against either tension or compression forces. The tube end is left strong after expanding, as this expander does not thin out the tube to any great extent.

I consider the quick-acting knockout tool very essential to the boiler shop tool room. It surely is a money-saver to any company (see Fig. 3). One man with this tool combination can prosser more flues perfectly in a given time than two men can in the same amount of time in any other way. I consider danger practically eliminated with this style of tool. The pounding out of the pin by side blows is also eliminated in the use of this tool. Excessive pounding on the side of the pin is not good for the pin, expander sections or tube, to say nothing of the accidents

Fig. 1

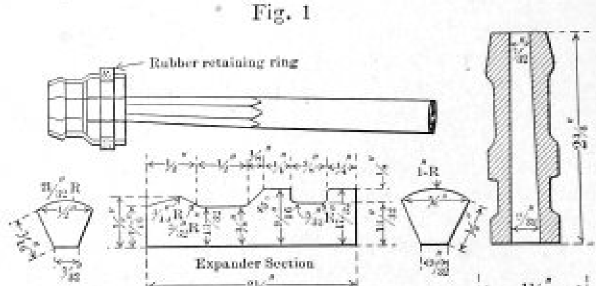


Fig. 2

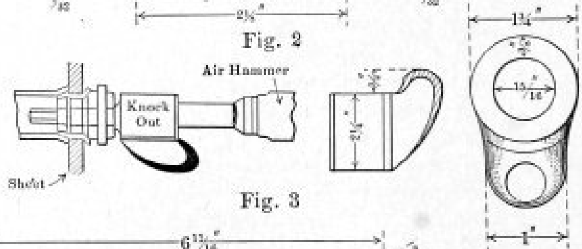


Fig. 3

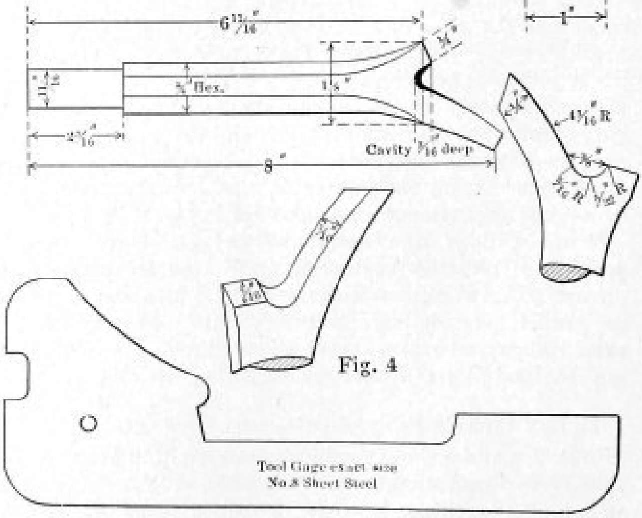


Fig. 4

Fig. 5

that might occur by a glancing blow of the hammer and the expense and delays for the renewal of broken expander parts.

Mandrel Extractor

This extractor or knockout is a sleeve fitting over the mandrel pin and is provided with an extension or arm which receives the blows from the air hammer. It does not interfere with the expansion of the expander in any manner and may be left in place at all times. To loosen or extract the expander pin after expansion has occurred, the air hammer is shifted from the mandrel pin to the knockout tool. The force of the blows acts in such a way as to free the expander sections from the mandrel. The mandrel releases itself instantly and creeps back faster than it entered. Theoretically speaking, every blow of the hammer forces the knockout against the adjacent expander segment and it has a tendency to move lengthwise in advance of the remaining segments. The contact of the tool and the segments afford a fulcrum over which the sleeve moves to impart to the mandrel pin a lateral tendency, which breaks the contact with the expander units. This knockout tool can also be used when expanding flues with the hand hammer, as a few blows applied to the extractor will draw the pin.

Beading Tools

The beading tool is one of the boiler maker's most important tools, providing it is kept in shape (see Fig. 4). When this tool is kept in proper shape or up to the gage, it is a money-saver for the railroad, for the reason that all the beads will be uniform, which will go a long way toward flue maintenance.

On the other hand, a beading tool that has been worn by prolonged use until it is out of gage will do more damage than any other tool I know of. For instance, if four or five men are using the proper kind of beading tools on your road and the engine goes in the roundhouse at some outside point where the flues are calked with a beading tool that is worn and out of gage, this one man will practically ruin the flue beads when calking same by flattening them out with his inferior beading tool. Then when the engine goes back home again it is calked with a uniform tool, and the uniform tool will not cover the flattened bead; consequently, we have a bead that has a burr, or, in other words, a bead with "whiskers," which must be trimmed off. This operation calls for additional time and expense, which is charged up against the engine; also a set of flues with beads that are not uniform.

In the event this same defect occurs two or three times, which is often the case, the stock for the bead becomes narrowed down until the heel of the beading tool begins to cut the flue sheet, which, in a short time, produces a set of flues that are calked in to such an extent that at times it is impossible to get an expander in the tube without removing a section or two. Oftentimes, when expanding the flues out again, they burst, which will raise the question: "What is the matter with flues on engine 300? she has only been out of the shop four or five months."

In answer to this question, the roundhouse boiler maker will say: "Her flues are no good, or thin, as they burst when I expanded them. Her beads are rotten; they break and I can't calk them in the proper manner. They don't fill the beading tool." The outcome of the whole business is that the roundhouse foreman turns in the important information to the master mechanic and he jumps astraddle of the boiler maker foreman's neck because he didn't set the flues with stock enough for a standard bead.

So it is very evident that one man can ruin the work of a dozen others in a very short time with an inferior beading tool. While this may sound like a story in a dime novel, nevertheless I have known it to be a fact.

We are at present using this style of beading tool with great success. Our flue sheets are in better condition at the present writing than they have been for years. We do not have as large a number of flues calked in as we had before we adopted this style of beading tool. It is next to impossible to cut the flue sheet with the heel of the tool, as it is broad and flat on the end and has no cutting edge. This tool takes about 5/16 inch of stock for a bead. This gives us a large high bead, but not a very broad one. We are getting more service out of this style of bead than we were getting from smaller beads of similar design.

Tool Gages

Tool gages for our beading tools, as shown in Fig. 5, are provided in our back shops and roundhouses. The boiler makers are requested to keep their tools up to the gage, which necessitates the gaging of the beading tool often. We endeavor to keep a supply of beading tools on hand at each roundhouse and back shop continually; that is, we try to keep about one dozen standard tools at each outside point for the day and night forces, and one-half dozen on the road en route to the back shops for repairs or redressing. Thus our supply is never diminished and we always have on hand a standard tool for the required occasion. Oftentimes a beading tool will get out of gage by calking just one set of flues, and again, on the other hand, a tool will last for half a dozen sets.

Mandrel Pin

The mandrel pin shown in Fig. 6 is used in the long-stroke air hammer with good results. It is not a new device, and I think it is the same as any other ordinary

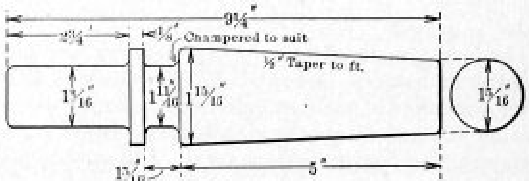


Fig. 6

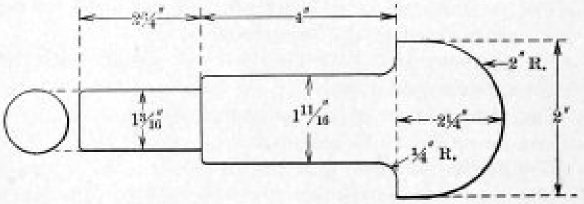


Fig. 7

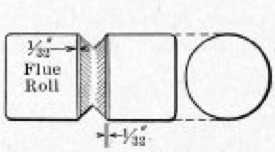


Fig. 8

mandrel pin, except that it has a shank on one end to fit the air hammer. However, I might state that the speed obtained with this tool in comparison to that of the hand method is much faster.

Belling Tool

The belling tool (Fig. 7) is also used in the long stroke air hammer. As we set our flues 5/16 inch out of the sheet for beads this leaves us quite a large amount of stock, which retards the proper action of the expanders by shortening up the reach of the expanders, or, in other words, the expanders are held out by the stock on the flue so that the toe of the expander oftentimes rests on the inside of the flue opposite to the very inside edge of the flue sheet, and when the flue is expanded the toe of the expander will slide or skim off the edge of the sheet to its proper place.

This action is detrimental to the flue, as the expander has a shearing action whenever this occurs. I also think it is twice as hard to expand flues when we figure on the expander belling out the stock during the expanding operation, especially when the stock is long, as in this case. Therefore, we bell our flues before we expand them. This operation does not require much time, and it is so much easier to expand the flues after they have been belled. This belling also eliminates the unseating of the flue, providing they have not been properly rolled beforehand.

How often have some of you readers, when rolling a set of flues, forgot your religion when the rollers kept working in or out—most generally out? It has been my experience quite often to be troubled in this manner, and I have in mind a shop kink that will eliminate this trouble.

Take your rolls out of the cage (Fig. 8) and have a small groove cut in the center of them, about 1/32 inch deep and 1/32 inch wide. Of course, you will have to anneal them to do this; but it pays, as the rolls will stick and hold in place by throwing up a small ridge on the inside of the flue. This will also aid in determining when the flue is rolled enough (providing you are in doubt) by the small ridge left on the inside of the flue that is made by the grooves in the rolls.

Speaking about a rigging to hold up the big air hammer in the firebox to expand flues; this is at present out of the question for me to describe, and I do not think it is necessary to illustrate our present style with a drawing, as we generally put an iron rod in one of the top flues and suspend the hammer by a rope or strap with a weight on the other end to counterbalance the air hammer. This contraption we hang over the rod, and "go to it." I am sure some other readers have a better rigging than this, so let's have it in the next issue of THE BOILER MAKER, in order that all may benefit by the information.

(To be continued.)

Superheated Steam

Factors Controlling Amount of Heating Surface —Contra Flow of Steam Against the Gases

BY HAROLD E. PEARSALL

The employment of superheated steam is becoming more general in modern steam plants, but even now there is great variation in the methods of calculating the required heating surface to obtain satisfactory results.

Heating surface depends upon the following points:

(1)—The evaporation from the boiler.
(2)—The percentage of moisture in the steam to be re-evaporated at the superheater.
(3)—The temperature of the flue gases in contact with the superheater tubes.
(4)—The temperature of the saturated steam.
(5)—The latent heat of the steam.
(6)—The degree of superheat required.
(7)—The specific heat of the steam.
(8)—The rate of transmission of heat.

Before taking a definite example I will deal first with each of the points upon which the heating surface depends, taking them in the same order as given before.

BOILER EVAPORATION

This varies greatly, but with good coal and stoking the following figures can be used for calculations:

LANCASHIRE BOILERS

Size	Evaporation in Pounds of Water per Hour
30 feet 0 inches by 9 feet 0 inches	8,000
30 feet 0 inches by 8 feet 6 inches	7,000
30 feet 0 inches by 8 feet 0 inches	6,000
28 feet 0 inches by 7 feet 6 inches	5,000
28 feet 0 inches by 7 feet 0 inches	4,500
26 feet 0 inches by 6 feet 6 inches	4,000

CORNISH BOILERS

Size	Evaporation in Pounds of Water per Hour
26 feet 0 inches by 6 feet 6 inches	3,500
24 feet 0 inches by 6 feet 0 inches	3,000
22 feet 0 inches by 5 feet 6 inches	2,500
20 feet 0 inches by 5 feet 0 inches	2,000
18 feet 0 inches by 4 feet 6 inches	1,800

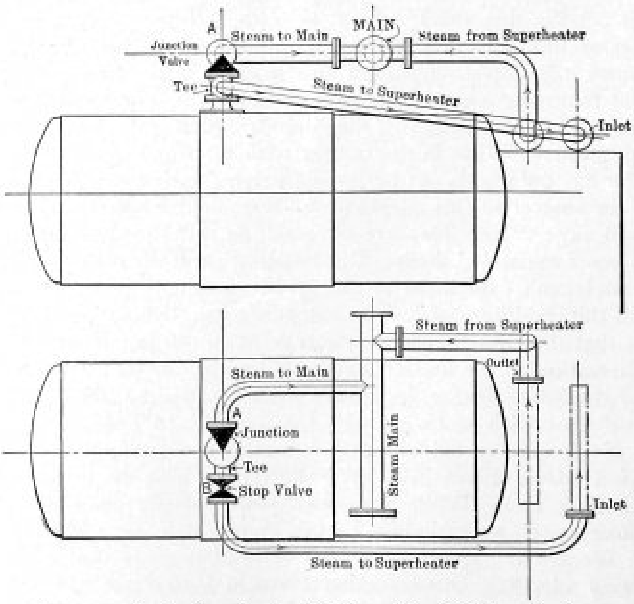
PERCENTAGE OF MOISTURE

The amount of water carried away by the steam through the junction valve varies with the steam space. For ordinary cases the following percentages may be taken:

	Percent Moisture
Lancashire boilers without steam dome	3
Lancashire boilers with steam dome	1½
Cornish boilers without steam dome	4
Cornish boilers with steam dome	2
Watertube boilers, about	5

TEMPERATURE OF GASES IN CONTACT WITH TUBES

The superheater is usually fitted in the boiler downtake just behind the boiler flues, and so arranged that from the



Arrangement of Superheater By-Pass Pipe Work with Steam Arranged to Flow Contra to Flue Gases back of the boiler to the tubes is about 9 inches. Where possible, the temperature of the gases at this point should be obtained from the plant by use of a pyrometer or other means. Where this cannot be done, the following table will serve as a guide:

Type of Boiler	Downtake Temperature, Degs. F.
Lancashire, 30 feet 0 inches, long burning good coal	1,100
Lancashire, 26 feet to 28 feet, burning good coal.	1,200
Lancashire, under 26 feet, burning good coal....	1,300
Cornish, average	1,000
Watertube, average	1,400

The temperature of saturated steam and the amount of latent heat can be obtained from a set of steam tables. Below are given the quantities most likely to be required:

Working Pressure of Boiler, Pounds Per Square Inch	Temperature of Steam, Degs. F.	Latent Heat B. T. U's
80	324	886
90	331	881
100	338	876
110	344	871
120	350	867
130	356	864
150	360	856
160	371	853
175	377	848
200	388	841
210	392	838

Degree of Superheat

This, of course, depends upon the conditions, length of pipe line, type of engine, etc. Even a small amount of superheat produces great saving in steam. In general practice a superheat of from 150 degrees to 200 degrees Fahrenheit is found to give very good results and will give a saving of 15 to 20 percent.

Specific Heat

Until recently the specific heat of steam was taken at about .48 for all temperatures. However, it has been proved that the specific heat varies with the temperature. The following table will give the specific heats usually required:

Working Pressure of Boiler, Pounds Per Square Inch	Amount of Superheat in Degs. F.	Specific Heat (Average)
80	150 to 200	.51
90	"	.51
100	"	.51
110	"	.52
120	"	.53
130	"	.53
150	"	.54
160	"	.55
175	"	.55
200	"	.55
210	"	.55

Rate of Transmission of Heat

No hard-and-fast quantity can be laid down for this, but from a number of tests I find that a transmission of 7 British thermal units per degree difference per square foot of heating surface gives good results.

Having dealt with each point upon which the heating surface depends, I will take an example:

Example.—Required a superheater to work in conjunction with a Lancashire boiler, 30 feet 0 inches by 9 feet 0 inches diameter, having a working pressure of 160 pounds per square inch. A superheat of 150 degrees Fahrenheit is required.

From the tables we get the following:

Evaporation	8,000 pounds per hour
Moisture (3 percent)	240 pounds per hour
Temperature of gases	1,100 degrees Fahrenheit
Temperature of steam (saturated)	371 degrees Fahrenheit
Latent heat of steam	853 British thermal units
Amount of superheat required	150 degrees Fahrenheit
Specific heat	.55
Rate of transmission	7 British thermal units per square foot

British thermal units required to raise 1 hour's evaporation 150 degrees Fahrenheit
= evaporation times specific heat times increase required
= 8,000 times .55 times 150
= 660,000 British thermal units

British thermal units required to re-evaporate 3 percent of moisture
= moisture times latent heat
= 240 times 853
= 205,000 British thermal units
Total = 865,000 British thermal units per hour

Temperature of saturated steam = 371 degrees Fahrenheit.
Temperature of superheated steam = 371 + 150 degrees = 521 degrees Fahrenheit.

$$\text{Average steam temperature } \frac{371 + 521}{2} = 446 \text{ degrees Fahrenheit.}$$

Flue gas temperature = 1,100 degrees Fahrenheit.

Difference between flue gas temperature and average steam temperature
= 1,100 degrees — 446 degrees
= 654 degrees Fahrenheit.

Transmission is 7 British thermal units per square foot per 1 degree difference of temperature.

$$\text{Then heating surface} = \frac{\text{total British thermal units}}{\text{difference in temperature times 7}} = \frac{865{,}000}{654 \text{ times } 7}.$$

= 190 square feet.

The velocity of superheated steam should be about 100 feet per second, and care must be taken in deciding the number of tubes that sufficient area is obtained.

The Flow of Steam

Much has been said for and against contra flow of the steam; that is, allowing the steam to flow against the gases. In practice there seems very little advantage in arranging this. When laying out an arrangement, I prefer to take the cold steam into the tubes nearest the boiler. This serves the purpose of keeping the tubes slightly cooler where they are subjected to the greater heat of the fire and so prolongs their life.

The formula used in the calculation can be stated as follows:

$$\text{Heating surface in square feet} = \frac{\text{Evaporation} \times \text{specific heat} \times \text{degrees superheat} + (\text{moisture} \times \text{latent heat})}{\text{Downtake temperature} - (\text{saturated steam temperature} + \tfrac{1}{2}\text{ superheat}) \times 7}.$$

Boiler Inspection

Boiler makers and inspectors of boilers are beginning to realize the necessity of a boiler safety law, but, as is well known, it is a hard problem to make the law-makers, who know nothing about a boiler, appreciate and realize the condition of affairs. For instance, in the writer's experience, there are cases of boilers over twenty years old that have never been inspected or tested by an inspector or boiler maker.

The writer would be glad to have expressions of opinion from other readers of The Boiler Maker who are also interested in this important subject. Inspector.

Boiler Power Versus Tractive Power—II

Discussion of Conditions Which Affect Economical Operation of Locomotive Boilers—Best Proportions of Heating Surface and Grate Area

BY WILLIAM N. ALLMAN

Fig. 1 is conveniently arranged and shows the percent of boiler pressure for the various piston speeds for both saturated and superheated steam and can be used for calculating the tractive power at any desired speed, and from which can also be readily obtained the horsepower.

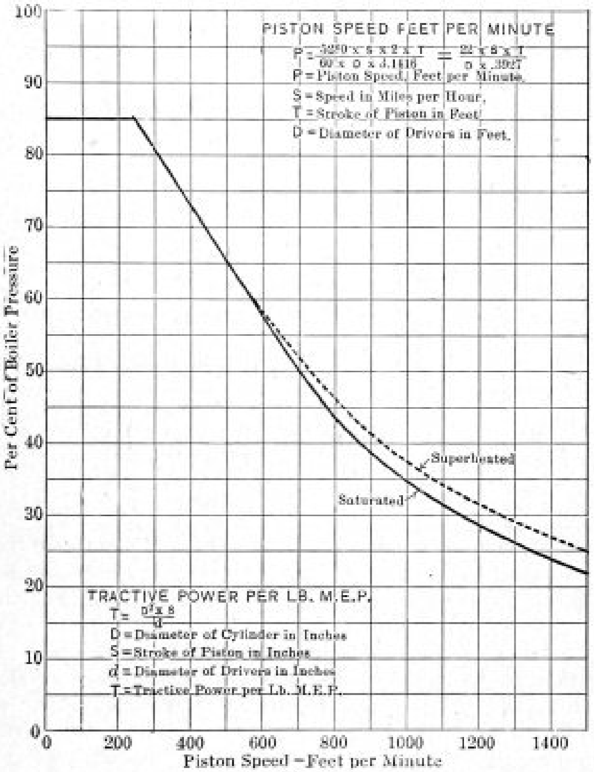


Fig. 1

It is evident that high speeds require high steaming capacity, and, as previously stated, the tractive power reduces with the speed, for the reason that it is not possible for the boiler to supply the quantity of steam required at full stroke at high speeds; therefore, it is necessary to shorten up the cut-off and, consequently, reduce the mean effective pressure and thereby reduce the tractive effort.

By comparing the results obtained from different types of locomotives, it is found that the amount of this reduction at any given speed is less as the relative size of the boiler is increased, and those locomotives which have a comparatively small proportion of their total weight on driving wheels usually show the least reduction in tractive force with increase in speed. This is illustrated in Fig. 2 recently given out by the Baldwin Locomotive Works. This diagram shows the percentage of the maximum tractive force developed by various types of locomotives through the range of speeds over which such locomotives are usually operated. The average percentages of the total weights, exclusive of tenders, carried on the driving wheels of these locomotives are as follows:

		Percent
4-4-2	Atlantic type	55
4-6-2	Pacific type	63
4-4-0	American type	66
4-6-0	Tew wheel type	76
2-8-2	Mikado type	79
2-6-0	Mogul type	86
2-8-0	Consolidation type	89
0-6-0	Switching type	100

It will be noted from diagram (Fig. 2) that at very low speeds the percentage of the maximum tractive force developed is nearly the same in the case of all the types, but as the speed increases the lines diverge until at 30 miles per hour the switcher develops only 34 percent of its maximum, while the Atlantic type develops 63 percent. It can therefore be seen that the higher the speed at which a locomotive is to operate, the greater must be the boiler capacity in proportion to the starting tractive force developed. It is therefore apparent that the maximum tractive force of a locomotive is not an accurate measure of its capacity at high speeds, and this fact must be considered when selecting power to perform a specified service. Therefore, the steaming capacity of the boiler must receive primary consideration.

Table 3 gives factors which will save considerable time when deriving the tractive power. In this table is shown the percentages of the boiler pressure as covered in the various formulas.

TABLE 3
MEAN EFFECTIVE PRESSURES FOR VARIOUS FACTORS

Boiler Pressure.	.52	.66²/₃	.85	1.5	1.7
100	52.0	66.7	85.0	150.0	170.0
120	62.4	80.0	102.0	180.	204.0
125	65.0	83.3	106.25	187.5	212.5
130	67.6	86.7	110.5	195.0	221.0
135	70.2	90.0	114.75	202.5	229.5
140	72.8	93.3	119.0	210.0	238.0
145	75.4	96.7	123.25	217.5	246.5
150	78.0	100.0	127.5	225.0	255.0
155	80.6	103.3	131.75	232.5	263.5
160	83.2	106.7	136.0	240.0	272.0
165	85.8	110.0	140.25	247.5	280.5
170	88.4	113.3	144.5	255.0	289.0
175	91.0	116.7	148.75	262.5	297.5
180	93.6	120.0	153.0	270.0	306.0
185	96.2	123.3	157.25	277.5	314.5
190	98.8	126.7	161.5	285.0	323.0
195	101.4	130.0	165.75	292.5	331.5
200	104.0	133.3	170.0	300.0	340.0
205	106.6	136.7	174.25	307.5	348.5
210	109.2	140.0	178.5	315.0	357.0
215	111.8	143.3	182.75	322.5	365.5
220	114.4	146.7	187.0	330.0	374.0
225	117.0	150.0	191.25	337.5	382.5
230	119.6	153.3	196.5	345.0	391.0
235	122.2	156.7	199.75	352.5	399.5
240	124.8	160.0	204.0	360.0	408.0
245	127.4	163.3	208.25	367.5	416.5
250	130.0	166.7	212.5	375.0	425.0
255	132.6	170.0	216.75	382.5	433.5
260	135.2	173.3	221.0	390.0	442.0

Factors Affecting Economical Operation

In considering the economical operation of the boiler, it was found after studying the subjects here described that the boiler would be much more efficient if close attention is given to certain conditions; for example, from experiments conducted by the United States Government, it was clearly demonstrated that for each 1/16 inch of scale added to the heating surface of the boiler it requires 15 percent more fuel than would be required if the boiler was entirely free from scale.

Superheaters make it possible to get a higher sustained tractive power out of a locomotive. The saving resulting from their use, however, does not show up on a locomotive mileage basis, but would occur when figured on a ton-mile basis.

BRICK ARCHES SAVE 10 PERCENT IN FUEL

It is generally agreed that by the application of brick arches a saving of 10 percent in fuel is realized. Furthermore, they protect the flues by keeping them at a nearly constant temperature, as well as preventing certain losses due to leaks. The arch tubes are also a valuable addition in the firebox, as they materially add to the heating surface.

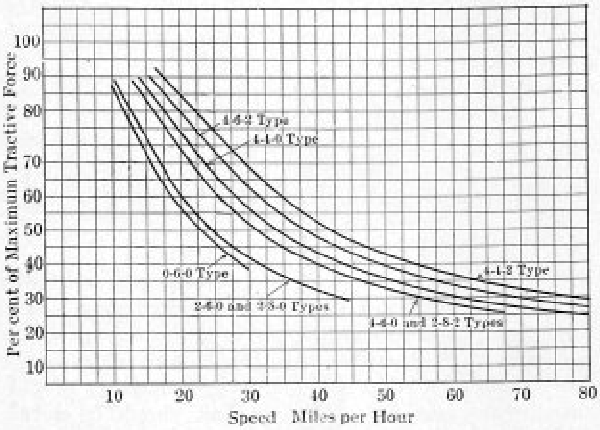


Fig. 2

As to the application of the stoker, it is doubtful if there is a real saving in fuel, as its chief merit is to fire larger quantities of coal than could be fired by hand. It is believed, however, that the application of the stoker will be much extended in the future, but until then its advantages will be more or less a matter of conjecture.

Special appliances, such as automatic fire doors, power reverse gear; rectangular and variable exhaust nozzles and smoke-consuming devices, all have a tendency to produce fuel economy, as they make the work of the engine men easier and improve the operation of the locomotive itself.

STEAMING CAPACITY

The steaming capacity, as the logical expression goes, is the ratio between the maximum evaporation and the water used by the cylinders in the same unit of time. For example, if 1,000 horsepower is continuously developed by the cylinders of an engine, and the efficiency is such that steam is drawn from the boiler at the rate of 27 pounds per horsepower hour, then the total evaporation of the boiler must be at the rate of $1,000 \times 27 = 27,000$ pounds per hour. Assuming that the maximum capacity of the boiler is 38,000 pounds per hour, the steaming capacity under these conditions would be $\frac{38,000}{27,000} = 1.41$. It is, therefore, evident that to increase this ratio, the efficiency of the boiler must be increased.

BEST PROPORTIONS OF BOILERS

The subject of best proportions of boilers, particularly with regard to heating surface and grate area, has been very much discussed in the technical press for the past twenty years, and with the increasing demand on the power, and larger boilers being constructed, it has been found necessary to depart from the practices which were in force at the period when an elaborate report was made in 1897 by the Master Mechanics Association. The basis of this report was cylinder volume, but the consensus of opinion gradually worked up to the basis of cylinder horsepower for determining the heating surface and grate area. The most recent recommendations along this line in 1916, and which is also covered in detail in bulletin No. 1017 issued by the American Locomotive Company, may be summarized as follows:

$$\text{Horsepower} = .0212 \times P \times A = \text{saturated steam.}$$
$$\text{Horsepower} = .0229 \times P \times A = \text{superheated steam,}$$

where

P = boiler pressure.

A = area of one cylinder in square inches.

Maximum horsepower assumed to be reached at a piston speed as follows:

700 = feet per minute for saturated steam.
1,000 = feet per minute for superheated steam.

The following represents results compiled from various reports of tests made under different conditions both in road tests and on testing plants and represent liberal factors.

TOTAL STEAM PER HOUR

Saturated steam = horsepower $\times$ 27.0.
Superheated steam = horsepower $\times$ 20.8.

These figures are based on coal containing 14,000 British thermal units per pound and for coal of better or poorer rating a percentage factor to be used.

GRATE AREA

Figuring 120 pounds of coal per square foot of grate area as the maximum consumption for economical evaporation, and basing this on coal of good quality, or 14,000 British thermal units, the grate surface required will then be as follows:

$$\text{Saturated steam } \frac{\text{horsepower} \times 4.00}{120} = \frac{\text{horsepower}}{30} \quad \text{(Formula 7)}$$

$$\text{Superheated steam } \frac{\text{horsepower} \times 3.25}{120} = \frac{\text{horsepower}}{36.9} \quad \text{(Formula 8)}$$

EVAPORATION

Some of the most recent data available, particularly tests which were made at Coatesville, Pa., show the following evaporating value as being assigned to the firebox and to the tubes, from which the approximate evaporation may be obtained:

EVAPORATION-POUNDS PER HOUR

Heating surface of tubes in square feet $\times$ 10.
Heating surface of firebox in square feet $\times$ 55.

RATIOS

The ratio of firebox volume to grate area should be about 5.5 or 6 to 1 for bituminous coal and 4.5 or 4.85 to 1 for anthracite coal.

The ratio of tube length to internal diameter should be about 100 to 1. The ratio of superheating surface to total saturated heating surface should be about 0.22 for boilers without combustion chambers and 0.29 for boilers with combustion chambers.

It is now an acknowledged fact that superheated steam is highly efficient in locomotive service, and an appreciation of the method of producing and using superheated steam will be much facilitated by a preliminary consideration of the more important properties in which it differs from saturated steam.

The specific volume of saturated steam diminishes with increase of temperature, while, on the other hand, the volume of superheated steam increases nearly directly in proportion to the rise of temperature. The specific volume for superheat of 200 degrees is increased approximately 25 percent and thus for the same cut-off in the cylinder the weight of steam required is about 25 percent less with 200 degrees superheat than with saturated steam with the same pressure.

As the value of the locomotive must ultimately be measured by the tractive effort which it is able to exert and maintain at the drawbar, we may with advantage examine more closely the part played by highly superheated steam in this direction.

Under ordinary working conditions with saturated steam, about 35 percent of the total quantity of steam admitted to the cylinders immediately precipitates without doing any mechanical work and passes through the engine as suspended water in the steam. Highly superheated steam, on the contrary, does not lose any of its capacity as a working agent. This condition is augmented by the low thermal conductivity of the superheated steam; while saturated steam is a good conductor of heat, highly superheated steam is a very bad conductor.

Hence it is clear that the application of highly superheated steam materially augments the tractive power and ultimately the hauling capacity of the locomotive, and this increase may be applied either to the haulage of heavier tonnage or increased speed. The increase in power is obtained through the use of larger cylinders, which can be accomplished without the necessity of increasing the size of the boiler.

As the volume of superheated steam increases proportionately to its temperature, this is one of the reasons for the greater economy obtained by its use, and with steam of approximately 600 degrees F., and by being cooled in the cylinders by the same amount it has been superheated, practically all losses due to condensation in the cylinders are eliminated.

Horsepower

The maximum horsepower which the engine can develop is fixed, when the grate area is of sufficient size, by the steam-producing qualities of the heating surface and steam consumption of the cylinders; the efficiencies of both, however, are slightly increased as the speed is increased.

It is desirable to make the grate area not less than 1/60 of the heating surface which gives the necessary ratio in order to provide for the absorbing of the heat produced at the grate by combustion with proper efficiency. If the heating surface is much less than 60 times the grate area, more heat will be produced at the grate than can be transferred to the water, with a consequent reduction in efficiency, while if the ratio is much above 70 the increase would not compensate for the additional weight involved.

(To be continued.)

Saftey Rules for Oxy=Acetylene Welding

The following rules have been adopted by the Western Pennsylvania Division of the National Safety Council, and may well be observed by all who are engaged in oxy-acetylene welding or cutting operations, and the transportation or care of oxygen and hydrogen tanks:

1. All pressure tanks should be fitted with safety relief devices, and tanks not so equipped should not be used.

2. The equipment should include a high-pressure gage to indicate the pressure on the tank, a reducing valve and a low-pressure gage to indicate the pressure on the torch. These should be assembled as one unit and so arranged that they need not be separated when they are attached to, or detached from, the tank. The two gages should have different-sized openings; one should have a right-hand thread and the other a left-hand thread, so that they cannot be interchanged. There should be one of these units for the oxygen tank and one for the acetylene tank.

3. All pressure regulators should be equipped with a safety relief valve which will relieve the pressure from the diaphragm and low-pressure gage in case the high-pressure valve should develop a leak.

4. Wire-wrapped hose should not be used.

5. The oxygen and acetylene hose should be of different color or the couplings should be stamped for identification purposes, so as to avoid interchanging the hose.

6. The torches should be of a type which will not backfire.

Rules for Operation

1. Under no condition should acetylene be used where the pressure is greater than 15 pounds per square inch.

2. Special care should be given to the storage of oxygen and acetylene tanks. Acetylene is classed as an explosive, and only a limited number of containers should be stored in any one place. Oxygen tanks should be stored in a separate place from acetylene tanks.

3. Oxygen and acetylene tanks should not be allowed to remain near stoves, furnaces, steam heaters or other sources of heat, and should not be exposed unnecessarily to the direct rays of the sun, as an increase in the temperature of the gas will cause a corresponding increase in the pressure within the tank. Any excess of heat may also soften the fusible safety disk with which the tank is provided, causing it to blow out and permitting the gas to escape.

4. Oxygen tanks should never be handled on the same platform with oil or grease, which might find their way into the valves on the tanks.

5. Oxygen and acetylene tanks should never be dropped nor handled roughly and should never be stood on end unless fastened so as to prevent them from falling over.

6. Tanks should not be handled by crane, either magnetic or mechanical.

7. All empty tanks should be marked plainly with the word "empty" and returned promptly to the storeroom.

8. An open flame should never be used for the purpose of discovering leaks in acetylene tanks. Leaks can generally be detected by the odor of the acetylene gas, and their location can be determined by applying soapy water to the surface of the tank and watching for the soapy bubbles formed by the escaping gas.

9. No repairs to oxygen or acetylene tanks or equipment should be made or attempted. All defects should be reported promptly to the foreman, and by him to the manufacturer.

10. Leaking acetylene tanks should not be used, but should be placed in the open air and all open lights kept away from them. All leaking acetylene tanks should be reported promptly to the foreman and immediately returned to the manufacturer.

11. All open flames should be kept away from any place where there is any possibility of acetylene escaping.

12. Care should be taken to protect the discharge valves of tanks from being bumped, as a jar may damage the valve and cause it to leak.

13. Grease in contact with oxygen under pressure may cause spontaneous ignition. Great care should be taken

not to handle threads or valves with oily hands or gloves, and gages should not be tested with oil or any other hazardous carbon. If a lubricant must be used, the purest glycerine is permissible.

14. Gages, apparatus, and torches requiring repairs, should be sent to the manufacturer, and local repairs should not be attempted. Valve seats should never be replaced except by the manufacturer.

15. The use and operation of the pressure regulator or reducing valve on oxygen or acetylene tanks should be as follows:

a. Open the discharge valve on the tank slightly for a moment and then close it. This is to blow out of the valve any dust or dirt that might otherwise enter the regulator.

b. By means of the stud or nut connection on the regulator, connect the regulator to the discharge opening of the tank.

c. Release the pressure-adjusting screw of the regulator to its limit.

d. Open the needle valve slightly, if there is one.

e. Open the discharge valve on the tank gradually to its full width.

f. Open the needle valve to its maximum, if there is one.

g. Adjust the pressure-regulating screw until the desired pressure is shown on the low-pressure gage.

16. The discharge valve on the tanks should be opened slowly, and care should be taken to avoid straining or damaging them by the use of a hammer or the wrong kind of wrench. A special wrench should be made for use in opening these valves in case they stick.

17. When the operation of the cutting or welding torch is stopped for a short time, the needle valve on the regulator should be closed, or the pressure-adjusting screw should be released to keep the pressure off the hose. The torches should be opened momentarily to let the pressure out of the hose lines.

18. All tanks should be inspected at the close of the day's work.

19. Proper precautions should be taken to protect the hose from flying sparks.

20. All hose should be examined periodically at least once every week. This should be done by cutting the hose off at the end of the connection and examining it. In addition, after a few months' use, the hose should be cut off about two inches back of the connection and examined for defects. A defective hose should never be used.

21. Special care should be taken to avoid the interchange of oxygen and acetylene hose or piping, as this might result in a mixture of these gases that would be highly explosive. The practice of using right- and left-hand threads is recommended.

22. White lead, grease, or other similar substances, should never be used for making tight joints. All joints and leaks in equipment should be made tight by soldering or brazing.

23. The oxygen and acetylene valves at the base of the torch should be tested daily for leaks.

24. Where hydrogen or other gas is used instead of acetylene, the same precautions should be observed as for acetylene.

25. A fire extinguisher should be carried as regular equipment, to be used in case of fire.

26. Men using welding apparatus should wear suitable welding goggles for eye protection, having frames that are non-conductors of heat (not celluloid), side shields to protect against hot particles of metal, and lenses of proper color.

27. Operator's clothing should be fireproof.

28. If valves become frozen, they should be thawed by hot water, not by flame or hot metal rod.

Saving Coal in Steam Power Plants*

Beginning at the grates upon which the fuel bed rests, see that the air spaces are properly proportioned to avoid loss of combustible material into the ash pit. This will depend on the kind of coal used. Study the fuel with this point in mind. Five percent is not an unusual loss from this cause.

The amount of grate surface is important, as it determines the rate of combustion. Ratios of grate area to boiler heating surface will vary from 1:35 to 1:60, depending on the characteristics of the coal and whether hand fired or stoker fired. For power purposes in hand-fired plants, do not permit the rate of combustion to fall below 15 pounds of coal per square foot of grate surface per hour, or go above 28 pounds with bituminous coal. With stokers the rate may be as high as the design of plant and the draft will permit. With the fine-steam sizes of anthracite the rate of combustion should not be less than 10 pounds.

With settings tight, to prevent infiltration of air, heating surface clean, radiation losses reduced by proper covering, piping and steam main lagged, engine valves tight and properly set, all condensation returned to the feed water heater, a good start will have been made in fuel conservation.

A good plant poorly operated will show low efficiency, while a poor plant skillfully operated will sometimes show a relatively high efficiency.

Principal Losses

The chief losses in boiler plant operation are:

Cause	Remedy
1. Dirty boiler—loss up to 25 percent........	Clean boiler
2. Leaky setting—loss up to 15 percent.......	Tight setting
3. Poor firing—loss up to 40 percent.........	Good firing

1. A boiler may be dirty on the inside or outside, or both. Dirt on the inside is due to scale formation and can be corrected by cleaning the boiler and then giving consideration to the character of the feed water and its proper treatment. See Engineering Bulletin No. 3 of United States Fuel Administration.

Outside cleaning must receive careful attention. A slight accumulation of soot deposited in a few hours' run will result in a growing loss of efficiency. Someone must be delegated to follow up this matter of soot and see that the cleaning is done thoroughly, frequently and regularly.

2. Air leaks reduce efficiency. The ordinary brickwork setting develops cracks and crevices which allow a considerable amount of air to enter the setting, lowering the temperature of the gases of combustion. The porous character of the brick itself is such that an appreciable leakage takes place through the walls.

The remedy is to point up the brickwork with plastic fireproof mixture and paint or cover the setting with a coat of airtight material.

3. Bad firing includes allowing holes to develop in fuel bed, carrying an uneven fire, carrying too thin a fire, carrying too thick a fire, stirring fire, thus forming clinkers, and improper manipulation of dampers. It is here that the human equation becomes of most importance. Attention concentrated on what takes place from day to day in front of the boilers will pay greater returns for the time spent than in any other part of the plant.

* Reprint of Engineering Bulletin No. 2; prepared by the United States Fuel Administration in collaboration with the Bureau of Mines.

How to Design and Lay Out a Boiler—VII

Calculations for Design of Girth Seams—Layout of Tubes—Location of Fusible Plug and Water Gage Glass

BY WILLIAM C. STROTT*

Considering first the front girth seam, we find that the outside circumference of the shell is $(73.0625 \times 3.1416) =$ 229.533 inches, or approximately 229 17/32 inches. Dividing this by the trial pitch, or 2¼ inches, we get $\frac{229.533}{2.25} =$ 102 inches. As 102 is not exactly divisible by 4, we may decide on either 100 or 104 spaces. We will figure on 100. The exact circumferential pitch will, therefore, be $\frac{229.5}{100} =$ 2.295 inches, or 2 9/32 inches.

Calculating the efficiency of the joint is now in order. Referring back to our work on the design of the longitudinal joint, and a further examination of the structure of a single lap-riveted joint, the student should at once be able to see that this type of joint may fail in but three ways, itemized as follows:

T.—Tearing of the plate between the rivet holes.

Sh.—Shearing of the rivets (notice that all rivets are in single shear).

Cr.—Crushing of the plate in front of the rivets.

Efficiency of Girth Seams

The possible strength of the solid plate in a unit length of the joint will, as heretofore, be designated by the letter *W*. (Note that the unit length of joint in this case is 2 9/32 inches, which is the maximum, and, of course, the only pitch with which we have to deal.) Using the same notations for pitch of rivets, tensile strength of plate, plate thickness, diameter of rivet hole, etc., as we did for the longitudinal joint, the values of *W*, *T*, *Sh* and *Cr* are as follows:

$W = P \times t \times T_s$, or 67,200 pounds.
$T = (P - d)\, t \times T_s$, or 39,800 pounds.
$Sh = N \times s \times a$, or 30,373 pounds.
$Cr = d \times t \times c$, or 47,300 pounds.

Substituting figures for letters in the above formula, the student should satisfy himself, by a complete solution, that the above values are correct. Dividing the least of the three remaining values (which is that for *Sh*) by *W* will give us the efficiency of the joint, or $\frac{30,373}{67,200} =$ approximately 45.2 percent.

The student should particularly notice that in this case the weakest part of the joint is not in the net section of plate between the rivets, as is usually although erroneously assumed, but that failure will first occur through shearing of the rivets. The efficiency for *T* is very high, being almost 60 percent, and proving how very possible it is for a careless designer to get into trouble. Were this joint intended for a pressure vessel in which the areas of the heads were not to be braced (requiring a circumferential joint efficiency of $.50 \times 92.4$ percent, or 46.2 percent), the designer would be figuring on having a joint good for 60 percent when, in fact, it is actually good for but 45.2 percent. This might cause a difference in shell plate thickness of 1/16 inch.

Since an efficiency of 45.2 percent is satisfactory for our purpose, revisions will not be necessary, but should a higher efficiency have been required it could be accomplished by employing larger rivets. A thorough investigation is always necessary when trying different schemes to obtain higher efficiency, as a gain at one point will usually cause a proportionate decrease at another.

The center ring seam is identical with the first, but the seam, where the rear head joins the inside course (i. e., the course having the smaller diameter) will differ slightly, owing to the decreased diameter, which is 72 inches. By using the same number of spaces, the pitch will be found to be $\frac{72 \times 3.1416}{100} = 2.26$ inches, which is even closer to the required 2¼ inches than are the other two seams. Therefore, no further calculations will be necessary.

With further reference to the circumferential seams, the A. S. M. E. Code provides as follows: "When shell plates of horizontal return tubular boilers exceed 9/16 inch in thickness, that portion of the plates forming the laps of the circumferential seams, where exposed to the fire, or products of combustion, shall be planed or milled down, as shown in Fig. 22, to ½ inch in thickness."

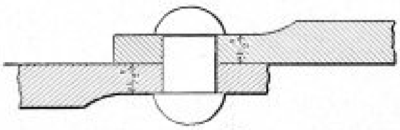


Fig. 22

If this requirement is not complied with in boilers having exceedingly thick plates, the water, by virtue of its poor conductivity, cannot conduct the heat away from the seam as rapidly as the intense heat of the furnace is absorbed by the metal. The rivet heads on the outside become overheated and in time burn off. Even that portion of the lap itself directly over the fire assumes what are termed "fire cracks."

Protection of Girth Seams

Referring again to Fig. 1, previously shown, it will be noted that the front circumferential seam is protected from the fire by being set about 4 inches into the front brick wall, but that the middle and rear ring seams are exposed. The conditions imposed on the rear seam are not nearly so severe as those on the middle seams, the latter being directly over the furnace and combustion chamber. For this reason the head and shell plates forming the lap of the rear ring seam do not have to be reduced to ½ inch as specified.

In connection with the foregoing, designers must bear in mind that when such a condition is encountered the efficiency of a circumferential joint (when same is milled or planed down to ½ inch) must be based on the reduced plate thickness.

In arranging the courses of plate, it is always desirable to have the calking edge of the sheet forming the first

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

course point *away* from the furnace, as it is very injurious to the metal when the flames impinge directly on to the beveled edge. The correct condition in all cases is to have the front course an *outside* course. If the shell be composed of three circular courses, as in Fig. 1, the rear course will also be of the larger diameter.

In order still further to protect the front ring seam, which is usually directly over the furnace, from developing fire cracks, some engineers specify that the first course be of such length that the seam in question will be located at least 12 inches beyond the bridge wall, out of the furnace entirely.

Welded Boiler Joints

Pressure vessels, instead of being riveted together, may have their seams welded, not by the oxy-acetylene torch or the electric arc (which give altogether too uncertain and more often dangerous results), but by means of the ordinary forging process—"hammer welding," as it is termed.

The reader may well wonder how such a process is or can be accomplished. Would a small portion of the seam at a time be heated in a forge and the plates welded together under sledge-hammer blows after lifting the shell out of the fire and running same on to an anvil? Up to the present time the author has never heard of a plant where "hammer welding" of pressure vessels was being accomplished, at least not in the United States. There have, however, been built in Europe a number of such plants, the patents covering the process being of German origin.*

Suffice it to say, however, that the time is not far distant when boilers and tanks will be "put together" not with the rivet and "gun" but in the "welding plant." It may take some little time for the master boiler maker of to-day to concede to the superiority of a hammer-welded joint—taking him probably years, as it did for him finally to accept the electric arc and oxy-acetylene flame (for repairing purposes at least). There appears absolutely no reason why a properly welded joint made by the forging process cannot be as sound as the solid plate. Actual tests of welds made on steel bars by expert forge smiths have proved years ago that such welds are stronger than the original section by virtue of the heat treatment the steel so receives and by the rearrangement of the crystals forming the structure of the metal, through working under the hammer. We may take the cold-rolled steel bars and cold-drawn steel wire, tubes, etc., as a perfect example. At the present time, however, the A. S. M. E. Code appears to restrict the use of welded joints, for it fixes the maximum efficiency of such joints at only 50 percent. Boilers so welded must be built of steel plates having a range of tensile strength of from 47,000 to 55,000 pounds per square inch.

Let us see what thickness of shell plate we would require for our boiler if the joints were to be welded. Applying formula (g),

$$t = \frac{R \times P \times F}{T_s \times E}.$$

Substituting figures for letters, we have:

$$t = \frac{36 \times 150 \times 5}{47{,}000 \times .50}, \text{ or } .947, \text{ say } 31/32 \text{ inch.}$$

Considering the present status of welded boiler joints, this is not excessive, for it should be realized that we were dealing with rather a large diameter of boiler and a very high working pressure. From this we may draw the conclusion that welding will for some time be applicable to comparatively small diameters and low working pressures, when the required thickness of shell plate does not exceed 5/8 inch, which is about the limit for externally fired boilers.

The next point in design to be taken up is the tube layout, and, after that has been accomplished, we will be in a position to take care of the bracing of the heads.

Tube Layout

When tubes are 18 feet or more in length, practice has demonstrated that they should not be less than 4 inches in diameter. If smaller, they tend to sag. Although tubes above 4 inches in diameter are manufactured, they are rarely, if ever, employed in boiler work; therefore, the tubes for this boiler will be 4 inches in diameter and ordered from the mill in nominal lengths of 18 feet.

To provide sufficient heating surface, a standard horizontal return tubular boiler of this size requires not less than seventy 4-inch by 18-foot tubes.

The easiest way to "work up" a tube layout is to draw the smaller head to a scale of not less than 1½-inch to 1-foot (⅛ size) and make enough templates 4 inches diameter (to the same scale) to represent the tube holes. Both heads of our boiler are to be the same size. This is becoming standard practice because it does not necessitate carrying so many flange formers on hand.

In such case, when the boiler shell is composed of two circular courses, one of the courses will have to taper into the other. This is practically unnoticeable, however, after the boiler is built, but attention is here merely called to the fact because special provision must be provided for same during the "laying out" process in the boiler shop. To facilitate drainage towards the rear end of the boiler, it is preferable to taper the rear course into the front course, which will give the vessel its smallest diameter at the circumferential seams.

The distance from the top of the uppermost row of tubes to the inside of the shell is in commercially exploited boilers usually made one-third the inside diameter of the shell. This is erroneously termed the "steam space," but in reality there is very little of this space left for steam when the boiler is in operation, as will now be shown.

Location of Fusible Plug

The lowest safe waterline must be maintained at 2 inches above the top of the uppermost row of tubes to obviate any possibility of overheating them. For the purpose of rendering the boiler "fool-proof" against this condition, a fusible plug, as illustrated in Fig. 23, is screwed

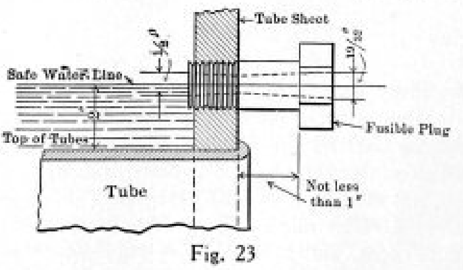


Fig. 23

into the rear head so that its center will be on this lowest safe waterline.

The fusible plug is made of brass so as to be non-corrosive, and through its center is a core filled with pure tin. This core tapers down towards its center, as is clearly indicated by the illustration, so that under normal conditions the steam pressure cannot force it out. The tin

* The readers of this magazine will in the near future be treated to a full description of this process. A plant for this purpose is now under construction in this country.

has a melting point between 400 degrees and 500 degrees Fahrenheit, and so long as there is water on one side of the plug to conduct the heat away from it, nothing will happen; but should the water in the boiler fall below the "danger line," the temperature of the tin will almost instantly reach its melting point, and the tin will be blown out by the pressure within the boiler. A "low water alarm" is the result, in the form of a ½-inch jet of live steam discharging into the combustion chamber of the boiler setting.

The volume of steam thus discharged is sufficient to "choke" the draft, and, should no one happen to be in attendance at the time a fusible plug "blows out," it would at least serve to deaden the fire.

After such an occurrence the only recourse is to draw the fire and "blow down" the boiler. After the furnace has cooled off sufficiently it is a simple matter to insert a new plug, but this procedure probably results in a lengthy shutdown of at least part, if not all, of the plant. Under such circumstances we may rest assured that when boilers are properly fitted with fusible plugs the water tenders or firemen in charge will be particularly careful to see to it that the boilers under their care will not very often be cut out of service from this cause.

The reason for placing the fusible plug 2 inches above the top of the tubes is to allow sufficient time to elapse

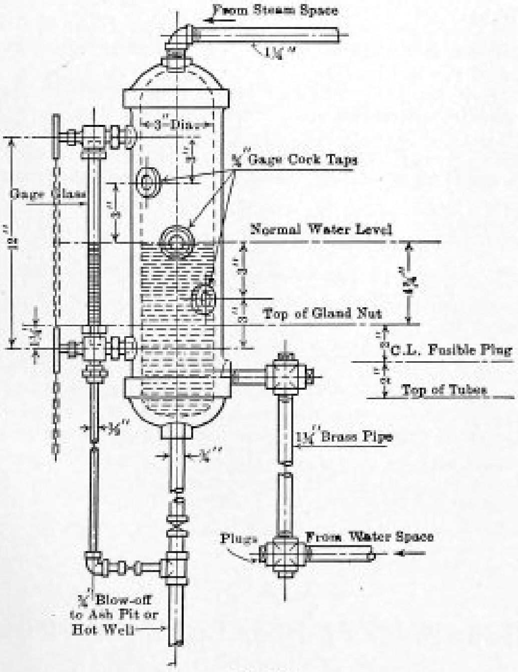


Fig. 24

for drawing the fire before the water has fallen below the tubes. If this should occur, the tubes on being uncovered would quickly become overheated, buckle, and probably burst. We may deduce from this that it is much cheaper to blow out a 25-cent fusible plug with nothing more serious than a temporary shutdown than it is to ruin a set of tubes, perhaps a whole boiler, or, which is not at all unlikely, to bring about the destruction of property and perhaps life.

WATER GAGE GLASS

For the purpose of indicating the level at which the water is standing, every boiler must be fitted with a water gage glass. On some types of boilers, chiefly those which are internally fired, it is possible to apply these water gages directly to the shell or head, but as is the case with brick-set boilers this cannot be done, and the water gage must be attached to a "water column" connected by means of piping to both the steam and water spaces of the boiler. A common form of water column with its water gage glass and connections is illustrated in Fig. 24.

The dimensions cover the size of water column usually employed on a boiler of this capacity. The three taps in the body of the column are for attaching gage cocks. They serve as a check on the water glass. Opening the upper cock should discharge live steam; middle cock, steam and water; and lower cock, water.

The lowest visible gage of water in the glass is just above the lower gland nut (see illustration) and the code requires that this be at least 2 inches above the lowest safe waterline. A careful fireman will usually maintain about a half gage of water, which, according to Fig. 24, would bring the final water level to approximately 9 inches above the top of the tubes.

Now, if the distance from the shell to the top row of tubes were to be made ⅓ of the boiler diameter, or ⅓ of 72 inches = 24 inches, there would be left 24 inches — 9 inches, or only 15 inches of actual steam space. A "dry pipe" placed under the main steam outlet would extend at least 8 inches down from the inside of the shell, or but 7 inches from the surface of the water in the boiler, provided this surface were in a quiescent state, but it is not. Just as the water boils in the proverbial tea kettle, so in the steam boiler, but in a more violent form. It is a pretty fair guess that the level of the water in the boiler is actually 3 inches higher than indicated by the water gage, with the result that the water is just about "splashing" over the internal dry pipe and thereby supplying wet, soggy steam to the engines or auxiliaries.

(To be continued.)

Keeping a Line on Prices

BY EDWIN L. SEABROOK

There is a much simpler method of comparing prices on supplies from the manufacturer or jobber than digging down into a pile of invoices every time it is necessary to make a comparison.

An index card system is used for this purpose. An ordinary index card, six inches wide and four inches deep, is ruled off into eight columns, at the head of which are printed:

ARTICLE SIZE OR NUMBER

Date	Bought From	Quantity	List	Per	Discount	Net Cost	Remarks

Each article is given a separate card, which is filed in a small case alphabetically. When purchases are made the data are placed on the proper card. An ordinary card contains spaces for twelve purchases and will last for several weeks or months, according to the size of the business.

By this method it can be seen at a glance of the card the variation in prices of any article. When quotations are offered it takes but a moment's time to look at the card in the file and make the comparison.

It is well understood by engineers that the hotter the cylinders of an engine are kept, the better is its economy. An ideal engine would have its cylinders as hot as the incoming steam. In an internal combustion engine, however, the cylinders have to be cooled, or they will burn out. The theory, therefore, is relative, as are all broad statements.

Programme of Master Boiler Makers' Convention to be Held in Chicago May 26-29

The eleventh annual convention of the Master Boiler Makers' Association will be held at the Hotel Sherman, Chicago, Ill., on May 26, 27, 28 and 29. 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:

FIRST DAY

Monday, May 26

Registration of Members and Guests Continued at 8 A. M.

Business Session

Convention called to order, 10:00 A. M.

Invocation—

Past President John H. Smythe, official chaplain.

Annual Address—

Hon. D. A. Lucas, 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:

Unfinished business.
New business.
Appointment of special committees to serve during convention:

President's address.
Auditing.
Resolutions.
Memorials.

Announcements.
Adjournment.

SECOND DAY

Tuesday, May 27

Two Sessions

Convention called to order, 9:00 A. M.

Committee Reports—

"What Should Be the Minimum Distance Between the Grates and the Lower Part of Arch Tubes for Different Classes of Locomotives?"

"What is the Proper Distance from the Door Sheet to the Brick Arch and from the Crown Sheet to the Brick Arch for the Various Classes of Locomotives?" 10:30 to 11:00 A. M. L. M. Stewart, chairman; W. F. Fantom, A. E. Brown, E. W. Young, G. B. Usherwood.

"Proper Method of Threading Radial Stays and Tapping the Hole in the Boiler for Them?"

"Is it Necessary to Give Radial Stays the Same Lead as the Tap with which the Holes were Tapped?" 11:00 to 11:30 A. M. H. J. Raps, chairman; Andrew Hedberg, J. J. Keogh, J. B. Smith, T. J. Reddy.

"Effect of Proper Upkeep of Ash Pan and Front End Draft Appliances on Fuel Economy?"

"Method Used in Determining Proper Design for Various Classes of Locomotives?" 11:30 A. M. to 12 M. George Austin, chairman; E. J. Nicholson, Fred Bayer, H. F. Weldin, H. B. Nelson.

"What is the Best Method of Bracing Locomotive Tenders?" Describe Method Used. 12 M. to 12:30 P. M. Thomas Lewis, chairman; E. J. Sweeney, J. J. Orr, J. P. Malley, J. T. Johnston.

Afternoon Session

Convention called to order, 2:00 P. M.

Committee Reports—

"What is the Advantage of Cutting Off Stay-Ends with Oxy-acetylene Over Old Method of Nippers and Chisels?" 2:00 to 2:15 P. M. W. S. Larason, chairman; John McGarrigal, J. B. Tynan, E. H. Hohenstein, A. E. Shaule.

Report of Committee on Law, G. W. Bennett, chairman; J. T. Goodwin, M. O'Connor. 2:15 to 2:30 P. M.

Report of Committee on Topics for 1920 Convention. 2:30 to 3:00 P. M.

"Oxy-acetylene and Electric Welding. 3:00 to 3:30 P. M.: H. J. Wandberg, chairman; John Harthill, L. M. Stewart, T. F. Powers, J. J. Davey.

Announcements.
Adjournment.

THIRD DAY

Wednesday, May 28

Convention called to order, 9:00 A. M.

Committee Reports—

"Which is the Better Method of Drilling Tell-Tale Holes—Before or After Application of the Bolts?"

"Which is the Better Method for Drilling in Either Case?"

"What is the Best Style of Drill for Opening Up Tell-Tale Holes in Old Staybolts?"

"Does It Pay to Use a High-Speed Drill for this Purpose?"

"What is the Best Lubricant for the Drill?" 10:00 to 11:00 A. M. L. R. Porter, chairman; A. N. Lucas, S. M. Carroll, Bernard Wulle, C. E. Erwin.

"What is the Best Style of Grate for Bituminous Coal?"

"Where Should the Dump Grate Be Located (*a*) in Road Engines, (*b*) in Switch Engines?"

"What Should Be the Percentage of Opening in Grates?"

"What Should Be the Percentage of Draft Opening in Ash Pans Compared with Area of Grates?" 11:00 A. M. to 12:30 P. M. W. H. Laughridge, chairman; L. M. Stewart, T. P. Madden, C. H. Patrick, C. A. Nicholson.

Afternoon Session

"What is the Best Method for Scaling Superheater Flues in the Boiler?"

"What is the Best Method of Rattling Flues?"

"What is the Best Method of Handling Flues in and Out of the Rattler?"

"How Many Revolutions Per Minute Should the Rattler Make for 2-inch and for 5⅜-inch Flues?"

"Describe Method for Safe-Ending Superheater Flues?" 2:00 to 3:00 P. M. W. J. Murphy, chairman: Andrew S. Greene, J. J. Mansfield, John Harthill, Louis Johnson.

Announcements.
Adjournment.

FOURTH DAY

Thursday, May 29

Convention called to order, 9 A. M.

Unfinished Business—

Report of Committee on President's Address, 10:00 to 10:05 A. M.
Report of Auditing Committee, 10:05 to 10:20 A. M.
Report of Committee on Resolutions, 10:20 to 10:30 A. M.
Report of Committee on Memorials, 10:30 to 10:40 A. M.

Election of officers, 10:40 to 11:45 A. M.

Good of the association and general discussion, 11:45 A. M. to 12:30 P. M.

Announcements and closing exercises of the convention, 12:30 P. M. to 1 P. M.

Delaware Has a Board of Boiler Rules

On April 8 Governor John E. Townsend, Jr., signed a bill which had been passed unanimously by the House and Senate, providing for the safety of life and property in the state of Delaware, establishing a Board of Boiler Rules and prescribing rules and regulations for the boilers used in the state, which shall be uniform with other state rules now in existence, in order to provide for the free interchange of boilers between states. The act defines the power of the Board of Boiler Rules, provides penalties for the violation of the act and the rules and regulations of the Board of Boiler Rules, and makes an appropriation for the carrying out of the provisions of the act.

The governor is to appoint a board of five citizens of recognized knowledge in the construction and use of steam boilers, who shall act as members of a Board of Boiler Rules. These five citizens shall be preferably a professor of mechanical engineering, a manufacturer of steam boilers, a user of steam boilers, a mechanical engineer, and a licensed stationary engineer.—*Power*.

The Boiler Maker

Published Monthly by
ALDRICH PUBLISHING COMPANY, INC.
Member of The Associated Business Papers, Inc.
6 East 39th Street, - - - - New York
8 Bouverie St., London, E. C.

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor.

Branch Office
Boston, Mass., 294 Washington street, S. I. CARPENTER.

A glance at the programme of the Master Boiler Makers' convention, printed on the opposite page, will show that the four days set aside for this meeting at the Hotel Sherman in Chicago in the last week of May will be fully occupied with the discussion of practical subjects. The programme is typical of previous boiler makers' conventions. The topics for discussion have been chosen by the members of the association at large and they have a practical bearing upon the every-day work of the boiler makers.

In view of the great value and usefulness of the work of the association as consummated at its annual conventions, no master boiler maker can afford to miss the opportunity of becoming identified with the association and thereby securing the benefits of membership and attendance at its meetings. From all indications, the convention this year will be the largest ever held, and every old or new member should make it a point to be on hand at the opening of the convention and attend every meeting scheduled for the four days of its activities.

In a letter from one of our subscribers, who expresses a desire to see in THE BOILER MAKER a series of articles relating to cost accounting for boiler shops, our attention is called to a few items making up the problem of cost accounting which our correspondent finds in his own work. These items are enumerated as follows:

"The cost of any job is made up of labor, material and overhead. The first two items can easily be figured. They call simply for an intelligent plan of keeping track of these expenses, and I have already found from my limited experience that this is a matter for each individual shop to work out for itself, according to its own circumstances. But, when we come to overhead, we are up against a problem that is difficult to solve.

"Overhead must include all expenses connected with the running of the business that cannot be charged directly to labor or material. We can easily figure out what our fuel, lights, insurance and so on will cost on the shop as a whole, but when we come down to the cost to be attributed to the work at each machine we have a difficult problem to solve. We must consider depreciation, insurance and upkeep on each machine and also for power, interest on the money invested in the machine and the like. Certain jobs will pass through the shop without using any of the machines; others will use, say, the shears and punch; others will require flanging, shearing, punching, drilling, reaming and other operations. We cannot in justice lump all the overhead on the shop as a whole, get a certain percentage and then figure that percentage against the labor or other cost on every job regardless of what kind of a job it is. On a hand-work job we cannot charge any of the depreciation and upkeep and interest and superintendence on machines such as we might rightly and justly charge against a job which used all of these machines.

"Again, after we know the depreciation, interest, etc., on each machine, how are we going to assess such overhead against any particular machine job? Suppose the overhead on the machine runs at $200 per year. If the machine were run on one job one hour during the year, to charge the overhead of this machine on this job as $200 would, of course, be impossible. If, on the other hand, the machine runs 200 hours during the year on a job, the overhead would be one dollar per hour. How are we to tell in advance what overhead to charge on work turned out by any particular machine?"

Many of our readers, of course, have similar problems to face. Many, probably, have satisfactory solutions to offer, and many more, good suggestions to make. In order to bring out a thorough discussion of this subject, we shall be glad to publish letters from our readers, describing their methods and experience in such work. These letters will be published promptly and paid for at regular space rates.

As a tangible result of the work of the committee on uniform boiler costs of the American Boiler Manufacturers' Association, a copy of the specifications of a certain type boiler is being sent by the committee to each member of the association with blank estimating sheets. Three estimating sheets are sent with the specifications—one for the boiler, one for the stack and one for the fittings. Upon receipt of these blanks, each member is requested to make an estimate on the boiler according to his usual methods, using current market rates for material and labor. These estimates are to be sent to the secretary of the association at least two weeks before the coming convention of the association, which will be held at the Hotel Lafayette, Buffalo, N. Y., on June 23 and 24. The names of the firms which make the estimates will not appear on the estimate sheet, but they will be identified by a given number, and the identity of the firm will be known only to the secretary of the association and will not be disclosed by him except by permission. Members of the association are instructed to use their own overhead burden and a 15 percent profit in making the estimates.

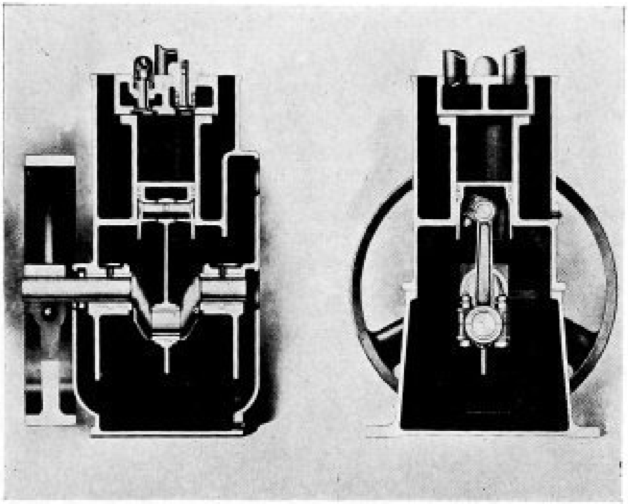
We are sure that everyone will agree with the secretary that this is a most excellent scheme and a practical step toward securing uniform boiler costs. The results will furnish a practical means of arriving at some definite method of harmonizing the work of individual boiler manufacturers in estimating on a definite set of specifications—a result which will be of the greatest benefit to all boiler manufacturers.

Engineering Specialties for Boiler Making

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

Imperial "Fourteen" Small Air Compressor

On April 15 the Ingersoll-Rand Company, 11 Broadway, New York, placed on the market a small air compressor of new design, known as the Imperial Fourteen. These new standard compressors, which are built in four sizes, provide a capacity ranging from 3 to 45 cubic feet per minute at pressures to 100 pounds per square inch, although they can be used for pressure requirements up to 200 pounds by increasing the horsepower. They are single-acting, belt-driven machines of the vertical type. Where they are designed to be driven from a line shaft, however, tight and loose pulleys are supplied. When designed to be used with an independent motor, they are furnished as a unit complete with the motor, endless belt and short-



Section of Imperial 14 Compressor

drive attachment. In the latter case, a hardwood base plate is included.

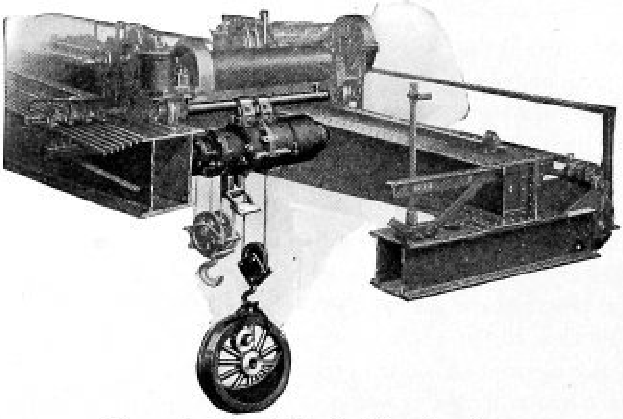
The smallest size is built with an air-cooled, ribbed cylinder for intermittent service, and with water-cooled cylinder of the reservoir type for continuous operation. The larger machines are water-cooled only; in the case of the largest size, a closed jacket or connection to the pressure system is optional.

Payne Auxiliary Hoist for Traveling Cranes

N. B. Payne & Company, 25 Church street, New York, is placing on the market a practical auxiliary hoist which may be attached to any standard overhead electric crane. The details of the apparatus are clearly shown in the accompanying illustration.

The manufacturers point out that the hoist does not take any more overhead room, does not require an extra trolley, does not shorten the travel of the trolley on the bridge, nor interfere with the accessibility of the main hoist. The average crane in a day's work handles a greater number of light loads than heavy. Since cranes for lifting heavy loads are slow-moving, their use results in a serious loss of time. These auxiliary hoists handle a light load of, say, three tons at a speed two to ten times as fast as the larger crane could possibly attain. The saving in power and the elimination of unnecessary labor are contributing factors.

These standard auxiliary hoists are supplied in from 1- to 5-ton sizes. Larger special sizes, however, may be fur-

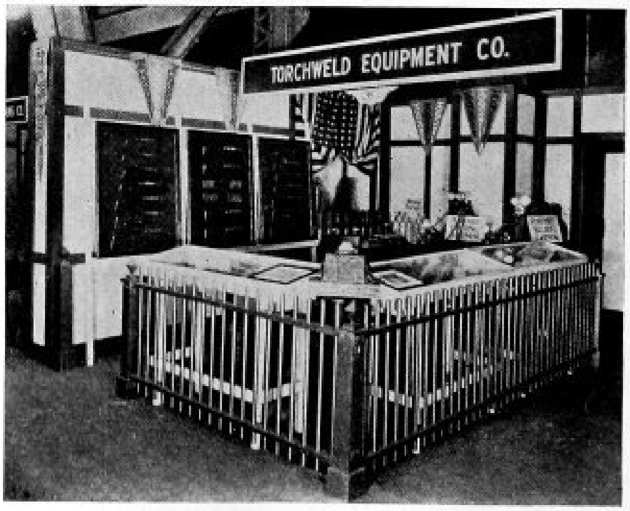


Payne Auxiliary Hoist for Traveling Cranes

nished for particular work. The control may be arranged from cage, floor or pulpit to suit the crane to which the apparatus is to be applied.

Torchweld Exhibition at the Railway Appliance Show

Everybody seems to have the same opinion as to the success of the National Railway Appliance Association in

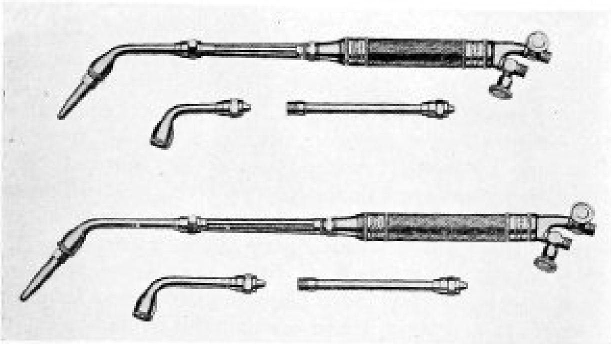


Torchweld Exhibit

putting on the railway appliance show at the Coliseum in Chicago during the week ending March 22.

One of the popular displays was that of the Torchweld Equipment Company, whose main office and plant is at Fulton and Carpenter streets, Chicago. The booth was arranged so as to permit the representatives of the different railroads not only to examine the apparatus on display but also to witness the repeated demonstrations of both welding and cutting equipment.

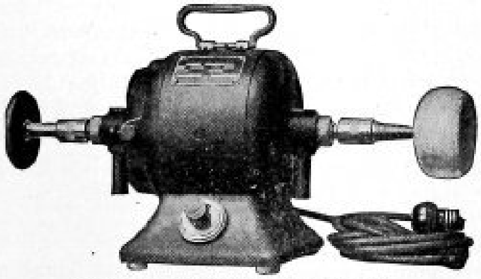
The boiler making fraternity showed great interest in the special railway model of welding torch demonstrated at the Torchweld booth and the various features demonstrated, such as the non-flash construction and the principle of mixing gases at equal pressure and equal consumption of both acetylene and oxygen. Over two hundred demonstrations were given during the four days of the show.



Torchweld Welding Torches

Motors for Polishing and Grinding

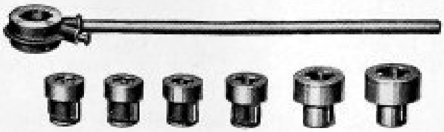
By the use of the polishing and grinding motors supplied by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., these operations are easily accomplished by simply snapping the switch to start the motor and applying the attachment to the surface for a few moments. The motor is always ready, and can be connected to any ordinary socket for use when grinding small parts.



Motor for Polishing and Grinding

The Beaver Jr. No. 3

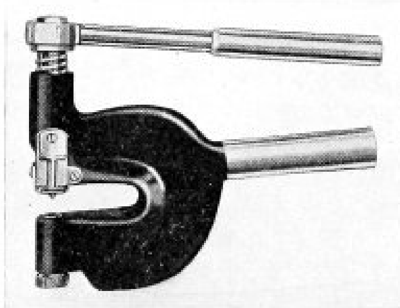
The accompanying illustration shows a pipe-threading tool known as the Beaver Jr. No. 3, which is supplied by the Borden Company, Warren, Ohio. It consists of one ratchet handle and individual die heads in sizes ranging from 1/8 to 1 inch. The tool can be used to advantage close to walls or rafters, in corners, against ceilings or in other difficult positions. Separate heads can be furnished to cut left-hand threads. The ratchet is controlled by a spring thumb-bolt of large size with a good grip, so that it can be turned with greasy hands without trouble. The Number 3 Beaver Jr. is made in American Briggs Standard and Whitworth Pipe Standard.



Beaver, Jr., Number 3

New Type of Steel Punch

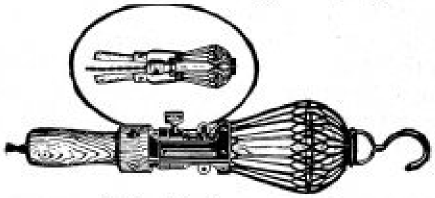
Paul W. Koch & Company, Chicago, Ill., has put on the market a so-called "Jiffy" punch which weighs 5 pounds and is 9½ inches long. It works in a small space; punches 5/32-inch, 3/16-inch, 7/32-inch and ¼-inch holes in metal up to 10 gage, and requires little oiling and no adjusting. The tool has a deep throat and one-piece automatic, disappearing stripper, giving a clear view to punch and punch mark for the next operation. Several sheets may be punched with one operation.



"Jiffy" Punch

Flexo Split Handle for Portable Lamp Guards

A special "Flexo" split handle has been put on the market by the Flexible Steel Lacing Company, of Chicago, Ill., which may be attached to the portable lamp guards manufactured by that company.



Adjustable Lamp Guard

The halves of the guards, including the handle itself, open wide from the hinge at the bottom, and can be instantly closed and locked around the switch at the end of any extension cord. The cord itself runs through the grooves in the handle.

Smooth-On for Repair Work

Smooth-On, which is manufactured by the Smooth-On Manufacturing Company, Jersey City, N. J., may be put to many uses in and around the shop for quick repair work. The mixture, when brought to the consistency of putty, can be utilized to fasten metal to a brick or concrete wall, or to tighten loose handles on tools. Mechanics have found it of use in permanently fastening washers or lock nuts to bolts, imbedding sockets in cement and fixing lock nuts in similar material. Smooth-On No. 1 is the preparation used for such jobs.

The Chicago Pneumatic Tool Company, Chicago, Ill., has moved its Milwaukee office from room 1305 Majestic building to room 1418 in the same building, where more convenient quarters, necessitated by the growing business of the company in this district, have been obtained.

Questions and Answers for Boiler Makers

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

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *6 East 39th street, New York City.*

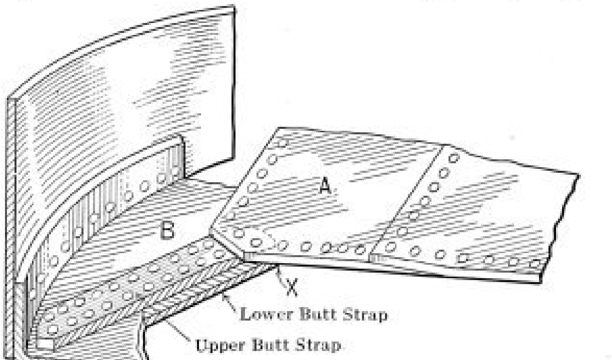
Tank Problem

Q.—During the last five or six months I have had under my supervision the erection of several acid tanks. The butt straps in four corners of this tank have caused considerable trouble by not being absolutely tight. Theoretically, of course, the butt straps should be more than sufficient to take care of any stresses coming at that point in the bottom. However, leaks have developed in each case at these points when the tank was entirely filled with water. In this particular case the tank is 30 feet high and rests on concrete grillage spaced about 2 feet. It has been our experience that the tank will be tight when there is 5 or 6 feet of water in it, but before we fill it, leaks open up, apparently in the rivets and in some cases in the seams. Although the writer realizes that some of our trouble may have been due to loose rivets, still matters did not improve a great deal by cutting out the loose rivets and re-driving them. We would be glad to know how such troubles may be overcome.

In another tank, 30 feet in diameter by 12 feet high, we have also experienced considerable trouble with the butt straps. These tanks set on a timber grillage spaced about 15 inches. Originally on several of these tanks we used a single butt with a single row of rivets. These butt straps did not cause us any trouble where the tanks were set on solid concrete foundations with a sand bedding, but the narrow as well as the wide butt straps caused considerable trouble where set on timber grillage.

In this connection, could you refer me to any tables published by boiler makers' associations or engineering societies giving the length of rivet stock used for various thicknesses of metal? J. L.

A.—If the connections at the four butts are made as shown in the sketch, and providing the rivets are properly spaced to produce tight seams, no great amount of trouble should be met with. Plate *A* is one of the plates forming the square, and plate *B* is a flange plate to which the shell is riveted. The upper butt strap is scarfed and placed under the lap of plate *A*. The lap connection at this point should be laid up well before riveting, which will aid in producing a good, tight joint. If the upper butt strap is properly scarfed, there will not be a very large offset in the joint connection. If this effect is large, an opening at



General View of Corner of Tank

x will result, in which case a *dutchman* would be used to fill up the gap and provide for a calking edge. This is a strip of soft steel or copper and should be fitted in place before riveting up the seams. The above suggestions you may have followed in your work.

As the bottom rests on grillage, it is possible that the stress due to the weight of the water springs the joints, causing leaks. To overcome this, shorten the pitch of rivets, and, if necessary, reduce their diameter. This will bring the overlapping plates closer together, and the pitch being smaller the spring in the plate between the rivet pitch is reduced. For overlaps the lap should equal about 1½ times the rivet diameter, which is laid off from the centerline of rivets. Along these corner connections it might be well to use a double row of rivets. Also I would suggest that cross supports between the piers in the grillage be employed, which may aid in overcoming the leaky seams. The length of rivets required depends on the diameter of rivet hole, plate thickness and shape of rivet head to be formed, and whether the rivets are driven by hand, pneumatic riveter or by hydraulic machine.

Following is a table for cone head rivets up to and including 1¼ inches in diameter:

Rivet Diameter, Inches	Length Required for Driven Head, Inches
⅝	1⅛
¾	1¼
⅞	1 5/16
1	1⅜
1⅛	1½
1¼	1⅝

Length for driven head is the rivet stock required to form the head. Total length required equals the grip plus stock for driven head.

Flanging Throat Sheets

Q.—I am sending a sketch of a one-piece throat sheet for a Belpaire boiler. (See Fig. 1.) This sheet will be flanged by hand. What I wish to know is: How would you flange a throat sheet of this kind? I have a one-piece flange block for both flanges. Which flange would you turn first?

I also have a locomotive throat sheet to flange, like the one shown in Fig. 3. Would you flange the circle part of this sheet first? Then wouldn't the upper part of the circle turn with the outside flange? F. J.

A.—It requires considerable practice to flange a throat sheet and to turn out the work free from all puckers, bucklings and shrinkage cracks. In the first place a considerable allowance should be made on the plate for the flanging along certain lines and curves, as it is much easier and cheaper to machine the edge of the plate after flanging than it is to do the flanging to very close limits.

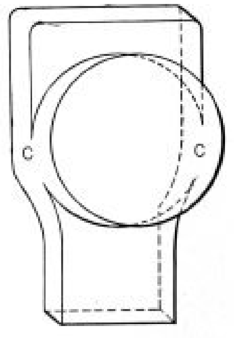


Fig. 1.—Belpaire Throat Sheet

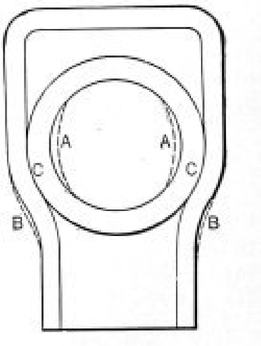


Fig. 3.—Pattern for Belpaire Throat Sheet

The allowances necessary for flanging the work in Fig. 1 will likely be at the locations as indicated by the dotted lines at *A* and *B*. This means that the hole cut in the plate will not be a circle, but it must be narrowed sidewise and thus made elliptical. Also, when forming the flange, its inner edge around the hole tends to close in as the work cools. Therefore, the edge of the circular flange should be set out more or less depending upon the thickness of the plate and the diameter and depth of the flange.

Referring to Figs. 1 and 3, it will be seen that there are two portions at *C* of the base of the circular flange in the same lines as the base of the outside edge flange. Also these two flanges are thrown in opposite directions, as in Fig. 1. These two flanges—the right and the left—could be turned at the same time, as the plate remains

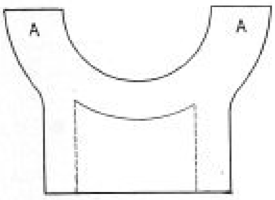


Fig. 4.—Pattern for Locomotive Throat Sheet

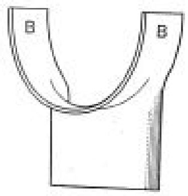


Fig. 2.—Locomotive Throat Sheet

flat at *C*. The same condition applies to the ends *A* of the pattern shown in Fig. 4, as the plate forming these ends remains flat, as at *B*, and hence the entire width should be turned through 90 degrees. In case the outside flanging causes too much distortion of the inside flange, then the circular opening could be protected by the use of bridges. Leave these bridges or strips when cutting the opening and they will support the work until the outside flanging is done. Then cut out the bridges. Difficult flanging operations such as required on throat sheets should not be attempted without making special preparations and without having the equipment of tools and forms, etc., necessary.

Requirements for Boiler Inspector's Job

Q.—I am writing to ask for a little information on how to pass an examination for boiler inspector—that is, what questions do I have to answer in regard to this position? I am a very good all-round boiler maker and am now foreman of a contract shop. J. O. A.

A.—To handle successfully the various problems arising in a boiler inspector's work and to pass an examination for such a position, one must understand thoroughly the principles and rules governing boiler design and construction. In such examinations questions are asked relative to calculations for determining strength of boiler parts, as riveted joints, stayed surfaces, shell plates, etc., to withstand given working pressures; also purpose of accessories, such as safety valve, gages, gage cocks, etc., and in regard to the procedure in making inspections of different types of boilers, and how repairs and testing should be properly made for different deteriorated parts. A sample list of questions can be had from the state authorities covering examinations previously held.

We would advise a course of study in boiler calculations and design. The following are books giving the rules and their application in a condensed form: The A. S. M. E. Boiler Code and "The Boiler" by Stephen Christie.

Submerged Flue Boiler

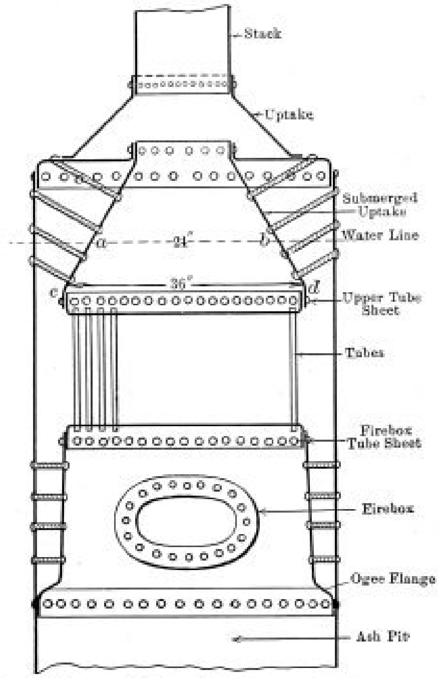
Q.—Please give a formula for finding the heating surface of a frustum of a cone, as, for instance, the top of a submerged flue vertical boiler; also a formula for finding the area of same. P. Z.

A.—In the accompanying sketch is shown a vertical boiler having submerged tubes, the different parts being indicated in a sectional view. The shell incloses the tubes, firebox and internal uptake. The internal uptake is a frustum of a cone and is reinforced by stays that connect it to the shell and top flanged head. A part of its surface is below the water line, and, as the hot gases and fire come in contact with it, this section is a heating surface. The upper part above the waterline is in contact with the steam, and under moderate steaming the heat from the surface tends to dry it.

The convex area of a frustum of a cone may be calculated as follows:

Multiply one-half the sum of the circumference of the upper and lower bases of the frustum by its slant height.

To find the heating surface of the uptake in contact with the water, we will assume that the upper base along the water line *a-b* is 24 inches in diameter, the lower base



Sectional View of Vertical Boiler with Submerged Tubes

at the tube sheet connection *c-d* is 36 inches in diameter, and the slant height equals 20 inches. Then, according to the rule, using these values, we have:

$$\frac{(24\times3.1416)+(36\times3.1416)}{2}\times 20 = 1{,}185 \text{ square inches.}$$

The new Chicago office of The Van Dorn Electric Tool Company, of Cleveland, manufacturers of portable electric drills, reamers and grinders, is located at 527 South Dearborn street and extends through to 528 Plymouth. William Cottrell is sales manager at the Chicago branch.

Work that is congenial is by no means as tiring as work that is distasteful. Select, therefore, with careful thought your life's occupation.

Repetition work for a man, day in and day out, means a low order of mentality. A man content to do one thing all the time is a stationary being.

Contentment is desirable if it is of the right kind. Yet, perfect contentment would result in stagnation.

Letters from Practical Boiler Makers

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

Staybolts

The two types of boilers where screwed water space staybolts are most in evidence are the locomotive and marine; that the former gives heaps of trouble is evidenced by the numerous discussions on the subject, the necessity of frequent renewals, the vast number of patents concerning staybolts of flexible type, and the advertisements of those which are already on the market.

It is rather curious but the fact is worth notice that in the Scotch marine boiler staybolt renewals are rare, while they are frequent in the locomotive boiler. The conditions are different, the quantity of steam generated per unit of weight is one factor; another is that the proportions of water space are smaller in the locomotive boiler.

The writer has always contended that the staybolt practice of his youth in connection with locomotive boilers was decidedly superior to quite a lot which has come under his notice in later years. In the locomotive shop, with which reduced the center diameter at one cut. The third like the fireboxes, of copper; the outer shell of the boiler, as well as the rivets, Lowmoor iron; the tubes were steel.

The staybolts were reduced in the center to give a cross-sectional area constant throughout, and each bolt had two telltale holes, one drilled from each end. The threads were chased up in a special center lathe with a multiple-pointed tool carried on the lathe slide rest. Altogether three specially rigged small lathes were used. The first drilled both telltale holes 3/16-inch diameter simultaneously and automatically. The second machine had a tipping saddle guided by a steel former on the front shear which reduced the center diameter at one cut. The third machine chased the threads with two passes of the tool. The threads were very perfect and were deliberately cut.

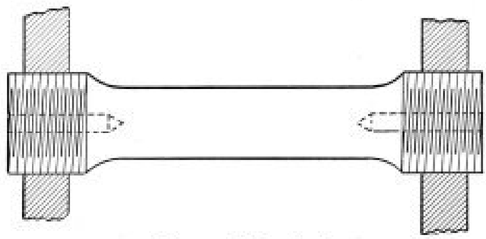
The finished staybolt, according to all theory of resiliency, when placed, was of uniform strength, and its length was sufficient to allow a couple of threads projecting at either end. No cutting to length was necessary, the stays were stocked of standard length to suit standard boilers and their length was fixed in sawing from the bar before machining. A cup tool was used to insert them having two clear threads, white lead putty was smeared on both ends and the thread was proportioned to give a tight fit, needing a twelve-inch bar to take them home. After placing, a polished steel drift was used to expand the stays outward from the center in the telltale hole, and they were lightly deformed with the flat face of a hammer to give additional security. The whole series of operations gave the metal the least distress with the easiest mechanical working.

Of course, stays did break owing to fatigue or some other cause, and shelling out the old stay, retapping and fitting fresh stays of very slightly larger thread was a veritable work of art. Such stays of suitable screwing were always stocked.

Such refined practice is unusual in the case of portable engine boilers, road rollers and locomotive type boilers not intended for railway use. Steel stays without telltale holes screwed throughout their length, nicked all round by chisel and broken by a blow in place and then riveted over both ends, have come under notice repeatedly in recent years.

Screwed stays in Scotch marine boilers are similarly treated. They are screwed throughout their length and placed and finished by similar means.

Some cases of staybolt breakage in Scotch boilers are most mysterious. It must be remembered that, unlike a locomotive boiler, every stay can be inspected by the aid of a light and some gymnastics or, rather, contortions each time the boiler is opened up. Although it is not easy for a grown man to inspect a large number at very close range, still the fact remains that it is possible to detect a broken staybolt much more easily than in a locomotive boiler.



Shape of Staybolt

One instance which came under personal observation was the three lower rows in the back end of the middle chamber of a Scotch boiler which was fractured close up to the chamber plate as if cut with a knife. The only conclusion possible was that the fracture was due to imperfect circulation and hurried steam raising. Blowing down the entire contents of the boiler and allowing the return of cold water from the sea has given similar effects. For these reasons the competent marine engineer always requires twenty-four hours' notice to get under way, and artificial or mechanical means are used to keep the water inside of the boiler circulating. The same system will usually allow pumping out the contents of the boiler overside in place of violent discharge through the blow-down valve.

These preparatory notes are worth consideration, as from both production and operating experience staybolts are subject to grave abuse. The subject all round is a very vexed one; but, in the opinion of the writer, certain precautions are within easy reach, and a little more refinement in shop process will do no harm.

First as to material; failing any other alternative, there is no question but that iron resists repeated alternations of stress better than steel, provided there is a considerable margin of safety. It is altogether a kindlier material, it resists fatigue better. Second, as proved by innumerable experiments, exact shape has a great bearing upon endurance under stress; the design which ensures a uniform cross section will endure longest. Reference need only be made to the theory of resiliency, the shape of a high-speed engine connecting rod bolts and the shape of a specimen for tensile testing. Again, the tests made upon a notched bar have a bearing on the subject. Anyone can experiment; a piece of ferrous material with a perfect surface will in many instances bend double cold—if not under repeated hammer blows it will do so by pressure means. It is one proof of a first-class rivet bar or boiler plate. If a chisel cut be made at the point where the bend is to occur, the best material in the world will fracture when bent through a small angle. The difference between iron and steel under this test is very marked. The iron tears, the steel fractures short.

Returning to staybolts of the usual type, where the thread is continuous under the conditions of alternate contraction and expansion in the adjacent plate, such breathing is the result of difference in temperature, and, though the movement is small in terms of end length, it is given by very great force. The chief stress in a Scotch boiler, for example, is not due to the pressure of the steam but to the difference in temperature between the plates at the steam level and those under vastly different heat conditions in the cool bottom below the furnaces. To restrict this movement is virtually impossible with the normally placed stays. The crown stiffening serves to prevent collapse from steam pressure, but does not minimize the upward expansion due to furnace temperature.

The conditions present are the worst possible, and it is seriously contended that the continuously screwed mild steel solid staybolt is the worst possible type while the most common. It is in effect a nicked test bar subject to alternate bending stress. The sharper the angle of the thread the worse the effect. The Whitworth form must here be superior to the U. S. thread. If staybolts are to be threaded throughout their length, then there is a clear case for alteration in thread form to one with more generously rounded outline or profile.

Fit of the Thread

Another matter is the question of the fit of the thread. It is possible to use a staybolt tap too long, although wear tends to take sharp edges off the tap; it is the sharpness of the thread on the staybolt which is important and the thread fit. Another question which arises is the method used to produce the thread itself. The consideration of this has some importance and a bearing on the subject. The number of threads in the plate itself are much less than in a nut. This leads to the use of a finer pitch, which is less easy to produce as a perfect thread.

Iron does suffer a disability in that the thread produced is not so clean in appearance, but special methods will take care even of this drawback, while when forced into a threaded hole it deforms more readily and this makes a tighter job with equal force to screw home. Reliance should be placed more upon the quality of the thread fit, and nothing but close supervision will ensure that this is present.

To take a steel stay screwed throughout its length which takes small force to turn and then to take a cold chisel to nick it round, breaking the end off with a hammer, renders the fit of the thread non-existent. The boiler maker trusts to heavy riveting over, and in some instances the thread might just as well be omitted.

Premising that a wrought iron stay of the design described above is used with a telltale hole at each end, having a really good fit in the screwed holes in plate, very light blows are all that is needed in the way of riveting over.

Such stays can be produced by specialized methods at no inordinate cost, a drift can be used with discretion in the telltale hole to help expand the stay into the thread, but reliance should be placed upon the fit of the thread as a primary consideration. It is possible to nick the stay to exact length before insertion by parting down to half or third diameter, and if the proportion is experimentally found, insertion with the correct amount of force should finish the parting by fracture. This gives a clear indication to the operator.

Just as in riveting itself, it is small refinements and more exact workmanship which can cut out trouble. There is some reason to suppose, if the combustion chamber sides in a locomotive boiler had more inward rake toward the top so that increase in staybolt length was accentuated above usual practice and that stays of the type described were used with the precautions cited, that the need for staybolts of flexible type would be lessened. The longer the staybolt the less distress to its material, and the adjacent plate, by breathing seems a common-sense conclusion. The greatest stress is at the point of highest temperature.

A recent contributor discusses and recommends larger staybolts of increased pitch. There are obvious limitations to the theory. Nine-sixteenths-inch plates are virtually standard everywhere for heating surfaces in contact with flame, and extension to pitch leaves the plates less supported.

Practice Worth Consideration

There are other considerations than freedom from weakness due to corrosion to be taken into account. Usual practice is worth consideration, and this keeps plate and staybolt sizes constant while altering the spacing. The protective sleeve of thin copper will be difficult to manipulate and would be ruled out for electrolytic reasons in marine practice.

Corrosion or wastage is due more to quality of feed water and its treatment than to erosion due to liberation of steam. Modern marine boilers always use nutted stays, which are also threaded into the plate, and the best practice includes a copper washer beneath the faced nuts used.

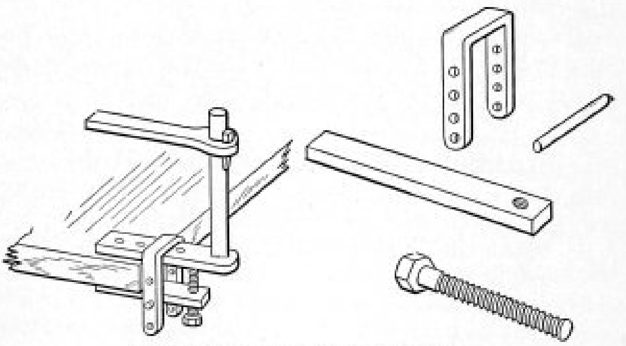
The whole problem of water space stays is worth extended study and investigation. It is common enough to find that such wastage is extremely local both in the stay itself and its position in the boiler. This points to local phenomena, which extended investigation should solve.

London, England. A. L. Haas.

A Handy Clamp for the "Old Man"

During a recent visit to a new plant in which a number of new boilers were being installed, I noticed a new idea that one of the boiler makers had devised to rig up his old man drill post. I sketched it into my note book and am passing it along for the readers, who may find need for it.

The sketch shows the clamp in use on the edge of a work bench, and, of course, one can easily see how it is



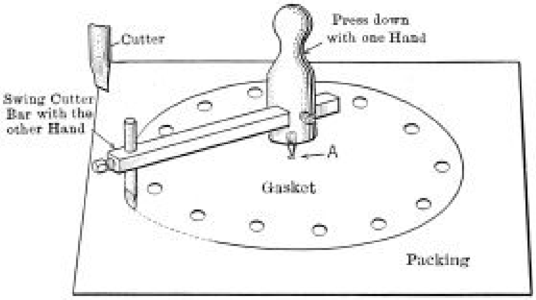
Clamps Used on Old Man Drill Post

applied. The details of the clamp are given in the smaller sketches; it is very simple and easy to make. The U-shaped strap is drilled with a set of eight holes to allow adjustment. The whole thing slips on over the foot of the "old man."

C. H. Willey.

Simple Handy Gasket Cutter

It only takes a few odd minutes and some scrap ends of stock to make this simple device, and it certainly is a handy thing to have in the tool kit. The sketch shows how it is made—just a piece of round stock with a square hole drilled and filed in it to receive the horizontal cutter bar, a set screw to hold it, and a pointed tip center screw, as at



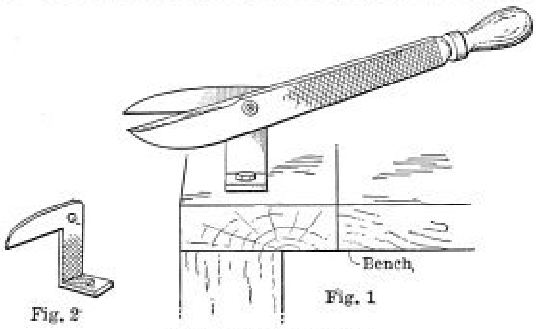
Gasket Cutter Made From Scrap Ends of Stock

A, to pivot the device when cutting the circle. Drill a hole in the end of the square bar to receive the piece of round stock that is used for a cutting knife. Put in a set screw to hold it and the rig is complete. To use it, lay the sheet of packing on a flat board or bench, set the cutter for the largest diameter of the gasket, cut this circle, then set it for the smaller inside circle and cut that.

HELPER.

Bench Shears

There is often a need for small bench shears that enable one man to hold the work in one hand and work the shears with the other. Formerly the way we used to do it was to grip one handle of the tinner's snip in the bench vise,



Improvised Bench Shear

but now we have a pair of improvised bench snips made from two old files. The sketches show how they were made.

Fig. 1 illustrates the lower jaw, which is secured to the bench; Fig. 2, the complete tool. The jaw sections of the file, of course, are ground smooth of file marks.

SHOP MAN.

Staybolts and the Telltale Hole

Some thirty-seven years ago the writer and a friend, now a foreman boiler maker, were walking near the tracks of the old Pittsburgh & Western Railway at Niles, Ohio, and, like all boiler makers, could not pass by a locomotive without looking her over. The day being Sunday, we had lots of time to do so, and the thing that attracted our attention most of all was the staybolts, for they had telltale holes not merely in the ends but clear through the entire length of the bolt. At that time the telltale hole was a novelty in boiler work; that is, they were not in general use and were not applied unless ordered when the engine was built.

Now it is very evident that the telltale holes in these bolts were made right at the mills where the staybolt iron was made and rolled. If I remember rightly, the holes were rather more than 3/16 inch in diameter.

As we all know, the object of the telltale hole is to notify us of the fact that a bolt is fractured and to give us warning of the impending danger. It is a common practice with some engine men to plug up the telltale holes just as soon as they show a leak and say nothing about it when arriving at the end of the division.

On one occasion the writer examined an engine that had been working on another division and found no less than twenty-three broken staybolts in the top row of the side sheet, and every one had the telltale hole plugged, some with the shank of a file driven in and hammered over. Now it would be a very difficult matter for an engineer to do this on the road, for the jacket and lagging would have to be removed to do so; therefore, it is evident that the man on hot work had done the trick to save *himself* a hard job, never giving a thought to the risk the engine crew were running with a boiler in such a condition.

With the staybolts having the telltale hole running through the entire length of the bolt, the matter of plugging up the telltale hole in a broken staybolt becomes a more difficult job for both engine man and boiler maker, for the hostler, when cleaning the fire, would see the leak and report it, even if the engine man had neglected to do so, and the attention of the foreman would be drawn to the fact and he would see that the defective bolts were removed.

For some reason or other it often occurs that the staybolt holes in the wrapper sheet and those in the firebox sheets are not always in line, either leaning to one side or up or down, so that drilling the telltale hole is a matter of guess work and the hole runs to one side of the center of the staybolt. This, of course, applies to drilling after the staybolts are in position. Careful fitting in the first place would avoid all of this trouble, but in new work, when all the holes possible are put into all the sheets, especially the mud-ring holes in back-head, throat, firebox door and flue sheets, before they are flanged (no matter how they are flanged, whether by hand or by press), there is always some variation in the work which will throw the staybolt holes out of line one way or the other and make it almost impossible for anyone to drill in the telltale holes exactly in the center of the bolt as they should be.

By drilling the holes before installation, this trouble would be overcome, but the top-sided staybolt would still remain unless the back-head, throat sheet, firebox door and flue sheets are left blank, so that the mud-ring holes could be put in after fitting. This would allow the fitter-up a chance to adjust the sheets should they be a little out of line in flanging.

The above applies to new work generally, but will also apply to general repairs. It stands to reason that a staybolt, to fulfill its function, should have a straight pull or be as near a right angle to the firebox sheets as possible.

The writer has very recently seen many staybolts give way while the boiler was under test on account of the holes being drilled in after the bolts were in position, the man doing the drilling not knowing that the bolts were out of line. The life of a staybolt out of line is a short one, and it is also a hard bolt to rivet up tight, either by hand or with the machine, for it is never held on solidly.

Allowing that it is impossible always to have our staybolts in perfect line, then the next best thing is to install the bolts with the telltale holes already drilled in. Of course this means that the bolts must be run in from the firebox side, which again makes it difficult to use the clippers for cutting off the bolts. This difficulty is easily overcome by having the bolts burned off by the oxy-acetylene cutting torch. Should hollow staybolts be used, they can be installed in the usual way and can be cut off with the clippers and both ends opened up in the usual way.

While on the question of staybolts, does it pay small roads to make their own staybolts and drill the telltale holes with the common drill press before the bolts are installed, or after installation by the small air machine when it is possible to procure the best staybolts that are on the market, in all lengths and sizes, with telltale holes already drilled, for far less than they can be made in any shop not provided with proper machinery for doing the work?

The writer has seen much valuable staybolt iron destroyed by a careless workman using a Stilson wrench on a 36-inch staybolt when a 6-inch bolt would have done. Yet there are master mechanics who want to run their shops at the least possible expense and will raise Cain over a few ½-inch washers lying around who cannot see the economy in the use of the staybolt cut to the proper length all ready to be used, but, because they must be carried in stock, he does not want them.

While working for such a man at one time the writer demonstrated the advantage of using the short staybolt with telltale hole drilled and the end of the bolt slightly countersunk, which allows the bolt to be riveted up without closing the telltale hole entirely. The demonstration was quite a success, but it never got any further than that.

It is the writer's experience that the telltale hole should be drilled before installation for the reasons given above.

Wilkinsburg, Pa. FLEX IBLE.

Hand Versus Power Riveting

It is a very usual experience in controversy to find initial misunderstanding result in ultimate agreement upon principles, even if upon practical details insoluble differences remain. Mr. Harrison and myself still differ, but have found common ground without which further argument would be vain and futile. My antagonist would be the first to admit that his opinions have been drastically revised since his first communication in this journal for July, 1917; but, like every man convinced against his will, he is of the same opinion still.

I must confess that such an attitude has my ungrudging admiration; it was from such material that the pioneer and the advocate of lost causes was made. To take a real gruelling and come up smiling for the next round is a type of physical heroism all too uncommon.

I have no desire to apply any moral or adorn any tale. On the question of the value of position drilling and hydraulic closure of rivets I can add nothing to what I have already said. There are, however, some folk who, like the Bourbons of France and later another European monarch, learn nothing and forget nothing. The blind sector of my mentality is as small as I can make it. I will allow no merit to punched holes and hand-closed rivets; they are both anathema to me and were long since excommunicated from the faith to which I belong. Mr. Harrison, being my elder, clings to the faith of his youth despite all the march of progress. He still continues to twist my admissions and prevent my gospel.

Hand-driven rivets can be made tight—yes, in thin plates of wrought iron with Lowmoor rivets; the means are insufficient with mild steel thick plates and large size mild steel rivets. He takes credit to himself for the results of my scrap yard observation where I showed that dissection resulted in self-condemnation of past bad practice.

A rivet loose in the hole and acting as a hydrant under test is in my humble opinion not a rivet at all; it is pure camouflage—the semblance without the reality. Consequently, it cannot even be a leaky rivet, for it is not a rivet at all.

Bolts applied to every seventh or eighth hole is surely poor practice. I like a draw immediately ahead of the hole under treatment, and a bolt every alternate hole is surely better practice than my opponent advocates. Further, the intermediate holes for a good distance get filled before one bolt at a time is withdrawn, to fill their location. Further, work upon a rivet lower in temperature than a low red is cruelty to the metal and does most often bring subsequent troubles in its train.

As stated often enough, it is possible to make imperfect seams, leaky rivets and a poor job with appliances of the greatest beauty and precision, designed solely to avoid such untoward results. Skill can never be overset by mechanical appliances, but these do allow a better job at a lower cost if rightly handled.

I congratulate Mr. Harrison upon the widening of his sector of mentality open to conviction; later, perchance, after further reflection he will come fully into line and declare his full conversion.

He started by telling us youngsters that boilers could not be built with tight seams even when the methods he then advocated were used; when modern appliances were installed it only made confusion worse confounded, hence he desired to return to a more primitive faith. Now, having discarded his sea boots and oilskins (come in out of the rain, in fact), he is inclined to believe that progress has been made, and even wishes to accentuate the rate of improvement.

Judging by this satisfactory state of affairs, rational boilers made on scientific lines are only a matter of time in America; once a new idea gets a firm hold it is like the bacillus of a contagious disease—it breeds with startling rapidity and becomes an epidemic.

If it is possible to persuade the older generation, with all a life's prejudice to overcome, then the battle is already decided and victory overwhelming and complete is within grasp. The missionary required to initiate the new order is now self-revealed, and I wish Mr. Harrison godspeed on a thankless task among the boiler shop heathen. When he has a tale of scalps to show, the pages of this journal are, I am sure, at his service for their display.

Perhaps I misread his article and have twisted his remarks to my own point of view, as he has perverted my remarks—borrowing my phrasing to suit his own ends—to his own angle of vision. Perhaps, indeed, like our lunar satellite, there is a side of both of us in eternal darkness where the light of day cannot penetrate. Who knows? Certain it is, that other aid is evident; witness the contribution of Flex Ible in the March issue, which contains Mr. Harrison's article. With the latter I do not agree in many particulars, and when some more ink comes to hand, or a few spare sheets of paper and the requisite time, Flex Ible will be duly admonished for the views he so ably expounds. Till then, at your service,

London, England. A. L. HAAS.

A boiler is a converter of latent energy into dynamic energy—the better the design of the boiler, the more economical is the tranformation. Poor handling of a well-designed boiler counteracts the value of design. A good man and a good boiler are a good combination.

Selected Boiler Patents

Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney,

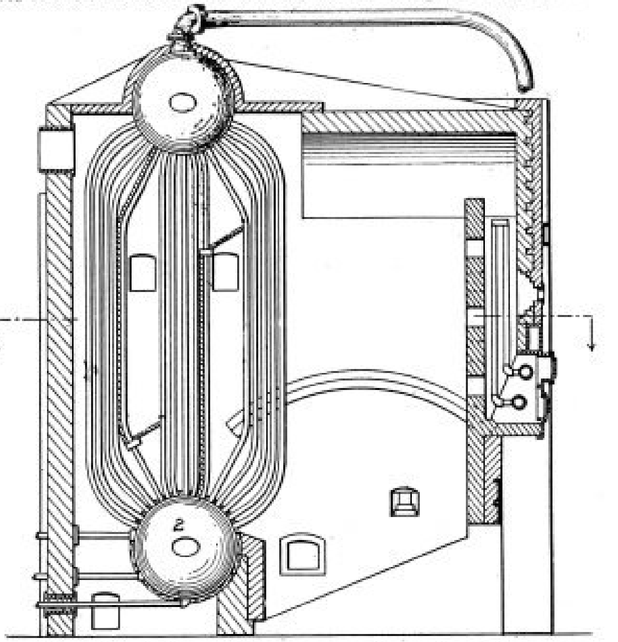
Washington Loan and Trust Building,

Washington, D. C.

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

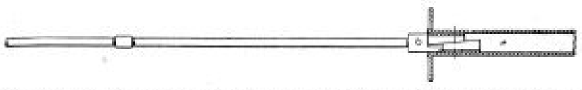
1,283,814. BOILER. GEORGE T. LADD, OF PITTSBURGH, PA.

Claim 1.—The combination, with a boiler consisting of an upper and lower drum, and a plurality of sets or banks of vertical tubes connecting the drums, of a baffle extending from the lower drum along the front tubes of the intermediate set or bank, and extending across the space between the first and intermediate sets of tubes a short distance below the upper drum, and a firebox or combustion chamber having its top above the portions of the baffling across the space between the first and intermediate sets of tubes, and of substantially uniform width for its entire length. Four claims.



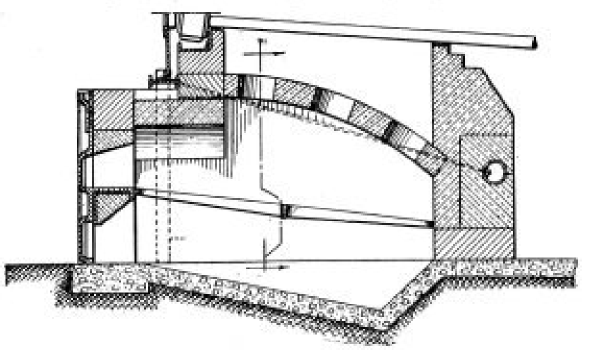
1,285,313. THIMBLE FOR REPAIRING BOILER TUBES. WILLIAM H. MORGAN, OF MARSEILLES, ILL., ASSIGNOR OF ONE-HALF TO PETER HYLAND PROCTOR, OF MARSEILLES, ILL.

Claim 2.—A device of the class described, comprising a pair of trough-shaped members having longitudinally inclined co-operating edges; and a pusher having inner and outer shoulders, the inner shoulder co-operating with one member, and the outer shoulder co-operating with the other member, to advance both members simultaneously in longitudinally stepped relation, the pusher being rotatable to present the outer shoulder to the first specified member, thereby to advance said member with respect to the other member, after both members have been advanced simultaneously by the pusher to a point of application. Three claims.



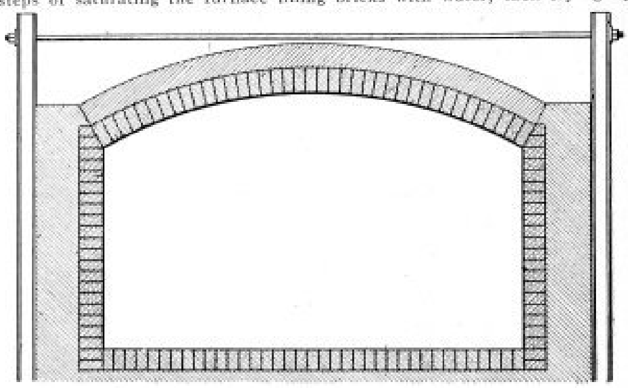
1,283,047. FURNACE. JOHN E. BELL, OF BROOKLYN, N. Y.

Claim 3.—A furnace having a grate, side walls, a front wall, a bridge wall, a front arch sprung between the side walls so as to span the front portion of the grate, a heat radiating arch comprising a series of spaced sections sprung from the bridge wall, adjacent the grade, to the front-wall above the front arch, transverse stays supported by the bridge and front walls, respectively, and tie-rods connecting the ends of the said stays exteriorly of the side walls. Three claims.



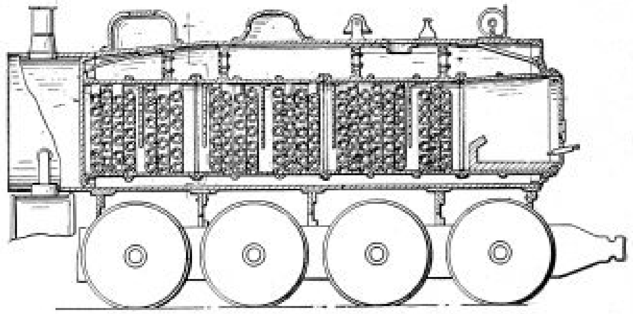
1,285,244. METHOD OF CONSTRUCTING FURNACES AND FIRE BRICKS THEREFOR. JOHN W. KUNZLER, OF PITTSBURGH, PA., ASSIGNOR, BY MESNE ASSIGNMENTS, TO W. W. LAPHAM, OF PITTSBURGH, PA.

Claim 1.—The method of constructing furnace linings, comprising the steps of saturating the furnace lining bricks with water, then laying up the bricks and coating the exposed surface of the bricks with a fire clay composition containing an alkali, and then immediately firing the furnace to set the coating. Four claims.



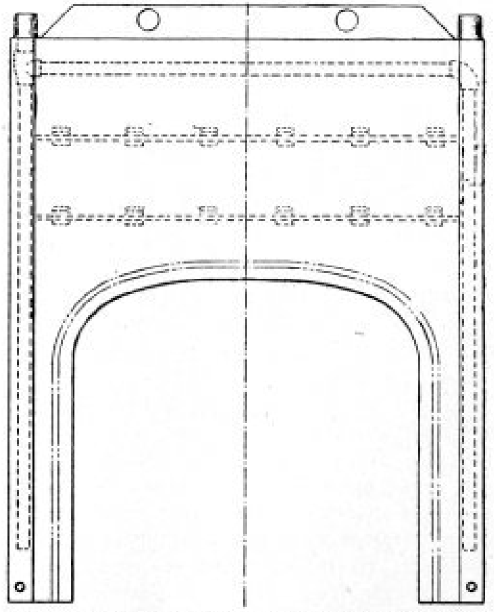
1,285,010. WATERTUBE BOILER. HYLTON A. BRISCO, OF FRESNO, CAL., ASSIGNOR OF TWO-THIRDS TO DIXON L. PHILLIPS, OF OAKLAND, CAL.

Claim 1.—A horizontal watertube boiler comprising inner and outer spaced cylindrical shells defining a water space between the same, a plurality of spaced sets of transversely extending water tubes arranged in the inner shell and communicating with the water space, and perforated heat deflecting plates arranged between each set of watertubes and extending from the upper surface of the inner shell to a point below the center thereof, as and for the purpose specified. Two claims.



1,282,864. FURNACE-DOOR FRAME AND THE LIKE. LUTHER L. KNOX, OF BELLEVUE, PA., ASSIGNOR TO BLAW-KNOX COMPANY, OF PITTSBURGH, PA., A CORPORATION OF NEW JERSEY.

Claim 1.—A hollow water sheet cooling structure comprising two metal plates or sheets, one of said plates or sheets having a plurality of internal slotted projections, and the other plate or sheet having a corresponding number of hook members whose hooks extend in a direction to engage the slots of said projections by a substantially parallel movement of one of the plates or sheets with respect to the plane of the other one; substantially as described. Four claims.



THE BOILER MAKER

JUNE, 1919

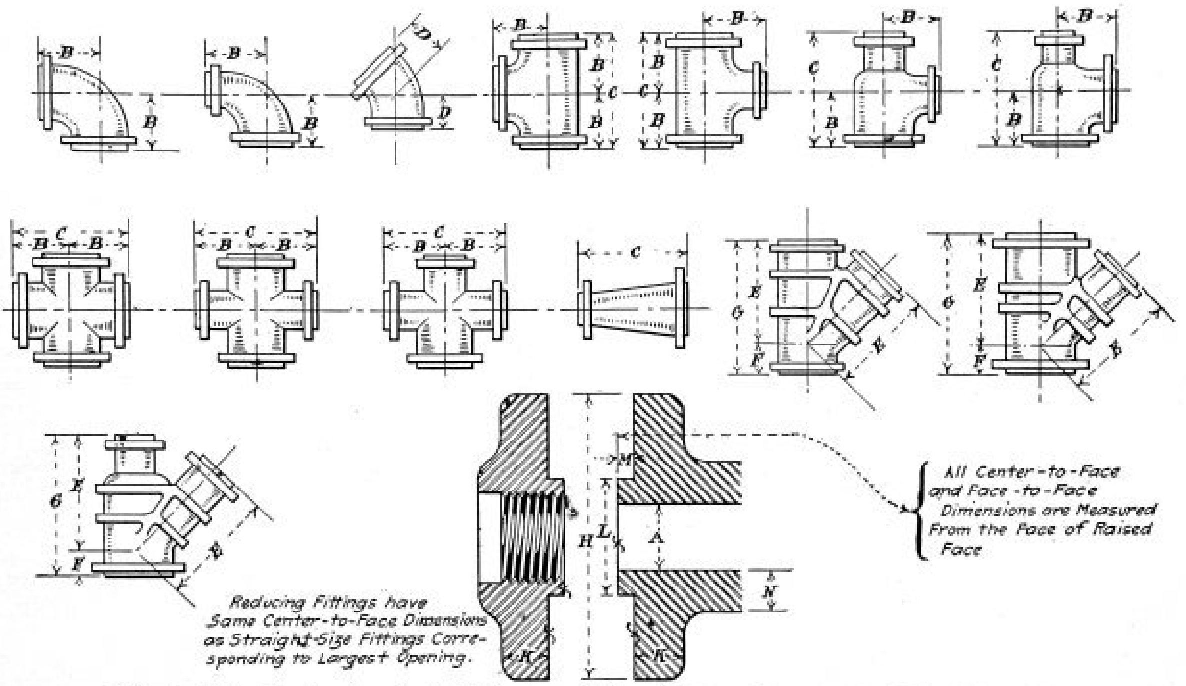


Fig. 1.—Hydraulic American Standard Flanges and Flanged Fittings Dimensioned in Tables 2, 3 and 4

Report of A. S. M. E. Committee on Standardization of Flanges and Pipe Fittings

Low-Pressure 50-Pound Standard Submitted—800-, 1,200-, 3,000-Pound Hydraulic American Standard

At the annual meeting of the American Society of Mechanical Engineers, December, 1918, the Committee on the Standardization of Flanges and Pipe Fittings presented for consideration the following additions to existing standards as comprised in the report known as *The American Standard for Pipe Flanges, Fittings and Their Bolting*, issued in 1914.

The report, which was prepared under the direction of J. P. Sparrow, late chairman of the committee, was issued by Arthur R. Baylis, acting chairman, Stanley G. Flagg, Jr., E. M. Herr, Arthur M. Houser, Julian Kennedy, E. A. Stillman, A. S. Vogt and W. M. White.

Angle Elbows and Special Fittings

Standardization of angle elbows and special angle fittings: From 1 degree to 45 degrees, use center-to-face dimensions of standard 45-degree elbows, American Standard, and over 45 degrees use center-to-face dimensions given for 90-degree American Standard elbows.

1.—A standard to be known as American Low-Pressure Standard for 50 pounds working pressure, tabulation of flange data attached. This standard was recommended after an agreement with the committee of the Manufacturers' Asociation.

2.—Three standards for hydraulic fittings, to be known as:

800-Pound Hydraulic American Standard.
1,200-Pound Hydraulic American Standard.
3,000-Pound Hydraulic American Standard.

Tabulations and data for each of these standards with joint designs are submitted for your consideration. These are given in Tables 1 to 4, inclusive, and in Figs. 1, 2 and 3.

The committee deems it inadvisable at this time to outline or recommend a standard for 600 pounds steam pressure with superheat, partly because there is at present no demand for fittings for this pressure and because the committee feels that it should be guided somewhat by experience in the field with the pressures and temperatures now in use, namely, 300 pounds pressure and 250 to 275 degrees superheat.

The Committee, however, is ready to advise that for

TABLE 1.—PROPOSED LOW-PRESSURE STANDARD FOR END FLANGES, BOLTINGS AND BODY THICKNESS—50-POUND WORKING PRESSURE

Size	Diameter of Flange	Flange Thickness	Bolt-Circle Diameter	Number of Bolts	Size of Bolts	Body Thickness	Size	Diameter of Flange	Flange Thickness	Bolt-Circle Diameter	Number of Bolts	Size of Bolts	Body Thickness
12	19	1 1/4	17	12	3/4	5/8	56	68 3/4	3	65	48	1 1/4	1 5/8
14	21	1 3/8	18 3/4	12	3/4	11/16	58	71	3 1/8	67 1/4	48	1 1/4	1 5/8
15	22 1/4	1 3/8	20	16	3/4	11/16	60	73	3 1/8	69 1/4	52	1 1/4	1 11/16
16	23 1/2	1 7/16	21 1/4	16	3/4	3/4	62	75 3/4	3 1/4	71 3/4	52	1 1/4	1 3/4
18	25	1 9/16	22 3/4	16	7/8	3/4	64	78	3 1/4	74	52	1 1/4	1 3/4
20	27 1/2	1 11/16	25	20	7/8	13/16	66	80	3 3/8	76	52	1 1/4	1 13/16
22	29 1/2	1 13/16	27 1/4	20	7/8	7/8	68	82 1/4	3 3/8	78 1/4	56	1 1/4	1 7/8
24	32	1 7/8	29 1/2	20	7/8	7/8	70	84 1/2	3 1/2	80 1/2	56	1 1/4	1 15/16
26	34 1/4	2	31 3/4	24	1	15/16	72	86 1/2	3 1/2	82 1/2	60	1 1/4	1 15/16
28	36 1/2	2 1/16	34	28	1	1	74	88 1/2	3 5/8	84 1/2	60	1 1/4	2
30	38 3/4	2 1/8	36	28	1	1	76	90 3/4	3 5/8	86 1/2	60	1 1/4	2 1/16
32	41 3/4	2 1/4	38 1/2	28	1	1 1/16	78	93	3 3/4	88 3/4	60	1 3/8	2 1/16
34	43 3/4	2 5/16	40 1/2	32	1	1 1/8	80	95 1/4	3 3/4	91	60	1 3/8	2 1/8
36	46	2 3/8	42 3/4	32	1	1 1/8	82	97 1/2	3 7/8	93 1/4	60	1 3/8	2 3/16
38	48 3/4	2 3/8	45 1/4	32	1 1/8	1 3/16	84	99 3/4	3 7/8	95 1/2	64	1 3/8	2 3/16
40	50 3/4	2 1/2	47 1/4	36	1 1/8	1 1/4	86	102	4	97 3/4	64	1 3/8	2 1/4
42	53	2 5/8	49 1/2	36	1 1/8	1 1/4	88	104 1/4	4	100	68	1 3/8	2 5/16
44	55 1/4	2 5/8	51 3/4	40	1 1/8	1 5/16	90	106 1/2	4 1/8	102 1/4	68	1 3/8	2 3/8
46	57 1/4	2 11/16	53 3/4	40	1 1/8	1 3/8	92	108 3/4	4 1/8	104 1/2	68	1 3/8	2 3/8
48	59 1/2	2 3/4	56	44	1 1/8	1 7/16	94	111	4 1/4	106 1/4	68	1 3/8	2 7/16
50	61 3/4	2 3/4	58 1/4	44	1 1/8	1 1/2	96	113 1/4	4 1/4	108 1/2	68	1 3/8	2 1/2
52	64	2 7/8	60 1/2	44	1 1/8	1 1/2	98	115 1/2	4 3/8	110 3/4	68	1 3/8	2 1/2
54	66 1/4	3	62 3/4	44	1 1/8	1 9/16	100	117 3/4	4 3/8	113	68	1 3/8	2 9/16

NOTE

1.—For sizes 10 inches and smaller, use regular 125-pound American Standard flange dimensions and templets.

2.—For sizes 12 inches and larger, use 125-pound American Standard flange diameters, bolt circles, and number of bolts, using bolt diameters as shown above, thereby maintaining interchangeability with 125-pound American Standard flanges.

3.—Screwed companion flanges should not be thinner than 125-pound American Standard thickness.

TABLE 2.—800-POUND HYDRAULIC AMERICAN STANDARD FLANGES AND FLANGED FITTINGS, 12 INCHES AND SMALLER, FOR FULL-WEIGHT WROUGHT PIPE. SEMI-STEEL AND CAST STEEL.
(See Fig. 1.)

See Fig. 1	Size	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	6	7	8	9	10	12
A	Inside diameter of port	1/2	3/4	15/16	1 1/4	1 1/2	1 7/8	2 1/4	2 3/4	3 1/4	3 3/4	4 1/4	4 3/4	5 3/4	6 3/4	7 5/8	8 5/8	9 3/4	11 1/4
B	Center to face, ell, tee, cross	3 1/2	4	4 1/2	5	5 3/4	6 1/2	7	7 1/2	8 1/2	9	10	11	12	13	14 1/2	15 1/2	16 1/2	17 1/2
C	Face to face, tee, cross, reducer	7	8	9	10	11 1/2	13	14	15	17	18	20	22	24	26	29	31	33	35
D	Center to face, 45-deg. ell	2 1/2	3	3 1/2	4	4 1/4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10	11
E	Center to face, lateral	7	8	9	10	11	12 1/2	13 1/2	14 1/2	16 1/2	17 1/2	19 1/2	21	22 1/2	24 1/2	27 1/2	29 1/2	31 1/2	34 1/2
F	Center to face, lateral	2	2 1/2	2 1/2	3	3 1/2	3 1/2	4	4 1/2	4 1/2	5 1/2	6	6 1/2	6 1/2	7	7 1/2	8	8 1/2	9
G	Face to face, lateral	9	10 1/2	11 1/2	13	14 1/2	16	17 1/2	19	21	23	25 1/2	27 1/2	29	31 1/2	35	37 1/2	40	43 1/2
H	Diameter of flange	4 1/4	4 3/4	5 1/2	6	6 3/4	8	8 1/2	9 1/2	10 3/4	11 1/2	13	14	15	16 1/2	18 1/2	20	21 1/2	24
K	Thickness of flange, Semi-steel	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 7/8	2	2 1/8	2 1/4	2 3/8	2 1/2	2 3/4	2 7/8	3	3 1/4
	Thickness of flange, Cast steel	..	..	..	..	..	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 3/8	2 1/2	2 5/8	2 3/4
L	Diameter of raised face	1 3/8	1 11/16	2	2 1/2	2 7/8	3 5/8	4 1/8	5	5 1/2	6	6 1/2	7 1/4	8 1/2	9 5/8	10 5/8	11 5/8	12 3/4	15 1/4
M	Height of raised face	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
N	Minimum metal thickness, Semi-steel	1/2	1/2	9/16	9/16	5/8	3/4	7/8	1	1 1/16	1 1/8	1 1/4	1 3/8	1 1/2	1 3/4	2	2 1/8	2 1/4	2 1/2
	Minimum metal thickness, Cast steel	..	..	..	..	..	5/8	11/16	13/16	7/8	1	1 1/16	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8
	Diameter of bolt circle	3	3 3/8	4	4 3/8	4 7/8	6	6 1/2	7 1/2	8 1/2	9 1/4	10 1/2	11 1/2	12 1/2	13 3/4	15 1/2	17	18 1/2	21
	Number of bolts	4	4	4	4	4	4	8	8	8	8	8	8	12	12	12	16	16	20
	Diameter of bolts	1/2	1/2	5/8	5/8	3/4	7/8	7/8	7/8	1	1	1 1/8	1 1/8	1 1/8	1 1/4	1 3/8	1 3/8	1 3/8	1 3/8
	Length of bolts, Semi-steel	2 3/4	3	3 1/4	3 1/2	4	4 1/4	4 1/2	4 3/4	5 1/2	5 3/4	6 1/4	6 1/4	6 3/4	7	7 3/4	8	8 1/4	8 1/2
	Length of bolts, Cast steel	..	..	..	..	..	3 3/4	4	4 1/4	4 1/4	5	5 1/2	5 3/4	6	6 1/4	7	7 1/4	7 1/2	7 3/4

800 Pounds Cold Water Working Pressure—Hydrostatic (no shock)
500 Pounds Cold Water Working Pressure—Shock
800 Pounds Air or Gas Working Pressure—Temperature Not Exceeding 100 Degrees Fahrenheit

These fittings are recommended for pump columns, oil-transmission lines, gas lines and other hydraulic service where shock is negligible for a maximum working pressure of 800 pounds and a maximum temperature of 100 degrees Fahrenheit. Where subject to shock, they are recommended for a maximum working pressure of 500 pounds.

The diameter of port is nominal size.

Reducing fittings carry same dimensions center to face as straight-size fittings corresponding to largest opening.

Flanges may be attached to the pipe by any of the following methods: Screw flanges; lap flanges; shrunk, peened or riveted flanges; flanges welded to pipe.

Flanges on fittings and valves, also all companion flanges except those for lap joint, should be furnished with 1/4-inch raised face, as shown in dimension table, Fig. 2, unless otherwise specified.

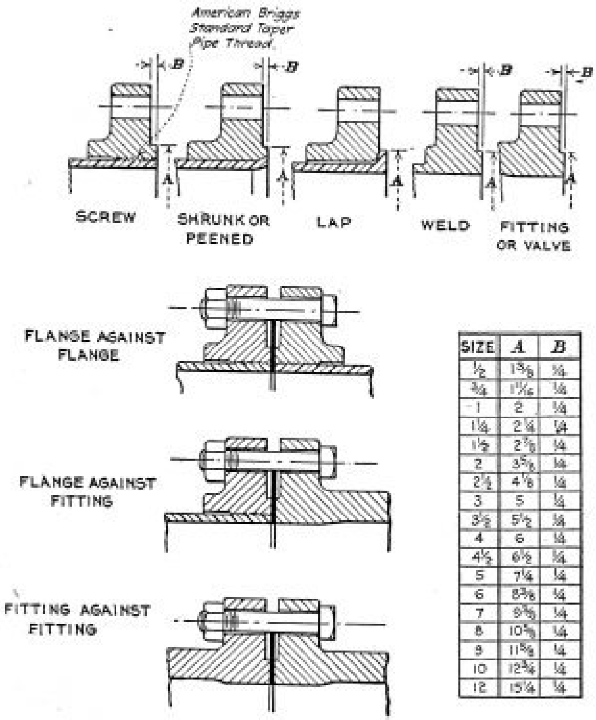
Bolt holes are 1/8 inch larger in diameter than bolts. Bolt holes straddle center lines. Unless otherwise specified, bolt holes in cast-steel fittings should be spot-faced.

Square-head bolts with hexagonal nuts are recommended. Hexagonal nuts on sizes 8 inches and smaller can be conveniently pulled up with open-end wrenches with minimum-design heads. Hexagonal nuts on sizes 9 inches and larger can be conveniently pulled up with box wrenches.

When flanges are screwed, shrunk, peened or riveted on the pipe, it is recommended that the end of the pipe and flange be refaced.

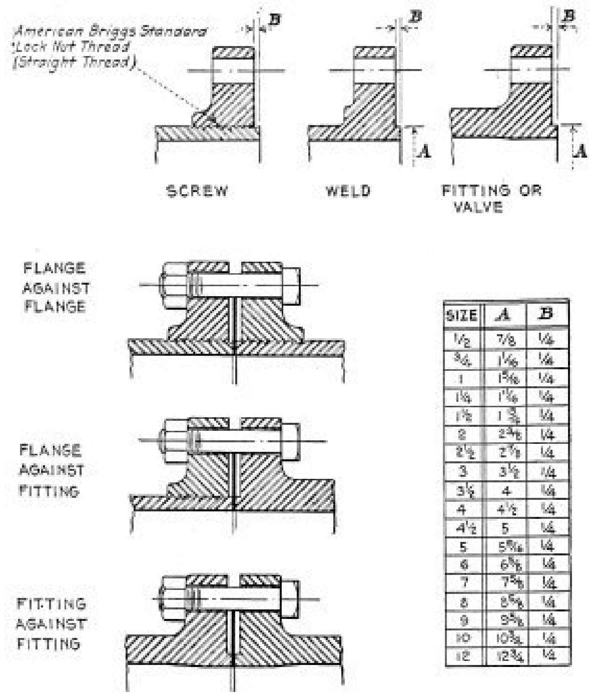
Gaskets extending from the inside of the pipe to the inside edge of the bolts are recommended. The ultimate compressive strength of the gasket must be sufficient to prevent its being crushed when bolts are pulled up.

Where long-radius elbows are desired, the use of pipe bends is recommended.



SIZE	A	B
½	1⅜	¼
¾	1 11/16	¼
1	2	¼
1¼	2¼	¼
1½	2⅝	¼
2	3⅝	¼
2½	4⅛	¼
3	5	¼
3½	5½	¼
4	6	¼
4½	6½	¼
5	7¼	¼
6	8⅜	¼
7	9⅝	¼
8	10⅝	¼
9	11⅝	¼
10	12¾	¼
12	15¼	¼

Fig. 2.—Flange Joints and Methods of Attaching Flanges to Pipe, 800-Pound and 1,200-Pound Hydraulic American Standard



SIZE	A	B
½	⅞	¼
¾	1 1/16	¼
1	1 5/16	¼
1¼	1 11/16	¼
1½	1 15/16	¼
2	2⅜	¼
2½	2⅞	¼
3	3½	¼
3½	4	¼
4	4½	¼
4½	5	¼
5	5 9/16	¼
6	6⅝	¼
7	7⅝	¼
8	8⅝	¼
9	9⅝	¼
10	10¾	¼
12	12¾	¼

Fig. 3.—Flange Joints and Methods of Attaching Flanges to Pipe, 3,000-Pound Hydraulic American Standard

TABLE 3.—1,200-POUND HYDRAULIC AMERICAN STANDARD FLANGES AND FLANGED FITTINGS, 12 INCHES AND SMALLER, FOR EXTRA STRONG WROUGHT PIPE. SEMI-STEEL AND CAST STEEL.

(See Fig. 1.)

See Fig. 1	Size	½	¾	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12
A	Inside diameter of port	½	¾	1	1¼	1½	2	2½	3	3½	4	4½	5	6	7	8	9	10	12
B	Center to face, ell, tee, cross	3¼	3¾	4½	4½	4¾	5¾	6½	7	7½	8½	9	10	11	12	13	14½	15½	16½
C	Face to face, tee, cross, reducer	6½	7½	8½	9	9½	11½	13	14	15	17	18	20	22	24	26	29	31	33
D	Center to face, 45-deg. ell	2	2¼	2¼	2¾	3	4¼	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10
E	Center to face, lateral	5½	6	6¼	7½	8¾	11	12½	13½	14½	16½	17½	19½	21	22½	24½	27½	29½	31½
F	Center to face, lateral	1¾	2	2¼	2½	2¾	3½	3½	4	4½	4½	5½	6	6½	6½	7	7½	8	8½
G	Face to face, lateral	7¼	8	9	10	11½	14½	16	17½	19	21	23	25½	27½	29	31½	35	37½	40
H	Diameter of flange	3½	4	4½	5	6	7	7½	8½	9¼	10¾	11½	13	14	15	16½	18¼	20	22
K	Thickness of flange { Semi-steel	9/16	⅝	11/16	¾	13/16	1¼	1⅜	1½	1⅝	1⅞	2	2⅛	2¼	2⅜	2½	2¾	2⅞	3
	{ Cast steel	..	..	..	..	..	1	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2⅜	2½	2⅝
L	Diameter of raised face	1⅜	1 11/16	2	2½	2⅞	3⅝	4⅛	5	5½	6	6½	7¼	8⅝	9⅝	10⅝	11⅝	12¾	15¼
M	Height of raised face	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼	¼
N	Minimum metal thickness { Semi-steel	7/16	7/16	½	½	½	9/16	⅝	⅝	¾	⅞	1	1⅛	1⅛	1¼	1⅜	1½	1⅝	1¾
	{ Cast steel	..	..	..	..	..	½	9/16	9/16	⅝	11/16	¾	13/16	⅞	1	1 1/16	1⅛	1¼	1⅜
	Diameter of bolt circle	2⅝	2⅞	3¼	3¾	4½	5¼	5⅝	6½	7½	8½	9¼	10½	11½	12½	13¾	15½	17	19¼
	Number of bolts	4	4	4	4	4	4	8	8	8	8	8	8	12	12	12	16	16	20
	Diameter of bolts	7/16	½	½	½	⅝	¾	¾	¾	⅞	⅞	⅞	1	1	1	1⅛	1⅛	1¼	1¼
	Length of bolts { Semi-steel	2¼	2½	2½	2¾	3	4	4¼	4½	4¾	5¼	5½	6	6¼	6¾	7	7½	7¾	8
	{ Cast steel	..		.		.	3½	3¾	4	4¼	4½	4¾	5¼	5½	5¾	6¼	6¾	7	7¼

1,200 Pounds Cold Water Working Pressure—Hydrostatic (no shock)
800 Pounds Cold Water Working Pressure—Shock
1,200 Pounds Air or Gas Working Pressure—Temperature Not Exceeding 100 Degrees Fahrenheit

These fittings are recommended for pump columns, oil-transmission lines, gas lines and other hydraulic service where shock is negligible for a maximum working pressure of 1,200 pounds and a maximum temperature of 100 degrees Fahrenheit. Where subject to shock, they are recommended for a maximum working pressure of 800 pounds.

The diameter of port is approximately the same as the inside diameter of extra strong pipe.

Reducing fittings carry the same dimensions center to face as straight-size fittings corresponding to largest opening.

Flanges may be attached to the pipe by any of the following methods: Screw flanges; lap flanges; shrunk, peened or riveted flanges; flanges welded to pipe.

Flanges on fittings and valves, also all companion flanges except those for lap joint, should be furnished with ¼-inch raised face, as shown in dimension table, Fig. 2, unless otherwise specified.

Bolt holes are ⅛ inch larger in diameter than bolts. Bolt holes straddle center lines. Unless otherwise specified, bolt holes in cast-steel fittings should be spot-faced.

Square-head bolts with hexagonal nuts are recommended. Hexagonal nuts on sizes 8 inches and smaller can be conveniently pulled up with open-end wrenches with minimum-design heads. Hexagonal nuts on sizes 9 inches and larger can be conveniently pulled up with box wrenches.

When flanges are screwed, shrunk, peened or riveted on the pipe, it is recommended that the end of the pipe and flange be refaced.

Gaskets extending from the inside of the pipe to the inside edge of the bolts are recommended. The ultimate compressive strength of the gasket must be sufficient to prevent its being crushed when the bolts are pulled up.

Where long-radius elbows are desired, the use of pipe bends is recommended.

TABLE 4.—3,000-POUND HYDRAULIC AMERICAN STANDARD FLANGES AND FLANGED FITTINGS, 12 INCHES AND SMALLER, FOR DOUBLE EXTRA STRONG WROUGHT PIPE. CAST STEEL.
(See Fig. 1.)

See Fig. 1	Size	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	6	7	8	9	10	12
A	Inside diameter of port	3/8	1/2	3/4	15/16	1 1/4	1 1/2	1 7/8	2 1/4	2 3/4	3 1/4	3 3/4	4 1/4	4 1/4	5 3/4	6 3/4	7 5/8	8 3/4	10 3/4
B	Center to face, ell, tee, cross	3 1/2	4	4 1/2	5	5 3/4	6 1/2	7	7 1/2	8 1/2	9	10	11	12	13	14 1/2	15 1/2	16 1/2	17 1/2
C	Face to face, tee, cross, reducer	7	8	9	10	11 1/2	13	14	15	17	18	20	22	24	26	29	31	33	35
D	Center to face, 45-deg. ell	2 1/2	3	3 1/2	4	4 1/4	4 1/2	5	5 1/2	6	6 1/2	7	7 1/2	8	8 1/2	9	9 1/2	10	11
E	Center to face, lateral	7	8	9	10	11	12 1/2	13 1/2	14 1/2	16 1/2	17 1/2	19 1/2	21	22 1/2	24 1/2	27 1/2	29 1/2	31 1/2	34 1/2
F	Center to face, lateral	2	2 1/2	2 1/2	3	3 1/2	3 1/2	4	4 1/2	4 1/2	5 1/2	6	6 1/2	6 1/2	7	7 1/2	8	8 1/2	9
G	Face to face, lateral	9	10 1/2	11 1/2	13	14 1/2	16	17 1/2	19	21	23	25 1/2	27 1/2	29	31 1/2	35	37 1/2	40	43 1/2
H	Diameter of flange	4 1/4	4 3/4	5 1/2	6	6 3/4	8	8 1/2	9 1/2	10 3/4	11 1/2	13	14	15	16 1/2	18 1/2	20	21 1/2	24
K	Thickness of flange	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2	1 5/8	1 7/8	2	2 1/8	2 1/4	2 3/8	2 1/2	2 3/4	2 7/8	3	3 3/8
L	Diameter of raised face	7/8	1 1/16	1 5/16	1 11/16	1 15/16	2 3/8	2 7/8	3 1/2	4	4 1/2	5	5 9/16	6 5/8	7 5/8	8 3/4	9 3/4	10 3/4	12 3/4
M	Height of raised face	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4	1/4
N	Minimum metal thickness	7/16	1/2	1/2	9/16	9/16	5/8	3/4	7/8	1	1 1/16	1 3/8	1 1/2	1 5/8	1 3/4	1 7/8	2	2 1/8	2 3/8
	Diameter of bolt circle	3	3 3/8	4	4 3/8	4 7/8	6	6 1/2	7 1/2	8 1/2	9 1/4	10 1/2	11 1/2	12 1/2	13 3/4	15 1/2	17	18 1/2	21
	Number of bolts	4	4	4	4	4	4	8	8	8	8	8	8	12	12	12	16	16	20
	Diameter of bolts	1/2	5/8	5/8	3/4	7/8	7/8	7/8	1	1	1 1/8	1 1/4	1 1/4	1 1/4	1 3/8	1 1/2	1 1/2	1 1/2	1 1/2
	Length of bolts	2 1/4	3	3 1/4	3 3/4	4	4 1/4	4 1/2	5	5 1/2	6	6 1/4	6 1/2	6 3/4	7 1/4	7 3/4	8	8 1/4	8 1/2

3,000 Pounds Cold Water Working Pressure—Hydrostatic (no shock)
2,000 Pounds Cold Water Working Pressure—Shock
3,000 Pounds Air or Gas Working Pressure—Temperature Not Exeeding 100 Degrees Fahrenheit

These fittings are recommended for hydraulic service where shock is negligible for a maximum working pressure of 3,000 pounds and a maximum temperature of 100 degrees Fahrenheit. Where subject to shock, they are recommended for a maximum working pressure of 2,000 pounds.

The diameter of port is approximately the same as the inside diameter of double extra strong pipe.

Reducing fittings carry same dimensions center to face as straight-size fittings corresponding to largest opening.

Flanges may be attached to the pipe by either of the following methods: Screw flanges; flanges welded to pipe.

Flanges on fittings and valves should be furnished with 1/4-inch raised face, as shown in dimension table, Fig. 3, unless otherwise specified.

Screw flanges are furnished with plain face and are threaded with American Briggs Standard lock-nut threads. The pipe should be threaded with American Briggs Standard lock-nut threads, and the end of the pipe should be faced off square. The pipe should be screwed through the flange until the end projects about 1/4 inch beyond the face of the flange and bears against the gasket.

When flanges are welded on the pipe, the end of the pipe should project through the flange and should be faced off square to form the raised face.

Bolt holes are 1/8 inch larger in diameter than bolts. Bolt holes straddle center lines. Unless otherwise specified, bolt holes should be spot-faced.

Square-head bolts with hexagonal nuts are recommended. Hexagonal nuts on sizes 5 inches and smaller can be conveniently pulled up with open-end wrenches with minimum-design heads. Hexagonal nuts on sizes 6 inches and larger can be conveniently pulled up with box wrenches.

Gaskets extending from the inside of the pipe to the inside edge of the bolts are recommended. The ultimate compressive strength of the gasket must be sufficient to prevent its being crushed when the bolts are pulled up. Soft metallic gaskets at least 1/16 inch thick are recommended.

Where long-radius elbows are desired, the use of pipe bends is recommended.

400 pounds steam pressure and not exceeding 250 degrees superheat, the 800-Pound Hydraulic American Standard in steel is adequate.

These recommendations bring the work of the committee up to date so far as any requests that they have before them for consideration are concerned.

Flues—III

Method of Removing and Replacing a Set of Flues in a Locomotive Boiler—Work Done in the Roundhouse

BY GEORGE L. PRICE

I will now explain the different operations we go through in removing a set of flues and replacing same. I am speaking of a set to be removed and replaced in the roundhouse.

Removing and Replacing Flues

The boiler maker cuts off the beads in the firebox while the helper is engaged in removing the front end appurtenances. After the beads are cut off in the firebox and the front end is removed, the boiler maker and helper cut the flues off in the front end with a large air motor. We have a substantial rigging to hold this motor. The boiler maker operates the air motor and the helper changes the flue cutter from one flue to the other as fast as they are cut.

After the flues are cut in the front end, the boiler maker locates the large hole in the front flue sheet and cuts out the burr. Most all of our engines have a large hole in the front flue sheet, about 2 1/4 inches in diameter, through which we remove all the flues from the boiler.

The day of removing the steam pipes, or dry pipe, from the front end to facilitate the removal of a set of flues, is past. This enlarged hole is located about four rows high in the center row of the sheet. The boiler maker then goes to the back end of the firebox with his small air hammer, and a heavy square tool for same, while the helper stays in the front end. I consider the air hammer ideal for knocking flues out of their holes in the firebox.

After the flues are removed the boiler maker takes his air gun to the front end and cuts out the burrs while the helper is cleaning the loose scale and dirt out of the boiler. When the front end burrs and loose scale have been removed, the boiler maker and helper go to the firebox end with an air motor and ream out the back flue sheet holes.

After this operation is finished the boiler maker files the holes in the back flue sheet while the helper files the holes in the front flue sheet. Then the boiler maker puts in his coppers while the helper scales the interior of the boiler; the dome cap has been removed in the meantime so as to give access to the interior of the boiler.

Putting in Copper Ferrules

We use the expander when putting in coppers. I am of the opinion that the expander is the proper tool to use for this operation, as it does not take the life out of the coppers as a roller will sometimes do when the copper is rolled hard to accommodate the swedged end of a flue. After the coppers are in and the boiler scaled, we then take the length of the flues. The helper remains in the interior of the boiler and guides the flue stick from hole to hole while the boiler maker marks the different lengths on the front flue sheet.

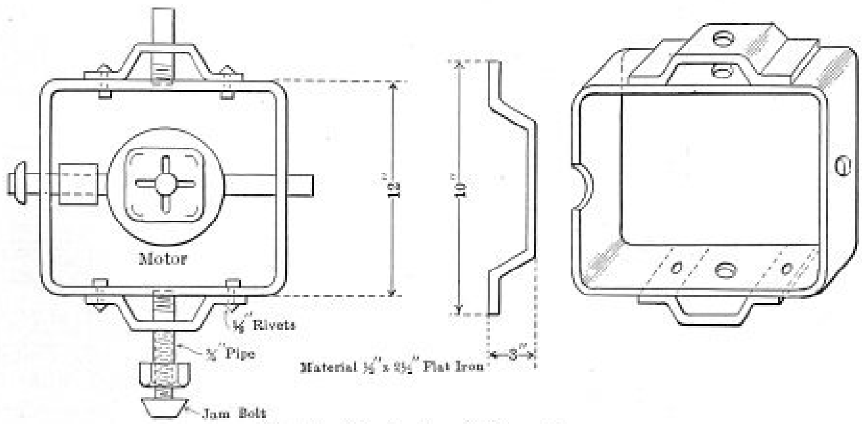


Fig. 9.—Rigging for Rolling Flues

We now proceed to cut off the flues. While the boiler maker and helper are engaged in this operation, the boiler washers are washing out the boiler. Having cut off the flues, they are taken to the front end of the engine by the laboring gang, where they are deposited at the engine and the helper arranges the flues according to lengths as they come on the sheet; or, in other words, he arranges them so that the different lengths will be handy when needed.

Entering the Flues

While he is arranging his flues, the boiler maker makes a thorough inspection of the boiler's interior. After this has been completed, we shove in the flues. The helper handles the flues in the front while the boiler maker goes in the boiler and enters them in the back flue sheet until the set is about one-half in, then the boiler maker goes to the firebox to complete this operation.

Some of you readers may ask why does the boiler maker go inside of the boiler to enter the flues? The reason for this is, on account of the steam pipes being left in the front end. There are about forty or fifty flues that will not pass the steam pipes, so we have to transfer them from one hole to another until they are in their proper places. This operation can be done much easier from the interior of the boiler by running them back into the water space and then entering them in their proper places in the front sheet.

When the flues are all run in, we pin them out with the mandrel pin, using the big air hammer. We pin them just enough to get the rollers into the flues. When we have finished pinning the flues in the firebox end, we set up a rigging to hold the air motor so that we can roll the flues in the firebox first.

The helper goes to the front end with a bar which he puts into the flue which is to be rolled, and sits on the bar to keep the flue from turning until it is rolled tight into the hole. He then takes his bar out of the flue and with the end of it he bumps the next flue to be rolled until he is told to stop by the boiler maker. The boiler maker allows the flue to come in just enough for bead. He then puts his rollers into the flue and turns on the air. Most generally the flue will be drawn in by the rolls during the rolling operation, but the boiler maker stands with his hammer in his hand ready to tap the flue back just before it becomes tight in the hole. Consequently, we set our flues and roll them at the same time.

Flues Set and Rolled at Same Time

I would not advise a novice to try this method of setting flues, as he would be sure to have all kinds of lengths for beads. A mechanic may experience a little trouble with this method for the first five or six flues; after which he can handle it all right. I forgot to state that we do not shut off the air or take the rollers out of the flue to knock the flue back. We just tap the cage of the roller with a hammer while it is turning in the flue, and the flue goes back very easily, providing you do not wait until the flue has been rolled too tight, as this is the critical part that requires the experience of a mechanic.

Quite a little time is gained by this method. However, on the other hand, I would not advise this method if your flues fit too tightly, because you would be compelled to hit your rollers hard to move the flue back, which would be dangerous. Besides, a tight flue will not creep to any noticeable extent, so that the helper could bump them into the required length and the flue would not move during the rolling operation.

Having completed rolling the flues in the firebox, we take the rigging down and move it around to the front end. But the helper does not put the rigging up until he has shimmed and pinned out the flues in the front end (Fig. 9). While the boiler maker is belling out the flues in the firebox end with the big air hammer and expanding same, the helper is shimming and pinning out the flues in the front end, and, when the boiler make is calking the flues in the back end, the helper is rolling the flues in the front end. The boiler maker and the helper finish this work at about the same time.

Testing the Boiler

The boiler is then tested and the helper holds a light in the end of each flue in the front end, while the boiler maker looks through each flue from the firebox end. We apply a test pressure of twenty-five percent above the working pressure, and make this inspection while the boiler is under pressure. Some of you readers may think it is not necessary to look through each flue when making the inspection, as a burst flue will run water out of one end or the other. Of course a burst flue will do that, but oftentimes we find a defective flue where the water will just ooze out slightly in the weld while the boiler is at its maximum pressure. The leakage is so slight that it will not run out of the flue ends yet the flue is defective and should be removed.

Having spotted all defective flues, we shut down the pressure, drain the boiler, remove the defective flues and then replace same with good ones. This completes our manipulations as far as the removing and replacing of a set of flues is concerned, and I would be pleased to read the experiences of others along this line.

After the flues are removed from the boiler they are taken to the rattler and rattled. Some rattlers hold a full set; some, one-half a set and others one-quarter of a set. Some railroad companies rattle their flues in water with a barrel or two of old bolts, nuts and other pieces of scrap iron thrown into the rattler to hasten the removal of scale and dirt from the flues. Other companies use a dry rattler. I prefer the water rattler, as it is not so noisy and is generally a time saver. It generally takes from twenty to forty minutes to clean a rattler full of flues.

I think a serious mistake is made by rattling flues for any extended period of time, as I consider the rattler a progressive agent in thinning out flues. In other words I have seen flues that have been rattled to death.

When the flues come from the rattler they are piled on flue horses near the cutters and the old coppers are knocked off of the ends. Then they are placed in the cutters and crop ends are cut off. They are then taken to the flue fire and the end to be welded is heated and belled out ready to receive the safe ends. The safe ends are then welded on in lengths from six, eight or ten-inch pieces, as may be required for the proper length of the flue. The safe end is also annealed after the welding process; also the smoke box end.

Annealing

In some shops the annealing is all done at once; that is, the entire set is loaded on an iron flue car and the car pushed into an annealing furnace—one end of the car at a time. After the annealing process, the flues are tested by water pressure and the defective flues thrown out.

In a great many shops, especially the larger ones, the methods of handling and working flues are possibly more advanced than we are using at present, and, while I may have some of these advanced ideas in mind, yet I am not in a position to finance a proposition that may expedite or lessen the cost of production, because promoting entails additional expense to first cost, and first cost looks bad on paper, especially to gentlemen who furnish the money; *so what's the use!*

However, I am still going to say something more about flues. When sorting out flues that come from the rattler or flue pile, I am of the opinion that all old flues should be weighed, and each flue should weigh about one and one-third pounds to the foot, and a flue lighter than this should be thrown out. It is not necessary to throw this flue away altogether but lay it aside to be cut up into lengths and used in your pump house boilers that carry a low steam pressure.

This method would eliminate all thin light pitted flues, and also reduce the chances of engine failures.

Reclaiming of Flues

Another item that I consider ideal for railroad companies to adopt is the reclaiming of flues. With this process it is possible to save thousands of dollars each year, and I am told that an eastern railroad up to January 20, 1915, reclaimed 22,565 two-inch tubes averaging from 16 to 21 feet in length, making a saving to them of about $33,847.50. Something worth investigating, don't you think? The process involved is as follows:

THREE TO FIVE FOOT SAFE ENDS WELDED TO OLD, SHORT TUBES
TUBES - 2" O.D. No. 11 B.W.G.
LOAD PER SQ. IN.

LINE No.	TUBE No.	KIND OF TEST TUBE	WELDING MACHINE USED	ACTUAL LOAD		ELASTIC LIMIT	TENSILE STRENGTH	ELONGATION IN 8 INCHES		WHERE BREAK OCCURED	CROSS SECTION OF BREAK	[illegible] WITHOUT WELD TAKEN AT [illegible] LBS. PER SQ. IN. FOR 100 PER CENT
				ELASTIC LIMIT LBS.	BREAKING LIMIT LBS.	LBS. PER SQ. IN.	LBS. PER SQ. IN.	ACTUAL INCHES	PER CENT			
37	1	OLD STEEL TUBE WELDED TO OLD STEEL TUBE WAS 8 TO 10 PER CENT BELOW WEIGHT	PNEUMATIC	14970	26910	23460	42184	.74	9.25	IN WELD (LONG LAP)		93.7
38	2	OLD STEEL TUBE WELDED TO OLD STEEL TUBE WAS 8 TO 10 PER CENT BELOW WEIGHT	"	21550	23490	33781	36823	.1	1.25	PULLED APART IN WELD		81.8
39	3	NEW STEEL TUBE WELDED TO OLD IRON TUBE	"	18250	29460	25747	41563	.68	8.5	AT EDGE OF WELD		92.4
40	4	NEW STEEL TUBE WELDED TO OLD STEEL TUBE	"	19780	31260	27906	44103	.56	7.0	AT EDGE OF WELD		98.0
41	5	OLD STEEL TUBE WELDED OLD AND VERY LIGHT STEEL TUBE WAS 10 PER CENT BELOW WEIGHT	"	15890	26490	24909	41525	1.26	15.85	2½" FROM WELD (IN THIN TUBE)		92.3
42	6	OLD IRON TUBE WELDED TO OLD STEEL TUBE	"	15400	26840	21726	37867	1.08	13.5	2" FROM WELD		84.1
43	7	OLD STEEL TUBE WELDED OLD AND VERY LIGHT STEEL TUBE, NO SCARF	"	16740	25040	23617	35327	.44	5.5	IN WELD		78.5

Fig. 10.—Results of Tests of Reclaimed Tubes

Take tubes from the scrap, clean them thoroughly in a rattler, cutting off all bad ends, then weigh them to find out if they are of sufficient weight to stand reclaiming. The usual practice is to make two good flues out of three old ones. By that I mean if there are twelve or thirteen feet of good flue, every third flue could be cut in the middle and this would supply material to lengthen the other two to eighteen feet each.

The Draper Manufacturing Company has made a test of two-inch outside diameter No. 11 B. W. G. tubes that are considered reclaimed tubes. The results of this test will be seen in Fig. 10. If I have been correctly informed, some time ago the question arose as to whether or not welded tubes were strong enough to stand the requirements as handed down by the Government boiler inspection laws. Or I may state it in this manner. There seemed to be some doubt in the mind of the chief boiler inspector, in regard to the strength of welded tubes as being sufficient for their everyday use under varying conditions to which they are subjected, so, in the interests of safety, a test was made showing the comparison of strength between a new tube and an old one.

(To be continued.)

Boiler Power Versus Tractive Power—III

Formula for Horsepower of Locomotive—Evaporative Value—Steaming Capacity—Rate of Combustion—Where Heat Losses Occur

BY WILLIAM N. ALLMAN

Formula for Horsepower of Locomotive

$$H.P. = \frac{P\,L\,A\,N}{33{,}000}. \qquad \text{(Formula 9)}$$

Where

P = mean effective pressure = (.85 × boiler pressure).
L = length of stroke in feet = $s \div 12$.
A = area of cylinder = $\frac{1}{4}\pi d^2$.
d = diameter of cylinder in inches.
s = stroke in inches.
N = number of strokes per minute, or 2 × revolutions per minute for one side, or 4 × revolutions as a total = 4 revolutions per minute.

$$R.P.M. = \text{Revolutions per minute} = \frac{\text{miles per hour} \times 5{,}280}{60 \times \text{circumference of drivers in feet}}.$$

D = diameter of drivers in inches.
S = stroke of cylinders in inches.
$\pi D/12$ = circumference of drivers in feet.

Substituting above values in formula 9, we have:

$$H.P. = \frac{.85 \times P \times S/12 \times \frac{1}{4} \times \pi \times d^2 \times 4\,(M.P.H.) \times 5{,}280}{33{,}000 \times 60 \times \pi \times D/12}. \qquad \text{(Formula 11)}$$

Simplifying, we have:

$$H.P. = \frac{.85 \times d^2 \times P \times S \times M.P.H.}{375 \times D}. \qquad \text{(Formula 11)}$$

Assuming the maximum speed to equal the diameter of the drivers in inches, $M.P.H. = D$, then formula No. 11 becomes, by cancellation,

$$H.P. = \frac{.85 \times P \times d^2 \times S}{375}. \qquad \text{(Formula 12)}$$

It is, therefore, evident that the horsepower is equal to the tractive power multiplied by the speed in miles per hour divided by 375.

Evaporative Value

It may be interesting to note the following results in Table 4, which were obtained from the Jacobs-Shupert tests a few years ago, at which time it was found that the evaporating quality of the firebox is of much higher value per square foot than that of the tubes:

TABLE 4

	Fuel.	
	Oil.	Coal.
	Pounds	Pounds
Evaporation per square foot of heating surface per hour for the entire boiler	9.78	11.77
Evaporation per square foot of heating surface per hour for the firebox only	49.59	51.92
Evaporation per square foot of heating surface per hour for the tubes only	6.47	8.43
Ratio of heat absorbed per square foot of heating surface of firebox to tube heating surface	7.6 to 1	6.15 to 1
Water evaporated per hour by firebox	16000	11982
Water evaporated per hour by tubes	24000	23423
Total water evaporated per hour	40000	35405
Horsepower developed in firebox	500	304
Horsepower developed in tubes	700	722
Total horsepower developed	1200	1026

In connection with tests that have been made on evaporative value of tubes it has been found that about one-half of the heat is taken up by the first quarter of the tube length. The use of exceptionally long tubes is, therefore, not altogether efficient. While the evaporative capacity of the boiler may be increased by the longer tubes, the rate of evaporation per unit of area is lower. There is quite a variation in practice as regards the ratio of tube length to the diameter, which ranges from about 91 to 126 times the internal diameter, and in one of the recent reports to the Master Mechanics Association it was stated that 100 times the internal diameter seems to give the best results.

Steaming Capacity

The steaming capacity of the locomotive as generally referred to is the ratio as between the maximum evaporation of the boiler in pounds per hour to the weight of water consumed by the cylinders in the same unit of time.

It has been shown by tests made on a number of occasions that steam is drawn from the boiler at the rate of 25 to 30 pounds per horsepower per hour, and that an evaporation of 12 to 15 pounds of water per square foot of heating surface per hour is attained, these values being for saturated steam, and for superheated steam the rate of steam drawn from the boiler being about 25 percent less.

It will then be evident that the efficiency of the boiler may be determined as follows:

If 1,000 horsepower is continuously developed by the cylinders, the rate of steam being 27 pounds per horsepower per hour, the total evaporation of the boiler must be at the rate of 1,000 × 27, or 27,000 pounds per hour. If the boiler has 2,500 square feet of heating surface, and it is assumed that each square foot of heating surface is capable of evaporating on an average of 13.5 pounds of water per hour, then the maximum capacity of the boiler is 2,500 × 13.5, or 33,750 pounds per hour. Therefore the steaming capacity would be:

$$\frac{33{,}750}{27{,}000} = 1.25,$$

or, in other words, the boiler has a capacity for evaporating 25 percent more water than is used by the cylinders.

Table 5 will be found convenient for calculating the weight of steam used in cylinders and covers ranges of pressures from 160 to 220 pounds and the maximum velocity at which full cutoff can be maintained can be determined by dividing the pounds of steam produced in a minute by the quantity of steam per revolution of the drivers. Dividing this by the factor obtained from formula 12 will give the speed in miles per hour at which full cutoff can be maintained.

$$C = \frac{336.13}{\text{Diameter of drivers}} \qquad \text{(Formula 12)}$$

In arriving at the steam-producing capacity of a locomotive boiler it was also suggested by the American Railway Engineering and Maintenance of Way Association a few years ago to compute same on the basis of the values as contained in Table 6. The values in this table are based on feed water at an average of 60 degrees F. and boiler pressure of 200 pounds and covers a range of various ratios of heating surface to grate areas. The quantity and quality of fuel burned is, of course, a factor in the steam production, and, by knowing the grate area and heating surface, the average steam production of locomotive boilers burning bituminous and other coals can readily be estimated from Table 6, assuming 4,000 pounds of coal as the maximum quantity that can be properly fired per hour.

Rate of Combustion

As stated in chemistry, each pound of fuel is capable of giving out a certain number of heat units. It is evident, therefore, that the more rapid the combustion the greater the amount of heat produced in a given time. In stationary boilers where the size of the rate is practically unlimited the rate of combustion per square foot of grate area is from 15 pounds to 25 pounds per hour. In locomotives, with the limited grate area available, this rate is many times exceeded, rising at times to as much as 200 pounds per hour. This rapid combustion results in a great loss of heat and a fall in the amount of water evaporated per pound of coal. It has been shown that when coal is burned at the rate of 50 pounds per square foot of grate per hour, 8¼ pounds of water may be evaporated for each pound of coal; while, if the rate of combustion is increased to 180 pounds per square foot of grate area, the evaporation will fall to about 5 pounds, a loss in water evaporation per pound of coal of nearly 40 percent. This loss may be due to a failure of the heating surface to absorb properly the increased volume of heat passing over them or to the imperfect combustion of the fuel on the grate, or it may be due to a combination of these causes.

The results of experiments show that, in general, the most efficient furnace action accompanies the lowest rates of combustion, and enforce the general conclusion that very high rates of combustion are not desirable, and, consequently, that the grate of a locomotive should be made large so that exceptionally high rates will not be necessary.

With high rates of combustion the loss of sparks is very serious and may equal in value all the other losses occurring at the grate.

Fig. 3 is a diagram representing the losses that occur due to an increase in the rate of combustion. The line *A-B* shows the amount of water evaporated per pound of coal for the various rates of combustion. Thus with a rate of 50 pounds per square foot of grate per hour, 8¼ pounds of water are evaporated. When the rate of combustion is raised to 175 pounds, only about 5⅓ pounds of water are evaporated. If it could be assumed that the heat developed in the furnace would be absorbed with the same degree of completeness for all rates of combustion, the evaporation would rise to the line *A-C*; if, in addition to this, it could be assumed that there were no spark losses, the evaporation would rise to the line *A-D*; finally, if, in addition to these, it could be assumed that there were no losses by the excessive admission of air or incomplete combustion, then the evaporation would remain constant for all rates of combustion, and would be represented by the line *A-E*.

That is, with the boiler under normal conditions, the area *A D C* represents the loss occasioned by deficient heating surface, the area *A C D* that occasioned by spark losses, and the area *A D E* that occasioned by excessive amounts

TABLE 5—WEIGHT OF STEAM USED IN ONE FOOT OF STROKE IN LOCOMOTIVE CYLINDERS

Cylinder Diameter is for High-Pressure Cylinders in Compound Locomotives

Diameter of Cylinder in Inches	Weight of Steam per Foot Stroke for Various Gage Pressures						
	220 Lbs.	210 Lbs.	200 Lbs.	190 Lbs.	180 Lbs.	170 Lbs.	160 Lbs.
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
12	0.405	0.389	0.370	0.354	0.337	0.321	0.304
13	0.475	0.456	0.435	0.415	0.396	0.376	0.357
14	0.551	0.529	0.504	0.482	0.459	0.436	0.414
15	0.633	0.607	0.579	0.553	0.527	0.501	0.476
15½	0.675	0.649	0.618	0.590	0.562	0.535	0.508
16	0.720	0.691	0.658	0.629	0.599	0.570	0.541
17	0.812	0.780	0.744	0.710	0.676	0.643	0.611
18	0.911	0.875	0.834	0.796	0.759	0.722	0.685
18½	0.962	0.924	0.881	0.841	0.801	0.762	0.724
19	1.015	0.975	0.928	0.887	0.845	0.804	0.763
19½	1.069	1.027	0.978	0.934	0.890	0.847	0.804
20	1.125	1.080	1.029	1.983	0.936	0.891	0.846
20½	1.181	1.134	1.081	1.032	0.984	0.936	0.888
21	1.240	1.191	1.134	1.083	1.032	0.982	0.932
22	1.361	1.037	1.245	1.189	1.133	1.078	1.023
23	1.487	1.428	1.361	1.300	1.238	1.178	1.118
28	2.204	2.117	2.017	1.926	1.835	1.745	1.657

For weight of steam used per revolution of drivers at full cut-off: Multiply the tabular quantity by four times the length of stroke in feet for simple and four-cylinder compounds. For two-cylinder compounds multiply by two times the length of stroke.

TABLE 6—AVERAGE HOURLY EVAPORATION PER 1,000 FEET OF HEATING SURFACE FOR VARIOUS RATIOS OF HEATING SURFACE TO GRATE AREA AND FOR VARIOUS RATES OF FUEL CONSUMPTION BASED ON USE OF BITUMINOUS COAL TESTING 15,000 B. T. U. PER POUND.

Ratio.	Pounds Coal per Square Foot Grate Area per Hour										
	60	70	80	90	100	110	120	130	140	150	160
R = 50	8136	8965	9690	10324	10879	11365	11790	12162	12487	12771	13020
R = 55	7697	8480	9165	9764	10288	10747	11149	11501	11809	12079	12314
R = 60	7295	8037	8686	9254	9751	10186	10567	10900	11191	11446	11669
R = 65	6913	7617	8233	8772	9244	9657	10018	10334	10610	10852	11064
R = 70	6566	7234	7818	8329	8776	9167	9509	9808	10070	10299	10500
R = 75	6238	6874	7430	7917	8343	8716	9042	9327	9576	9794	9985
R = 80	5939	6542	7070	7532	7936	8289	8598	8868	9104	9311	9492
R = 85	5677	6255	6761	7204	7591	7930	8227	8487	8714	8912	9085
R = 90	5440	5993	6477	6900	7270	7594	7878	8126	8343	8533	8699
R = 95	5211	5471	6205	6611	6966	7277	7549	7787	7995	8177	8336

Above table assumes feed water at average of 60° F. and boiler pressure 200 pounds.
For 160 pounds boiler pressure approximately one-half percent greater quantity would be evaporated.
For coal of different thermal value than 15000 B. T. U. multiply tabular amounts by following decimals

14,500 B. T. U. 0.967
14,000 B. T. U. 0.933
13,500 B. T. U. 0.900
13,000 B. T. U. 0.867
12,500 B. T. U. 0.833
12,000 B. T. U. 0.800
11,500 B. T. U. 0.767
11,000 B. T. U. 0.733
10,500 B. T. U. 0.700
10,000 B. T. U. 0.667

of air as well as by imperfect combustion in the firebox.

The efficiency of the locomotive, from the standpoint of water evaporated per pound of coal, falls off as the rate of combustion per square foot of grate area is increased.

LOSS OF HEAT

In passing, it will not be amiss to state that there are losses due to radiation and loss of heat in products of combustion. Table 7 shows results of tests made on the testing plants at St. Louis and Altoona, Pa.

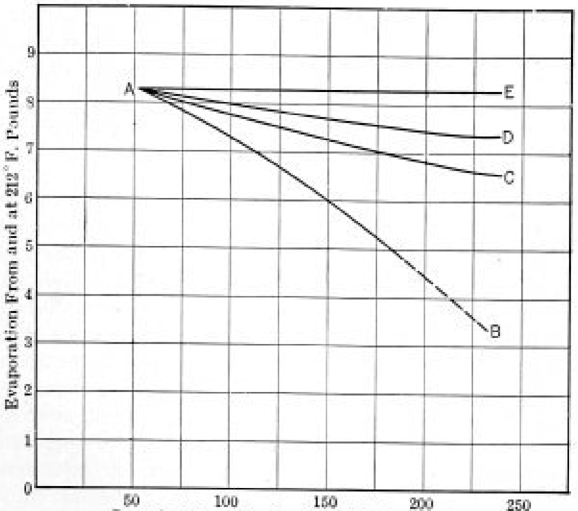


Fig. 3.—Diagram Showing Losses That Occur Due to Increase in Rate of Combustion

TABLE 7

	ST. LOUIS	ALTOONA
The loss by CO increases	From a trace up to about 2 percent	From 0.4 to 2.4 percent.
Loss of heat in the gaseous products of combustion decreases	From about 18 percent to about 11 percent	From 18 percent to 15 percent.
The boiler efficiency decreases	From about 74 percent to about 43 percent	From about 68 percent to 52 percent.
Efficiency of absorption of heat, or absorption of heat by heating surface of heat produced by combustion	81 percent	79 percent.

From some recent tests made by the experiment station of the University of Illinois, as covered in circular No. 8, it developed that losses may be summed up as shown in Table 8, and it is also shown what distribution of the power there is. The largest loss of heat is that which is exhausted by the cylinders and passes out through the stack.

TABLE 8

	Percent
Heat in exhaust steam	52.0
Used by steam auxiliary apparatus	6.0
Usefully applied as work at drawbar	6.0
Loss to heat in gases	14.0
Loss to ash pan	4.0
Loss to cinders	8.0
Loss by radiation	5.0
Loss to unburned gases and soot	4.0
Loss due to locomotive friction	1.0
Total	100.0

CONCLUSIONS

The efficiency of the boiler is not altogether a question of heating surface. For example, a boiler may be so crowded with tubes as to hinder circulation, with the consequence that there is a reduction in the evaporation per square foot of heating surface in a unit of time. The percentage of area of boiler occupied by the tubes is not only dependent upon the spacing of the tubes, but also upon the relative position of the crown sheet with regards to the top of the boiler. For instance, in a wagon-top design the crown sheet can be placed relatively higher than in the straight-top type of boiler; consequently, the wagon-top type shows a larger percentage of the area covered by the tubes, and upon checking into a number of designs the percentages run as follows:

	Minimum.	Maximum.	Average.	Majority Running Between
	Percent.	Percent.	Percent.	Percent.
Wagon-top type	24	40	32	29 to 35
Straight top	21	35	28	25 to 33

There have been quite a number of reports made on the use of superheaters with reference to the economy resulting from their use, and from reliable data it has been found that a saving of 15 to 25 percent in fuel and 20 to 30 percent in water consumption can be realized in everyday operation through the use of superheater and brick arch. While the cost of maintenance is higher with superheaters, this is more than offset by the saving of fuel and water.

How to Design and Lay Out a Boiler—VIII

Problems Involved in Design and Layout of Tube Sheet—Location of Manhole—Spacing of Tubes—Types of Braces

BY WILLIAM C. STROTT*

With the foregoing facts in mind, the designer should always endeavor to get as much space between the top row of tubes and the shell as possible. Of course increasing the height of this segment, as it is termed, increases its area also. Consequently, the greater this area, the more braces are required to stay it. This matter, however, represents increased first cost, and the competitive boiler manufacturers make it their business to keep production costs down to a minimum.

It is not, however, the purpose of this treatise to deal with the design of "cheap" boilers, but rather boilers that will be inductive of the highest possible results while in service, both as regards their safety as pressure vessels and their efficiency as steam generators.

Horizontal return tubular boilers 48 inches in diameter and over *must* have a manhole in the front head below the

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

tubes; smaller boilers may have a manhole, or a handhole. Manholes may be either circular or elliptical in shape, and, as the latter form is more economical in space and serves its purpose satisfactorily, it has become the standard. The minimum dimensions allowed for such manholes are either 11 inches by 15 inches or 10 inches by 16 inches in the clear. We shall adopt the 11-inch by 15-inch size.

A template of the manhole should be made in accordance with Fig. 25 and placed at the bottom of the drawing of the tube sheet. To permit of satisfactory flanging, a clearance of 3½ inches must be allowed from the inside of the manhole flange to the outside of the head. This gives a nominal dimension of 9 inches to the centerline of the manhole.

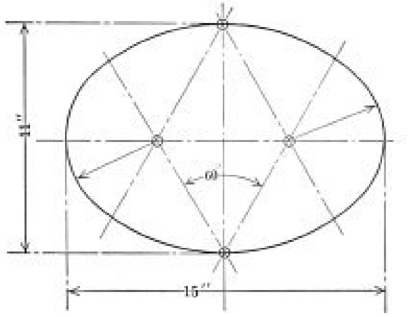


Fig. 25

A clearance circle should next be drawn in, not less than 2 inches from the outside of the head, and no tube hole should in any event go beyond this line. Of course the exact clearance in any case depends on the radius to which the flange is turned, and at least ¼ inch from the heel of the flange to the edge of the tube hole should be allowed. If any tubes should be just the least bit on the "round" of the flange, it will be difficult to properly expand them into place. Such tubes are also a source of leakage while in service, on account of the hinging action of the flange during expansion and contraction of the metal. This is also known to boiler operators as the "breathing action" of the heads. For the same reason just cited, another clearance line should be drawn 2 inches all around the manhole opening.

Then, after the through-rods are calculated, if their size is such that the nuts on same will not satisfactorily clear the tubes, the latter should be moved up. In short, it requires considerable skill to develop a good tube layout, but after a little practice the student should experience no difficulty in securing satisfactory initial arrangements.

With regard to the spaces between the vertical rows of tubes, the theory of water circulation in a boiler of this type must be appreciated. Fig. 26 illustrates graphically just how the circulation of water is propagated in a horizontal return tubular boiler, the arrows indicating the direction of the currents.

Since the largest volume of water passes up through the center of the vessel, the tubes at this point ought to be far enough apart so as not to impede the circulation. About 2 inches clear between the two central vertical banks of tubes is considered good practice, and the balance of the vertical rows should have not less than 1¼ inches clear space between them. For the spacing of the horizontal rows, 1 inch should be the minimum to prevent mud and scale from caking in between the tubes. After a boiler has been in service for some time, the tubes become coated with mud and scale, which narrows these passages still further. When the circulation is restricted, violent ebullition (boiling) is the result. The water at the bottom of the vessel nearest the fire on being generated into steam forces the water above it out into the steam space with a geyser-like action. This is termed "priming," and also results in very wet steam.

If the plate ligaments between the tube holes are made too small, there is grave danger of the plate breaking through during the punching process, although some boiler makers apparently fail to appreciate the enormous energy required to force a 3-inch or 4-inch diameter punch through the ordinary gages of plate. Tests have also proven that the plate ligament between the holes when *punched* out loses at least 12 percent of its original tensile strength. For this reason the *very best* boiler specifications demand that *all* holes be drilled from the solid plate (which refers to rivet holes also). This is a very expensive practice, however, and tests seem to show that punching does not injure the metal to a distance of more

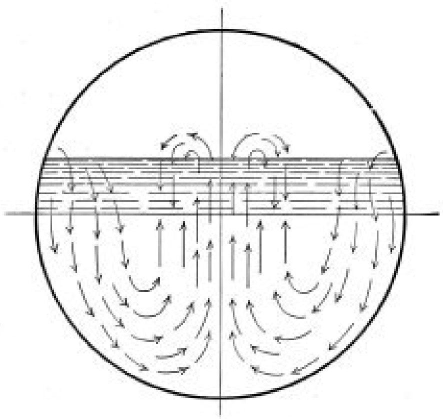


Fig. 26

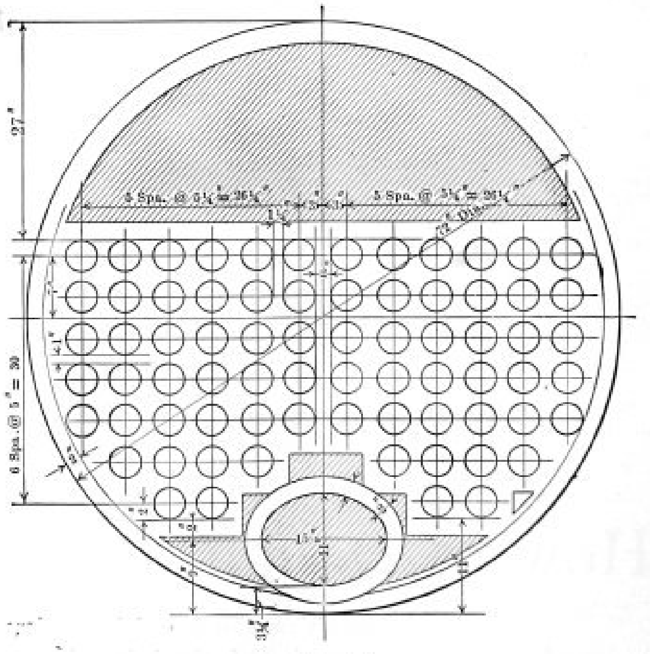


Fig. 27

Neither tubes nor braces are permitted to extend below the centerline of the manhole, as this space is reserved to permit free access into the boiler for the purpose of cleaning, inspection or repairs. The bottom row of tubes should not even be placed as low as the centerline of the manhole—first, to provide clearance for the nuts on the ends of the through-rods, and, second, and of still greater importance, because any tubes placed low in the shell have practically no value as effective heating surface. A good rule is to allow about 2 inches at least from the centerline of the manhole to the bottom of the lower row of tubes.

than ⅛ inch from the edge of the hole. The A. S. M. E. Code demands that tube holes be punched at least ½ inch small and reamed to size, and rivet holes punched ¼ inch small and reamed to size after assembling, with all parts bolted in place. This is an alternative to drilling from the solid plate.

Having drawn in the manhole and clearance lines, and bearing in mind the tolerations cited, it should now be a very simple matter to lay in the tubes. Due to the peculiarities of circulation currents as were indicated in Fig. 26, the tubes should be arranged in vertical and horizontal rows, no staggering being permitted. Fig. 27 is a tentative layout of the tubes. This may be subjected to a slight revision later, but for the present we shall base our calculations on the dimensions given.

The drawing shows that by having kept the tubes down as far as possible, and maintaining reasonable spacing, we have secured a steam space of 27 inches, being a gain of 3 inches over the usual practice. This may seem a trivial amount, considering the extra expense for bracing, but the improvement in steaming is very great and will make satisfactory returns on the extra initial cost. It should also not be overlooked that this arrangement has resulted in the addition of two more tubes, thereby giving the boiler considerable more heating surface, which means increased boiler horsepower.

We are now in a position to figure on bracing for the heads, and the segment above the tubes will first be provided for. The upper shaded portion of Fig. 28 is the area under consideration. It is found by the following formula, the letters referring to Fig. 28:

(3) $$A = \frac{4\,h^2}{3}\sqrt{\frac{2 \times r}{h} - 0.608}.$$

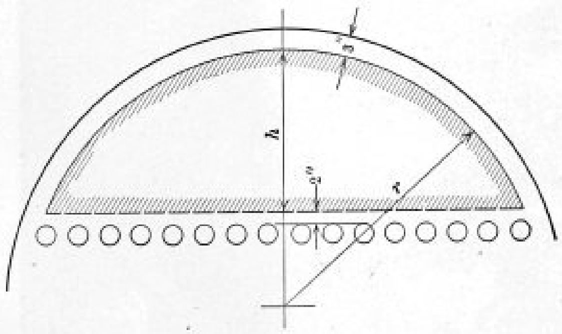


Fig. 28

It should be noticed that the entire area between the tubes and shell is not figured in, because the flange around the head has a certain value as a reinforcement, and is found by the following formula:

(4) $$d = \frac{5 \times T}{\sqrt{P}},$$

where d = unstayed distance from shell, in inches.
T = thickness of head in *sixteenths* of an inch.
P = maximum allowable working pressure in pounds per square inch.

If formula (4) gives a figure which is less than the outside radius of the flange, then the radius may govern, providing same does not exceed eight times the thickness of the head.

Substituting in formula (4), we get:

$$d = \frac{5 \times 9}{\sqrt{150}}, \text{ or } 3.67, \text{ say } 3\tfrac{5}{8} \text{ inches}$$

Also, the tubes, on account of their great holding power, are considered as supporting the plate 2 inches all around themselves. These allowances are clearly indicated in the figure, whence for our case,

h = 27 inches — ($3\frac{5}{8}$ inches + 2 inches), or $21\frac{3}{8}$ inches.
r = 36 inches — $3\frac{5}{8}$ inches, or $32\frac{3}{8}$ inches.

Substituting and solving formula, we get:

$$A = \frac{4 \times 21\frac{3}{8} \times 21\frac{3}{8}}{3}\sqrt{\frac{2 \times 32\frac{3}{8}}{21\frac{3}{8}} - 0.608}, \text{ or } 935 \text{ square inches.}$$

This value may also be obtained from table 7, which has been computed by means of formula (3).

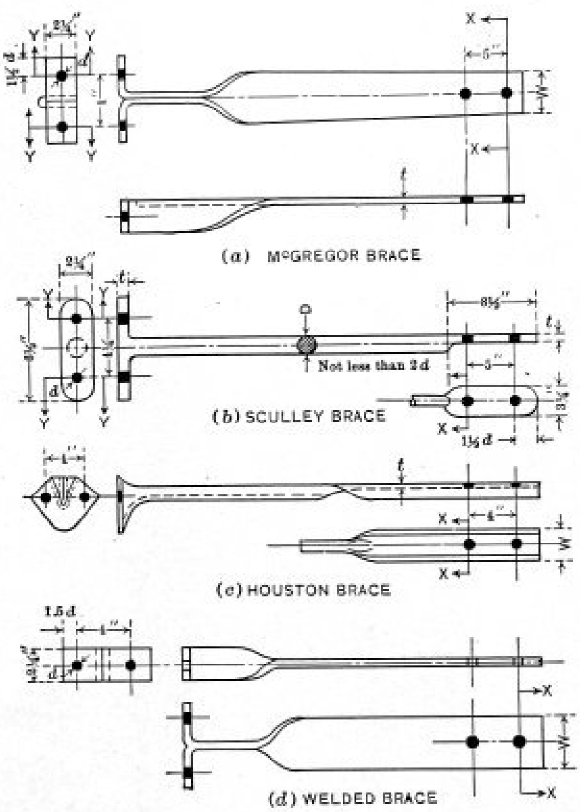


Fig. 29

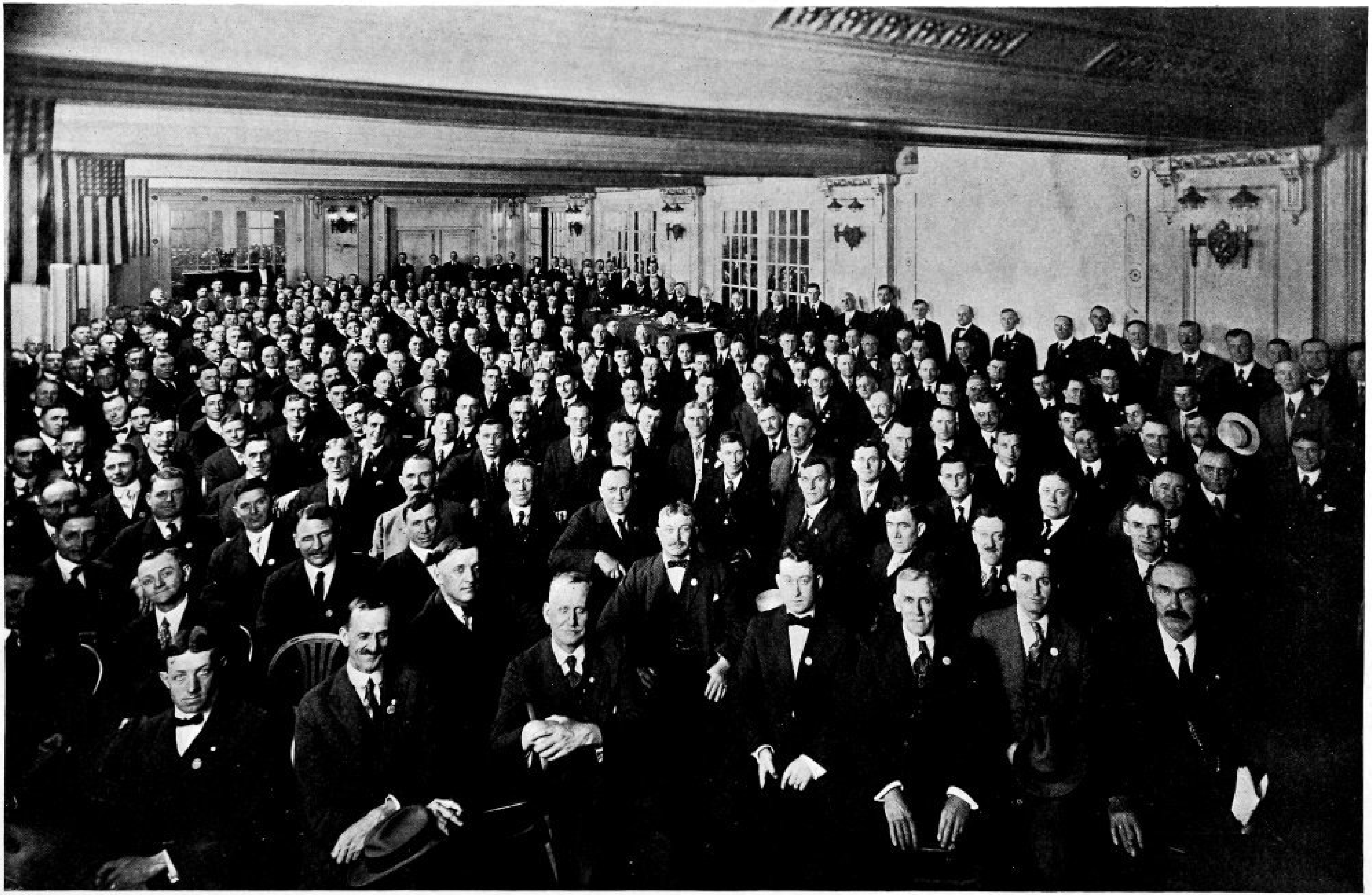
The most generally adopted type of staying for this purpose in any boiler where the volume of space is restricted is by means of the diagonal brace, of which there are three distinct forms, illustrated in Fig. 29 (a), (b), (c) and (d).

The patents on the McGregor brace have long ago expired, and they are now being manufactured very cheaply by almost any boiler shop. The Huston brace, patented and manufactured by the Lukens Iron & Steel Company, Coatesville, Pa., is of a similar form, except in the construction of the pad or "crow-foot." The latter is pressed out solid, while the McGregor is first split at one end for a distance of about 7 inches, doubled over on itself and bent out at right angles to form the foot. The Huston brace also features a channel section for that part of the shank which is riveted to the boiler shell. This provides added inherent stiffness, but no allowance is made for same when figuring on the strength of the brace.

The Scully brace, patented and manufactured by the Scully Steel & Iron Company, of Chicago, differs from the other two entirely. It is forged in one heat from a solid bar of steel.

For the cheaper classes of work, a welded brace is employed, as shown in Fig. 29 (d). This form should not

(*Continued on page* 189.)



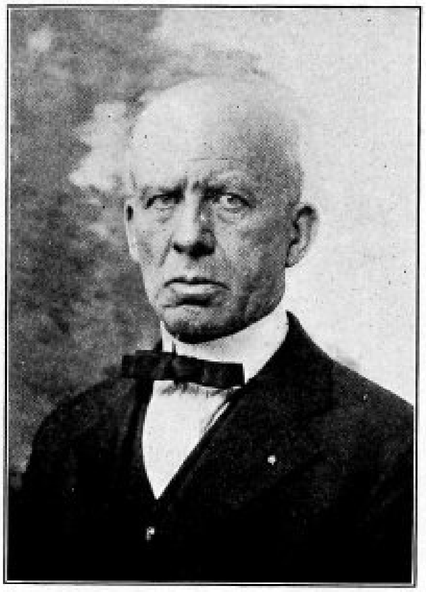
Eleventh Annual Convention of Master Boiler Makers Association at Hotel Sherman, Chicago, May 26-29

Master Boiler Makers Annual Convention

Largest Convention of Railway Boiler Makers Ever Held Meets in Chicago—Important Questions of Boiler Construction and Maintenance Discussed

The eleventh annual convention of the Master Boiler Makers' Association—the first meeting that the association has held since 1916—was opened at 10 A. M. on Monday, May 26, in the Olympic Theater, Chicago, with President D. A. Lucas in the chair. After an invocation by the Rev. Dr. White and an address of welcome to the city by Mr. Harry D. Miller, prosecuting attorney of the city of Chicago, representing the mayor of the city, the president introduced Mr. Frank McManamy, assistant director of operations of the United States Railroad Administration.

D. A. Lucas, Retiring President



John B. Tate, President-Elect

Abstract of Mr. McManamy's Address

Without the support and co-operation and the work of the members of this association in building, maintaining and repairing boilers of all kinds—good, bad and indifferent—the army and the navy would never have got their supplies and their men and their guns to the seaport; they never would have got them on the ships to go to France. If ever there was a time in the history of the American railroads that the best efforts of the Master Boiler Makers' Association were needed, it was when war was declared. During the period of the war we had many locomotives to maintain and keep in service from roads that were in distant sections of the country, and it required all of the ingenuity and skill and effort of the master boiler makers and those that were working under them to keep these locomotives in service, along with a whole lot of others that were not in any too good condition.

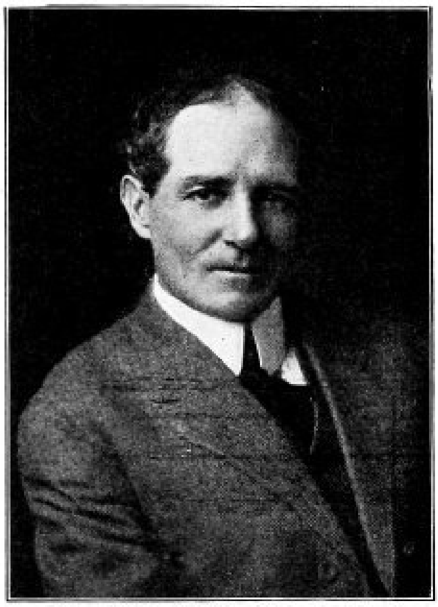
I have gone over the papers to be presented here, and I find them very interesting. Among them is one concerning the arch, the proper distance from the door sheet to the brick arch and from the crown sheet to the brick arch. Those are the important factors in firebox construction and maintenance. It is true that on different types of locomotives dimensions vary, but it is also true that an arch that is too close to the crown sheet will give increased maintenance cost by heating the crown sheet stays and by slightly overheated crown sheet, by bulged crown sheets, particularly when you get a little mud on top of it, and the distance from the door will seriously affect the steaming qualities of the locomotive.

There is another paper on radial stays, the proper method of tapping threads in firebox sheets. There are differences of opinion as to the best method of applying radial stays, but I do not think I will find any difference of opinion in this audience on this one fact, that radial stays must first be properly made, they must have a good, clean thread cut on them with a sharp tool—not one that rips whole sections of the thread off—they must be of the proper size so that they will be applied tight in the sheet, the threads must be in alinement so they will not be stripped when they are applied, and they must be properly driven, and if you do not do those things you are laying up trouble for yourselves.

Autogenous Welding

While the subject of oxy-acetylene and electric welding has been frequently discussed, it is most interesting. Without the oxy-acetylene torch, which is used for cutting, and also the oxy-acetylene method of welding, as well as the electric welding, our boiler shops would be about in the same position that they would be if we took the air tools away from them—they would be lost. It has been such a money-saver and such a time-saver that its proper use should be encouraged in every way. But if we want to discourage its proper use and kill the usefulness of the tool, there is no better way of doing it than by overdoing it, being over-enthusiastic as to what we can do with the welding torch. We can do anything with the cutting torch, but the welding outfit won't build boilers; it has got its little failures. There are many things it can do better than any other tool, many ways in which it can save money and time and locomotive hours; but it cannot do everything, and the one thing in connection with it is that, like the radial stays, it has got to be properly used by a man who knows how to do it.

The Railroad Administration wants the very best work you know how to perform. We want the various tools and the various new methods used just as far as they can be properly and safely used, and when you reach that limit do not try to overstrain it, because there are other methods of doing the work in ways that are reliable and that are known to be efficient. The members of this association are responsible for both quantity and quality of boilers. We expect from the members of the Master Boiler Makers' Association the most hearty and sympathetic co-operation with the Railroad Administration in our efforts to properly maintain and economically operate



Chas. P. Patrick, First Vice-President

the locomotives of the country during the period the railroads are under government control.

Following Mr. McManamy's address, the president read his annual address and the secretary and treasurer presented their annual reports.

According to the report of the secretary, it was stated that at the date his report was prepared there were nearly 600 names on the membership roll, 31 applications having received the endorsement of the chairman of the executive board for ratification at the convention. Nearly 200 names were subsequently added.

Mr. William C. Crum, of Eagle Grove, Ia., who, on account of ill health, had been pensioned by the railroad with which he had been connected, was elected an honorary member of the association without dues, and honorary membership was also conferred upon Mr. A. G. Pack, chief inspector of locomotives of the United States Railroad Administration.

TUESDAY MORNING SESSION

At the opening of the first session on Tuesday, Mr. A. G. Pack, chief inspector of locomotives of the Inter-State Commerce Commission, addressed the convention, outlining the work and responsibilities, as well as the beneficial results of the federal locomotive inspection service.

Following Mr. Pack's address the convention proceeded to take up the discussion of the technical papers which were presented in the form of committee reports.

What Should Be the Minimum Distance Between Grates and the Lower Part of Arch Tubes for Different Classes of Locomotives? What is the Proper Distance from Door Sheet to Brick Arch for the Various Classes of Locomotives?

The minimum distance between the grates and the lower part of the arch at the throat sheet for different classes of locomotives depends upon the local conditions; that is, as to the grade of coal they are using, whether it fills up badly or not; whether the firemen have been taught to shake grates and keep the fire worked down. We have a great many engines which have as a minimum distance eight inches, and the railroads are getting along very successfully with it, but, as said before, this is a local condition, depending upon the coal and the way the firemen fire the engines.

In regard to the proper distance from the door sheet to the top of the brick arch and from the crown sheet to the top of the brick arch for the various classes of locomotives—this also is a local condition. We have run arches in a great many cases as close to the crown sheet as 11 inches, with good results, but there are some railroads that insist that the arch shall not be closer than 16 to 18 inches.

The distance from the door sheet to the top of the arch is a very varying distance, depending upon the length of the firebox. The arch should be run as long as possible in all cases and the top of the arch should be up higher than the top of the door.

As stated above, there is no hard and fast rule for these distances; hence it is difficult to give any condensed statement on it.

L. M. STEWART, Chairman.

INDIVIDUAL REPORT OF MR. E. W. YOUNG

Taking up the first of the two questions viz., "The minimum distance between grates and the lower part of arch tubes for different classes of locomotives."

It is really impossible to set any figure as an answer to this question, as so many variables must be taken into account. What would be a minimum figure for one railroad, would not be a minimum figure for some other railroad. What would be a minimum figure for a certain shape of firebox would not be the proper minimum figure for some other shape of firebox, even though the locomotives may be of the same class.

The distance from the grates to the lower part of the arch tube may be less with a throat sheet that sets back at an angle from the vertical than for a throat sheet which is vertical.

The distance from the grates to the lower part of the arch tube may be less in the case where the grate is flat, than in the case where there is a steep toboggan pitch of the front end of the grate.

The distance from the grates to the lower part of the arch tube may be less in a short firebox than in a long firebox.

The distance from the grates to the lower part of the arch tube may be less in a compound locomotive with its mild draft than in a simple locomotive with its sharp draft.

The distance from the grates to the lower part of the arch tube may be less with one grade of coal than with some other grade of coal.

On account of the variable conditions, it is impossible to set any figure for this feature. A good rule and a simple one may be stated as follows: Locate the arch tubes as high above the grates as the design of the firebox will permit.

In some cases this has meant that the arch tubes have had to be located as near as eight inches to the grate, and yet satisfactory results have been accomplished; however, better results will be obtained if the throat sheet be such that the distance of 18 inches can be obtained between the grates and the arch tubes.

In regard to the second question of the subject, viz., "What is the proper distance from the door sheet to the brick arch in various classes of locomotives?"

It is just about as difficult to say what shall be the answer to this question as it is to answer the first question. One answer to this question might be stated as follows: "The brick arch should approach the door sheet as near as possible without restricting the area between the arch and the door sheet, to a figure below the gas area through the flues." It is very seldom, however, that we find a case where the arch can be run as close to the door sheet as the above solution would dictate, due to the fact that under such a condition the gas area between the arch and the *crown sheet* is unduly restricted by approaching the door sheet so close. It might be stated that an arch may be built back to within 24 inches of the door sheet, provided conditions other than the relation of the arch to the door sheet will permit.

A good rule in connection with arch designs is that an arch should be as long as conditions will permit, and it is usually the case that these conditions must be studied from two or three angles before we can decide just what the length of the arch shall be or what the distance shall be between the arch and the door sheet.

We think you can appreciate the fact that it has always been the case that arches have had to be designed to be placed in a firebox, already designed. It would be very much easier to get an ideal arch if the arch were first designed and then the firebox built around it. If the latter condition were the fashion, it would be very easy to answer the two questions, and they would read about as follows:

No. 1. The grates should be placed 18 inches below the front end of the arch tubes.

No. 2. The door sheet should be placed about 24 inches from the back end of the arch.

It should be understood, however, that the above two specifications can rarely be made use of for the very reason that arches are built into fireboxes instead of fireboxes built around arches.

Arch tubes must be so located in the flue sheet that there will be access to the front end of the arch tube through the waterleg. In order to get this access through the waterleg, and through a plug hole in the outside throat sheet, arch tube locations are often found to be impractically low and in such instances the special spacer block is used to elevate the front course of arch brick, so that practical firing clearance is obtained.

Following you will find the distances on the different types of locomotives used on the Chicago, Milwaukee & St. Paul Railway, also those used on the United States Standard Locomotives. You will note at a glance the various difference in distances.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY

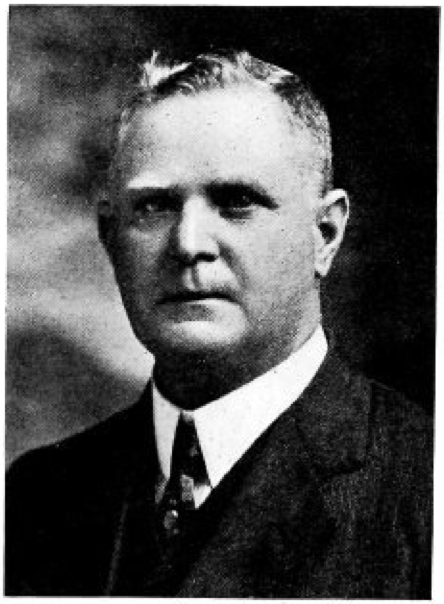
Type	Distance Between Grates and Lower Part of Arch Tube, Inches	Distance from Door Sheet to Brick Arch, Inches
I-5	13½	45½
G-4	18	37
A-1	16	49
A-2 straight top	13½	53½
A-2 slope top	14	44½
B-4 wide firebox	14½	64½
B-4 narrow firebox	11½	67
G-6	13	46
K-1	24	59
L-2	23½	49

U. S. STANDARD LOCOMOTIVES

060	10	28
0B0	10	37
4- 6-2-A	13	53
4- 6-2-B	15	47
2- 6-2-A	13½	52
2- 8-2-B	15	47
4- 8-2-A	15	46
4- 8-2-B	15	42
2-10-2-A	14½	42
2-10-2-B	15	59

The use of syphons in the place of arch tubes will, in very many cases permit of considerable better firing clearance, than can be obtained where arch tubes are used. There may be many cases of firebox construction in which an arch on syphons will be practical while arches on arch tubes would be impracticable.

Syphons make a good foundation for a brick arch, and on account of their being so substantial they make a practical device to take the place of arch tubes. We have on the Chicago, Milwaukee & St. Paul Railway engine 7615 equipped with these syphons, which have been in service about six months and which are giving excellent results, showing increase in efficiency and a large saving in fuel.* Arrangement is now being made to apply these syphons to several different classes of engines.



Thomas Lewis, Second Vice-President

E. W. YOUNG,
General Boiler Inspector,
C. M. & St. P. R. R.,
Dubuque, Iowa.

DISCUSSION

Mr. Stewart: I believe that the minimum distance between the grate and the lower part of the arch tube should be all that the design of the firebox will allow. In the distance from the door sheet to the brick arches of various classes of locomotives, I think the arch should extend at least to the height of the door hole; on the other hand, get close to the crown sheet.

Mr. Hartwell: I found out that a brick arch cannot be made standard for a locomotive, but you want a point to start from. Put the brick arch four inches below the lower end of the lower tube, placing the brick arch within

* The results of this installation are given in detail in an article on a "New Type of Firebox Construction" on page 33 of the February, 1919, issue of THE BOILER MAKER.

two-thirds of the length of the firebox; see that your area from the crown sheet to the top of the brick arch is fifteen to twenty-five percent greater than the area of your flues, and you will get a fair basis to start from. We have found that on different locomotives it comes nearer to that standard than anything you can get.

Mr. Berry, of The Grand Trunk: In putting up the brick arches, should they be fitted right up to the flue sheet and the side of the firebox?

Mr. Hartwell: I am an advocate of putting the brick arch up tight against the back flue sheet.

Mr. Whalen: I believe that setting the arch back according to the American Arch Brick Company's method, about five inches from the flue sheet, and keeping your fire down, well underneath, will give you the best results.

T. P. Madden, Third Vice-President

Mr. Young: The proposition of placing the brick arch against the flue sheet is a local condition and depends upon the class of fuel you are using.

Mr. Nimmo, of the Santa Fe: We made some tests of brick arches and we found that when the opening between the crown sheet and the top of the brick arch was the same as the area of the flues, it caused the radial stays to leak. The result was that we gave it ten percent more than the flue area, and it eliminated the trouble of the leaking from radial stays.

Mr. Austin: I want to agree with Mr. Young in regard to the distance of the arch from the flue sheet; it is practically a local condition and you have got to adjust it to your requirements. It is the same idea exactly with the distance from the crown sheet. As a general proposition, I should say that we should not hesitate to recommend the distance from the crown sheet to the top of the arch as eighteen to twenty inches, and the brick arch, tight up against the flue sheet, and the minimum distance between the grate and the bottom of your arch should be not less than twelve inches. That will apply to old power. New power should be built for an arch. It is a money-saving proposition from start to finish.

The Chair: We have with us Mr. R. H. Aishton, Regional Director of the Northwest, whom I take pleasure in introducing to you.

Abstract of Mr. Aishton's Remarks

I have been a big believer in meetings of this kind, and I know from having operated a railroad about forty years, or being connected with it, that every man on a railroad is better for attending these conventions and listening to the discussions, even if he does not agree with them. The educational feature of it is very valuable to the road he is connected with.

A boiler is the whole heart of a railroad, because without locomotives the railroad could not run, and without a boiler a locomotive could not run, and for this reason you men sitting here in this room can do more to promote the efficient operation of these railways than any other single set of railroad men in the service. If your locomotives are not in good condition, if you are having engine failures on the road and it is due to something you or your men have neglected and you fail to see to it, what happens? The railroad stops. There isn't anything more expensive, unless it is a head-end collision, than an engine failure on a railroad. The railroad problem is a good deal like having an engine with twenty-one feet six inches between the front and back flue sheet, and a twenty-one-foot flue to fit in there. That is just about where the railroads are today. In other words, our expenses are fixed and our earnings do not fill the gap. What are you fellows going to do? You have got a six-inch-short flue there and have got to fit it in at both ends to the flue sheets. To do this you weld on a piece. That is exactly what has got to be done with the railroad situation; we have got to weld on a piece, and the length of the piece we weld on means the amount of additional earnings we have got to have in order to take up these terrific expenses.

It depends somewhat on your efforts and on your ability to conduct your work so that you get as near 100 percent efficiency out of every locomotive you let out of your shops as possible, in order that the expenses on the one hand may be cut down, and the piece we have got to weld on the flue, to meet the flue sheet, is no larger than necessary. There never was a time when the railroad officers, such as you folks here, ought to work closer in concord, in order to eliminate all these extraordinary costs and get as near 100 percent out of the railroads, as right now, because any deficiency will come square back on ourselves.

There are a hundred ways you can help. There are two axioms in the railroad business; one is to get the maximum of steam with the minimum of fuel—that is your job. The other is to get the maximum of tons per mile of train haul, and that is my job. I will attend to my end of it; I want you folks to attend to yours, and I know you will.

How can you do it? Take this matter of cleaning flues. I went through a roundhouse the other day and saw some fellows cleaning flues. They went about half way through the flue, did not go from the front to the back end; didn't go through it at all. The flue was half cleaned; I saw it myself. Who was responsible for that? Why, it was not the poor cuss that was cleaning those flues; it was the foreman who was watching that job; he is the fellow who was really responsible.

Take the matter of superheaters. A superheater put in a locomotive to-day costs about $2,600. On one road, through the improper cleaning of the superheater flues and pipes, one-third of the extra efficiency of the engine, due to superheating, was lost; in other words, there was one-third of $2,600 on that engine that was not earning any money. That was not right. See that your fellows cleaning those superheaters keep them clean.

Take the matter of grates. I was out on one railroad last week and they took the grates out of one engine in the shop and the fingers were all burned off the grates. I said, "How long have they been burned off?" They did not know; they were that way when the engine came in. Every minute that grate is going in that condition, just so many minutes there is coal dropping through those grates that the Railroad Administration gets no benefit from, and are paying about twice as much for now as they did a year and a half ago. Isn't it worth saving? The cost of the grate is infinitesimal as compared with the coal that is continually going to waste under those grates.

When I came in here some gentleman was wisely expounding about brick arches. If we decide to keep on putting in brick arches, I do not know anything more important than to maintain those brick arches properly. The brick arch isn't any good at all when it is down in the firebox mixed up with the coal, as I have seen it lots of times. Then there is another thing, and that is the lack of a vacuum in the front end of locomotives. If all the locomotives in the United States had absolutely complete vacuums in the front ends, we would be able to increase the train tonnage and train movement of freight in this country something like 8 to 10 percent. That looks big, but just take the train movement and earnings and figure what that would mean in money and how far it would go toward offsetting this deficit of about $280,000,000 last year. I don't know what it will be this year, but every little helps.

Just keep in mind that every dollar that is wasted, every bit of inefficient work that goes out of the shop under your charge, means a charge against you, a charge against me, and a charge against the people of the United States, because the bill has got to be paid, and I ask you, as good American citizens and loyal railroad workers, to go back to your homes with the determination that so far as possible every bit of waste will be eliminated, to the end that we can render the people here in this country efficient transportation service.

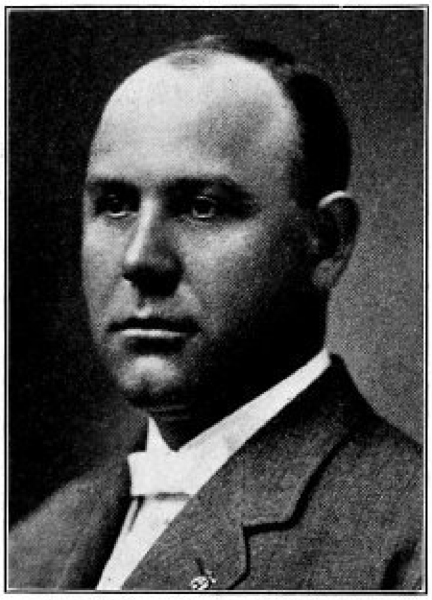
Discussion of Brick Arches Resumed

Mr. Wintersteen: In regard to the brick arch and the draft of the engine making the crown bolts leak, I do not think there is anything in it, as long as you keep the mud off the crown and plenty of water on it. I hunted for a leaky crown bolt on the Pennsylvania for over a year and did not find any. Their engines did not have any brick arches. They never knew what a leaky crown bolt was until they put the brick arches in, and after a year they commenced to get leaky crown bolts. One day I drifted into Wilmington and an engine came in and I saw a leak and ordered the fire out of the engine. They opened up the blow-off cock and emptied the boiler and found that there was a red hot brick arch and no water in the boiler. That makes a whole lot of leaky crown bolts. The man did not give the arch time to cool before he emptied the water off the crown sheet. I believe a whole lot of leaky crown bolts are due to that thing.

C. R. Bennett: The firebox should not be designed to suit the arch. The firebox should be designed for the shell of the boiler and to get the horsepower; then after you do that I honestly feel that you should have an arch in the firebox, because it means saving fuel and increasing your steam pressure and taking care of your steam pressure after you have produced it. I will also agree that if you put your arch up too close to your crown sheet you will make your crown sheet stays leak, regardless of whether you have got good or bad water, because there is a certain point you must put your arch to, with reference to the crown sheet, so that the heat will drive the water away from the crown sheet. You can drive the water out of the circulation tubes with the heat if you overdo it. That is your trouble.

Suppose you had a superheater engine on a division, and every time the engine came in the flues were stopped up; it is important that the flues should be open. As to having two or three extra bricks, some of these gentlemen will come and tell you that if you want to move your arch all you have got to do is to take a couple of asbestos gloves and lift this brick to one side. I never got into a firebox in my life where I could lift the bricks that way; they are too hot. If you have got a superheater engine and your trouble is a stopped-up flue, due to coal, leave some of the brick out and maintain the number of bricks so you can get at your flues and keep them clean.

Mr. Churchill: We are testing a brick arch out in our territory. On one engine there we applied what they call the checkered system—that is, leaving out every other



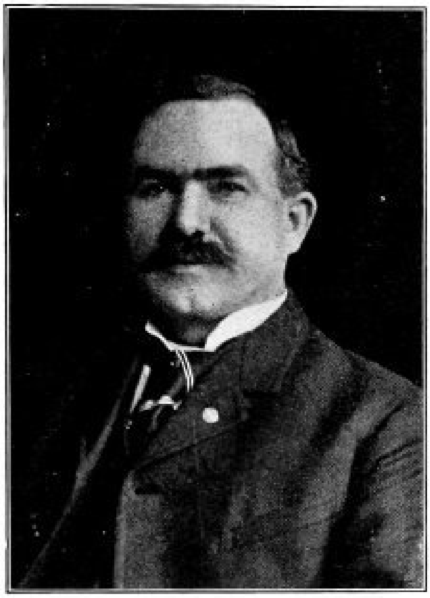
E. W. Young, Fourth Vice-President

brick as we go up, six rows of brick across the firebox, in checkered form. That did not give good results. Then we took out the top row of bricks and set the arch back eight inches from the throat sheet, the inner throat sheet on the combustion chamber, and in the last four trips of this engine saved 10 percent of coal on the last trip over the road.

C. G. Warnberg: In regard to brick arches, I believe it is a good deal due to local conditions. Take good water and you can run your arch up high and will have no boiler trouble, but you get light and foamy water, and you have not only got to lower your arch, in order to run your crown sheet dry, but you have openings on the side; otherwise the staybolts will be leaking all the time and won't last.

Mr. Austin: In reading over this paper, it looks to me like the committee had gone to a good deal of trouble gathering information. They have made recommendations which seem to me to be pretty well along general lines. I would move that this convention adopt the standards recommended by this committee for placing brick arches in locomotive fireboxes. In order to avoid criticism about building the boxes to suit the arch, I would change the phraseology. Where it says the grate should be placed about eighteen inches below the front end of the arch tube, I think that should be changed to read: "The arch should be placed eighteen inches above the grate." The next paragraph says the door sheet should be placed about 24 inches from the back end of the arch. I think the arch should be placed 24 inches ahead of the door sheet. That is the only change I would recommend in the phraseology, but I would like to see this convention become an authority and adopt a standard.

Mr. Jacobs, of the Williamette: I just had a little experience last month with some engines that they made a test on. I could not get any results out of them. I kept on burning out my grates, and finally I went to work and did not use any rule to get the measurements; I simply went to work and put in more brick. The result was that when the engineer came back on his run the following day I asked him, "How is she?" He said, "What did you do?" I told him I put in one more row of brick on each side, and the result was that they burned about four tons of coal less on a 150-mile run than it did the day before, so



Frank Gray, Fifth Vice-President

I asked him, "Would you suggest putting in another one?" and he said, "Yes." So I did, and this last Saturday, before I came down here, I just met the engineer before he came off from his run and asked how he was satisfied. He said "Perfectly," and so I believe in not using a rule and using your head.

E. W. Young: It is impossible to adopt a fixed standard for those two questions; it depends on local conditions, and that is what we have all been dealing with.

Mr. Miller, of Virginia: You cannot adopt a standard for it; you have just got to suit your local conditions, that is all.

Arthur Brown, of the L. & N.: A few years ago the brick arch was subject to condemnation. To-day we realize that that was a mistake—that the brick arch is essential for fuel economy, and also the generation of steam. But I am personally of the opinion that the design of a locomotive boiler should cover a proper appliance for a brick arch; in other words, set the brick arch to receive the best results from that particular design of boiler.

Mr. Mackey, of the Santa Fe: On the Santa Fe we went through the experimental stage about eight or nine years ago, and we have not deviated any after we found out what we wanted. I have two kinds of coal under my supervision—one which we call the yellow coal. If you run a brick arch back from the flue sheet you cannot keep it from getting honeycombed. By running this brick arch close to the flue sheet we absolutely cut out our honeycomb. We have another kind of coal that does not honeycomb. We can run the brick arch away from the flue sheet or close to the flue sheet, but we have a number of large heavy-power engines that the arch tubes are not over ten or twelve inches from the grates, and the arch tubes are designed in such manner that you can only have two tubes to carry the brick, and it leaves possibly a dozen or fifteen tubes exposed below the arch, and I find that we have to renew those flues, the bottom flues, 50 or 100 of them, every six to eighteen months, where, otherwise, if the flues are not exposed, we will run them two, three or four years.

Mr. Lucas: I believe that the brick arch proposition is a local affair and should be taken care of locally at each terminal. We have got this one condition to bear in mind, and that is that we are changing roundhouse foremen fre-

W. H. Laughridge, Treasurer

quently; we are changing boiler maker foremen frequently, as well as the brick arch men and the flue men, and to keep your system standard you have got continually to keep this topic before them.

Mr. Callihan: I recently had occasion to make an inspection of six oil-burning Mallet boilers of the Western Pacific. They figured that they needed the brick because the heat caused loose staybolts and radials, and it was impossible to keep them tight. After putting in the brick arches they have not had to remove an arch tube in two years of service. The flues are in excellent shape. The first set of brick put in lasted over six months. Up to this time they are a wonderful success.

Mr. Frunke, of Tacoma, Wash.: The gentleman said something about brick arches in oil burners. Oil burners are all we have got. We put in our first brick arches about three years ago, and are putting arch tubes in oil burners now, but there is a whole lot of difference in putting an arch in an oil burner and in a coal burner. If you put an arch in an oil burner the same as you do in a coal burner, I do not think you will have much of a door sheet; it won't be long before it is burned out or your radial stays are burned out.

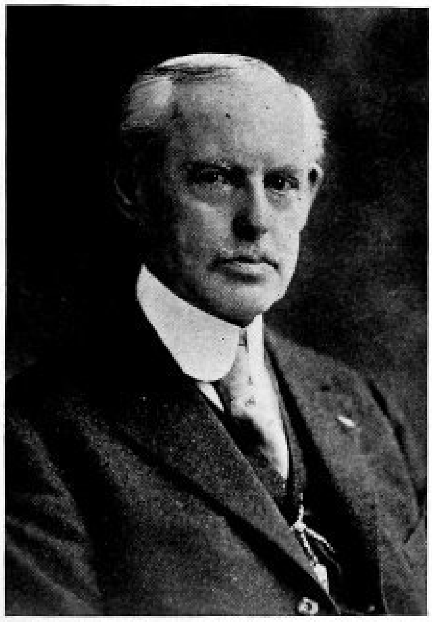
Mr. Gaines, of the Milwaukee: I have been inspecting engines for quite a number of years, handling local terminals. I want to tell you that it is purely and simply a local condition.

The Proper Method of Threading Radial Stays and Tapping Holes for Same. Is it Necessary to Give Radial Stays the Same Lead as the Tap with which the Holes were Tapped?

The theoretical way to thread a radial stay is to make its thread aline with the tap with which the holes in crown and roof sheets are tapped.

Rigid experiments have proven that no better results are obtained from this method than where no attention was paid to the alinement.

This is due to a slight variation in taps and threading machines, and the tendency of the tap when tapping the roof sheet to assume a radial position in relation to roof sheet.



Harry D. Vought, Secretary

A practical method of tapping the holes is to use a double ended tap. However, good results are obtained with single ended spindle taps.

It is very necessary that the tapping and applying of radial stays should have the same consideration as staybolts in side sheets. The holes should be tapped with a suitable length tap so as to make a continuous thread. Radial bolts should be threaded in a machine equipped with a lead screw. If this is done there will be no trouble with entering bolts in crown sheet, on stripped threads.

H. J. RAPS, Chairman.

DISCUSSION

Mr. Raps: This is a very important subject. My opinion is that it is not necessary to give the bolts the same lead as the taps. I think it costs a little more money to do that. We have bolts made in the lathe and some in the horizontal bolt cutter, and you will find one just as good as the other. You can interchange the bolts from one hole to the other. My opinion is that the bolt without the lead is as successful as the bolt with the lead, and costs less money.

Mr. Borneman: I would like to ask the gentleman if he has any leaky radial stays. If he states that he can get along without having the threads match in the crown and the sheet, I do not believe that as pertaining to boiler construction. You may trust yourself, but you cannot trust everybody else in putting in those stays.

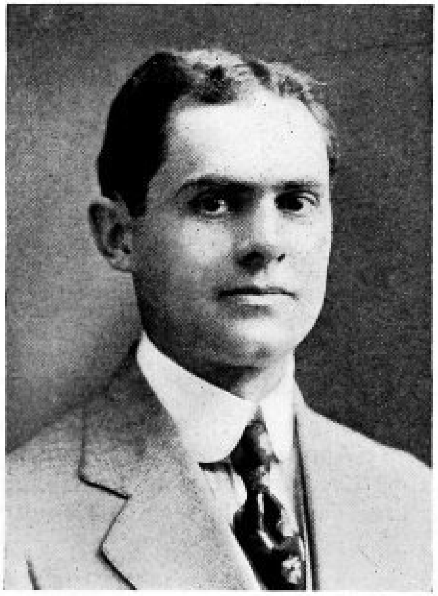
A. N. Lucas: If any one of us were going to order a boiler built, would we tell the manufacturer that he could screw the bolts in any old way? We would certainly advise him very strictly that the bolts had to be in pitch with the tap.

The Chair: They do not pitch.

A. N. Lucas: They should pitch. We are figuring the proper method of having them in lead.

Thos. Powers: We cut our bolts in a machine that is accurate, but how many of us know that we maintain our tap and lead? There isn't half a dozen of us tapping these holes for bolts with a long tap.

Mr. Raps: I made a very rigid experiment and found



J. F. Raps, Chairman Executive Committee

that the more I cut the angle at the wagon top, the greater the tendency for the tap to take a radial position with the wagon top, so that when you screw the bolt in from the outside and it is a snug fit, it will not strike the hole on the inside of the crown sheet; it will not line up with that hole.

A. N. Lucas: In tapping out a set of radial stay holes in the crown sheet and roof sheet with a set of taps composed of our 1, 2, 3 and 4, you are applying the short bolts first, your bolts are being cut in the machine for tap No. 1 and you are cutting to that tap. When you start on No. 2 you are cutting them to No. 1 tap, because the taps differ; taps are not all alike, they are not all in pitch. It is just as easy to cut them in lead with a tap as otherwise.

Mr. Powers: Do you make your bolts before you tap your hole, or afterward? The point I want to make is this, there may be a difference in some taps before and after tapping the hole, due to the strain you put on either the motor or the machine.

A. N. Lucas: I would not think so.

Mr. Powers: I know it, because I have tried it.

A. N. Lucas: When we are cutting the radial stays we cut the large end first, and before we cut the small end we have got a small adjustable die that we put on the bolt cutter and put the tap in the machine, in the head, and adjust the die back of the job to the tap; then we cut the small end of that bolt and you can try your tap on and it is perfect.

Mr. Patrick: If there is any one thing I have experimented with it is the threading of a crown bolt, radial bolt, and I have never found that you could get a proper lead on any crown bolt. It does not make any difference whether you turn it right in a lathe, or what; you might get it in the bolt, but you will not have it in the tap or on the sheet. You can turn your bolts up on a lathe and they will not match your tap. I do not believe there is anything in a lead; you certainly cannot get a thread over a twenty-fourth part of an inch, half a thread, and when you are tapping out a crown sheet in a wagon top your sheets will spring more than one-twenty-fourth inch. I believe it is a loss of time and money to consider a lead on a staybolt.

Mr. Wallace, of Sioux City: I have never yet found a machine that you can take and put a tool on or a gage on after a bolt is made, or a tap, either, that will come true within one-thousandth of an inch, and if a man puts two radial stays in a crown sheet, two sizes, the larger size on the bottom, it is absolutely impossible to get them to gage. That is my experience.

Mr. Austin: I would like to corroborate Mr. Patrick's remarks. I think he has given the common-sense, practical view of it.

Mr. Stewart: In my experience there is nothing at all in the lead on the radial stays; it is just an expense and a very slow, costly proposition.

TUESDAY AFTERNOON SESSION

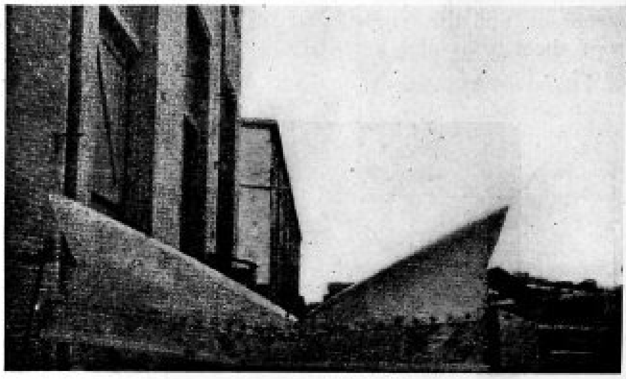
Effect of Proper Upkeep of Ash Pan and Front End Draft Appliances on Fuel Economy, and Method Used in Determining Proper Design for Various Classes of Locomotives

Your committee has failed to locate a recognized rule for designing ash pans. The result of our investigations indicates that methods are largely the result of experiments which have developed designs which seem best suited to the type of locomotive and condition of service. The objective to be attained was a self-cleaning arrangement of sufficient storage capacity to prevent the necessity of dumping the ashes except at regular ash pan cleaning points; and to prevent the cinders from burning and warping the pan. The lower parts are designed to be practically air tight, air for draft being admitted at the upper parts only. Ash pan air inlets of eight classes of locomotives averaged 14 percent of grate area, which, from information obtainable, seems to be about the average air opening in ash pans for coal burning engines.

With the modern wide firebox pans are made wide at the top, projecting several inches beyond the mud ring with vertical sides to prevent sparks from falling or being blown out by side winds. These upper plates are sloped toward the hopper or storage part so that cinders will slide to the hopper. There seems to be a tendency to sacrifice this slope to obtain greater draft opening, which has resulted in some instances in the cinders piling up on the wings and shutting off the draft, as well as causing stuck grates and burned grates and connecting bars. Therefore, we believe that the slope from the hopper to the edge of the pan should be not less than 30 degrees, and rather than lose this slope it is better policy, if possible, to get increased air opening from back or front.

We have stated the objective points to be attained in designing ash pans and wish to suggest that when locomotives are being designed, the ash pan should be considered and provided for as being an important part of the machine, and not as something to be hung on after the locomotive has been set up. The modern ash pan is expensive to construct and still more expensive to maintain, and the greatest possibility of improvement seems to be in the designers who may find it practical to change the frame lines or other parts sufficiently to give relief where it is greatly needed.

Your attention is called to the photographs of what is known as the Madden ash pan. This pan is simple in construction, has no hoppers, and is less liable to warp,



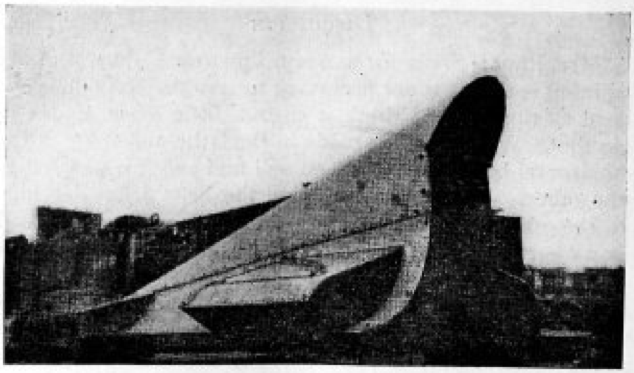
Madden Ash Pan

and the work of keeping ash pan hopper slides and dumps in operative condition is greatly reduced. This pan seems to be growing in favor. It is reported to this committee that there are 700 of them in use on one road. Mr. Thomas P. Madden, general boiler inspector of the Missouri Pacific Railway, and the fourth vice-president of this association, is the patentee of the device. The application and adaptability of this pan largely depend on the room which is left by the designer of the locomotive to apply an ash pan.

MAINTENANCE OF ASH PAN

Slides, hoppers and dumps should be maintained in an operative condition. Grates should be maintained in first-class condition. Broken, burned, or warped grates should not be allowed in service. One bad grate often causes damage to a whole section, also waste of fuel and damage to ash pan.

No air openings should be allowed in the ash pans except those provided for in the design. This is particularly important in case of oil burning locomotive draft pans, for the reason that air leaks permitted at other points than those designed usually result in brick work troubles as well as interfering with the proper steaming of the locomotive. A sketch of an oil burning pan is pre-



Side View, Madden Ash Pan

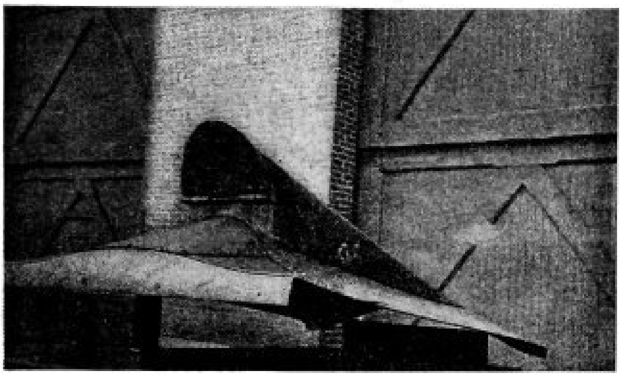

"And this is the result"—
Not one bolt has split in heading, threading or driving.
"Drilled from the solid Bar"
Joseph T. Ryerson & Son.
Chicago, New York, St. Louis, Detroit.
ULSTER SPECIAL
SEAMLESS HOLLOW IRON
IMPROVED PATENT METHOD

sented for the information of those who are not familiar with oil burning locomotives.

Air leaks at lower parts of coal burning locomotive ash pans are extremely undesirable and annoying not only on account of burning and warping plates of ash pan, but particularly on account of sparks dropping and causing fires along the right of way, it being a mooted point whether fires set from locomotives are not most frequently from the pans rather than the stack.

Front End Draft Appliances

Method of determining design of front end draft appliances has, no doubt, as its basic principle, what was



End View, Madden Ash Pan

known as the Master Mechanics' front end, and, like other parts, constant experiments and experience develop a type of front or setting to suit the conditions.

All parts of ash pan and front end appliances should be carefully fitted and securely bolted in place so that there is no reasonable probability of any part becoming displaced, and should be maintained at all times in first-class condition, each part performing its full function strictly in accordance with the design. We particularly refer to draft openings and passages which govern the flow of air and gases through the firebox flues and smoke arch. Dampers which are designed to be operated should be maintained in an operative condition and air be admitted only at such points as the drawings provide for. Draft passages should be maintained so that all the drafts will pass through those channels, which is not the case if loose or poor fitting plates are allowed. To illustrate: Draft appliances, which include deflecting plates, nozzle petticoat pipe and stack, may be designed and adjusted to clean cinders thoroughly from front ends, and because plates were not well fitted, leaks direct to the stack were sufficient to defeat the object of the design, causing cinders to accumulate in the front end, sometimes resulting in burning and warping front end rings and doors and overheating lower joints of exhaust and steam pipes and developing leaks at those parts.

Front End Leaks

Your committee is of the opinion that positively no air leaks should be permitted and that where front ends show indications of burning on account of the combustion of cinders it is just as often the result of poor fitting plates and air leaks as it is of faulty design or of wrong adjustment of draft appliances. We also incline to the opinion that we should make use of the autogenous welding process to secure permanently to the smoke arch and flue sheet a suitable sheet iron border to which to bolt deflecting plates. This border may be spot welded when being applied or welded in solid. At any rate, it can be an absolutely tight fit—in fact, air tight, if desired. An arrangement of this kind will expedite the work of applying or removing deflecting plates and simplify front end inspection.

There are many ideas as to the type of, and adjustment of, petticoat pipes, and your committee naturally hesitates to give expression to their opinion on the matter, and it will perhaps suffice to state that petticoat pipes should be maintained to practically a true circle free from holes or indentations, and be securely held in central position between nozzle and stack.

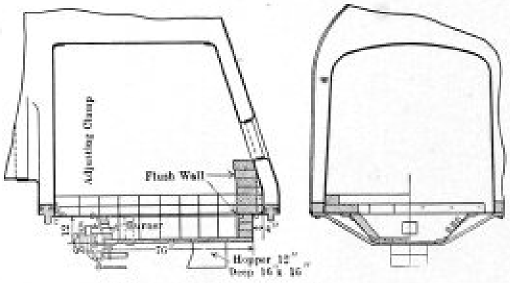
As an item of interest to this association, and to give an idea of general dimensions of draft openings, the following is given. We find in eight different classes of coal burning locomotives the following comparative dimensions of draft passages:

Eight Coal Burning Locomotives

Ash pan air inlets equal 14 percent of grate area, or 39.5 percent of grate opening, and is 4 percent more than flue opening area, the flue opening area being about the same or slightly less than ash pan air inlets, and about one-half of the area of grate opening. From this it would appear that pan opening and flue opening are practically the same, while stack area is about 10 percent of flue opening area.

Seven Oil Burning Locomotives

Have same stack opening and flue opening and grate area. They have no grates, but the air inlets through the fire or brick pan, also called the draft pan, are 28 percent less than the flue opening area and are 69 percent or a little more than twice the stack opening. The comparatively small air openings to the fire in oil burning engines compared to coal may raise the question of whether or not we are allowing too much air to the coal burner, especially with a clean fire. We are of the opinion that the size and location of these openings have been worked out principally by experimental process and, while perfection may not have been attained, when we observe



Oil-Burning Fire Pan Arrangement

a good steaming oil burner at work, one is pretty apt to conclude that there is not much room for improvement.

The effect of proper upkeep of ash pan and front end appliances is to save fuel, and maintaining a high standard of condition of those parts saves labor and effects an economy.

Like many other economies which can be effected in any line of business and yet not be reducible to plain figures, we must accept the above statement because we know that well maintained draft appliances and ash pans do fully perform their functions of furnishing the necessary drafts for economical combustion of the fuel and prevent fires being set out and the destruction and loss of property, which is an important economical consideration. That well fitted and well secured parts of the draft appliances reduce the liability of displacement and failure on account of not steaming and loss of fuel due to poor steaming, also reducing the necessity of constant changing of front end draft appliances, which is another considerable economy, and finally, well maintained draft appliances may well be considered the difference between a satisfactory, efficient locomotive, which everyone appreciates, and a poor steaming inefficient machine that no engineer wants to run.

GEO. AUSTIN, Chairman.

The Best Method of Bracing Locomotive Tenders

Speaking from past experience the best method we know of to brace locomotive rectangular tanks is what is known as the tee bar and plate method.

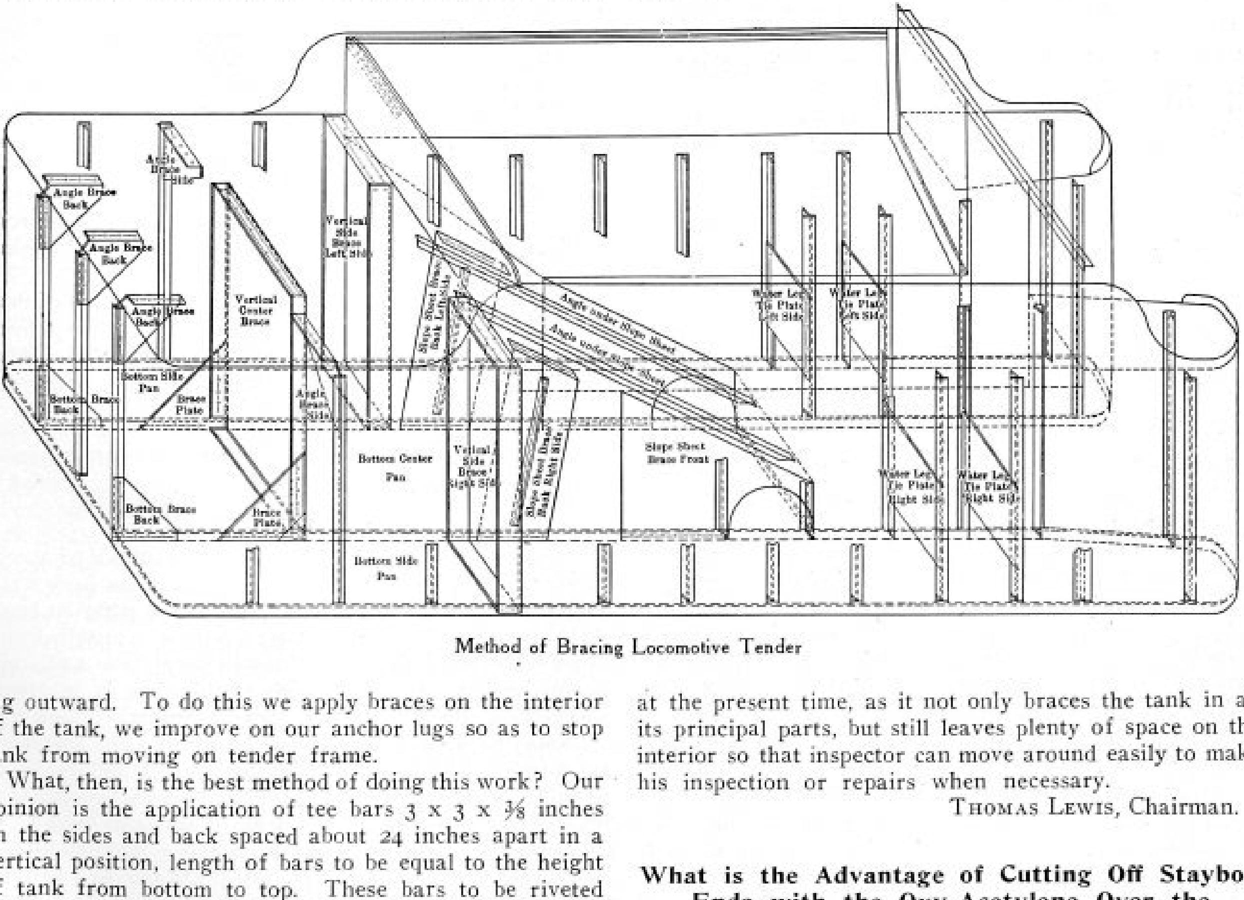
The object of bracing locomotive tenders is to make them strong to stand the strains and stresses that take place when engine is in motion rounding curves, sudden stops, constant jerking, water surging back and forth, and to prevent the sides and back of the tank from bulging outward. To do this we apply braces on the interior of the tank, we improve on our anchor lugs so as to stop tank from moving on tender frame.

What, then, is the best method of doing this work? Our opinion is the application of tee bars 3 x 3 x ⅜ inches on the sides and back spaced about 24 inches apart in a vertical position, length of bars to be equal to the height of tank from bottom to top. These bars to be riveted with not less than ⅝-inch diameter rivets spaced about six inches apart, zigzag.

The top of tank at the rear end is braced by the application of tee bars riveted to the under side with gussett plates riveted on ends. The slope sheet in the coal space is braced by the application of two tee bars riveted to the under side, also supported by stay plates placed vertically and riveted to the slope sheet and tank bottom reinforced by angle bars. Dasher or splash plates of ¼-inch or 5/16-inch thickness are used for the purpose of frustrating the rush of water in the tanks; they also form a brace for top and bottom of tank. One plate is placed in the center between the coal slope sheet and the back of the tank. Two plates are placed on each side; these are riveted to the top and bottom of the tank. A center dasher plate flanged on the sides and riveted to the top of the tank; also gusset plates are applied at the bottom and riveted, which gives the dasher plate added strength. We believe in order to make a permanent job all braces should be riveted and not bolted, the size of rivets to be according to the thickness of braces used.

This method of bracing is recommended for all rectangular tanks made from steel plates of 5/16-inch thickness or less, because in our opinion we get better service than is given by the old method of applying the longitudinal angle iron bars with cross stays. Also it has the tendency to eliminate leaky rivets in anchor lugs. We are of the opinion that when *weight* is not taken into account when designing locomotive tenders if the tanks were made from heavier material, say steel sheets ⅜-inch thick, it would greatly simplify the matter of bracing as heavier material could be used which no doubt would be more satisfactory. However, with ¼-inch plate for the tank sides and top, and 5/16-inch thickness of plates for the bottom of the tank we offer the best method of bracing that we know of at the present time, as it not only braces the tank in all its principal parts, but still leaves plenty of space on the interior so that inspector can move around easily to make his inspection or repairs when necessary.

THOMAS LEWIS, Chairman.



Method of Bracing Locomotive Tender

What is the Advantage of Cutting Off Staybolt Ends with the Oxy-Acetylene Over the Old Methods of Nippers and Chisels?

As to the advantage of cutting off stay-ends with oxy-acetylene over the old method of nippers and chisel. Your committee believes the first thing to be considered is shop conditions.

In a shop that is equipped with crane facilities, where boilers are removed from frames and can be turned in any position, then the nippers can be used to good advantage. However, we have frequently heard complaints that the nippers do not make a good even end to drive, and it is very often necessary to go over the bolts and trim them with chisel before driving.

The use of the chisel in cutting off stay ends can hardly be considered, as it will damage the thread on the bolt and in the sheet; it also elongates the holes.

We believe the acetylene is so far superior to this method that there is hardly any room for discussion.

In using the oxy-acetylene process the bolts can be cut to a uniform length, with the boiler in any position.

It leaves the bolt annealed for driving. In shops that are not provided with crane facilities, for boilers with narrow fireboxes, for cutting off scattered bolts, bolts applied in patches and radial stays, or whether boiler is on frames and in upright position and bolts are applied from the inside, we believe the acetylene has no equal.

As to the difference in cost, this will depend a great deal on the operator of either the acetylene or nippers.

W. S. LARSON,
J. B. TYNAN,
Committee.

Report of Committee on Law

Amend SECTION 1, ARTICLE III so as to provide that the list of officers shall include a "Secretary-Treasurer" instead of a "Secretary and a Treasurer."

The object of this change is to consolidate the two offices and assign their duties to a single officer.

Combine ARTICLES VII and VIII as SECTIONS 1 and 2 of ARTICLE VII, amending the former article by striking out the words "and remit the same at stated intervals to the Treasurer."

Amend ARTICLE VIII by striking out the words "and receipt for."

Succeeding articles to be changed in their numbering to correspond with all changes.

Amend SECTION 2, ARTICLE XI by striking out the word "shall" and substituting the word "will" so that it will read "will be valuable to the Association."

Amend SECTION 3 of the same article by adding after "active service" the following: "Or others whose experience will be valuable to the Association."

Amend ARTICLE XVI by adding a new section to be known as SECTION 1, and change the numbering of present sections 1 and 2, to read 2 and 3:

SECTION 1: The President shall within 30 days following his election appoint a committee of three for each topic to report at the next annual convention on such topics as are adopted for that occasion, and also a committee of three to report a list of subjects in advance for the next succeeding annual convention.

Add new article:

ARTICLE XVIII: SECTION 1: There shall be a standing committee on law to consist of three members to be appointed by the President after assuming the duties of his office and such appointments shall include at least one member of such committee who served in such capacity during the year preceding an annual convention of the Association.

SECTION 2: At the first session of each annual convention the President is authorized to appoint for the period of such convention the following committees, and any additional committees which circumstances may make necessary for the time that the Association is in session: Auditing, President's Address, Memorials Resolutions.

SECTION 3: The President is further authorized to appoint annually a special committee of three, after the selection of the place of meeting for the annual convention, whose duty it shall be to arrange for special speakers, and make such other arrangements for the convention as may be found necessary.

G. W. BENNETT, Chairman.

Topics for Next Convention

In submitting the following topics for the 1920 convention, the committee wish to call to the attention of the members the necessity of compiling all of the data possible in order that the reports approved by the convention may be adopted as standard practice. It is the consensus of opinion that heretofore this association has not arrived at any definite decision or conclusion on any subject discussed. Each subject should be fully developed by the committee and after careful discussion and revision, if necessary, should be adopted by the convention. In this way only will we attain prestige and be recognized as an authority on subjects pertaining to our vocation.

(1) What is the best type of washout plug, arch tube plug or cap to be used in order to overcome leaking, when boiler is under pressure? Kind of thread, number of threads per inch and taper per foot? Proper location of washout plugs in boiler?

(2) Which firebox steel gives the best results from actual service test; steel having a tensile strength of from 48,000 to 58,000 pounds, or 55,000 to 65,000 pounds per square inch?

(3) Is the superheating and reducing of steam pressure on boilers advantageous as to staybolt breakage compared with boilers of the same class not superheated?

(4) Is it necessary to maintain the cinder hopper on bottom of smoke arch of all locomotives? On what size locomotive should it be maintained? Which is the better design to overcome air leaks?

(5) Is the flanging of firebox sheets on the flange press detrimental to the material? When can cold flanging be employed to the best advantage?

(6) Oxy-acetylene welding, describe best method of performing various classes of work, including preparing, placing in position and welding cracks, patches and sheets.

(7) Electric welding, describe method of preparing cracks, patches, sheets and flues for welding.

(8) General discussion.

J. F. RAPS, Chairman.

WEDNESDAY MORNING SESSION

Acetylene Welding

Much has been said as to the different methods of acetylene welding. Many of the shops a few years back were equipped with the portable generator, using what we term "high pressure." Later, new apparatus was installed and shops were piped throughout for the acetylene and oxygen, using low pressure, which at this time is in pretty general use throughout the United States. There are a number of shops that still use the oxygen and acetylene gas furnished in holders, with the oxygen holders containing 1,800 to 2,000 pounds, and the acetylene holders from 200 to 250 pounds pressure. Where this method is used it is necessary to have the different regulators for the oxygen as well as the gas; this outfit for each welder. But where the "low pressure" system is used, it is only necessary to have the regulators where the gas is generated and the oxygen manifold, and it is the opinion of your committee that the "low pressure" system piped throughout the different departments, both oxygen and acetylene, will give the best results.

WELDING TORCHES

There are several different makes of welding torches on the market to-day and, while they will all do good work with an experienced operator, we believe there is some difference and some torches work out better than the others; that is, they are more quickly regulated and do not back-fire as readily as some other makes. In most all cases the welding tips are made up of copper and give much better results than the brass.

CUTTING TORCHES

Many different styles of cutting torches are on the market, and while they all do good work, some seem to do better than others. Some will back-fire readily, where with others it is almost impossible to make them back-fire, and in some cases both with the welding and cutting torches where they do back-fire, they can be ignited quickly from the heated iron without readjusting; where, with other makes, it is necessary to shut off and start all over. This causes a loss of time as well as a waste of material.

I do not feel that it is necessary at this time to go into details in regard to the method of preparing and welding up the different jobs, such as cutting out and preparing new sheets for welding and many other jobs we find to do, due to the fact that the papers furnished herewith by the committee explain this fully and undoubtedly will be printed in full and furnished in our *Proceedings*.

I might add that many of the different shops have different methods and are seemingly getting good results. As to our practice at this time on the Chicago, Milwaukee & St. Paul Railway I might say to start with, we are and have been welding in all our side sheets, bolting up securely, applying staybolts and rivets before welding. We are also welding all our cross-seams by removing rivets, scarfing down, and welding up all holes and are not removing any staybolts getting first-class results; welding in all our door collars, inside and out; three-quarter door sheets, one-half flue sheets top or bottom; full flue sheets; front sections of crown sheet; welding in bottom patches of front flue sheet, 12 inches to 20 inches high; cutting off all our staybolts and radial stays with the torch; in fact, doing everything in the line of welding we may find to do, and I can say that the sheets we are welding up are standing up good and giving us no trouble. The only trouble we do have at times is welding in patches in old side sheets, or where side sheets go to pieces rapidly, due to poor water conditions. Where engines are in bad water territory, sheets do bulge between the bolts and at times the weld is pulled in two.

I might add that in visiting the different railroad shops, I find that of the firebox work, such as applying fireboxes, side sheets and door sheets, the welding in most cases is being done with the acetylene torch. Shops visited had both the acetylene and electric welding outfits, but were using the electric outfit mostly for welding flues, mud ring corners and roundhouse work, where I believe the portable electric welding outfit will give good results.

At this time we have just installed the electric welding outfits, and figure on welding in all flues, mud ring corners, side sheets cutting out the center and welding in new without removing mud ring rivets. Also figure on doing considerable firebox and boiler work with the electric welder, where flanges on front or back flue sheet are still good, cutting out the center and welding in new.

HENRY J. WANDBERG, Chairman.

Best Method of Application and Drilling of Telltale Holes, Etc.

The best method in all cases to apply telltale holes is before the staybolt is applied. This may be done on an automatic drilling machine or a small drill press rigged up for this in the shop.

I also believe that it is the most economical and best method to cut the bolts off with the oxy-aceylene torch, in this way not disturbing the bolt in the sheet as is done with a hammer or a chisel bar, or staybolt nippers.

It is the practice in our shop to punch the telltale hole in the staybolt on a forging machine in the blacksmith shop. This is done in one heat in two operations; first a rather blunt tool is used which punches a hole about 3/8 inch in diameter to about 5/16 inch depth, which acts as a countersink on end of bolt; the bolt is then raised in the die and a 7/32 inch hole 1½ inches deep is punched.

Personally, I am of the opinion that this is the best method known of applying telltale holes in staybolts. If the dies are properly made the result will be a bolt of proper size with the telltale hole in the center.

For drilling telltale holes we use a 7/32 inch high speed twist drill both in new bolts and in opening up old telltale holes. However, where holes are forged as above mentioned, we do not find it necessary on new bolts to use a drill, as the holes can be very easily opened with a taper pin.

Lubricant used in our shop is composed of soft soap and water, both for drilling and for opening up new bolts.

LOUIS R. PORTER, Chairman.

Best Method of Scaling Superheater Flues, Etc.

I sent out a large number of letters to members asking for information on these various subjects covered in Topic No. 4, and to date have received no answers to my letters, due no doubt to the fact that they did not have the time to give this subject which it really requires. It is true I could make up a report giving my own opinion and views, together with the two committeemen who wrote me, but I do not think this sufficient on so important a subject, especially at this time, as I have second-hand information that there are a number of new tools on the market for cleaning flues as well as welding superheater flues. In view of the above facts, I do not feel that I have had sufficient time to collect the proper information and data required to make what I would consider any kind of an intelligent report suitable to bring before the convention.

I would therefore recommend that this subject, as well as the committee, be continued to our 1920 convention.

W. J. MURPHY, Chairman.

THURSDAY MORNING SESSION

At the final session of the convention on Thursday morning, after considering the reports of the committees on the president's address, auditing, resolutions and memorials, the association elected the following officers for the ensuing year:

President, John B. Tate, foreman boiler maker, Pennsylvania Railroad, Altoona, Pa.

First vice-president, Charles P. Patrick, general foreman boiler maker, Erie Railroad, Cleveland, Ohio.

Second vice-president, Thomas Lewis, general boiler inspector, Lehigh Valley Railroad, Sayre, Pa.

Third vice-president, T. P. Madden, general boiler inspector, Missouri-Pacific Railroad, St. Louis, Mo.

Fourth vice-president, E. W. Young, general boiler inspector, Chicago, Milwaukee & St. Paul Railroad, Dubuque, Ia.

Fifth vice-president, Frank Gray, general foreman boiler maker, Chicago & Alton Railroad, Bloomington, Ill.

Secretary, Harry D. Vought, 95 Liberty street, New York.

Treasurer, W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio.

Chairman, executive board, John F. Raps.

Secretary, executive board, Edward J. Reardon.

Members of executive board (one year): B. F. Sarver, A. N. Lucas, Henry F. Wandberg; (two years) L. M. Stewart, John F. Raps, John Harthill; (three years) Thomas F. Powers, Harry F. Weldin, E. W. Reardon.

Registration at Master Boiler Makers' Convention

BOILER MAKERS

Frank H. Albrecht, B. F. M. & O., 407 S. 16th st., Murphysboro, Ill.
J. A. Albrecht, F. B. M., N. Y. Central R. R. Co., Buffalo, N. Y.
C. B. Amanns, B. M., Southern Ry. Shop, 212 E. Park ave., Knoxville, Tenn.
Andrew Anderson, Gen. B. Insp., D. & R. L., 970 S. High st., Denver, Colo.
J. A. Anderson, Gen. F. B. M., Industrial Works, Bay City, Mich.
William B. Atkinson, F. B. M., M. & N. A. R. R., Harrison, Ark.
George Austin, G. B. I., A. T. & S. F. R. R., Topeka, Kan.
Cornelius Bader, F. B. M., M. C., 737 Military ave., Detroit, Mich.
G. G. Bailey, F. B. M., N. Y. Central, Toledo, Ohio.
W. R. Barnes, G. B. I., Central of Ga., 563 Oak st., Macon, Ga.
F. A. Batchman, F. B. M., N. Y. Central R. R. Co., Elkhart, Ind.
C. J. Bauman, F. B. M., N. Y., N. H. & H. R. R., New Haven, Conn.
Fred Bayer, F. B. M., P. C. C. & St. L. Ry., Columbus, Ohio.
John F. Beck, F. B. M., G. R. & I. R. R., 426 Thomas st., Grand Rapids, Mich.
Arthur J. Beland, F. B. M., Chicago Junction R. R., Chicago, Ill.
William D. Bell, F. B. M., Southern Ry., 4325 Ave. B, Birmingham, Ala.
C. R. Bennett, B. M. F., Penn. R. R., Logansport, Ind.
G. Bennett, Foreman, Penn. R. R., Verona, Pa.
G. W. Bennett, I. C. C., 15 Kent st., Albany, N. Y.
Frank E. Berrey, F. B. M., Erie Railroad, Cleveland, Ohio.
John Berry, Boiler Inspector, Grand Trunk R. R., Toronto, Ont.
J. B. Best, B. M., N. P., Staples, Minn.
W. Bleick, Gen. Foreman, G. H. & S. A. Shops, El Paso, Texas.
George Bliss, F. B. M., New Durham, N. J.
Frank C. Blount, F. B. M., Southern Ry., 1101 N. 23d st., Richmond, Va.
H. F. Boersig, B. M. S., S. P. & S. Ry., 1206 West 15th st., Vancouver, Wash.
H. E. Bolman, Asst. Foreman, C. & O. & I. Ry., Peru, Ind.
L. Borneman, F. B. M., C. St. P. M. & O. R. R., 1121 Selby ave., St. Paul, Minn.
William G. Bower, F. B. M., Chicago & N. W. R. R., 4157 Washington Blvd., Chicago, Ill.
John A. Brandt, Gen. Boiler Ins., N. Y., O. & W. R. R., 343 North st., Middletown, N. Y.
John Brennan, F. B. M., Great Northern, Everett, Wash.
James D. Brewer, F. B. M., Tenn. Central R. R., Nashville, Tenn.
W. A. Brooks, Gen. F. B. M., Penn., C. & P. Div., Wellsville, Ohio.
A. E. Brown, G. F. B. M., L. & N. R. R. Shops, New Albany, Ind.
C. Browning, F. B. M., Grand Trunk R. R., Battle Creek, Mich.
John S. Buntin, F. B. M., Southern Pacific Ry., 1515 Peale ave., Bakersfield, Cal.
Thomas E. Burdett, F. B. M., C. & N. W., Green Bay, Wis.
L. J. Burns, F. B. M., Northern Pacific, St. Paul, Minn.
C. J. Burnside, F. B. M., B. & O. R. R., 1200 Race st., Connellsville, Pa.
R. Burnside, Dist. B. I., New York Central, Oswego, N. Y.
C. F. Buell, Foreman, M. P. R. R., Nevada, Mo.
Chas. C. Butler, Asst. Gen. B. I., C., R. I. & P., Horton, Kan.
Jeremiah Cahill, D. B. Ins., Great Northern, 907 Second ave., So., Glasgow, Mont.
G. M. Calmback, W. S. & B. M., K. C. Southern, Pittsburg, Kan.
Jesse C. Campbell, M. K. & T. Ry., Parsons, Kan.
Edward Cantwell, B. F., Big Four, Bellefontaine, Ohio.
J. J. Casey, F. B. M., N. Y. Central R. R. Co., Weehawken, P. O., Union Hill, N. J.
J. H. Chastain, B. M. F., N. C. & St. L. R. R., Atlanta, Ga.
J. W. Churchill, B. M. F., M. P., Osawatomie, Kan.
James C. Clark, Gen. Foreman, P. & B. Ry., Reading, Pa.
James E. Clare, B. I., I. C. C., 541 N. Grove ave., Oak Park, Ill.
R. W. Clark, N. C. & St. L. R. R., Nashville, Tenn.
James P. Collins, B. I., I. C. C., 402 P. O. Bldg., Omaha, Neb.
Wm. J. Collins, B. I., S. P. & S., 1125 Missouri ave., Portland, Ore.
Albert H. Conley, F. B. M., Penn. R. R., 208 N. 4th st., Olean, N. Y.
P. Conley, Foreman, Galveston Terminal, Galveston, Texas.
Roy Connor, F. B. M., K. C. M. & O., 333 N. Market st., Wichita, Kan.
J. E. Cooke, M. B. M., Bessemer & Lake Erie R. R., Greenville, Pa.
Walter C. Coon, Dist. B. I., N. Y. Central, 33 Butler ave., Buffalo, N. Y.
H. M. Cooper, Gen. B. F., Lima, Ohio.
J. H. Cooper, Gen. B. I., Ann Arbor R. R., Owosso, Mich.
Alfred Cooper, G. F. B. M., St. Jos. & G. I. R. R., St. Joseph, Mo.
Charles C. Corns, B. F., C. & N. W. Ry., Belle Plaine, Ia.
William J. Corliss, B. I., Public Service Commission, Albany, N. Y.
P. E. Cosgrove, G. F. B. M., Elgin, Joliet & Eastern R. R., Joliet, Ill.
M. S. Courtney, Great Northern R. R., St. Paul, Minn.
R. A. Creger, B. M. F., N. P. R. R., 415 9th st., S. Brainerd, Minn.
R. P. Crimmins, F. B. M., Big Four R. R., Mattoon, Ill.
John O. Crites, G. B. I., Penn. R. R., 928 High st., Williamsport, Pa.
John Crowley, F. B. M., C., B. & Q., 1320 Penn st., St. Joseph, Mo.
Alex Cunningham, B. M. F., Missouri, Okla. & Gulf Ry., 538 S. 6th st., Muskogee, Okla.
James Daly, B. I., 479 E. State st., Hammond, Ind.
John J. Daly, F. B. M., P. & R. Ry., 1159 N. 5th st., Reading, Pa.
J. J. Davey, G. B. I., Northern Pacific Ry., St. Paul, Minn.
S. W. Davis, F. B. M., Southern Ry., 705 Park st., Bristol, Va.
Frank Davison, F. B. M., C. P. & St. L., Jacksonville, Ill.
G. C. Dean, Gen. Boiler Foreman, Wabash Railroad, Decatur, Ill.
W. H. Deen, F. B. M., C. & O. of I. R. R., 466 W. Main st., Peru, Ind.
Emil Derntins, B. M. F., U. P., 2539 La Fayette st., Denver, Colo.
H. J. Dickman, B. M. F., Atlantic Coast Line, 609 Day st., Florence, S. C.
J. Didier, F. B. M., Southern Ry., 125 S. Long st., Salisbury, N. C.
G. C. Duffy, Gen. F. B. M., 2736 Madison ave., Kansas City, Mo.
V. H. Dunford, Jr., F. B. M., Seaboard Air Line, Portsmouth, Va.
Hugh C. Dugan, B. M. F., P. & R. Ry., 464 Crescent st., Harrisburg, Pa.
P. Dugan, Gen. B. F., The Delaware & Hudson Co., 152 Hudson ave., Green Island, N. Y.
Daniel I. Dunkelberger, B. I., P. & R. Ry., Reading, Pa.
J. A. Doarnberger, F. B. M., N. & W. R. R., Roanoke, Va.
John Donnelly, F. B. M., D. & H., 123 3d st., Cohoes, N. Y.
David Doyle, F. B. M., C. & N. W. Ry., Fond Du Lac, Wis.
T. C. Dougherty, F. B. M., 308 N. Dallas st., Ennis, Texas.
Charles H. Douglas, F. B. M., Central Vermont, 36 Main st., St. Albans, Vt.
James L. Downs, F. B. M., N. Y. Central, 1017 Nelson ave., New York, N. Y.
Lewis Eberle, B. M. F., B. & O. R. R., Garrett, Ind.
Jerry Eder, F. B. M., C. & B. W., 1351 N. Avers ave., Chicago, Ill.
P. J. Egan, F. B. M., Erie, Meadville, Pa.
Joseph Eischeid, Gen. B. I., C. G. W. Ry., Oelwein, Iowa.
C. E. Elkins, Gen. F. B. M., 1212 West 11th st., Little Rock, Ark.
W. H. Evans, F. B. M., Georgia R. R., Augusta, Ga.
William F. Fantom, F. B. M., I. C. R. R., 7721 Eggleston ave., Chicago, Ill.
Stewart A. Fegan, B. I., G. T. Railway, 49 Elmwood ave., Toronto, Can.
Adolph Feisner, B. M. F., I. C. R. R., 623 Sumner st., Waterloo, Iowa.
John Feld, F. B. M., M. & St. L. R. R., Marshalltown, Iowa.
M. J. Fennelly, Dist. B. Ins., N. Y. C. Ry., 30 Magnolia ave., Jersey City, N. J.
John T. Fincane, Gen. F. B. M., Southern Pacific, Tex. La. Line, Houston, Texas.
Geo. G. Fisher, F. B. M., Belt R. R. of Chicago, 8711 Peoria st., Chicago, Ill.
Kearn E. Fogerty, G. B. F., C., B. & Q., 309 S. 12th st., Havelock, Neb.
D. G. Foley, F. B. M., D. & H. R. R., Green Island, N. Y.
E. F. Follin, G. B. F., G. N. R. R., Great Falls, Mont.
Willard Forbell, Asst. Foreman, L. I., 94 Main st., Astoria, L. I.
Martin J. Ford, B. I., D., L. & W. R. R., 125 Tenth ave., Scranton, Pa.
Charles E. Fourness, B. I., C., M. & St. P. Ry., Milwaukee, Wis.
William George, B. M. F., M. C. R. R., Michigan City, Ind.
W. F. George, Gen. Boiler Ins., Mobile & Ohio R. R., Meridian, Miss.
John German, Asst. Supv. of Boilers, N. Y. Central R. R. Co., Collinwood, Ohio.
R. C. Gibson, G. P. Insp., Kansas City So. R. R., 302½ Rose st., Pittsburg, Kan.
Archibald Giddings, F. B. M., D. & I. R. R., Two Harbors, Minn.
Peter J. Gibler, G. B. Foreman, G. C. & S. F. Ry., 720 N. Angline st., Cleburne, Texas.
T. Gilbert, F. B. M., G. S. & F. R. R., 811 Walnut st., Macon, Ga.
K. K. Gill, F. B. M., A. & W. P. & W. of A., 215 N. McDonough st., Montgomery, Ala.
Wm. J. Gillespie, Gen. Loc. & Boiler Insp., P. & L. E. R. R., McKees Rocks, Pa.
Gus H. Gjertsen, M. B. M., N. P., No. P. Gen. Office Bldg., St. Paul, Minn.
William Glenn, F. B. M., S. A. & A. P., 401 Hopkins st., Yoakum, Texas.
Thomas P. Golden, F. B. M., B. R. I., Chickasha, Okla.
Jno. W. Goodrich, B. M. F., C., M. & St. P. Ry., 1003 W. Main st., Ottumna, Iowa.
James T. Goodwin, Boiler Tube Expert, National Tube Co., Plainfield, N. J.
John T. Gorman, Dist. G. B. I., C., M. & St. P. Ry., Kansas City, Mo.
H. R. Gossett, F. B. M., V., S. & P., 108 Harriston st., Monroe, La.
W. R. Grace, Assist. Gen. B. Insp., Union Pacific, Omaha, Neb.
Fred S. Graefe, F. B. M., A. T. & S. F. R. R., San Bernardino, Cal.
Charles W. Grant, B. M. F., U. & D. R. R., 96 Chester st., Kingston, N. Y.
Frank Gray, Gen. Boiler Foreman, C. & A. R. R., 705 W. Mulberry st., Bloomington, Ill.
A. G. Green, U. S. Insp. Loco., 436 P. O. Bldg., Denver, Colo.
T. P. Green, Boiler Shop Foreman, Chicago, Terre Haute & S. E. R. R., 1315 5th st., Bedford, Ind.
Andrew S. Greene, G. F. B. M., Big Four System, Indianapolis, Ind.
Frank A. Griffin, Gen. Insp. Motive Power, Erie, 224 Santigo ave., Rutherford, N. J.
M. H. Griffin, B. M. I., L. I., 132 Herkimer st., Brooklyn, N. Y.
John Grosart, B. F., N. Y. C. R. R., 26 Bell st., Ashtabula, Ohio.
James G. Gunn, F. B. M., Illinois Central, 115 E. Elm st., Cherokee, Iowa.
Chas. E. Hagen, F. B. M., C. & W. I. Ry., 5553 S. Green st., Chicago, Ill.
George T. Hall, F. B. M., Erie R. R., Marion, Ohio.
J. M. Handlan, F. B. M., O. W. R. & N. Co., 588 Borthwick st., Portland, Ore.
John A. Handley, F. B. M., Term. R. R. Asso., St. Louis, Mo.
Robert J. Hanna, F. B. M., Erie R. R., 193 Pacific st., Paterson, N. J.
L. E. Hardeman, Gen. Supt., M. K. & T., 619 Chestnut st., Denison, Texas.
R. A. Harnig, F. B. M., Wabash, Moberly, Mo.
Carl H. Harper, F. B. M., C. N. R. R., Van Wert, Ohio.
Wm. P. Harrison, F. B. M., A. T. & S. F., La Junta, Colo.
Jeremiah Hart, F. B. M., C., B. & Q., 200 So. 7th st., Hannibal, Mo.
John Harthill, G. F. B. M., N. Y. Central R. R. Co., 1101 E. 145th st., Cleveland, Ohio.
James C. Hayes, F. B. M., M. & O. R. R., Tuscaloosa, Ala.
M. E. Healy, F. B. M., B. & O., Baltimore, Md.
Andrew Hedberg, B. M., C. & N. W. R. R., Winona, Minn.
J. H. Heessel, F. B. M., C., B. & Q., 1209 W. Jefferson st., Creston, Iowa.
Frank Hein, B. I., Lehigh Valley, 475 Fillmore ave., Buffalo, N. Y.
C. W. Heiner, Foreman, I. C. R. R., Mattoon, Ill.
C. L. Hempel, G. B. I., U. P. R. R., Omaha, Neb.
Frank J. Hickey, F. B. M., Southern Pacific Co., 1614 J st., Sacramento, Cal.
John E. Hidde, G. B. I., M. & St. L., Minneapolis, Minn.
P. J. Hiett, F. B. M., K. C. S. Ry., 1807 N. Grand ave., Pittsburgh, Kan.
Ernest E. Hillinger, F. B. M., N. Y. Central, 250 Wagner ave, Sloan, N. Y.
R. L. Hoffman, F. B. M., W. Maryland, 340 N. Mechanic st., Cumberland, Md.
E. H. Hohenstein, G. B. I., Rock Island Lines, Rock Island, Ill.
J. A. Holder, G. M. B. M., Seaboard Air Line, 931 Ann st., Portsmouth, Va.
C. A. Holly, Asst. F. B. M., 581 Walnut st., Elizabeth, N. J.
W. H. Hopp, F. B. M., C., M. & St. P. R. R., Dubuque, Iowa.
J. U. Houser, G. B. F., Oregon Short Line, 1029 N. Main st., Pocatello, Idaho.
E. J. Houston, F. B. M., I. C. R. R., 209 N. Maple st., Centralia, Ill.
H. Howard, B. Foreman, I. C. R. R., Jackson, Tenn.
Frederick J. Howe, Gen. B. F., C., B. & O., Aurora, Ill.
Wm. Hucabee, F. B. M., Kansas City Southern, 1543 Laurel st., Shreveport, La.
T. Hughes, B. M. F., Lake Erie & Western, Peru, Ind.
Edward Hunt, Asst. Gen. B. I., I. C. R. R., Central Station, Chicago, Ill.
E. L. Hunt, F. B. M., N. Y. Central, 145 E. 4th st., Oswego, N. Y.
P. S. Hursh, Gen. Boiler Insp., B. R. & P. R. R., DuBois, Pa.

Charles Hyland, 926 Francis st., Jackson, Mich.
Philip Inscho, F. B. M., L. & H. R. R., 21 Wheeler ave., Warwick, N. Y.
John Jacob, Gen. B. M. F., C., M. & St. P., 215 12th ave., Green Bay, Wis.
R. W. Janes, B. I., C., M. & St. P., Miles City, Mont.
H. R. Jeffries, F. B. M., U. P., 1211 Rowland ave., Kansas City, Kan.
F. J. Jenkins, Gen. B. I., Texas & Pacific, Dallas, Texas.
Lewis S. Johnson, F. B. M., Colorado So. Shops, 2521 Race st., Denver, Colo.
Jas. T. Johnson, Asst. G. B. I., A. T. & S. F. R. R., 1106 W. 40th Place, Los Angeles, Cal.
Harry Jordan, B. F., N. Y., O. & W., 10 Jordan ave., Carbondale, Pa.
E. Keathley, F. B. M., Southern, 412 N. Main st., Knoxville, Tenn.
J. C. Keefe, F. B. M., T. & O. C. Ry., 114 Liberty st., Bucyrus, Ohio.
William F. Keidel, F. B M., D. & H., 11 Center st., Oneonta, N. Y.
Hugh Kennedy, F. B. M., G. T. Ry., Toronto, Can.
Robert S. Kennedy, B. M. F., S. P. R. R., Portland, Ore.
John J. Keogh, G. B. F., Rock Island R. R., Moline, Ill.
William Kerr, Boiler Foreman, C. & N. W. R. R., Clinton, Iowa.
William Kieninger, G. F. B. M., A. T. & S. F. R. R., 319 Buinton Blvd., Topeka, Kan.
J. C. Kingley, F. B. M., N. Y., N. H. & H. R. R., 313 Howard ave, New Haven, Conn.
G. A. Kinzel, F. B. M., E. J. & E. R. R., Gary, Ind.
Frank H. Kissinger, B. I., Phil. & Reading R. R., Reading, Pa.
Charles M. Klink, F. B. M., C., M. & St. P. Ry., 3308 19th ave., S., Minneapolis, Minn.
F. W. Knauer, B. F., Detroit, Toledo & Ironton, Jackson, Ohio.
O. H. Koebernik, Gen. B. I., Nickel Plate, Conneaut, Ohio.
H. J. Koelz, F. B. M., C. R. I. & P., 2302 Fourth ave., Moline, Ill.
John Kovec, F. B. M., A. T. & S. F. Ry., Richmond, Cal.
Samuel T. Krahenbuhl, B. S. F., S. A. L., Atlanta, Ga.
Charles Kraus, F. B. M., Big Four, Indianapolis, Ind.
John Kremer, F. B. M., C., M. & St. P. R. R., Chicago, Ill.
M. C. LaFlare, F. B. M., B. & O. C. T., 220 E. 57th st., Chicago, Ill.
Wm. Lacey, Roundhouse Foreman, I. H. B., Hammond, Ind.
S. P. Lambert, D. B. I., C. & O. R. R., 1109 N. 23d st., Richmond, Va.
W. S. Larason, Foreman, Hocking Valley R. R., Columbus, Ohio.
William H. Laughridge, G. F. B. M., Hocking Valley R. R., Columbus, Ohio.
James Laysek, F. B. M., Great Northern, Superior, Wis.
Daniel E. Lehan, B. M. F., C. & N. W. R. R., Ashland, Wis.
Edward J. Lemcke, B. M. F., C., M. & St. P. Ry., 536 N. Troy st., Chicago, Ill.
A. C. Lenz, F. B. M., Ann Arbor, Oswosso, Mich.
Thomas Lewis, Gen. B. Insp., Lehigh Valley System, Sayre, Pa.
Jos. R. Libera, B. M. F., 448 Marshall st., Milwaukee, Wis.
Robert A. Lines, Stationary Boiler Insp., St. L. & S. F., Springfield, Mo.
Charles J. Longacre, Foreman B. M., Penn. R. R., 644 Monroe ave., Elizabeth, N. J.
A. N. Lucas, Shop Supt., C., M. & St. P. R. R., 3115 Sycamore st., Milwaukee, Wis.
D. A. Lucas, 1318 Ry. Exchange Bldg., Milwaukee, Wis.
W. H. Lucas, Traveling Boiler Insp., M. C., 67 Rosebury Place, St. Thomas, Ont.
Peter Lux, F. B. M., C. & N. W. R. R., 1101 N. Keeler ave., Chicago, Ill.
W. W. McAllister, G. B. F., Southern Pacific R. R., 348 E. 13th st., Tucson, Ariz.
A. L. McClintock, F. B. M., Big Four, 120 E. 7th st., Mt. Carmel, Ill.
H. J. McCracken, G. B. I., S. O. Ry. & W. P., 2215 P st., Sacramento, Cal.
F. E. McCune, F. B. M., C. R. I. & P. R. R., 432 W. 72d st., New York, N. Y.
John McDermott, F. B. M., I. C. R. R., Water Valley, Miss.
John McGarrigal, B. F., Illinois Central R. R., 1024 Broadway, Paducah, Ky.
L. P. McHugh, Gen. Boiler Insp., Mobile & Ohio R. R., 215 N. 18th st., Murphysboro, Ill.
John F. McKenna, F. B. M., N. Y., N. H. & H. R. R., Providence, R. I.
John McKeown, F. B. I., Erie R. R., 350 Payne ave., Galion, Ohio.
William A. McKeown, Dist. Insp., I. C. C., 82 Northwood ave., Columbus, Ohio.
T. J. McKerihan, F. B. M., Penn. R. R., 1103 2d st., Juniata, Pa.
Sam McLeod, F. B. M., D. & St. L. R. R., 3900 Lipan st., Denver, Colo.
Patrick McLoughlin, F. B. M., N. Y. C. R. R., 611 S. 3d st., Elkhart, Ind.
John McMahon, F. B. M., N. P. R. R., 715 W. Pine st., Missoula, Mont.
Frank McManamy, Asst. Director U. S. R. A., Washington, D. C.
S. A. McMonagle, F. B. M., M. P. R. R., 316 Lawn ave., Kansas City, Mo.
J. W. McNamara, G. F. B. M., L. E. & W. R. R., Lima, Ohio.
L. B. Mackey, A. T. & S. F. R. R., Albuquerque, N. Mex.
J. J. Madden, B. F., C. R. I. & P. R. R., 1108 7th st., Fairbury, Neb.
T. P. Madden, Gen. Boiler Insp., M. P. R. R., St. Louis, Mo.
Hugh Maguire, F. B. M., Lehigh & New Eng. R. R., Pen Argyle, Pa.
John J. Mahoney, G. F. B. M., U. P. R. R., 123 W. 27th st., Cheyenne, Wyo.
T. L. Mallam, F. B. M., Penn. R. R., 227 Norway ave., Trenton, N. J.
J. J. Mansfield, Chief Boiler Insp., C. R. R. of N. J., 74 Pearsall ave., Jersey City, N. J.
L. W. Markey, F. B. M., Swift & Co., Chicago, Ill.
F. Marks, F. B. M., Midland Valley R. R., 1634 Dorchester ave., Muskogee, Okla.
R. L. Marshall, F. B. M., B. R. & P. R. R., DuBois, Pa.
Nicholas W. Martin, F. B. M., M. & St. L., 52 Ash st., Minneapolis, Minn.
Eugene H. Marx, 4307 Oakenwald ave., Chicago, Ill.
John Matheson, Dist. Insp. Loco. Boilers, U. P. R. R., Salt Lake City, Utah.
F. A. Mayer, G. M. B. M., Southern Ry., Washington, D. C.
F. L. Meyer, F. B. M., Penn. R. R., 405 Grant st., Dennison, Ohio.
Chas. Miller, F. B. M., Virginian R. R., 904 9th st., Preston, W. Va.
J. F. Miller, G. B. I., P. M. R. R., 1073 Washington ave., Grand Rapids, Mich.
John Miller, B. M. F., Penn Lines West, 536 Walden ave., Toledo, Ohio.
L. H. Mims, B. I., Atlantic Coast Line, 223 Covington st., Florence, S. C.
James H. Minchan, Eng. House F., D., L. & W. R. R., 132 Mifflin ave., Scranton, Pa.
John Minzing, Boiler Insp., E. J. & E. Ry., Joliet, Ill.
James T. Mitchell, Gen. B. M. F., C. & S. R. R., 2434 Bryant st., Denver, Colo.
Lee Mitchel, B. M., I. C. R. R., E. St. Louis, Mo.
Thomas D. Mitchell, F. B. M., K. & I. Term., 656 S. 39th st., Louisville, Ky.
C. H. Mohr, F. B. M., M. P. R. R., 303 S. Ash st., Livingston, Mont.
Wm. N. Moore, F. B. M., St. L. R. R., 1929 N. Crawford ave., Chicago, Ill.
A. W. Morgan, F. B. M., O. S. L., Salt Lake City, Utah.
L. O. Moses, F. B. M., K. & M. R. R., Middleport, Ohio.
G. R. Munn, F. B. M., Atlantic Coast Line, Rocky Mount, N. C.
Martin Murphy, G. B. Insp., B. O. S. W. R. R., 1005 Ragina ave., Price Hill, Cincinnati, Ohio.
W. J. Murphy, G. F. B. M., Penn. R. R. Lines West, Fort Wayne Shops, Allegheny, Pa.
M. Murray, F. B. M., C. & P. R. R., Mt. Savage, Md.
C. N. Nau, Pres. & Gen. Mgr., United Boiler Heating & Foundry Co., 200 Wilcox ave., Hammond, Ind.
Robert H. Naylor, F. B. M., P. & R. Ry., 2160 N. Marston st., Philadelphia, Pa.
John T. Neary, B. F., C. & N. W. R. R., 1014 4th st., Antigo, Wis.
H. B. Nelson, B. M. F., M. P. R. R., Sedalia, Mo.
M. H. Newgirg, Gen. B. Insp., B. & O. R. R., Baltimore, Md.
Lewis Nicholas, Jr., Dist. Loco. Boiler Insp., I. C. C., P. O. Bldg., Indianapolis, Ind.
C. A. Nicholson, F. B. M., Southern R. R., 18 Ethel st., Atlanta, Ga.
E. J. Nicholson, F. B. M., C. & N. W. R. R., 1372 Island ave., Milwaukee, Wis.
George G. Nicol, Asst. G. B. I., A. T. & S. F. Ry., 514 W. Coal ave, Albuquerque, N. Mex.
J. K. Nimmo, Asst. Gen. B. Insp., A. T. & S. F. R. R., 1300 Tyler st., Topeka, Kan.
Wm. Norton, Boiler Foreman, I. W. R. R., 415 N. State st., Indianapolis, Ind.
Albert W. Novak, Dist. G. B. I., C., M. & St. L. R. R., 621 Penn Ave. N., Minneapolis, Minn.
Thomas J. O'Brien, F. B. M., P. & R. Ry., Philadelphia, Pa.
George A. O'Connor, Fed. Loco. Insp., 314 P. O. Bldg., San Antonio, Texas.
J. J. O'Connor, F. M. B., Southern Pacific Co., Ogden, Utah.
M. O'Connor, G. F. B. M., C. & N. W. R. R., Missouri Valley, Iowa.
O'Laughlin Thomas, G. F. B. M., Gt. Northern R. R., 626 Aurora ave., St. Paul, Minn.
Jos. V. Oliver, Boiler Insp., 97 Wolts ave., Lehigh Valley R. R., Buffalo, N. Y.
Thomas R. Oliver, Detroit & Mackinac Ry., E. Tawas, Mich.
Luke S. Ollis, G. B. Insp., B. & M. R. R., 104 Pearl st., Keene, N. H.
P. J. O'Malley, F. B. M., Lackawanna R. R., Chauncey ave., North Arlington, N. Y.
John J. Orr, D., L. & W. R. R., Scranton, Pa.
J. D. Osborn, F. B. M., A. T. & S. F. R. R., 515 Bissell ave., Richmond, Cal.
B. F. Owen, D. & R. G. R. R., Salt Lake City, Utah.
Chas. P. Patrick, G. F. M. B., Erie R. R., Cleveland, Ohio.
L. Peck, Boiler Insp., P. S. & N. R. R., Angelica, N. Y.
Geo. M. Petty, F. B. M., C. R. I. & P. R. R., 211 Louisa st., Shawnee, Okla.
C. F. Petzinger, M. B. M., Cen. of G. R. R., 742 Courtland ave., Macon, Ga.
John L. Phares, B. M. F., Western Maryland R. R., Elkins, W. Va.
Edwards Phillips, F. B. M., C. B. & Q. R. R., 556 S. West st., Galesburg, Ill.
Wm. Pollock, Gen. F. B. M., B. & O. R. R., 310 Renova st., Pittsburgh, Pa.
I. J. Pool, Gen. B. I., B. & O. R. R., 2133 Dennison st., Baltimore, Md.
L. J. Pool, Asst. B. M. F., Erie R. R., 1042 Grove st., Meadville, Pa.
E. C. Porter, B. M. F., C. & N. W. Ry., Clinton, Iowa.
Louis R. Porter, F. B. M., Soo Line, 802 20th st., Minneapolis, Minn.
J. A. Powell, F. B. M., Cen. of G. R. R. Shops, Columbus, Ga.
John F. Powers, F. B. M., C. R. I. & P. R. R., 726 Ellis Blvd., Cedar Rapids, Iowa.
John P. Powers, F. B. M., C. & N. W. R. R., 9050 1st st., Escanaba, Mich.
Thos. F. Powers, G. F. Boiler Dept., C. & N. W. R. R., 1129 S. Clarence ave., Oak Park, Ill.
Robert B. Praddock, G. B. I., R. R. Administration, Philadelphia, Pa.
E. W. Pratt, S. M. P., C. & N. W. R. R., 215 N. Oak Park ave., Oak Park, Ill.
Thomas Purcell, F. B. M., Santa Fe R. R., Winslow, Ariz.
G. H. Quick, F. B. M., M. K. T. T. R. R., 621 S. 3d st., Waco, Texas.
Frank J. Rahrie, F. B. M., B. & O. S. R. R., Chillicothe, Ohio.
J. N. Ralston, F. B. M., A. B. & A. Ry., 7632 N. Paulina st., Fitzgerald, Ga.
Henry J. Raps, G. F. B. M., I. C. R. R., 1206 E. 72d st., Chicago, Ill.
John F. Raps, G. B. Insp., I. C. R. R., 4041 Ellis ave., Chicago, Ill.
Joseph L. Reagon, F. B. M., Lehigh Valley R. R., 135 Howard st., Waverly, N. Y.
Edward J. Reardon, Dist. Insp. Loco. Boilers, I. C. C., 1303 Kimball Bldg., Chicago, Ill.
G. M. Rearick, B. Insp., 85 Germania st., Galeton, Pa.
T. J. Reddy, F. B. M., C. & E. W. R. R., 908 Main st., Danville, Ill.
A. J. Redmond, B. F., L. I. R R., 85 Forest ave, Rockville Centre, L. I.
J. G. Reese, B. I., C., M. & St. P. R. R., 320 3d st., Savanna, Ill.
Daniel S. Rice, F. Boiler Shop, Penn. R. R., 28th st. Shops, 6926 Bennett st., Pittsburgh, Pa.
F. J. Rice, Chief Boiler Insp., U. S. R. A. and C. & N. W. R. R., P. O. Box 233, Dunkirk, N. Y.
D. J. Richards, Layer Out, S. P. R. R., 1602 Nance st., Houston, Texas.
George N. Riley, National Tube Co., 7225 Mead st., Pittsburgh, Pa.
Edward H. Ritter, D. B. Insp., B. & O. R. R., 392 Andover st., Newark, Ohio.
Geo. W. Roan, F. B. M., C. & N. W. R. R., 406 W. Broadway, Eagle Grove, Iowa.
John A. Roberts, Asst. Gen. F. B. M., 52 Melrose ave., E. Lansdowne, Del. Co., Pa.
G. S. Robertson, Gen. F. B. M., F. W. & D., Childress, Texas.
G. P. Robinson, Asst. Engineer Am. Loco. Co., 1006 Union st., Schenectady, N. Y.
George Robinson, F. B. M., Penn. R. R., 2623 N. 6th st., Harrisburg, Pa.
Wm. E. Rollinson, 5907 University ave., Indianapolis, Ind.
Leonard C. Ruber, G. F. B. M., Baldwin Loco Wks., 15 Lexington ave, E. Lansdowne, Pa.
Horace Rushton, Assist. F. B. M., Pere Marquette, 10 Wilson ave., St. Thomas, Ont.
Robert Russell, Boiler Insp., G. T. R. R., 9 Irving st., Battle Creek, Mich.

Wm. H. Ruvane, B. F., S. P. L. A. & S. L. R. R., 107 W. 3d st., Los Angeles, Cal.
Clement Ryan, F. B. M., U. P. R. R., 4228 Mason st., Omaha, Neb.
Corbet A. Ryder, F. B. M., L. & N. R. R., 461 S. Lawrence st., Mobile, Ala.
T. N. Sadler, F. B. M., C. & N. W. R. R., South Kaukauna, Wis.
B. F. Sarver, F. B. M., Penn Lines W., 234 E. Woodland ave., Ft. Wayne, Ind.
Joseph B. Schmidlin, B. M. F., N. Y. C. R. R., 76 Langmeyer ave., Buffalo, N. Y.
Henry M. Schmitt, F. B. M., Northern Pacific R. R., Parkwater, Wash.
H. H. Service, Sup. of Welding, A. T. & S. F. R. R., 308 Jefferson st., Topeka, Kan.
Geo. A. Severy, 5537 Hyde Park Blvd., Chicago, Ill.
C. W. Shaffer, I. C. R. R., 4041 Ellis ave., Chicago, Ill.
W. J. Shank, Gen. B. F., C. & N. W. R. R., 210 W. 7th st., Boone, Iowa.
A. E. Sahule, B. M. F., D., M. & N. R. R., Proctor, Minn.
C. C. Shepard, Gen. B. Insp., Oregon Short Line, Box 14, Pocatello, Idaho.
Geo. M. Sherbert, F. M. B., Rutland R. R., Rutland, Vt.
Wm. B. Shoemaker, Supt., Hibben & Co., 7138 Constance st., Chicago, Ill.
L. D. Shumaker, F. B. M., A. C. L. R. R., 223 Market st., Montgomery, Ala.
W. E. Simcox, B. M. F., Southern R. R., Columbia, S. C.
Simms, Insp. Loco. Boiler, I. C. R. R., 1303 Kimball Bldg., Chicago, Ill.
Chas. A. Smith, Gen. F. B. Shop, C. G. W. R. R., 228 5th ave., Oelwein, Iowa.
D. P. Smith, F. B. M., C. B. & W., 711 W. 1st st., McCook, Neb.
Fred M. Smith, F. B. M., Southern R. R., 708 S. Main st., Princeton, Ind.
H. W. Smith, F. B. M., Pere Marquette R. R., 940 S. LaFayette st., Grand Rapids, Mich.
John Smith, F. B. M., L. E. R. R., McKees Rocks, Pa.
S. T. Songer, Gen. B. M. F., St. L. S. W., 1812 S. Cherry st., Pine Bluff, Ark.
W. B. Sprouse, B. M. F., Arizona Eastern R. R., Globe, Ariz.
W. B. Stallangs, Gen. B. M. F., I. C. R. R., Memphis, Tenn.
Daniel A. Stark, G. B. F., L. V. R. R., 611 S. Elmer ave., Sayre, Pa.
W. F. Stauch, G. B. Insp., B. & O. R. R., 23 E. Holiday st., Newark, Ohio.
L. W. Steeves, F. B. M., M. C. R. R., 76 Moore st., St. Thomas, Ont., Canada.
M. L. Steinbuck, B. M. F., C. & N. W. R. R., 318 Shelton st., Chadron, Neb.
Henry V. Stevens, Gen. B. F., A. T. & S. F. R. R., 414 Rural st., Emporia, Kan.
L. M. Stewart, F. B. M., Atlantic Coast Line, Waycross, Ga.
John E. Stokes, F. B. M., I. C. R. R., 300 S. Jefferson st., Clinton, Ill.
Wm. Strinsky, B. M. F., C. M. & S. P. Lines, Tacoma, Wash.
F. J. Sullivan, B. M. F., I. C. R. R., 197 Empire st., Freeport, Ill.
Joseph Sullivan, F. B. M., N. Y. C. R. R., 275 Hoyt st., Buffalo, N. Y.
E. J. Sweeney, Gen. F. B. M., N. Y. C. R. R., 421 Bauer st., Hammond, Ind.
T. J. Talbott, F. B. M., R. F. & P. R. R., 409 Marx st., South Richmond, Va.
John B. Tate, F. B. M., Penn. R. R., 200 Logan ave., Altoona, Pa.
Leo Thomas, G. B. F., B. & O. R. R., Newark, Ohio.
Peter Thompson, F. B. M., C. R. I. & P. R. R., 1315 Center st., Goodland, Kan.
J. E. Tierney, F. B. M., C., B. & Q. R. R., 4717 Gladys ave., Chicago, Ill.
Frank D. Timms, B. M. F., D. L. & W. R. R., 140 Blaine ave., Buffalo, N. Y.
Frederick Todtz, F. B. M., N. W. R. R., Omaha ave., Norfolk, Neb.
Theodore Tottenhoff, F. B. M., U. P. R. R., 902 E. 4th st., North Platte, Neb.
U. R. Tracy, F. B. M., C. R. I. & P. R. R., 1508 Wells st., Little Rock, Ark.
John Troy, F. B. M., Pere Marquette, 919 N. 6th st., Saginaw, Mich.
W. Tucker, F. B. M., I. C. R. R., 127 S. Magnolia st., McComb, Miss.
John J. Turner, F. B. M., B. & O. C. T., 4228 Baring ave., East Chicago, Ind.
Thomas Turner, Jr., B. M. F., P. C. C. & St. L. R. R., 1800 Wright st., Logansport, Ind.
E. C. Umlawf, Gen. F. B. M., Erie R. R., 50 Church st., New York city.
Wm. Urban, Gen. B. M. F., A. T. & S. F. R. R., 315 S. W. 4th st., Newton, Kan.
George B. Usherwood, Supr. Boilers, N. Y. C. R. R., 119 Wood ave., Syracuse, N. Y.
Otto C. Voss, Supt. Boiler Shop, Allis-Chalmers Co., 218 24th st., Milwaukee, Wis.
George Wagstaff, American Arch Co., 30 Church st., New York city.
Chas. H. Walker, F. B. M., West Shore R. R., 4639 Hudson Blvd., North Bergen, N. J.
Frank Walla, F. B. M., C., St. P. & O., 1405 Prairie st., Sioux City, Iowa.
H. J. Wanderberg, F. B. M., C., M. & St. P. R. R., 3321 Sycamore st., Milwaukee, Wis.
Victor Warner, F. B. M., N. P. R. R., 9226 Clyde ave., Chicago, Ill.
Leon E. Washburn, F. B. M., Erie R. R., 215 Willow ave., Susquehanna, Pa.
August Weis, F. B. M., C., Ind. & La. Ry., 1001 Roberts st., LaFayette, Ind.
Harry F. Weldin, F. B. M., Penn. R. R., 3026 N. 15th st., Philadelphia, Pa.
John L. Welk, G. B. Insp., Wabash R. R., 959 E. Eldorado, Decatur, Ill.
Jas. A. Wesson, Asst. Foreman, Pere Marquette R. R., 895 N. 3d ave., Saginaw, Mich.
A. L. West, Box 14, Marshalltown, Iowa.
Harry V. West, Gen. B. M. F., El Paso & S. W. R. R., 2511 Blvd., El Paso, Texas.
Benj. F. Whalen, F. B. M., C. I. & W. R. R., 346 N. Holmes ave., Indianapolis, Ind.
Chas. Whalen, F. B. M., N. Y. C. R. R., 535 Seymour st., Syracuse, N. Y.
M. I. Wharton, F. B. Shop, Penn. R. R., 149 9th st., Renovo, Pa.
Wm. Whitfield, F. B. M., Penn.-Chi. Term., 9508 Peoria st., Chicago, Ill.
C. L. Whitman, F. B. M., C. & N. W. R. R., 609 California ave., Huron, S. Dak.
P. P. Wigand, F. B. M., Southern R. R., Erwin, Tenn.
J. M. Williams F. B. M., Southern R. R., 1314 Selma ave., Selma, Ala.
Wm. J. Williams, A. F. B. M., Erie R. R., 289 North st., Meadville, Pa.
Frank. E. Wilson, F. M. B., F. E. C. Ry., St. Augustine, Fla.
J. T. Wilson, B. Insp., C. & M., St. P. R. R., 607½ Main st., Miles City, Mont.
E. R. Winnett, Gen. L. Insp., Los Angeles & Salt Lake, 4117 N. Griffen ave., Los Angeles, Cal.
John Wintersteen, M. M., Cornwall R. R. Co., 1138 Lehman st., Lebanon, Pa.
F. N. Witting, F. B. M., D. S. S. & A. R. R., 1123 N. 3d st., Marquette, Mich.
Willard E. Wolfe, Foreman, C. R. I. & P. R. R., Valley Junction, Iowa.
E. D. Woolridge, Gen. B. F., I. N. & G. N. Ry., 406 May st., Palestine, Texas.
Frank Yochem, B. M. F., M. P. R. R., 15 N. Holbrook st., Ft. Scott, Kan.
C. F. Young, B. I., L. S. & M. S. R. R., 920 Willard st., Elkhart, Ind.
D. G. Young, F. B. M., Southern R. R., 1205 Prince st., Alexandria, Va.
E. W. Young, Gen. B. Insp., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.
Reynold C. Young, F. B. M., C. & N. W. R. R., 323 3d st., Baraboo, Wis.
Emil Zeigenbein, G. F. B. M., M. C. R. R., 119 Gilbert st., Jackson, Mich.
Charles Zietz, F. B. M., D. & C. G. R. R., 1018 S. Corona st., Denver, Colo.
Wm. D. Zietz, G. F. B. M., Southern Pacific Co., 1270 Oak Grove ave., Los Angeles, Cal.
Paul Zitterman, F. B. M., A. T. & S. F. R. R., San Bernardino, Cal.
John R. Zureick, Gen. B. F., B. O. R. R., 57 Prosser ave., Sta. P., Cincinnati, Ohio.

SUPPLY MEN

R. E. Ahern, St. Louis, Mo.
R. B. Alforte, 2611 E. 10th st., Indianapolis, Ind.
C. E. Allen, 58 N. 2d st., W., Salt Lake City, Utah.
I. Allison, 165 Maple ave., Downers Grove, Ill.
W. L. Allison, Glenlake ave., Chicago, Ill.
A. C. Andresen, 1010 Fisher Bldg., Chicago, Ill.
J. T. Anthony, 30 Church st., New York, N. Y.
Edward Aplin, 2807 Union ave., Chicago, Ill.
G. A. Barden, Commercial Trust Bldg., Philadelphia, Pa.
W. S. Barnes, 547 E. 114th st., Cleveland, Ohio.
W. H. S. Bateman, Commercial Trust Bldg., Philadelphia, Pa.
R. W. Benson, 50 Church st., New York, N. Y.
G. A. Borden, Commercial Trust Bldg., Philadelphia, Pa.
L. P. Bower, 2001 Union Central, Cincinnati, Ohio.
H. A. Bowles, Elgin, Ill.
George R. Boyce, 3414 W. Adams st., Chicago, Ill.
A. B. Brown, 1938 Warren ave., Chicago, Ill.
H. H. Brown, 6 E. 39th st., New York, N. Y.
Tom Brown, 20 W. Jackson Blvd., Chicago, Ill.
I. A. W. Brubaker, Millersburg, Pa.
L. D. Buch, Evanston, Ill.
H. C. Bughman, Jr., S. Severance Mfg. Co., Pittsburgh, Pa.
Ed. Buker, 6351 Kimbark ave., Chicago, Ill.
J. E. Burke, 6 E. 39th st., New York, N. Y.
Fred W. Busche, 653 Clinton st., Milwaukee, Wis.
J. C. Campbell, 20 E. Jackson Blvd., Chicago, Ill.
M. Campbell, 118 Clinton st., Chicago, Ill.
J. L. Callahan, 1105 Peoples Gas Bldg., Chicago, Ill.
George R. Carr, 332 S. Michigan ave., Chicago, Ill.
John T. Carroll, 2125 Coventry Road, Cleveland, Ohio.
W. F. Caspers, 4740 N. Hamilton st., Chicago, Ill.
O. T. Caswell, Winona, Minn.
David J. Champion, 2490 Coventry Road, Cleveland, Ohio.
Wm. H. Champieux, 6104 Kimbark ave., Chicago, Ill.
Roy M. Chisson, 1550 Indiana ave., Chicago, Ill.
John O. Clark, 1765 Elston ave., Chicago, Ill.
B. C. Clements, 30 Church st., New York, N. Y.
A. W. Clokey, 157 Walnut st., Hinsdale, Ill.
W. H. Connell, Jr., 235 Oliver Bldg., Pittsburgh, Pa.
P. J. Conrath, 4414 Michigan ave., Chicago, Ill.
E. C. Cook, 327 La Salle st., S., Chicago, Ill.
R. S. Cooper, 600 W. Jackson Blvd., Chicago, Ill.
A. E. Conrow, 4319 N. Mozart st., Chicago, Ill.
H. S. Covey, Cleveland Pneumatic Tool Co., Cleveland, Ohio.
G. M. Crownover, 333 Railway Exchange Bldg., Chicago, Ill.
Scott Daffer, Great Pacific Hotel, Chicago, Ill.
W. H. Dangel, 325 W. Ohio st., Chicago, Ill.
H. Darby, 91 Kent st., St. Paul, Minn.
Harrison T. Davies, 2435 Grand ave., Milwaukee, Wis.
L. K. DeBus, 116 E. 3d st., Cincinnati, Ohio.
W. F. Delaney, Richmond, Va.
F. J. Dennis, 6100 Kimbark ave., Chicago, Ill.
Ethan I. Dodds, Vanadium Bldg., Pittsburgh, Pa.
Wm. Draper, Port Huron, Mich.
F. B. Evarts, 660 E. 82d st., Cleveland, Ohio.
J. W. Eviston, Railway Exchange Bldg., Chicago, Ill.
J. W. Faessler, Moberly, Mo.
H. K. Fenstemaker, 224 N. Carpenter st., Chicago, Ill.
E. S. Fitzsimmons, 122 S. Michigan ave., Chicago, Ill.
J. Rogers Flannery, Vanadium Bldg., Pittsburgh, Pa.
J. W. Fogg, 1732 Kolmar ave., Chicago, Ill.
F. B. Fretz, Box 68, Burlington.
H. F. Funney, Independent Pneumatic Tool Co., Pittsburgh, Pa
J. Philip Furbeck, 339 Railway Exchange Bldg., Chicago, Ill.
P. F. Gallagher, Vicksburg, Miss.
George A. Gallinger, 11 Broadway, New York, N. Y.
R. V. Gardner, 1033 W. Lake st., Chicago, Ill.
H. B. Gigandit, 801 S. Elizabeth st., Lima, Ohio.
Henry F. Gilg, 1223 Island ave., Pittsburgh, Pa.
E. J. Gimmison, 224 N. Desplaines st., Chicago, Ill.
J. T. Goodwin, 740 Canton ave., Plainfield, N. J.
C. W. Hancock, 50 Church st., New York, N. Y.
Frank C. Haase, 339 Railway Exchange Bldg., Chicago, Ill.
A. G. Hauck, 2232 Bogen st., Cincinnati, Ohio.
Stuart Hawley, 5519 Hyde Park Blvd., Chicago, Ill.
W. F. Heacock, 1020 McCormick Bldg., Chicago, Ill.
H. B. Hench, Jos. T. Ryerson & Son, Chicago, Ill.
R. J. Himmelright, 30 Church st., New York, N. Y.
William A. Hogan, 3031 Troost ave., Kansas, Mo.
George E. Howard, Flannery Bolt Co., Pittsburgh, Pa.
R. S. Howell, Bulletin Bldg., Philadelphia, Pa.
R. B. Howsley, 1124 Broadway, Indianapolis, Ind.

L. S. Hungerford, Jr., 158 W. Lake st., Chicago, Ill.
Walter A. Johnson, 11 Broadway, New York, N. Y.
E. W. Kavanagh, Jos. T. Ryerson & Son, Chicago, Ill.
Chas. E. Keenan, 165 Broadway, New York, N. Y.
J. W. Kelly, 515 N. Grove ave., Oak Park, Ill.
A. T. Kensey, 120 Broadway, New York, N. Y.
Elmer A. Key, 102 Merchants st., St. Louis, Mo.
Thos. F. Kilcoyne, 1229 Sixth ave., Huntington, W. Va.
R. F. Kilpatrick, 224 N. Clay st., Louisville, Ky.
John C. Kuhns, 7120 Luella ave., Chicago, Ill.
O. F. Ladkow, 1311 Fredericka Bldg., Milwaukee, Wis.
B. N. Law, 2236 Lumber Exchange Bldg., Chicago, Ill.
Albert C. LeQuellec, 120 Broadway, New York, N. Y.
Frank F. Leavenworth, 600 W. Jackson Blvd., Chicago, Ill.
William Leighton, 333 Railway Exchange Bldg., Chicago, Ill.
H. W. Leighton, Jr., 311 Peoples Gas Bldg., Chicago, Ill.
W. J. Leighty, 814 E. 44th st., Chicago, Ill.
James A. Lindsley, 4209 Sheridan Road, Chicago, Ill.
C. J. Little, 185 Jose Campu st., Detroit, Mich.
L. B. MacKenzie, 608 S. Dearborn st., Chicago, Ill.
Fred H. McCabe, 9 Water st., Lawrence, Mass.
M. M. McCallister, 230 E. 26th st., Erie, Pa.
C. A. McCune, 30 Church st., New York, N. Y.
J. T. McGrath, Bloomington, Ill.
Robert D. McIntosh, 4725 Park ave., Chicago, Ill.
Thomas Mahar, 12 Spring st., White Plains, N. Y.
Eugene H. Marx, 5408 Oakenwald ave., Chicago, Ill.
G. R. Maupin, Moberly, Mo.
L. P. Mercer, 1616 Fisher Building, Chicago, Ill.
Chas. B. Moore, Railway Exchange Bldg., Chicago, Ill.
Wm. P. Moore, Harrisburg, Pa.
J. P. Moses, 913 Buena Terrace, Chicago, Ill.
Ed. Muker, 6351 Kimbark ave., Chicago, Ill.
John P. Neff, 40 Church st., New York, N. Y.
H. C. Newton, Cleveland Pneumatic Tool Co., Chicago, Ill.
E. S. Nicholas, 114 Church st., Detroit, Mich.
John L. Nicholson, 630 Marquette Bldg., Chicago, Ill.
F. J. O'Brien, 2525 Cedar st., Milwaukee, Wis.
Clarence C. Oslerhout, 816 Floyd ave., Rome, N. Y.
Chas. F. Palmer, 5816 Blaedsten ave., Chicago, Ill.
F. J. Passino, 600 W. Jackson Blvd., Chicago, Ill.
J. W. Patterson, 4214 N. Hermitage, Chicago, Ill.
R. T. Peabody, 120 Broadway, New York, N. Y.
L. R. Phillips, 208 S. LaSalle st., Chicago, Ill.
Norman S. Phulin, 1550 E. 66th st., Chicago, Ill.
H. E. Pierce, Ewald Iron Company, Louisville, Ky.
E. S. Pike, 1432 Howard ave., Chicago, Ill.
Tom Plunkett, 158 W. Lake st., Chicago, Ill.
Tom Plunkett, Jr., 1550 Indiana ave., Chicago, Ill.
J. L. Ponic, 833 Golt avenue, Chicago, Ill.
Alfred Prather, Pioneer Bldg., Seattle, Wash.
T. H. Price, 12th and Alabama sts., Indianapolis, Ind.
Geo. T. Pront, 1689 10th ave., Huntington, W. Va.
J. D. Purcell, McCormick Bldg., Chicago, Ill.
J. C. Reid, 6040 St. Lawrence ave., Chicago, Ill.
W. S. Reid, 2873 Holmes ave., Chicago, Ill.
George N. Riley, National Tube Co., Pittsburgh, Pa.
W. M. Robertson, 1241 Clay st., Topeka, Kan.
Jay G. Robinson, 224 N. Desplaines st., Chicago, Ill.
Phillip Robinson, Peoples Gas Bldg., Chicago, Ill.
Wm. E. Rollinson, 5907 University ave., Indianapolis, Ind.
W. Scorls Rose, 50 Church st., New York, N. Y.
J. M. Rutherford, 608 S. Dearborn st., Chicago, Ill.
Gilbert E. Ryder, 30 Church st., New York, N. Y.
F. W. Sager, Midvale Steel & Ordnance Co.
W. C. Sayle, Cleveland Punch & Shear Works Co., Cleveland, Ohio.
L. W. Schnitzer, 1505 Peoples Gas Bldg., Chicago, Ill.
Arthur Scott, Cleveland Pneumatic Tool Co., Cleveland, Ohio.
C. A. Seley, McCormick Bldg., Chicago, Ill.
George A. Severy, 5537 Hyde Park Blvd., Chicago, Ill.
F. W. Shupert, Oxweld Railroad Service Co., Chicago, Ill.
W. A. Slack, 224 N. Carpenter st., Chicago, Ill.
George Slate, 6 E. 39th st., New York, N. Y.
E. N. Spencer, Imperial Brass Co., Kansas City, Mo.
Fred G. Squire, 537 S. Dearborn st., Chicago, Ill.
B. E. D. Stafford, Vanadium Bldg., Pittsburgh, Pa.
J. E. Stenger, 1738 Bryn Mawr Road, Cleveland, Ohio.
A. E. Stenzel, 326 Madison st., Chicago, Ill.
E. N. Stevens, Imperial Brass Co., Kansas City, Mo.
Stephen F. Sullivan, 346 Railway Exchange Bldg., Chicago, Ill.
L. S. Thomson, Widener Bldg., Philadelphia, Pa.
George Thompson, 30 E. 42d st., New York, N. Y.
Chas. Thulin, 1550 E. 66th st., Chicago, Ill.
Joseph A. Trainor, 1504 N. 18th st., Philadelphia, Pa.
T. J. Venning, 660 E. 82d st., Cleveland, Ohio.
H. H. Warner, 3612 Blaisdell ave., Minneapolis, Minn.
George Webster, 30 Church st., New York, N. Y.
Richard Welsh, 707 Great Northern Bldg., Chicago, Ill.
A. L. West, Box 14, Marshalltown, Iowa.
H. E. Wheeler, 308 Oxford st., London, Ont., Can.
George P. White, 6810 East End ave., Chicago, Ill.
William George Willcoxson, 6732 Ridgeland ave., Chicago, Ill.
A. W. Willcuts, 470 E. Euclid st., Detroit, Mich.
L. F. Wilson, Bird-Archer Co., Chicago, Ill.
W. M. Wilson, 4278 Drexel Blvd., Chicago, Ill.
Louis W. Withmeier, 10328 Clifton Blvd., Cleveland, Ohio.

LADIES

Mrs. I. A. Albrecht, Buffalo, N. Y.
Mrs. T. Allen, Chicago, Ill.
Miss Katherine Allen, Chicago, Ill
Mrs. W. B. Atkinson, Harrison, Ark.
Mrs. Cornelius Bader, Detroit, Mich.
Mrs. W. H. S. Bateman, Philadelphia, Pa.
Mrs. C. J. Baumann, New Haven, Conn.
Miss Carrie Beck, Grand Rapids, Mich.
Mrs. John F. Beck, Grand Rapids, Mich.
Mrs. A. J. Beland, Chicago, Ill.
Mrs. J. Bell, Chicago, Ill.
Mrs. W. D. Bell, Birmingham, Ala.
Mrs. C. J. Bennett, Logansport, Ind.
Mrs. G. Bennett, Verona, Pa.
Mrs. G. W. Bennett, Albany, N. Y.
F. E. and Miss Berry, Cleveland, Ohio.
Mrs. John Berry, Toronto, Canada.
Mrs. W. Black, Chicago, Ill.
Mrs. H. F. Boersig, Vancouver, Wash.
Mrs. L. Borneman, St. Paul, Minn.
Mrs. W. G. Bower, Chicago, Ill.
Mrs. George Boyce, Chicago, Ill.
Miss Claire Boyles, Chicago, Ill.
Mrs. A. C. Breed, Peoria, Ill.
Mrs. J. Brennan, Everett, Wash.
Mrs. J. B. Brest, Staples, Minn.
Mrs. Tom Brown, Chicago, Ill.
Mrs. C. H. Browning, Battle Creek, Mich.
Leta and Edna Browning, Battle Creek, Mich.
Mrs. John S. Bunting, Bakersfield, Cal.
Mrs. C. J. Burnside, Connelsville, Pa.
Mrs. R. Burnside, Oswego, N. Y.
Mrs. Charles C. Butler, Horton, Kan.
Mrs. Jesse C. Campbell, Parsons, Kan.
Mrs. C. E. Carry, Chicago, Ill.
Mrs. J. J. Casey, Weehawken, N. J.
Lillian and Katherine Chastain, Atlanta, Ga.
Mrs. J. E. Clare, Oak Park, Ill.
Mrs. J. E. Clark, Reading, Pa.
Mrs. R. W. Clark, Nashville, Tenn.
Mrs. J. P. Collins, Omaha, Neb.
Mrs. W. J. Collins, Portland, Ore.
Mrs. P. J. Conrath, Chicago, Ill.
Miss Beatrice Cook, Chicago, Ill.
Mrs. E. C. Cook, Chicago, Ill.
Mrs. J. E. and Miss Cook, Greenville, Pa.
Mrs. W. E. Cook, Buffalo, N. Y.
Mrs. H. M. Cooper, Lima, Ohio.
Mrs. P. E. Cosgrove, Joliet, Ill.
Mrs. G. M. Crownover, Chicago, Ill.
Mrs. Alex Cunningham, Muskogee, Okla.
Mrs. James Daly, Hammond, Ind.
Miss Helen Davey, Minneapolis, Minn.
Mrs. J. J. Davey, Minneapolis, Minn.
Mrs. S. W. Davis, Bristol, Va.
Mrs. H. J. Dickman, Florence, S. C.
Miss E. Didier, Salisbury, N. C.
Mrs. J. L. Didier, Salisbury, N. C.
Miss Mary Didier, Salisbury, N. C.
Mrs. John Donnelly, Cohoes, N. Y.
Mrs. Richard Doolin, Hammond, Ind.
Mrs. T. C. Dougherty, Ennis, Texas.
Mrs. C. H. Douglass, St. Albans, Vt.
Mrs. D. E. Dugdale, Washington, D. C.
Mrs. Thomas F. Dugan, Green Island, N. Y.
Mrs. G. Dullum, Chicago, Ill.
Mrs. J. L. Downs, New York, N. Y.
Miss M. C. Downs, New York, N. Y
Mrs. Lewis Eberle, Garett, Ind.
Mrs. Almeda S. Ennis, Philadelphia, Pa.
Miss R. Evans, Augusta, Ga.
Mrs. W. H. Evans, Augusta, Ga.
Mrs. W. F. Fantom, Chicago, Ill.
Mrs. S. A. Fegan, Toronto, Canada.
Mrs. M. J. Fenley, Jersey City, N. J.
Mrs. G. G. Fisher, Chicago, Ill.
Master E. J. Fitzsimmons, Chicago, Ill.
Mrs. E. S. Fitzsimmons, Chicago, Ill.
Miss A. Fletcher, Sacramento, Cal.
Miss A. E. Flynn, Chicago, Ill.
Mrs. Edward F. Follin, Great Falls, Mont.
Mrs. J. W. Fogg, Chicago, Ill.
Mrs. P. F. Gallagher, Vicksburg, Miss.
Mrs. W. George, Michigan City, Ind.
Mrs. K. K. Gill, Montgomery, Ala.
Mrs. M. Givn, Chicago, Ill.
Master E. Glenn, Yoakum, Texas.
Mrs. W. Glenn, Yoakum, Texas.
Mrs. T. P. Golden, Chickasha, Okla.
Mrs. J. W. Goodrich, Ottumwa, Iowa.
Mrs. J. T. Goodwin, Plainfield, N. J.
Mrs. J. Graham, Bucyrus, Ohio.
Mrs. Bessie Grant, Chicago, Ill.
Mrs. Frank Gray, Bloomington, Ill.
Mrs. A. S. Greene, Indianapolis, Ind.
Mrs. Frank A. Griffin, Rutherford, N. J.
Miss Helen Grossart, Ashtabula, Ohio.
Mrs. C. E. Hagan, Chicago, Ill.
Misses M. L. and G. Hagen, Chicago, Ill.
Mrs. Fred B. Hain, Chicago, Ill.
Mrs. L. E. Hardeman, Denison, Texas.
Mrs. Carl A. Harner, Van Wert, Ohio.
Mrs. John Harr, Newton, Kan.
Mrs. John Harthill, Cleveland, Ohio.
Mrs. Gus C. Hartwig, Springfield, Ill.
Mrs. L. C. Hasse, Congress Park, Ill.
Mrs. G. J. Hatz, Omaha, Neb.
Mrs. W. F. Heacock, Chicago, Ill.
Mrs. Frank Hein, Buffalo, N. Y.
Mrs. C. W. Hemer, Mattoon, Ill.
Mrs. Frank J. Hickey, Sacramento, Cal.
Miss Elsie Hohenstein, Rock Island, Ill.
Miss Bee Hopp, Dubuque, Iowa.
Mrs. Wm. Hopp, Dubuque, Iowa.
Mrs. H. Howard, Jackson, Tenn.
Mrs. T. S. Hursh, Dubois, Pa.
Mrs. C. Hyland, Jackson, Mich.
Mrs. Philip Inscho, Warwick, N. Y.
Mrs. R. W. James, Miles City, Mont.
Mrs. H. R. Jeffries, Kansas City, Kan.
Mrs. T. A. Jones, Joliet, Ill.
Mrs. E. Keathley, Knoxville, Pa.
Mrs. W. F. Keidel, Oneonta, N. Y.
Mrs. Wm. Keiser, Franklin Park, Ill.
Mrs. J. W. Kelly, Oak Park, Ill.
Miss Anna F. Kennedy, Portland, Ore.

Mrs. Robert S. Kennedy, Portland, Ore.
Mrs. Elmer A. Key, St. Louis, Mo.
Mrs. J. C. Kingsley, New Haven, Conn.
Mrs. O. H. Koebernik, Conneaut, Ohio.
Miss Anna Kovec, Richmond, Cal.
Mrs. J. T. Kovec, Richmond, Cal.
Mrs. S. T. Krahenbuhl, Atlanta, Ga.
Miss C. Lacey, Hammond, Ind.
Mrs. W. Lacey, Hammond, Ind.
Mrs. O. F. Ladtkow, Milwaukee, Wis.
Mrs. M. C. LaFlare, Chicago, Ill.
Mrs. M. S. Laranson, Columbus, Ohio.
Mrs. A. M. Lawhon, Knoxville, Tenn.
Miss E. Lenaburg, Chicago, Ill.
Mrs. Thomas Lewis, Sayre, Pa.
Miss Nan Lucas, Milwaukee, Wis.
Mrs. W. H. Lucas, St. Thomas, Ont., Canada.
Mrs. P. Lux, Chicago, Ill.
Mrs. F. J. O'Brien, Milwaukee, Wis.
Mrs. J. W. Patterson, Chicago, Ill.
Mrs. George Riley, Pittsburgh, Pa.
Mrs. E. S. Richardson, Oak Park, Ill.
Mrs. L. W. Schnitzer, Milwaukee, Wis.
Mrs. H. J. Warner, Minneapolis, Minn.
Mrs. C. C. McCandles, Chicago, Ill.
Mrs. H. G. McCracken, Sacramento, Cal.
Mrs. F. E. McCune and son, Chicago, Ill.
Miss M. McDermott, Water Valley, Miss.
Miss E. J. McDowall, Chicago, Ill.
Mrs. John McGarrigal, Paducah, Ky.
Mrs. L. P. McHugh, Jackson, Tenn.
Mrs. E. J. McKernan, Topeka, Kan.
Mrs. John McKeown, Galion, Ohio.
Mrs. John F. McKenna, Providence, R. I.
Mrs. Sam McLeod, Denver, Colo.
Miss Anna Mabry, Wichita, Kan.
Mrs. T. P. Madden, St. Louis, Mo.
Mrs. Hugh W. Maguire, Penn Argyle, Pa.
Mrs. John J. Mahoney, Cheyenne, Wyo.
Mrs. T. M. Mallam, Trenton, N. J.
Mrs. L. W. Markey, Chicago, Ill.
Mrs. R. L. Marshall, Dubois, Pa.
Mrs. G. Matheson, Chicago, Ill.
Miss Emma Mayer, Washington, D. C.
Mrs. W. U. Moore, Chicago, Ill.
Mrs. C. H. Mohr, Livingston, Mont.
Mrs. A. W. Morgan, Salt Lake City, Utah.
Mrs. J. F. Miller, Grand Rapids, Mich.
Mrs. J. H. Mineham, Scranton, Pa.
Mrs. Lee A. Mitchel, E. St. Louis, Mo.
Mrs. Robert H. Naylor, Philadelphia, Pa.
Mrs. C. A. Nicholson, Atlanta, Ga.
Mrs. E. J. Nicholson, Milwaukee, Wis.
Mrs. E. S. Nicholas, Detroit, Mich.
Mrs. Wm. Norton, Indianapolis, Ind.
Mrs. Albert W. Novak, Minneapolis, Minn.
Mrs. Thomas J. O'Brien, Philadelphia, Pa.
Mrs. J. J. O'Connor, Ogden, Utah.
Mrs. M. O'Connor, Missouri Valley, Iowa.
Miss R. O'Connor, Ogden, Utah.
Mrs. Thomas O'Laughlin, St. Paul, Minn.
Master Austin O'Malley, N. Arlington, N. J.
Mrs. J. N. Oliver, Buffalo, N. Y.
Mrs. Thomas R. Oliver, E. Tawas, Mich.
Mrs. John J. Orr, Scranton, Pa.
Mrs. Bertha O. Osborn, Richmond, Cal.
Mrs. W. L. Owen, Salt Lake City, Utah.
Mrs. A. G. Pack, Washington, D. C.
Mrs. E. P. Patrick, Cleveland, Ohio.
Master Charles E. Patrick, Cleveland, Ohio.
Mrs. L. Peck, Angelica, N. Y.
Mrs. C. F. Petzinger, Macon, Ga.
Mrs. J. J. Pool, Baltimore, Md.
Mrs. L. R. Porter, Minneapolis, Minn.
Mrs. J. A. Powell, Columbus, Ga.
Master Raymond Powell, Columbus, Ga.
Mrs. John P. Powers, Escanaba, Mich.
Mrs. G. H. Quick and baby, Waco, Texas.
Mrs. F. J. Rahrle, Chillicothe, Ohio.
Mrs. J. N. Ralston, Fitzgerald, Ga.
Mrs. H. J. Raps, Chicago, Ill.
Mrs. John F. Raps, Chicago, Ill.
Mrs. Joseph L. Reagon, Waverly, N. Y.
Mrs. E. J. Reardon, Chicago, Ill.
Mrs. G. M. Rearick, Galeton, Pa.
Miss M. Rearick, Galeton, Pa.
Mrs. D. S. Rich, Pittsburgh, Pa.
Mrs. D. J. Richards, Houston, Texas.
Mrs. E. F. Ritter, Newark, Ohio.
George and Fred Rosenberg, Chicago, Ill.
Mrs. Leonard C. Ruber, E. Lansdowne, Pa.
Mrs. H. Rushton, St. Thomas, Ont., Can.
Mrs. Robert Russell, Battle Creek, Mich.
Mrs. Corbet A. Ryder, Mobile, Ala.
Mrs. B. F. Sarver, Ft. Wayne, Ind.
Mrs. H. M. Schmitt, Parkwater, Wash.
Mrs. C. W. Shaffer, Chicago, Ill.
Mrs. L. D. Shumaker, Montgomery, Ala.
Miss V. M. Simcox, Columbia, S. C.
Mrs. Mary Simcox, Columbia, S. C.
Miss Mammie Simcox, Columbia, S. C.
Mrs. W. E. Simcox, Columbia, S. C.
Mrs. Ed. G. Simms, Chicago, Ill.
Miss Fred M. Smith, Princeton, Ind.
Mrs. W. J. Sprouse, Globe, Ariz.
Mrs. A. M. Spurling, Chicago, Ill.
Mrs. H. B. Stevens, Emporia, Kan.
Mrs. W. Strinsky, Tacoma, Wash.
Mrs. J. Sullivan, Buffalo, N. Y.
Mrs. J. B. Schmidlin, Buffalo, N. Y.
Mrs. Wanda Sidlar, Rock Island, Ill.
Mrs. F. W. Smith, Grand Rapids, Mich.
Mrs. D. A. Stark, Sayre, Pa.
Mrs. A. E. Stenzel, Congress Park, Ill.
Mrs. F. J. Sullivan, Freeport, Ill.
Mrs. John B. Tate, Altoona, Pa.
Mrs. Leo Thomas, Newark, Ohio.
Mrs. F. Todtz, Norfolk, Neb.
Mrs. T. Tottenhoff, North Platte, Neb.
Mrs. J. Troy, Saginaw, Mich.
Mrs. E. W. Turner, Knoxville, Tenn.
Mrs. J. J. Turner, East Chicago, Ind.
Mrs. Thomas Turner, Jr., Logansport, Ind.
Mrs. W. Urban, Newton, Kan.
Mrs. G. B. Usherwood, Syracuse, N. Y.
Miss N. L. Usherwood, Syracuse, N. Y.
Mrs. James R. Vance, St. Louis, Mo.
Mrs. O. C. Voss, Milwaukee, Wis.
Miss Grace Voss, Milwaukee, Wis.
Mrs. Harry D. Vought, Montclair, N. J.
Mrs. E. H. Wade, Chicago, Ill.
Mrs. H. J. Wandberg, Milwaukee, Wis.
Mrs. V. Warner, Chicago, Ill.
Mrs. August Weis, LaFayette, Ind.
Mrs. Harry F. Weldin, Philadelphia, Pa.
Mrs. J. A. Wesson, Saginaw, N. Y.
Miss Whitfield, Chicago, Ill.
Mrs. C. L. Whitman, Huron, S. Dak.
Mrs. Edna G. Williams, Selma, Ala.
Mrs. J. T. Wilson, Niles City, Mont.
Mrs. E. R. Winnett, Los Angeles, Cal.
Mrs. John Wintersteen, Lebanon, Pa.
Mrs. E. D. Wooldridge, Palestine, Texas.
Mrs. Frank Yochem, Ft. Scott, Kan.
Mrs. E. G. Young, Alexandria, Va.
Mrs. E. W. Young, Dubuque, Iowa.
Mrs. Emil Zeigenbein, Jackson, Mich.
Mrs. W. D. Zietz, Los Angeles, Cal.

GUESTS

C. W. Adams, St. Thomas, Ont., Canada.
J. W. Anderson, Winona, Minn.
Joseph O. Ashback, Deer Lodge, Mont.
P. H. Baker, Indianapolis, Ind.
W. C. Bell, Jackson, Mich.
C. M. Bentley, Chicago, Ill.
Harver Boltwood, Cleveland, Ohio.
C. E. Carry, Chicago, Ill.
W. R. Fegan, Toronto, Canada.
John Harr, Newton, Kan.
Norman Hopp, Sioux City, Iowa.
Rudolph Johnson, Stoney Island.
John Kennedy, Stratford, Ont., Canada.
C. A. Kothe, Youngstown, Ohio.
F. C. Kurraech, Kankakee, Ill.
A. M. Lawhon, Knoxville, Tenn.
R. Lacey, Hammond, Ind.
W. C. McCune, Toledo, Ohio.
F. B. McDonnell, Ft. Wayne, Ind.
Wm. Malthauer, Cleveland, Ohio.
Arthur Mathison, Chicago, Ill.
Wm. Mathison, Chicago, Ill.
W. E. Moran, Cincinnati, Ohio.
E. N. Nelson, Chicago, Ill.
Alonzo G. Pack, Washington, D. C.
A. P. Roe, General Passenger Agent, Lake Shore Railroad.
Charles Schycor, Oak Park, Ill.
A. E. Shaule, Proctor, Minn.
T. Duff Smith, Winnipeg, Manitoba, Canada.
John T. Stroud, Cincinnati, Ohio.
J. Urban, Chanute, Kan.
C. N. Walker, Chicago, Ill.
M. L. Zeider, Hammond, Ind.
Walter Ziegenbein, Jackson, Mich.

An idea is one thing; to make use of it is quite another. The law says that a suggestion is not an invention any more than a pumpkin seed is a pumpkin.

A combination of ground glass and oil cuts better than emery in grinding the seats of globe or check valves. Water will wash the glass, while emery sticks in the metal.

Remember that a chemical combination may result in a total change in the nature of the various elements involved. Thus water is entirely different in its physical makeup from the gases, oxygen and hydrogen, which form water when chemically combined in the proper proportions.

In this country a carpenter rips a plank by holding it with his knees and uses the saw with the teeth toward him. Not so in the West Indies. There the carpenter clamps the board down and rips it with the teeth of the saw held away from him. He holds the saw with both hands, and, strange to say, rips faster that way.

Supply Men's Exhibits at the Convention

Air Reduction Sales Company, New York.—Automatic acetylene generators, compressed acetylene gas welding apparatus and supplies.

American Flexible Bolt Company, New York and Pittsburgh.—American staybolt, American rivet, hollow bolts for marine boilers and bollow iron for locomotive fireboxes, reduced body solid bolts.

Charles H. Besley & Company, Chicago.—Full line of Besley taps for all purposes.

Bird-Archer Company, New York.—Harter circulator device, designed by Mr. Harter, of the Missouri-Pacific Railway, to improve circulation of locomotive boilers; locomotive compounds, including anti-scale, anti-foam and anti-leak, for railroad use.

Boss Nut Company, New York.—Rivets, carriage and machine bolts, Boss lock nuts.

W. L. Brubaker & Bros., New York.—Taps, dies and reamers.

Burden Iron Company, Troy, N. Y.—Burden iron rivets, Burden staybolt iron, Burden engine bolt iron.

A. M. Castle & Company, Chicago, Ill.—Exhibiting products of Lukens Steel Company, Champion Rivet Company, Reading Iron Company, Detroit Seamless Steel Tubes Company, American Rolling Mill Company, Lennox Throatless Shear Company.

Champion Rivet Company, Cleveland, Ohio.—Rivets, special design of rivet for driving without the necessity of calking.

Central Iron & Steel Company, Harrisburg, Pa.—Photographs of products made from plates turnished by the company, including boiler plates, firebox plates, ship plates, flanged heads, dished heads and special plates of all descriptions.

Chicago Pneumatic Tool Company, Chicago, Ill.—Boyer riveting and chipping hammers and holder-ons, Little Giant air drills, Little Giant electric drills and grinders.

Cleveland Pneumatic Tool Company, Cleveland, Ohio.—Air tools, Bowes air hose couplings, Cleco valves and fittings.

Cleveland Punch & Shear Works Company, Cleveland, Ohio.—Catalogues, circulars and other descriptive matter pertaining to boiler making machinery, such as punches, shears, bending rolls, plate planers, angle shears, etc. Catalogue of small-tool line, showing punches and dies, rivet sets, chisel blanks, etc.

Cleveland Steel Tool Company, Cleveland, Ohio.—Punches, dies, rivet sets, chisel blanks, drift pins.

Dearborn Chemical Company, Chicago, Ill.—Water-treating system, anti-foaming and anti-scale.

Draper Manufacturing Company, Port Huron, Mich.—Pneumatic flue welding and swedging machines, tools for repairing superheater ball units.

J. Faessler Manufacturing Company, Moberly, Mo.—Arch tube and superheater tube rolling and flaring expanders, sectional and roller tube expanders, tube cutters, etc.

Flannery Bolt Company, Pittsburgh, Pa.—Separate parts of the Tate flexible staybolt and tools of installation, new models of "F.B.C." flexible staybolt, showing the drilled Tate bolts and cap and sleeves welded to outer boiler plate.

Gary Screw & Bolt Company, Gary, Ind.

Globe Seamless Steel Tubes Company, Milwaukee, Wis.—Seamless steel cold-drawn boiler tubes and mechanical tubings for bushings and sleeves of valve gears, driver brake fulcrums and pins, equalizer fulcrums and pins, radius rod pins, etc., up to 3¾ inches outside diameter and any thickness of wall.

Hauck Manufacturing Company, Brooklyn, N. Y.—No. 15 hand kerosene torches with specially constructed burner without coils and all straight-lined oil passage ways, No. 5-A compressed air outfit and No. 4 and 8 hand pump and compressed air outfit; new type "Midget" forges burning crude or kerosene oil fuel equipped with Hauck special type furnace burner operated without pressure.

Independent Pneumatic Tool Company, Chicago, Ill.—Thor pneumatic chipping hammers, Thor one-piece, long-stroke riveting hammer, size "P" Thor drill, No. 8 Thor close-corner drill.

Ingersoll-Rand Company, New York.—Pneumatic tools.

Keller Pneumatic Tool Company, Grand Haven, Mich.—Sections of drills and chipping and riveting hammers in operation to show valve operation, scaling and chipping and riveting hammers, rivet sets, jam riveters, holder-ons, dolly-bars, sand and bench rammers, valve and valveless air drills.

Key Boiler Equipment Company, St. Louis, Mo.—Key safety handhole caps for watertube boilers, oil-still plugs, tube plugs, Master hole plates, tube expanders.

Locomotive Firebox Company, Chicago, Ill.—Models and plans of Nicholson thermic syphons as applied to locomotive fireboxes.

Locomotive Superheater Company, New York.

Lovejoy Tool Works, Chicago, Ill.—Lovejoy tube cutter, Perfection reversible staybolt chuck, Palmer pneumatic trip, sectional expanders, roller tube expanders, Lovejoy ball bearing jacks, "Okadee" blow-off valves.

McCabe Manufacturing Company, Lawrence, Mass.—Flanged flue sheets and corners flanged by the McCabe pneumatic flanging machine.

The Macleod Company, Cincinnati, Ohio.—Oil-burning rivet forge, ½-gallon Lucy Jane compressed air oil burner, oxy-acetylene welding and cutting equipment, 17-gallon oil-burning torch, compressed air type.

Mahr Manufacturing Company, Minneapolis, Minn.—No. 2 boiler shop torch (oil-burning), No. 15 oil-burning rivet forge.

National Railway Devices Company, Chicago, Ill.—Shoemaker pneumatic firebox door.

National Tube Company, Pittsburgh, Pa.

The Oxweld Railroad Service Company, Chicago, Ill.—Oxy-acetylene welding and cutting apparatus and supplies.

Page Steel & Wire Company, New York.—Armco iron welding rods and wire for oxy-acetylene and electric welding.

Parkesburg Iron Company, Parkesburg, Pa.—Charcoal iron boiler tubes; flue sheet, showing proper method of setting flues, showing each stage of operation for both ordinary beading and for welding.

Railway Journal, Chicago, Ill.

Rivet Cutting Gun Company, Cincinnati, Ohio.—Flexible rivet-cutting gun (Cincinnati rivet buster) with safety device consisting of tool retainer and rivet head catcher and hammer-head attachment, this tool devised to displace hand sledging for breaking staybolts and rivets.

Joseph T. Ryerson & Son, Chicago, Ill.—Seamless hollow staybolt iron with hole drilled through solid finished bar; complete flue shop machinery for the repairing and maintenance of boiler tubes, including flue cleaner, hot saw and expander, automatic safe end machine; furnaces, roller and pneumatic welders, swedgers, etc.

THE BOILER MAKER, New York.

The Scully Steel & Iron Company, Chicago, Ill.—Everlasting locomotive blow-off valve, Everlasting valves with gearing for washout installation, Ideal sectional spring tube expanders, Ideal roller tube expanders, Ideal sectional spring ferrule expanders, railroad tube cutters, pneumatic beading tools, pneumatic staybolt headers, pneumatic rivet sets, guaranteed hand tools, cold cutters, backing-out punches, chisels, etc., staybolt taps, threaded staybolts, hose couplings, Wangler rotary bevel shears, Scully rotary splitting shears, chain hoists.

Spencer-Otis Company, Chicago, Ill.

Torchweld Equipment Company, Chicago, Ill.—Welding and cutting equipment, portable and stationary plants, accessories and supplies.

Vulcan Engineering Sales Company, Chicago, Ill.—Hanna type pneumatic riveters for both locomotive boiler and mud-ring work.

The Welding Engineer, Chicago, Ill.

Prime Manufacturing Company, Milwaukee, Wis.—Prime composite washout plug.

Hilles & Jones Company, Wilmington, Del.—Circulars, catalogues, etc., illustrating punching and shearing machinery, bending rolls, etc.

Western Welding & Equipment Company, Chicago, Ill.—Oxy-acetylene welding and cutting apparatus (K-G Welding & Cutting Company, New York), electric arc welders (Lincoln Electric Company, Cleveland).

Nathan Manufacturing Company, New York.—Injectors, lubricators, boiler washers and testers, boiler checks, gage cocks, steam valves, reverse gear throttles, water gages.

Wilson Welder & Metals Company, Inc., New York.—Wilson's plastic-arc, welder control panel and specimens of welds on various metals, illustrating advantages of automatic control of current resulting in uniform heat at the arc.

Bastian-Blessing Company, Chicago, Ill.—Rego welding and cutting apparatus.

Duntley-Dayton Company, Chicago, Ill.—Pneumatic hammers and drills, electric drills, hose couplings, rivet cutter.

Imperial Brass Manufacturing Company, Chicago, Ill.—Imperial oxy-acetylene and oxy-hydrogen welding and cutting equipment, Imperial lead-burning equipments for all combinations of gases.

Railway Mechanical Engineer, New York.

U. S. Rubber Company, Chicago, Ill.

Goodyear Tire & Rubber Company, Akron, Ohio.

Key-bolt Appliances Company, Buffalo, N. Y.—Specimens of key-bolts.

Otis Steel Company, Cleveland, Ohio.

Ewald Iron Company, Louisville, Ky.

Rome Iron Mills, Inc., New York.—Rome hollow stayoblt iron, Rome superior solid staybolt iron, Rome perfection engine bolt iron.

Forester Paint & Manufacturing Company, Winona, Minn.—Various kinds of graphite, locomotive paint compounds, Forester's locomotive cement.

Penn Iron & Steel Company, Creighton, Pa.

Midvale Steel & Ordnance Company, Philadelphia, Pa.

S. Severance Mfg. Company, Glassport, Pa.

Steel Boilers and the Board of Trade

The Board of Trade's rules for the construction of steel boilers are being considered with the view to certain amendments being made; but, as the details are not yet ready for publication, and as the construction of a large number of boilers under the Board's survey is probable in the near future, a brief statement of the approximate changes which will result has been issued for the information of the surveyors, engineering firms, boiler makers and users interested therein.

It should be understood that the amendments apply only to boilers made of steel manufactured by firms in the Board's list in Section 108 of the Instructions as to the Survey of Passenger Steamships, the boilers being open for inspection during construction, the workmanship of the highest class as required for the lowest factor of safety, and the Board's existing rules complied with in all respects except as amended below. The following data are embodied in the statement referred to:

CYLINDRICAL SHELLS

$$\frac{s \times (t - 2) \times J}{2.8 \times D} = \text{working pressure,}$$

where s = minimum tensile strength of plates in cylindrical shell, in tons per square inch.

t = thickness of shell plates in thirty-seconds of an inch.

J = smallest calculated percentage strength of longitudinal joint, as determined by ascertaining (1) the plate percentage strength, (2) the rivet percentage strength, and (3) the combined plate and rivet percentage strength.

D = inside diameter, in inches, of the shell plates in the strake considered.

The maximum pitch of the rivets may be increased to 12¼ inches. In other respects the riveting should be in accordance with the Board's existing rules.

BUTT STRAPS

To be in accordance with the existing rules, excepting that, in every case, 1/8 inch is to be added to the thickness of the inside strap.

FLAT PLATES

The pressures allowed by the Board's rules, using the constants and formula in the printed instructions, may be modified as follows:

Constant 240.—On end plates up to and including 3/4 inch in thickness, the pressure obtained by the present rules should stand. On end plates 1 1/4 inches thick, the pressure allowed may be increased by 10 percent. For plates of intermediate thickness a proportionate increase of pressure may be allowed.

Constant 210.—As with constant 240.

Constant 165.—As with constant 240, but substituting 7/8 inch and 1 3/8 inch respectively for the thickness mentioned as allowable for constant 240.

Constant 150.—As with constant 240, but substituting 7/8 inch and 1 3/8 inches respectively for the thickness menmentioned as allowable for constant 240.

Constant 100.—Pressures allowed on combustion chamber plates supported by nutted stays are to be calculated by the present rules.

Constant 66.—Pressures allowed on combustion chamber plates supported by riveted stays to be calculated by the present rules for plates up to and including 1/2 inch in thickness. For plates 11/16 inch thick, the pressures allowed may be increased by 6 percent.

For plates of intermediate thickness, a proportionate increase of pressure may be allowed.

TUBE PLATES

In accordance with the Board's existing rules for the present.

COMBUSTION CHAMBER STAYS

In accordance with the present rules.

STEEL LONGITUDINAL STAYS

Stays having threads screwed not coarser than six per inch:

$$\frac{(D - 0.34)^2 \times 9{,}500}{\text{area supported}} \times \frac{s}{28} = \text{working pressure,}$$

where D = diameter of the stay over the threads in inches.
s = minimum tensile strength limit of stay, which should not exceed 28 tons per square inch.

The maximum stress per square inch allowed is not, however, to exceed 10,600 pounds for steel stays of 27 tons, and 11,000 pounds for steel stays of 28 tons tensile strength per square inch.

In cases where the ends are enlarged and the body of the stay is smaller in diameter than at the bottom of the threads the rule will be:

$$\frac{(d - 0.125)^2 \times 9{,}500}{\text{area supported}} \times \frac{s}{28} = \text{working pressure,}$$

where d = smallest diameter of the stay, in inches.
s = minimum tensile strength limit of stay, which should not exceed 28 tons per square inch.

The above is conditional on the longitudinal stays of double-ended boilers being efficiently supported at the midlength position.

STAY TUBES

For iron stay tubes as at present used, without the material having been tested in the Surveyor's presence, a stress of 7,000 pounds per square inch on the net section may be allowed.

FURNACES

The working pressure which may be allowed on corrugated furnaces should be ascertained by the following formula:

$$\frac{c \times (t - 1)}{D} = \text{working pressure,}$$

where D = external diameter at the bottom of the corrugation or camber, in inches.
t = thickness at the bottom of the corrugation or camber, in thirty-seconds of an inch.
c = 480 for furnaces of the Fox, Morison or Deighton section, and 510 for furnaces of the bulb section made by the Leeds Forge Company.

HYDRAULIC TEST

For boilers whose working pressure (W. P.) does not exceed 100 pounds per square inch:

W. P. × 2 = hydraulic test pressure in pounds per square inch.

For boilers whose working pressure exceeds 100 pounds, but does not exceed 200 pounds per square inch:

W. P. × 1 1/2 + 50 = hydraulic test pressure in pounds per square inch.

For boilers whose working pressure exceeds 200 pounds per square inch:

W. P. × 1 3/4 = hydraulic test pressure in pounds per square inch.

The foregoing brief statement is issued at the present time in order that makers and users of boilers may take immediate advantage of the amendments contemplated in the rules now under consideration.

Boiler designs should be submitted as early as possible, in order that any necessary amendments may be made before the material is ordered.

Legal Decisions Affecting Boiler Makers

RULING ON LEASE OF MACHINERY WITH OPTION TO PURCHASE

A corporation leased machinery with the right to purchase, and with the provision that if the lessor filed a petition in bankruptcy the title should pass to the lessee company. The lessee exercised its right under the contract and became the purchaser of the machinery, the lessor thereafter becoming bankrupt. In an action by the lessor's trustee, the Pennsylvania Supreme Court held that the lessee's liability to pay the price named in the contract became fixed, and a verdict for the price was properly rendered. (*Buell vs. Williamsport Staple Co.*, 104 *Atl.*, 572.)

WARNING EMPLOYEE OF KNOWN DANGER

The Illinois Appellate Division holds that where a master has knowledge, or is charged with knowledge, of the fact that slag removed from ore smelting furnaces is liable to explode when improperly or insufficiently cooled, it becomes his duty, as a matter of law, to warn a servant. In the particular case, the workman was engaged at the task of removing slag while it was yet hot from the furnaces in a wheelbarrow. The court held that the employer was responsible for the warning of the employee as to the danger incident to the work, since it was not shown that the employee had any knowledge that such slag was likely to explode. As a basis for damages for personal injuries due to such an explosion, evidence that six or more similar explosions had previously occurred was held sufficient. A finding was sustained that the defendant, in the exercise of due care, should have given notice of the dangers attending the work which the plaintiff was directed to perform. (*Stolarcz vs. Interstate Iron & Steel Co.*, 207 *Ill. App.*, 7.)

The Boiler Maker

Published Monthly by

ALDRICH PUBLISHING COMPANY, INC.

Member of The Associated Business Papers, Inc.

6 East 39th Street, - - - - New York

8 Bouverie St., London, E. C.

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor.

Branch Office
Boston, Mass., 294 Washington street, S. I. CARPENTER.

We regret that, owing to circumstances over which we had no control, it becomes necessary for us to apologize to our readers for the delay in publishing this issue of THE BOILER MAKER and also for the incomplete report of the Master Boiler Makers' convention which it contains.

As in previous years, arrangements were made through the secretary of the Master Boiler Makers' Association for the delivery into our hands within ten days after the close of the convention of a complete copy of the proceedings of the convention. This the stenographer who took the report of the convention failed to do, and we find it necessary to postpone publication of the remainder of the discussion at the convention until next month.

As predicted in our last issue, the Master Boiler Makers' convention was a record-breaker, eclipsing all previous conventions of the association, both in attendance and in the increase in membership. Over four hundred master boiler makers attended the convention, and a far greater number of members took part in the proceedings than ever before.

Several subjects of vital importance in railroad boiler work were adequately dealt with in committee reports, and these brought forth an unusual amount of discussion from both old and new members. The first subject discussed was the application of brick arches, and, while the conclusions of the committee which had this subject in hand were to the effect that such installations must necessarily depend upon local conditions and that no hard-and-fast rules can be laid down to govern the arrangement of brick arches for different types of locomotives and different services, nevertheless the general discussion of the subject showed many interesting and valuable methods of overcoming difficulties and securing the best efficiency in applying the brick arch to locomotive fireboxes.

Another subject which has been discussed by the association for a good many years was the use of oxy-acetylene and electric welding in boiler making and repairs. New developments are continually being made, not only in the welding apparatus but also in the methods of making welds, and the general opinion of the members of the association is strongly in favor of the more extended use of both methods of welding in so far as they can be applied without rendering boilers unsafe due to the uncertainty of the strength of the welds.

The thirty-first annual convention of the American Boiler Manufacturers' Association will be held at the Lafayette Hotel, Buffalo, N. Y., on Monday and Tuesday, June 23 and 24.

An interesting programme for the convention has been arranged, which includes reports from Mr. E. R. Fisk, of the Heine Safety Boiler Company, on the American Uniform Boiler Law Society; from Mr. Charles E. Gorton, chairman of the American Uniform Boiler Law Society, on the promulgation of the boiler code; an address by Dr. D. S. Jacobus, advisory engineer of the Babcock & Wilcox Company, New York, on methods of increasing boiler room efficiency; and discussion of a great variety of important subjects, among which are the following:

The registration of stationary type boilers only in the State to which they are shipped; also, registration of portable boilers only in the State where same are manufactured; the advisability of passing a resolution rescinding the A. B. M. A. Boiler Steel Specifications and the adoption of the A. S. M. E. specifications as the future standard of the American Boiler Manufacturers' Association; trade acceptances and the settlement of accounts receivable and also of accounts payable; annual depreciation for large tools and small tools; the necessity of using 6 percent on total investment as part of overhead charges; standardized data report form from all States; standardization of steam pressure for watertube and firetube boilers; uniform terms of payment as applied to contracts for watertube and firetube boilers; estimates made by members on standard 72-inch by 18-foot firetube boilers; uniform cost accounting; proper methods of obtaining labor costs in the shop on individual jobs; labor conditions as a result of the war and its effect upon business; apprenticeship.

In addition to the above, a number of topical questions will come up for discussion, including maximum and minimum heights for 72-inch by 18-foot horizontal return tubular boilers from the grates to the boiler shell for hand-fired setting; the minimum distance from rear head of same type and size boiler to inside of rear boiler wall for same kind of setting; the minimum height for a stack on same size boiler, assuming stack to be set directly on damper plate; relation of stack area to tube area for horizontal return tubular boilers; minimum thickness of side walls for brick setting of 72-inch by 18-foot boiler, also thickness for No. 1 firebrick lining in firebox for hand-fired setting; minimum thickness of side walls for brick setting of watertube boiler of about 500 horsepower stoker-fired, and thickness of No. 1 firebrick lining in furnace of same.

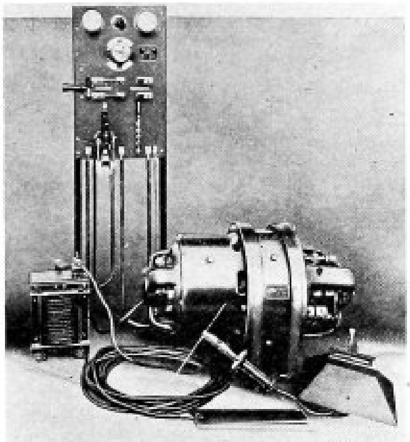
Engineering Specialties for Boiler Making

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

Electric Arc Welder for Both Portable and Stationary Use

After an exhaustive investigation into the requirements of machine shops, railroads and shipyards, the U. S. Light & Heat Corporation, Niagara Falls, New York, has developed a special line of electric arc welding machinery. For shops where it is practicable to bring the parts to be welded to within fifty or seventy-five feet of the welding apparatus, a stationary type is provided; also a light weight portable machine is made which may be taken direct to the work, whether it be in the shop or yard.

With a rated capacity of 4 kilowatts the U. S. L. arc welder gives 200 amperes direct current, or less, with an arc voltage of 17 to 22 volts and open circuit voltage of 35 to 65 volts. It is made in the form of a converter for use on 100 to 125 volts direct current circuits only, and in the form of a motor-generator for all other alternating current and direct current circuits. Weighing only 665 pounds, it is claimed that the converter delivers current at the arc through the arc stabilizing reactor with the remarkably high efficiency of 65 to 70 percent.



U. S. L. Arc Welder

The motor-generator type consists of a 7½ horsepower alternating current or direct current motor on the same shaft with a 4 kilowatt U. S. L. welding generator. Inherently regulated, compound wound, self excited and with drooping voltage characteristic, it is claimed that the generator, as well as the converter, produces an arc peculiarly suited to arc welding.

For portable use a truck equipped with motor-generator, or converter, panel, reactor, cover and cable reel is supplied. The truck, which is 28 inches wide, 55 inches high over cover and 54 inches long, weighs with complete equipment about 1,500 pounds.

Keller-Master "Sure-Lox" Chipping Hammer

The Keller Pneumatic Tool Company, Grand Haven, Mich., has recently placed upon the market a new type of pneumatic chipping hammer—the "Sure-Lox." The noteworthy feature is the manner of locking the handle to the cylinder. The "Sure-Lox" locking device eliminates the old style clamp-bolt. The handle is locked in a positive and rigid manner to the cylinder by means of a key inserted in the cylinder, engaging one of a series of slots in the handle. The key is held securely in place, and the entire locking arrangement covered by a spring clip. All projections or obstructions which might interfere with the convenient handling of the tool are eliminated. In this construction, it is claimed, all objections have been overcome which have heretofore characterized previous efforts to improve upon the clamp-bolt type.

"Sure-Lox" Chipping Hammer

Another exclusive feature claimed for the "Sure-Lox" is the extra long striking end on the piston, ⅝-inch instead of 3/16-inch, as commonly used in clamp-bolt types. The retaining wall in the cylinder is also correspondingly increased, making the hammer stronger and lengthening its life, as well as giving it increased adaptability for a wider range of work.

All moving parts are hardened, ground and lapped in size. All parts are made accurately interchangeable. The handles are drop forged, oil and heat tested and sand blasted. The hammers are furnished with open or closed handle, piston type of throttle valve, round or hexagon bushing, eight- or twelve-pitch thread on cylinder and handle, as specified. The "Sure-Lox" hammers are made in ten sizes ranging from an inch and one-quarter to four-inch stroke.

Faessler's New Line of Expanders

A new line of roller expanding and flaring tools has recently been developed by the J. Faessler Manufacturing Company, Moberly, Mo., a firm which for more than thirty-five years has devoted itself exclusively to meeting the needs of boiler makers. The additions to the Faessler output are designed for use on locomotive superheater tubes, stationary, watertube and marine boilers. Rigorous tests show, it is claimed, that they perform with ease a perfect job of rolling the tube tight in the sheet, and also flaring or belling to any desired angle up to 45 degrees.

The locomotive superheater expander is made in five standard sizes, namely, for 4½-inch, 4¾-inch, 5-inch and 5½-inch tubes. The stationary, watertube and marine boiler tube expander is manufactured for twelve sizes of tubes ranging from 2½ inches to 4 inches. Excepting that the latter is designed for larger tubes than the former, these two expanders are the same in construction and operation. As is the case with all Faessler tools, the parts throughout are of heat-treated and tempered steel and every bearing surface is carefully hardened.

These parts are as follows: Cage, mandrel, taper rollers, flaring rollers, spindle guide nut, cage plug, spindle guide, spindle guide roller, large roller bearing ring, small roller bearing ring, mandrel stop body, retaining spring ring, mandrel stop segments, and mandrel washer.

Both expanding and flaring operations are performed with the same tool, which is not removed from the tube until the work is completed. When the expander, which is self-feeding, has been inserted into the tube to the point of the flaring part of the flaring roller, the mandrel is to be turned to the right until the tube is rolled tight in the sheet. To obtain the flare, the mandrel stop is placed against the cage, which prevents the mandrel from entering the expander further, and then by continuing to turn the mandrel to the right the expander is forced further into the tube and the flare is produced. To remove the expander, the mandrel is turned to the left.

Faessler Locomotive Superheater Flue Expander

The tube is now rolled and flared. If beading is required, all that is necessary is to proceed with the ordinary hand or air-hammer tool.

The locomotive arch-tube and watertube boiler expander made in fifteen standard sizes for tubes of from 2½ inches to 4½ inches has a longer reach than the other tools. The collar is adjustable ordinarily up to a maximum distance of 10 inches between the base of the collar and the center of the rollers, or longer reach to order if so desired. Tightness of joint is assured, it is claimed, regardless of the thickness of the tube sheet or manifold and regardless of the distance between the inside and outside sheets. In operation, the adjustable collar on the cage shank is set back from the outside sheet to the distance the tube projects from the inside sheet and then the operator proceeds exactly as with the other tools already described.

The Faessler process does not pinch or thin the tube at the bottom of the flare and the outside cage of the sheet, it is claimed. These parts are left of the same thickness of gage as the body of the tube. The tools are durable, and this advantage, together with their effectiveness and ease in handling, makes Faessler's new expanders notable additions to the products of a firm of old and deservedly high reputation.

Boiler Inspector Perfects Steam Generator for Internal Combustion Motors

Harry Lacerda, of Jersey City, N. J., a boiler inspector with the Emergency Fleet Corporation, has recently perfected a steam generator for internal combustion motors used on automobiles for the purpose of preventing settlement of carbon on the piston heads and spark plugs.

The invention is now in use on cars running 8,000 miles and showing no indication of carbon. The steam generator does its work while the car is running, requiring no attention and at the same time increasing the mileage obtained from a gallon of gas.

Some day a man will come along and make use of the heat over the boilers on board ship to warm the vessel and in so doing save steam. Who will be the man?

W. H. Keller Introduces a New Valveless Air Drill

The New Keller master valveless drills, recently put on the market by the Keller Pneumatic Tool Company, Grand Haven, Mich., are built in non-reversible and reversible compound types, including a reversible wood-boring machine and a reversible grinder. The drills are driven by four single acting pistons arranged in pairs at right angles, each pair connected to opposite wrists of the crank shaft. Perfect balance insures smooth running and freedom from vibration. The one-piece cylinder body is provided with hand-hole openings, covered with removable plates, giving ready access to crank connections.

The connecting rods and pistons are made from Vanadium steel. The connecting rods are attached to the pistons by a ball and socket joint, secured by an ingenious-looking device which permits replacement of either the connecting rod or piston. The crank shaft is a drop forging, hardened and microground. The connecting rods are attached to the cranks by means of toggle joints secured with lock-nuts, which also serve to materially stiffen the rods.

Keller Valveless Air Drill

The main gear is cut from a solid blank of high-grade steel, enclosed in a separate case which, filled with grease, it is claimed insures independent and permanent lubrication. The spindle bearing is extra long with an additional bearing where it joins crank shaft, thus protecting the spindle and casing from heavy strain or severe work or when the drill is used in a horizontal position. The thrust is borne by a ball thrust bearing.

T. J. Hudson, of the Chicago Pneumatic Tool Company, has been appointed acting manager of the pneumatic tool sales division, effective April 15, succeeding F. H. Waldron, who returns to Minneapolis, Minn., as district manager of sales for the Minneapolis territory.

Oil and water will not mix; but after mixing water with lime you can then mix the result with oil.

Questions and Answers for Boiler Makers

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

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *6 East 39th street, New York City.*

Cone and Elbow Development

Q.—Kindly explain how to determine the line of intersection between an elbow and a cone. The cone is inclined and intersects the elbow on center. Also demonstrate how the patterns for the elbow are to be laid off. F. B.

A.—In Fig. 1 is illustrated a general view of this intersection, showing how the cone is considered to pass through the elbow to connect with the three sections *A*, *B* and *C*. Problems of this kind are met with in blower, heating and ventilating work.

Lay off the lines *x*-y and *Y*-*Z*, Fig. 2, at right angles to each other. With point *Y* describe the arc for the center of the elbow. Then locate the required sections of the elbow. Place the center line of the cone in its proper position, and about it draw the outline of the cone. With semicircle from point *m* as a center with the same radius as used in the drawing of the one in the elevation. Arrange the reference numbers in their proper positions in the plan, and where the horizontal projectors intersect the vertical ones drawn from the base line of the cone in the elevation locates points which lie on the ellipse.

Now imagine the lines 2-8, 3-7, 4-6 to form cutting planes which are passed through the elbow, as in Fig. 1.

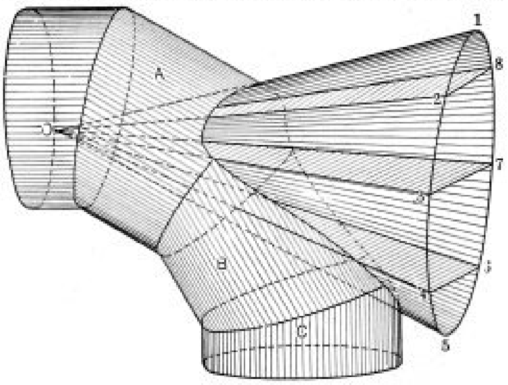


Fig. 1.—General View of Intersection Between Cone and Elbow

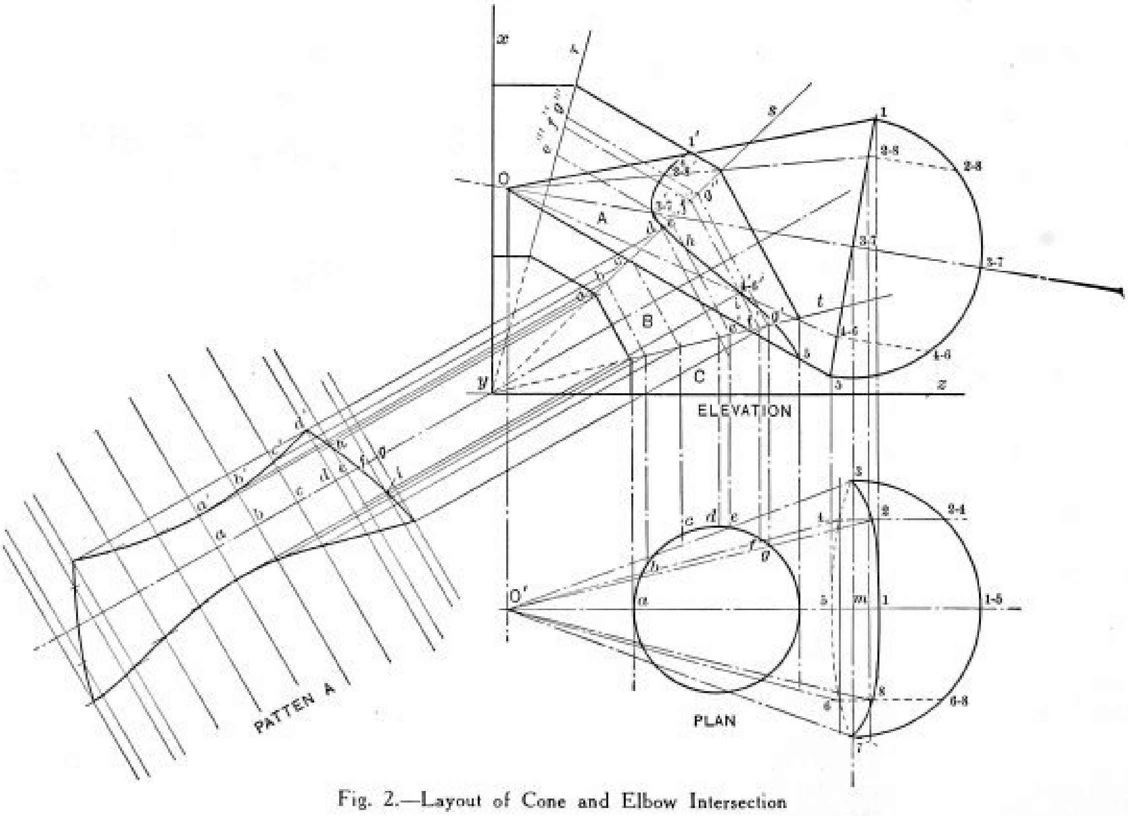


Fig. 2.—Layout of Cone and Elbow Intersection

point 3 on its base describe a semicircle and divide it into four equal parts. About the horizontal centerline in the plan draw the foreshortened view of the cone. Point *O* of the elevation is projected to *O'* in the plan view. The elliptical outline of the cone is determined by drawing a

Where these planes intersect the outline or curved surface of the elbow locates points on the line of intersection. To simplify the development work, consider these planes to pass through a cylinder as represented by the circle in the plan. Where the sides of the triangles cut or intersect the circle at c-f-g locates the points required for finding the miter in the elevation. Therefore, vertical projectors are drawn first to intersect the miter y-t locating the points c', f' and g'. Parallel to the axis of section B extend the lines to y-s at c''-f''-g''. Parallel to axis of A extend them to y-r at c'''-f'''-g'''. Where the radial lines O-1, O-2, O-3, O-4, etc., intersect these lines locates points on the miter line as at $2'$-$3'$-$4'$. If a separate development is made for the position of each elbow section a great deal of labor is involved.

The pattern for B is laid off at right angles to its axis. Spaces a-b, b-c, c-d, d-e, e-f and f-g are transferred from the circle in the plan view.

Bracing Boiler Head

Q.—Please advise regarding the necessity of bracing the top head of a vertical boiler of the type shown in the sketch. The head is of firebox steel 3/8 inch thick, tensile strength 55,000 pounds. The head is subject to a pressure of 115 pounds per square inch. The top course is 12 inches diameter, as per sketch, leaving 9½ inches on each side. For the pressure required, what do you consider the proper course and what style of bracing? J. H. M.

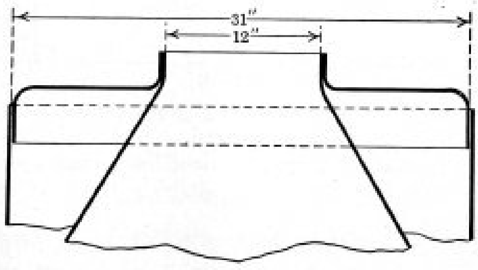
A.—An unstayed head, if circular in form as in a boiler head and supported at the edges, may carry safely a pressure figured according to the following formula:

$$P = \frac{3t^2T}{2r^2f},$$

in which P = allowable pressure in pounds per square inch.
t = plate thickness in inches.
T = tensile strength of plate.
r = radius of unstayed portion of head.
f = factor of safety.

The section of a head or segment of a head within 3 inches of the flange in large heads requires staying, the 3-inch distance from the flange receives its support from the riveted flanged section.

In this example the diameter of the head equals 31 inches, plate thickness 3/8 inch, ultimate tensile strength 55,000 pounds per square inch, factor of safety 6, and working pressure 115 pounds.



Sketch of Head of Vertical Boiler

In working this example consider first that the head is solid; substituting values in the formula, we have:

$$P = \frac{3 \times (.375)^2 \times 55{,}000}{2 \times (12\tfrac{1}{2})^2 \times 6} = \frac{23{,}203}{187.5} = 123.7 \text{ pounds.}$$

The radius of the unstayed part of the head equals $\frac{31 - 6}{2} = 12\tfrac{1}{2}$ inches, when the 3-inch section around the flange is subtracted from the diameter.

From the calculations with a high factor of safety of 6, the pressure of 115 pounds is allowable on the unstayed head.

The A. S. M. E. Code gives the following on the upper combustion chamber:

Par. 231. Maximum Allowable Working Pressure on Truncated Cones.—Upper combustion chambers of vertical submerged tubular boilers made in the shape of a frustum of a cone when not over 38 inches diameter at the large end, may be used without stays if figured by the rule for plain cylindrical furnace (Par. 239), making D in the formula equal to the diameter at the large end. When over 38 inches in diameter, that portion over 30 inches in diameter shall be fully supported by staybolts or gussets to conform to the provisions for the staying of flat surfaces.

Par. 239. Plain Circular Furnaces.—The maximum allowable pressure for unstayed, riveted, seamless or lap-welded furnaces, where the length does not exceed 6 times the diameter and where the thickness is at least 5/16 inch, shall be determined by one or the other of the following formulae:

(a) Where the length does not exceed 120 times the thickness of the plate,

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

(b) Where the length exceeds 120 times the thickness of the plate,

$$P = \frac{4{,}250 \times T^2}{L \times D},$$

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

Rule for Determining Pressure on Wasted Plate

Q.—Would like to know your method of finding the safe working pressure of boiler plates that are worn.

Example.—A locomotive boiler with shell plates 1 inch thick is worn in one place to a depth of 1/8 inch. Would it still be safe for a working pressure of 210 pounds? The joints are double butt straps with an efficiency of 82 percent.

Also would like to know if the pitch and diameter of the rivets for a patch on the shell are found in the same manner as rivets for a joint. A. M.

A.—According to the A. S. M. E. Code on existing installations for finding the maximum allowable working pressure, the following is given in paragraph 378:

"The maximum allowable working pressure on the shell of a boiler or drum shall be determined by the strength of the weakest course, computed from the thickness of the plate, the tensile strength of the plate, the efficiency of the longitudinal joint, the inside diameter of the course and the factor of safety allowed by these Rules:

$$\frac{TS \times t \times E}{R \times FS} = \text{maximum allowable working pressure, pounds per square inch.}$$

Where TS = ultimate tensile strength of shell plate, pounds per square inch.
t = thickness of shell plate in weakest course, inches.
E = efficiency of longitudinal seam, the method of determining which is given in Par. 181 of these Rules.
R = inside radius of the weakest course of the shell or drum, inches.
FS = factor of safety allowed by these Rules.

"379. Boilers in service one year after these Rules become effective shall be operated with a factor of safety of at least 4 by the formula, Par. 378. Five years after those Rules become effective the factor of safety shall be at least 4.5."

In this case, if the proper factor of safety were used in determining the safe working pressure in accordance with the rules mentioned, the following method of calculating the pressure allowed on the weakened shell plates may be employed:

Multiply the working pressure by the reduced thickness of shell plate in the weakest course and divide the product by the original plate thickness.

Thus, 210 × 7/8 = 183¾ pounds allowable working pressure.

The miles applied in determining the efficiency of longitudinal joints are also applied in calculating the strength of joints for boiler patches. As boiler patches are made in different shapes the aim should be to design the seam to give the strongest joint possible. The square or rectangular patch is of the weakest form, as the horizontal seam being single riveted or double riveted lap gives a very small joint efficiency. By making the patch so that the seams are diagonal, the joint is much stronger than for seams of the same kind placed horizontally. This is due to the fact that in a boiler the stress due to the pressure is twice as great on the longitudinal seam as on the girth seam; therefore, by placing the seams in the patch vertically and diagonally, the diagonal seam will have an efficiency lying between the efficiency of a horizontal joint and a girth joint.

To determine the strength of a diagonal joint, calculate the joint efficiency as for a longitudinal joint, then multiply this efficiency by the factor corresponding to the inclination used for the diagonal seam.

Factor	Angle of Diagonal Seam with Girth Seam, Degrees
1.51	30
1.42	35
1.34	40
1.27	45
1.20	50
1.15	55
1.11	60

The factors given are those usually met with.

Development of an Oblique Connection

Q.—Will you please give the layout of a connection between pipes 1 and 2 as shown in the enclosed drawing, Fig. 2. ANXIOUS.

A.—The plan and front elevation in Fig. 2 show an inclined pipe intersecting a vertical pipe of a larger diameter obliquely. In both views, the connection is foreshortened—that is, it is not shown in its true size and angle between them. Connecting the inclined pipe is an elbow which joins a transition or tapering piece. To bring the pipe connections into a view showing their true relationship, the construction in Fig. 3 is given.

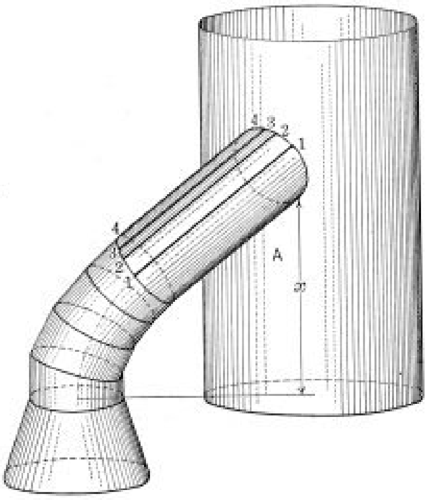


Fig. 1.—General View of Pipe Connection

In Fig. 3 the diagonal elevation is laid off at right angles to the pipe axes *a-b* of the plan view. The distance *x* is the vertical distance of the bottom of the oblique pipe *B* above the plane of the lower base pipe *A*. Draw in the center lines of the elbow and pipe *B*. Describe a circle as shown equal to the diameter of the pipe *B* and divide it into any number of parts. Project lines from these points parallel with the axis of *B*, making them of indefinite length.

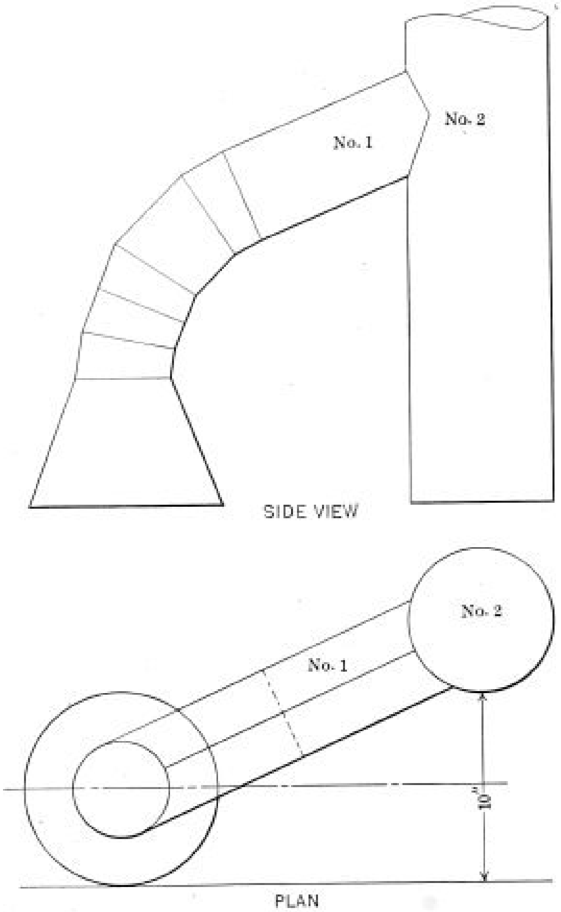


Fig. 2.—Outline of Pipes

In the plan and from point *b* draw a circle of the same size; divide it into the same number of parts and draw projectors from these points parallel with the center line *a-b* to intersect the circle or plan view of pipe *A*. From the points 1-2-3-4-5-6-7 on the circle draw lines at right angles to *a-b* to intersect the corresponding lines in elevation, thus locating points 1′-2′-3′-4′, etc., which lie on the miter line. The pattern for *B* and the opening in the pattern of *A* can now be laid off.

PATTERNS

Development of Opening in A.—Lay off the stretchout line *m-n* and on this line set off the lengths *a-b*, *b-c*, *c-d*, etc., equal to the arc lengths between points 1-2, 2-3, 3-4. From these points draw lines at right angles to *m-n*. On these lines locate the points 1″-2″-3″-4″, etc., by projecting lines at right angles to the pipe *A* from the points on the miter line. The stretchout of the pattern *A* equals the product of its neutral diameter times 3.1416.

Pattern B.—In this case the pattern is laid off at right angles to the cylinder. Its length equals the circumference of the pipe taken at the vertical layer of the plate. The

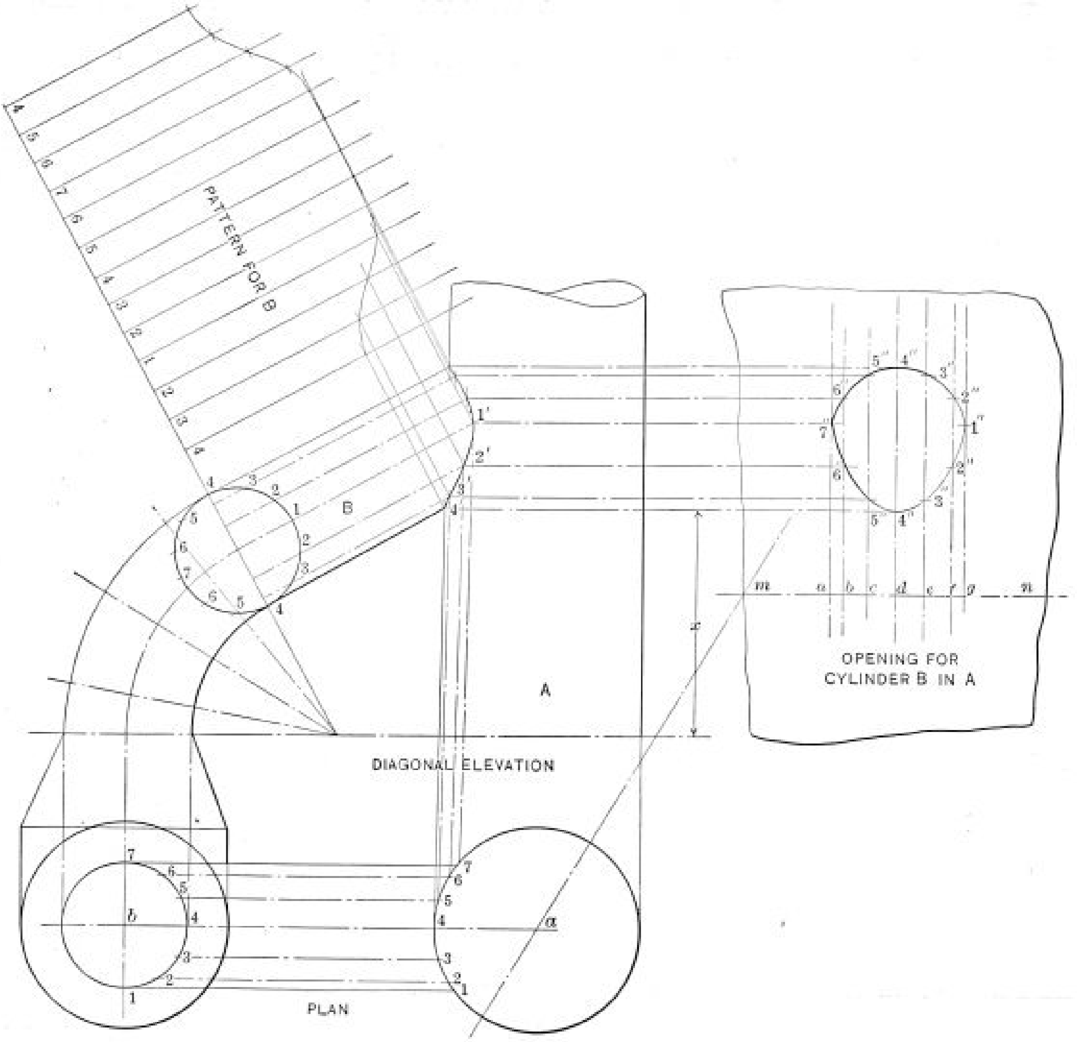


Fig. 3

stretchout is divided into the same number of equal divisions as contained in the circle for *B*. Projectors are then drawn in as shown. Allow for laps.

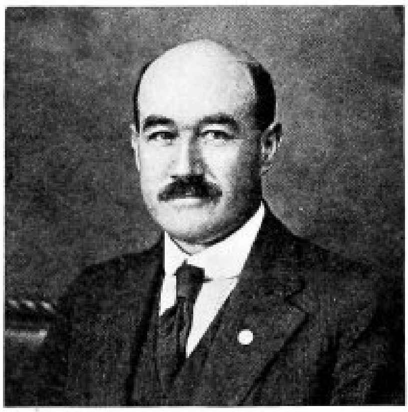
How to Design and Lay Out a Boiler—VIII

(*Continued from page* 161.)

be confused with the McGregor brace, for there is no splitting and doubling over of the bar as in the latter. One of the "toes" of the foot of brace (d) is *welded on*. In order to bring the palm of the brace in the proper position for attaching to the shell it must be twisted to the form indicated.

All of these diagonal braces as illustrated must be heated and bent to fit the boiler, after the shell and heads have been riveted together, and before the tubes are in place. The rivet holes in the shell end of the braces should not be punched before fitting, but scribed from the rivet holes in the boiler shell, because the exact length of the braces cannot be accurately determined beforehand.

Charles H. Stoddard, who for three years has been chief engineer of the Moore & Scott Iron Works, San Francisco, Cal., has been appointed consulting marine engineer of the Heine Safety Boiler Company, manufacturers of Heine watertube boilers, with plants located at St. Louis, Mo., and Phœnixville, Pa. Mr. Stoddard, who received his technical education at Stamford University, has had extensive experience in the designing of a great



Charles H. Stoddard

variety of machinery and vessels on the Pacific Coast, including boilers of all types, engines, steamers, tugboats, standard wheel and sidewheel river boats, war ships and cargo vessels.

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 Useful Lesson for the Apprentice

Figs. 1 and 2 show the elevation and plan of a coal-bucket body. Set out and divide the plan into equal parts. From the points found on the outer radius extend dotted lines up through elevation, touching the top, as shown. This gives the straight heights for the angles. Transfer these heights to the right angle, Fig. 3, and number 2, 3, 4, etc. Along the base set off the lengths of solid lines found in the plan. It will not be necessary to take the length of the line 1 from the plan, as this will be taken direct from the elevation.

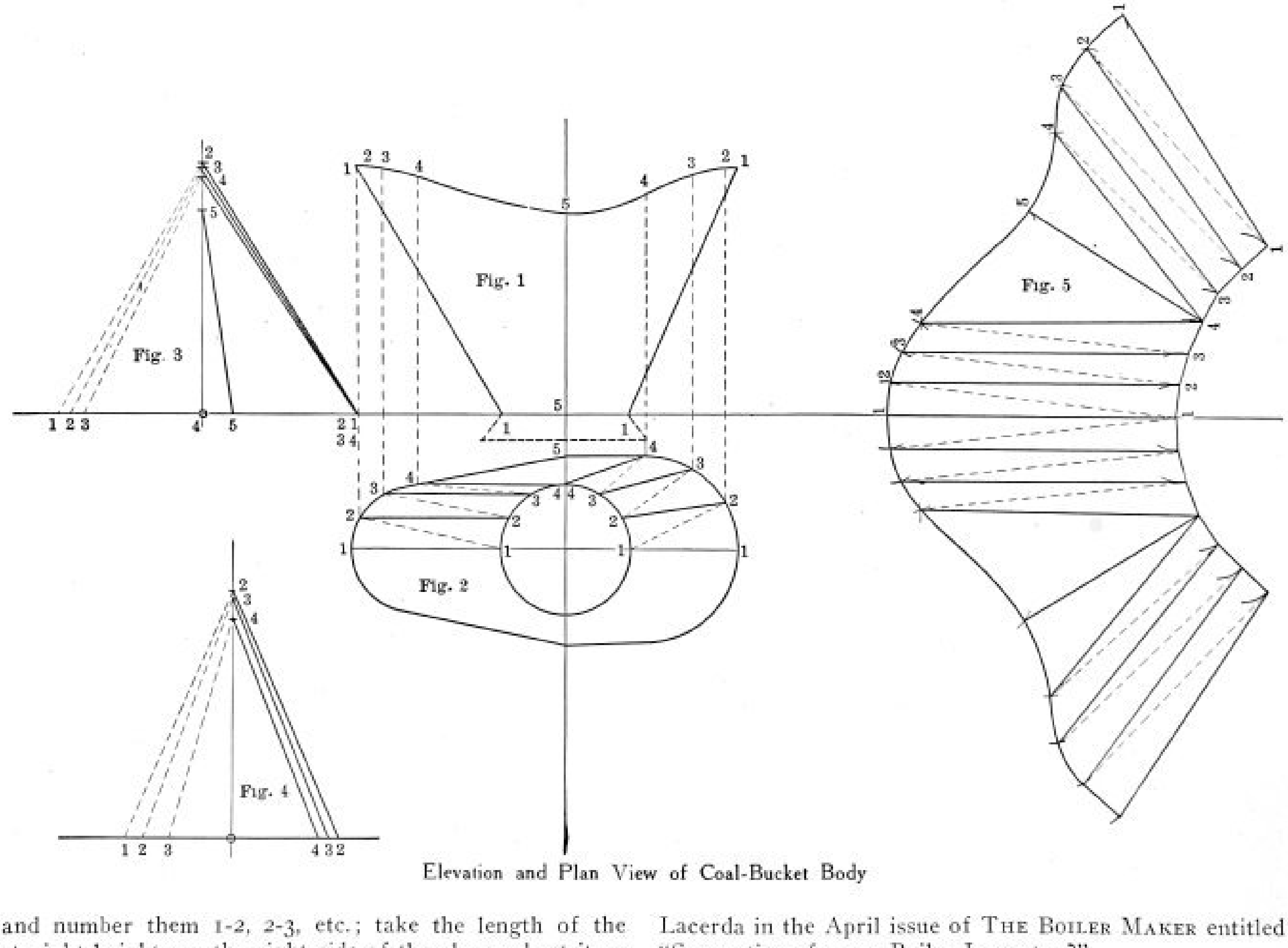
Now take the lengths of the dotted lines from the plan and set them off on the base of the right angle, as shown, and number them 1-2, 2-3, etc.; take the length of the straight heights on the right side of the plan and set it on the right angle, Fig. 4; transfer the length of the solid and dotted lines, as shown.

Set off the line 1-1 on Fig. 5 direct from the elevation. With the dividers set to the divisions found on the plan, strike an arc on each side of the line 1-1; take the length of the dotted line, 1-2, Fig. 3, and strike the arcs thus found; draw dotted line 1-2 on the pattern. The work is now nearly ready to strike another small arc at the bottom.

A little study of the pattern will show how easy will be the placing of the remainder of the lines. The pattern is laid out to the rivet-seam with allowance for wiring to be added at the top. The student will find it simple to apply a bottom and, if desired, an extended base in the shape of a truncated cone, as shown by the dotted outline on the base of the elevation.

This method can also be used in laying out the base of a stack when the base is rectangular at the bottom and fits to the radius of the boiler.

Lorain, Ohio — Joseph Smith.



Elevation and Plan View of Coal-Bucket Body

Suggestions from a Boiler Maker

May I request a little space in your valuable paper in replying to the short article contributed by Mr. Harry Lacerda in the April issue of The Boiler Maker entitled "Suggestions from a Boiler Inspector?"

I do not believe that the majority of shops make a practice of doing work that would not be accepted a few years ago. Of course there are some shops that do not have the proper equipment of tools to handle boilers expeditiously and they are, therefore, "up against it" in trying to compete with a modern shop. As a consequence, the work is rushed and, in doing so, the boiler makers slight their part of the work in order to gain time. Again, some concerns may take a contract too cheap. In this case, they rush the work by giving the foreman of a shop a price on the labor required to build the boiler; then there are still other firms that would prefer to lose on their contracts rather than to have the reputation of putting out a bad piece of work.

There are, of course, two sides to this controversy. Sometimes a boiler inspector may go beyond reason, although I must admit that, in my experience, I have met only one inspector who I can truthfully say did this. From my own experience, I would rather make repairs on a boiler under the boiler inspector any time than under the engineers and master mechanics of the plants.

RIVETING BOILERS

A Scotch marine or locomotive boiler, or, in fact, any other kind of a boiler, that has a seam of rivets or throat sheet below the grate line must be riveted and calked with the greatest care, since that part of the boiler has a lower temperature than the rest of the boiler. The upper part being much hotter than the lower part, the strain is increased necessarily on the lower seams. Some foremen always make it a rule to drive the first rivets at these seams and throat sheets, because the slack material will draw up much easier and tighter where the riveting is started than it will where the last few rivets are driven.

RIVETING A SCOTCH MARINE BOILER FURNACE

On Scotch marine boiler furnaces the place to start to rivet should always be at the bottom of the furnace. This has been proven by foremen with good experience who were capable of taking hold of a tool and showing the workmen how the work ought to be done. All foremen should have that kind of experience in order to run a shop.

CALKING TOOLS

In boiler work, calking tools should be ground to a round end. In the case of plates ½-inch thick or over, a calking tool should have a diameter close to 5/16-inch or ⅜-inch, and should be held in about the position shown

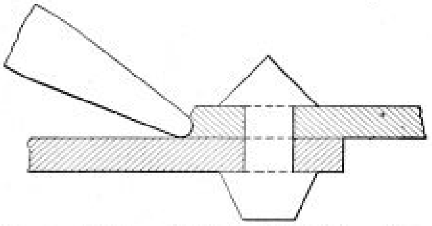


Fig. 1.—Position of Calking Tool When Plates are ½-Inch Thick and Over

in Fig. 1. If the plates are planed, one heavy fuller is all that is necessary to calk with; where the plates have been beveled with bevel shears, a fuller of half this thickness should be used at a light force of the hammer after the heavy tool has been used.

Split-calking should not be allowed, because it will spring the edge of the plate up and allow the pressure to get between the plates. A square tool only upsets the plate at the calking edge. The advantage of calking with a fuller is that it upsets the plate and, at the same time, lays the calking edge down against the bottom plate.

Bay City, Mich. GLENN LACEY.

Position Drilling Versus Separate Drilling

After due consideration, it would appear that the contribution of Flex Ible in the March issue is another nail in the coffin of bad workmanship. Its interest does not lie so much in its support of position drilling as in the fact that its author still has misgivings on the subject; also, it forms another pretty piece of internal and first-hand evidence that methods of boiler making in America differ in many respects from those in Great Britain.

Illustrative of what I mean is the commendation of hydraulic formers to take out the flats at the edge of plates and give them fair seating at the seam. Such flats used to be flogged up in the bad old days, and that any adjustment is necessary is evidence of inferior workmanship.

The rolls common in British shops *roll to true circular form* and do not leave flats at all. For proof of this, stress is laid in modern specifications on the point; the rolls used must roll to true cylindrical form, leaving no flats. Cover straps are hydraulic pressed in formers to exact curvature, the flanging press being utilized to do this hot.

Cold flanging or creep flanging, little by little, is also prohibited; plates must be flanged entire at a single heat, and subsequently entirely annealed. Indeed, it is much cheaper and easier to form them in this way because the results are absolute and duplicate, and the plates assemble perfectly without need for coaxing.

The seam that gaped ¼ inch and formed a receptacle for the cuttings of the drill is really interesting; there is an unconscious humor about such workmanship methods highly diverting. What sort of boiler maker pulled up the bolts and was satisfied to go on riveting does not transpire; he was no mechanic, that is very certain.

Flex Ible states: "A hole drilled on the flat should relieve the mind of both builder and purchaser, knowing, as they do, that every precaution has been taken." If he really believes that every possible precaution has been taken, that is his affair; such method is self-condemnatory.

It is not the Board of Trade who are responsible for position drilling; their activity is confined to the supervision of marine boilers—save in the event of explosion, when they form the committee of enquiry to allot responsibility. Fines of $500 on owner, or owner's engineer, in addition to full costs, help to stimulate proper supervision.

The majority of boilers are installed under the superintendence of a boiler insurance authority whose regulations are quite as stringent as the Board of Trade. As they assume responsibility for periodical inspection and upkeep and are by status held responsible for catastrophe due to bad design or poor workmanship, they exercise an influence upon boiler making quite unique. There is no other industry so closely supervised from outside, and this most often in its own interest.

Flex Ible asks, "What is position drilling?" and himself gives the answer, "Are all the holes in a boiler to be drilled after the boiler is rolled?" In addition to this, position drilling implies that all thicknesses which overlap are holed at one and the same time. This minimizes the apparently slow method of simple holing. "Holes drilled in the flat will meet all requirements of the present code, according to Flex Ible. "Why the extra cost of position drilling?"

The reason is, that position drilling is cheaper, more certain, gives absolute results at a minimum cost and pays the cost of the necessary plant over and over again in freedom from trouble—workshop and operating. It is the best method yet devised to secure the twin ends of superior workmanship and safety. The reason for its slow introduction is the vested prejudice of an entire trade who have to be coaxed and not driven. It was the same in Great Britain many years ago, but no boiler shop worth the name adopts any other method than position drilling, and the shops which use the superior method exclusively are going to win the confidence of boiler authorities, inspectors and engineers generally.

It is impossible with holes punched or drilled separately that exact correspondence in assembly can be secured;

it would be a superhuman feat if it could be done at all. The real reason which underlies all the controversy is the cost of the plant for position drilling and the doubt whether the product, irrespective of capital expenditure, will not cost more. On both these counts the present writer will pledge his reputation that rightly handled, *all things considered,* the prime cost of product will be reduced, not increased.

Only a few days ago, in conversation with an enterprising manufacturer, surprise was expressed that he had just spent $50,000 on special machines for his own peculiar methods of production, each machine being special both in design and built simply. The answer was rather startling: That machine cost $10,000; it does in 60 minutes what previously took 54 hours.

I do not contend that position drilling can give results quite so startling as this, but it is a fact that the best methods are the cheapest, even counting investment interest on plant. Come to that, why use steam boilers at all; they are expensive to buy, install and run, they represent large capital expenditure; but, and it is a big "but," they pay.

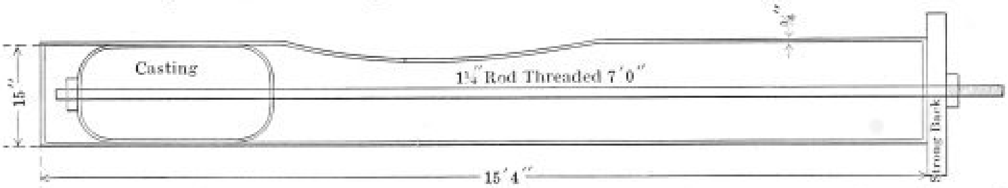
As time goes on, it will be found that any other method save position drilling will be prohibited. In the interim, it is the only method for high pressures and repetition work. To insure reputation, you must position drill, that is the moral.

London, Eng. A. L. HAAS.

Repairing a Collapsed Tube

A job which recently came to our shop proved to be such a puzzler for a while that I am presenting it to the readers of THE BOILER MAKER, as I believe it will be of interest to them.

There was submitted to us a seamless tube, 3/8-inch thick, 15 inches inside diameter and 15 feet 4 inches long. This tube had collapsed to a depth of about 3 inches for a length of 4 feet, as shown by the sketch. While we were figuring on just how to straighten the tube we ran across the casting shown in the sketch, which had been lying in the scrap pile. It was part of an air brake cylinder, I believe. This casting was about 1/4-inch smaller than the inside of the tube.



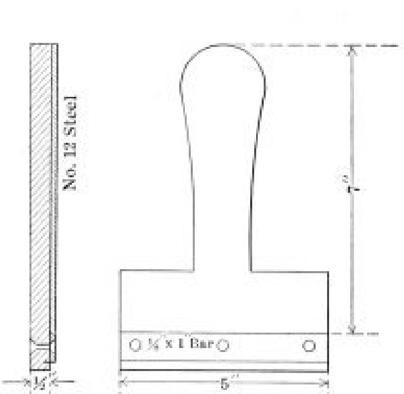


Fig. 1.—Collapsed Tube
Fig. 2.—Slotting Sheet Metal

We made the rod, as shown, and rigged it up with a strongback on the end of the pipe farthest from the crushed place. The pipe was then heated with a coal-oil blow torch and we pulled the casting through with the threaded rod. By keeping a concentrated heat just ahead of the casting, we made it work fairly well. We then put the tube into nearly as good shape as when new.

If any reader knows of an easier or better way to perform this job, I would like to hear from him.

In the January number of THE BOILER MAKER I noticed an article by Mr. C. H. Willey on "Slotting Sheet Metal." Herewith I present another method, which I believe is original.

We made quite a number of pieces, shaped as shown in the sketch. These pieces, which are of No. 12 steel, are afterwards pressed into lever grips. We at first punched them out, but found that this made a rough job, and it took so much time to dress them up in the emery wheel that a jig was made, as shown, out of 1/2-inch boiler plate. The pieces are sheared as near to size as possible, then clamped in the vise with the jog and trimmed with a ripper. The 1/8-inch x 1-inch bar on the jig acts as a stop to keep the sheet metal from slipping in the vise.

In cutting anything like this, the secret is to hold the tool about 1/8-inch above the edge of the jig. This tears the metal along the jig and a very smooth cut can be made without cutting into the jig. As many as one hundred of these pieces have been cut in the jig in a day and about fifty have been punched. This is quite a time-saver when it is considered that they require no dressing after cutting.

Joplin, Mo. S. R. W.

Re-Tubing a Locomotive Boiler

In the January issue of THE BOILER MAKER there was an article on the cheapest and best method of retubing locomotive boilers. In most shops where many tubes are removed they are equipped with a machine and air for cutting them off in the smokebox. When the dry pipe is removed, it is an easy matter to take the flues out through this hole, after they are cut in the front end and the beads cut off on the firebox end. But before removing the flues it is best to make a small roller that will bolt to a couple of the studs around the hole, or bolt a piece of board over the lower part of the hole so as not to cut the dry pipe hole, making it difficult to get a tight joint there when it is put back.

A man should be placed inside the boiler to hold the flues toward the opening while they are being knocked out of the back flue sheet, and another man should be in the smokebox to pull the flues out.

If the dry pipe is not removed the flues will have to be taken out of one of the flue holes. Select a hole near the center of the front flue sheet, and enlarge it enough to allow the flues to pass through it. If a reamer is not available this can be done with a round nose or a flat chisel bent on an angle so that it will cut the entire thickness of the sheet. It is not advisable to enlarge the hole much over 1/4 inch in diameter, as it will weaken the sheet.

If the flues have a large amount of scale on them they may pull through the hole with difficulty, especially those on the outside rows where the water from the injectors comes in contact with the flues as it enters the boiler. But this can generally be knocked off with a hammer, enough at least to allow the flues to pass through the hole.

The hole will probably be rather rough and have lumps in it here and there after chipping. But after the entire set of flues has passed through it, it will be an easy matter to remove these with a file and pair of flue rollers, if any roughness remains. You will find the flues have smoothed the holes to a certain extent.

If there is no cutter, the flues will have to be ripped in both ends and knocked back into the back flue sheet until they drop down inside the boiler in the front end, when they can be removed through the big hole. If the boiler is equipped with superheated flues, as most of the large engines of to-day are, and they are to be removed also, it is an easy matter to get the small flues out of the larger holes after the superheater flues are removed.

To remove the superheater flues proceed in the same manner as you would if you were taking out the small flues; that is, after cutting them off inside the front flue sheet, or ripping them and knocking them back, enlarge one of the holes by chipping some of the metal out with a flat chisel and pull the flues through it.

After the flues are all removed, they are placed in a rattler to remove the scale from them, after which a new piece about 6 or 8 inches is welded on to them if they are not too thin or pitted too badly to be used again. They are then cut to the required length and put back into the boiler.

After the flues are removed the burrs or flue ends that remain in the front flue sheet should be removed. All loose dirt and scale should be removed, and the boiler scaled with an air hammer and blunt tools that will not cut into the sheets.

While the flues are in the rattler, and being welded, all rough edges should be removed from the back flue sheet with a rough half-round file and the ferrules applied. A gage should be tried in each hole after the ferrule is applied to see if it is large enough for the flue to enter. This gage can be made of a piece of flue about 8 inches long and swagged to the same size on one end that the flues are to be swagged.

If the flue sheet is warped badly, the gage should fit loosely into the hole, or otherwise the flues which strike some of the holes on an angle, on account of the bulge in the sheet, will be tight, requiring the copper ferrule to be rolled more, which takes considerable time when the flue has to be knocked back and the ferrule rolled. If the sheet is not warped very much, the ferrules need not be rolled so much.

The flues should be a snug fit, but not too tight; they should drive through the ferrules with about 3 or 4 blows from a 10 to 12-pound sledge.

After the ferrules are all finished, the length should be taken, or before they are applied, if the flues are ready to be cut. The length can be taken with a long stick made with a shoulder on one end so it will catch on the outside of the back flue sheet, while a mark is made on the other end of the stick, flush with the outside of the front flue sheet. The stick should not be allowed to sag in the middle or the flues will be too long. It is not necessary to measure every hole, but is safest to measure every other hole, as there is considerable difference between the length, especially when the sheets are warped badly. Beginning with the shortest length, number them 1, 2, 3, etc. Be sure to mark the number over each hole so as not to get the wrong flue in the wrong hole when you are applying them. Also mark the flues.

After the lengths of all the flues are taken, the marks on the stick should be set out a half inch to allow for the bead, which will give you one-quarter inch at both ends, and the flues cut to the required length and annealed on both ends so they can be worked without breaking. The flues are now taken to the engine and are ready to be applied.

Before applying the flues, a copper ferrule should be rolled into the large hole through which the flues were removed. It should be rolled enough so the flue will pass through it.

A man should be put inside the boiler to transfer the flues back of the steam pipes, if they are not removed, and to place them into the back flue sheet.

After the flues are stuck into the boiler they should be set in the firebox end. A large-headed bolt should be placed in the front end of the flues when driving them into the back flue sheet, so as not to damage the flue, which is very soft after being annealed.

If the flue sheet is warped badly, allow a good one-quarter inch for a bead. If it is not warped or cut from the beading tool, a short one-quarter inch is sufficient. If the flues were properly cut to the required length, there will be about one-quarter inch sticking out of the front flue sheet also.

After the flues are set, they should be rolled lightly with a pair of rolls, then expanded with a pair of sectional expanders, driving the pin into the expanders three times.

The flues are next beaded over with a good beading tool that is perfectly smooth and will not leave any ridges or cuts in the flue. Be sure your beading tool is not too large, or it will cut into the sheet.

After the firebox end is finished, cut some strips about 1¼ inches wide, preferably of galvanized iron, to use for shims in the front end. These should be long enough to drive snugly between the flue and sheet, so it will not have to be rolled too much to make it tight, thus weakening it. The shims should be scarfed on both ends so as not to make a lump which will be hard to get tight.

After all the flues are shimmed, give them a good rolling.

After rolling the flues in the front end, some of them can be beaded over, to help brace the flue sheet. The boiler is now ready for the hydrostatic test.

All work should be done with compressed air when it and the tools are available, as it is much quicker than by hand.

Denver, Col. ARTHUR MALET.

Finding the Area of an Irregular Patch

To find the area of an irregular patch: First draw ordinates across the breadth of the patch at equal distances apart, the first and last ordinates each being a half space

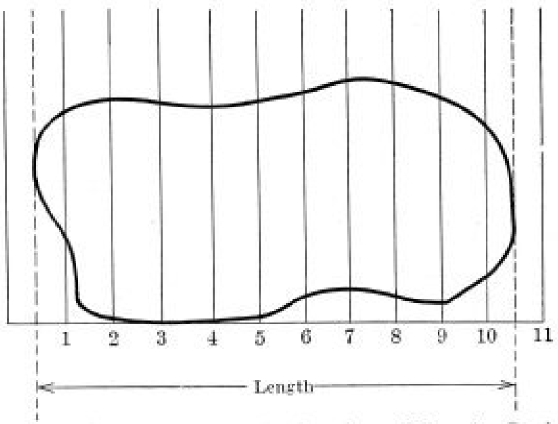


Diagram Showing Method of Finding Area of Irregular Patch

from the ends of the patch. Then find the average breadth by adding together the lengths of these lines included between the boundaries of the patch and dividing by the number of lines added. Multiply this average breadth by the length.

The greatest number of ordinates the more accurate will be the area of the patch.

Oswego, N. Y. JOHN H. HARRISS.

Selected Boiler Patents

Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney,

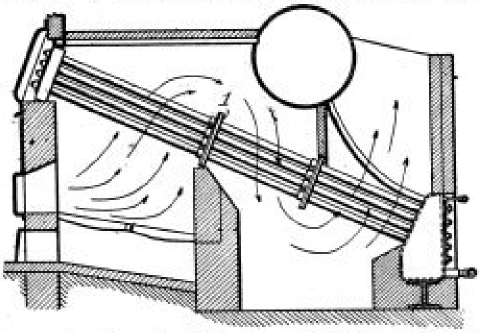
Washington Loan and Trust Building,

Washington, D. C.

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

1,285,677. WATERTUBE BOILER. HENRY J. GEBHARDT, OF CHICAGO, ILL.

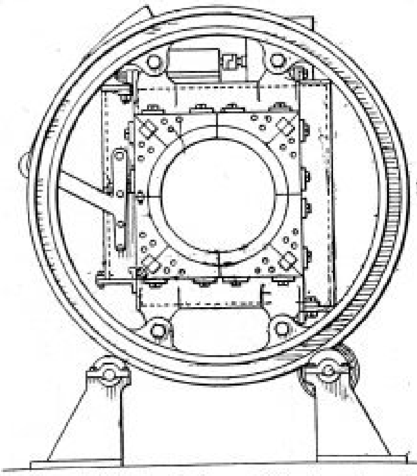
Claim 1.—A watertube boiler comprising a header having inlet and outlet openings in the inner side thereof, tubes for said openings to



circulate the water through said header and means forming compartments in the header to divert the outgoing water to said outlet openings, the base of the header itself forming a settling chamber, and a blow-off for the outer side of said chamber at the bottom thereof. Nine claims.

1,284,880. LINING FOR FURNACES. WALTER C. ELY, OF TERRE HAUTE, IND.

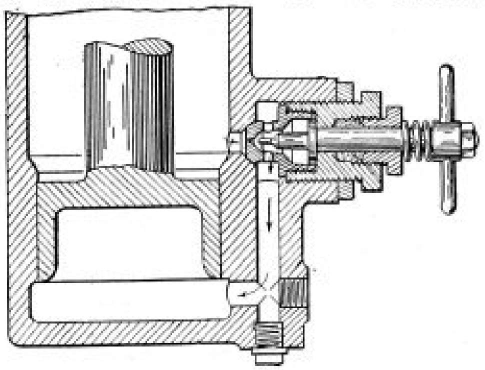
Claim 4.—A furnace comprising perforated metallic walls, a lining made up of hollow blocks secured to said wall, the sides of the blocks adjacent said walls being open affording communication between



the interior of each block and the outside atmosphere through the perforations of said wall; and a perforated partition in each block substantially parallel with the outside wall adjacent such block dividing the block into cells with communication between the cells through the perforations of said partition. Eleven claims.

1,290,865. AUTOMATIC REGULATOR FOR BOILER-FEED APPARATUS. ALFRED HYMAN ANTHONY, OF COLCHESTER, ENGLAND.

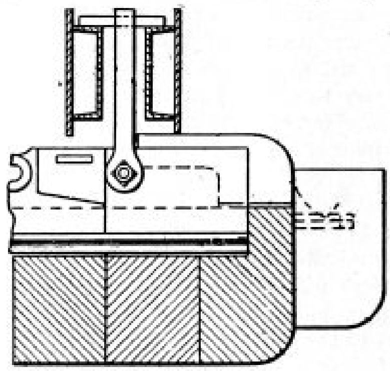
Claim 1.—In apparatus for automatically controlling the flow of feed



water to a boiler, the combination of, a cylinder having means to admit feed water at feed pressure to one end thereof, a piston within the cylinder, a duct external to the cylinder giving communication between the two ends thereof, said duct having a closured cleaning aperture so situated as to render the interior of the duct accessible from outside the cylinder, and having a closured aperture adjacent its inlet orifice, which duct has its entrance orifice fitted with a removable plug shaped to provide a restricted entrance path into the duct, and means operatively connecting the said piston to the boiler feed check-valve. Six claims.

1,284,065. FURNACE ARCH CONSTRUCTION. MYRON H. DETRICK, OF CHICAGO, ILL., ASSIGNOR TO M. H. DETRICK CO., OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

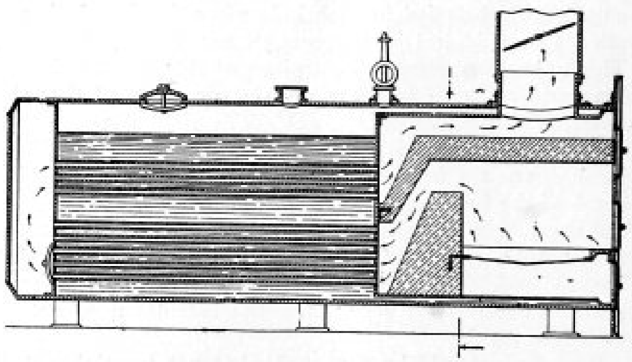
Claim 1.—In a furnace having an arch bar, a fire brick supported thereby, a nose-brick adjacent said fire brick, and a stationary member above said bar, a lever-like extension holder comprising a basal portion



resting on the said fire brick, an inwardly extending portion lying beneath and bearing against the under part of said stationary member, and a nose-brick supporting portion extending outwardly beyond the said basal portion. Six claims.

1,282,832. BOILER. FREDERICK B. HIBBARD, OF PHILADELPHIA, PA.

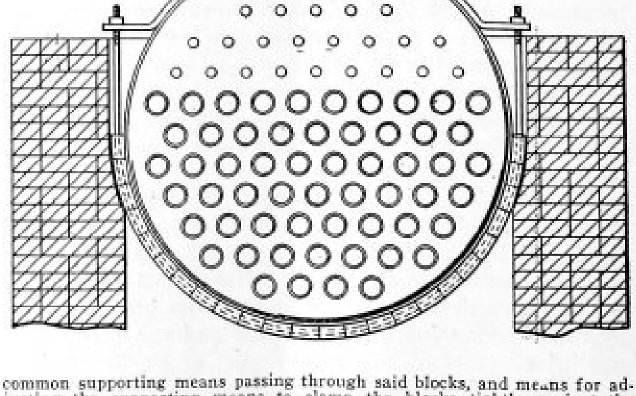
Claim 1.—In a horizontal internally fired return tubular steam boiler, the combination of a shell having front and rear tube sheets, tubes fitted therein, a fire box at one end of said shell comprising an inner shell spaced within the first mentioned shell and forming a water and



steam jacket about the fire box, an arch and bridge wall for said fire box of refractory material, the rear part of said arch having an inclined formation extending to a point substantially below the top of the bridge wall, and forming with the bridge wall a restricted passage from the top of the fire box to the plane of the bottom thereof and to the outgoing tubes. Two claims.

1,287,954. BOILER-SEAM PROTECTOR. JOHN W. GATES, OF MONTREAL, QUEBEC, CANADA.

Claim 1.—In a device of the class described, a series of refractory blocks interengaging at their ends and co-operating to cover a boiler seam, a



common supporting means passing through said blocks, and means for adjusting the supporting means to clamp the blocks tightly against the boiler. Five claims.

THE BOILER MAKER

JULY, 1919

Arc Welding in Railroad Shops

Why Welds Fail—Application of Welding to Firebox Construction—Rules, Regulations and Instructions for Arc Welding

BY B. C. TRACY*

One of the greatest benefits derived from the use of the arc welding by the various railroads has been that of lengthening the life of flues and the elimination of possibly 90 percent of flue failures, which have been obtained through arc welding the bead of the flues to the back head.

Many railroads have installed the arc welders for this purpose alone with varying success. Some railroads have profited greatly, while others have abandoned the practice of arc welding the flues as well as other parts of their equipment, claiming the process is a failure.

It has been conclusively proven that the failures were due to one or more of the following causes:

First.—Experimenting with a view to accomplishing a single purpose.

Second.—False economies in the purchase of welding iron.

Third.—Improper preparation of the work before welding and lack of care following the operation.

Fourth.—Indiscriminate selection of welding operators.

Explaining the items mentioned above:

First.—Many roads insert the flues through the head without using copper ferrules and weld the bead to the sheet without any preparation. Where such welds break, which is sure to occur, arc welding is condemned. Other roads have belled the flues and had them welded without further preparation with the same results. Many similar instances could be cited.

Second.—To make an efficient weld, a uniform grade of iron must be used.

Third.—A few rules will help:

(a) Under no circumstances weld a set of flues (that is, the beads to the back head) until they are thoroughly sand-blasted to remove the dirt and grease from the head.

(b) Prohibit the use of oil on the flues or on the expanding and beading tools.

(c) Weld no flues until they have been properly prossered and beaded. Chip off all burrs with a chisel and leave the joint between the flues and the sheet clean.

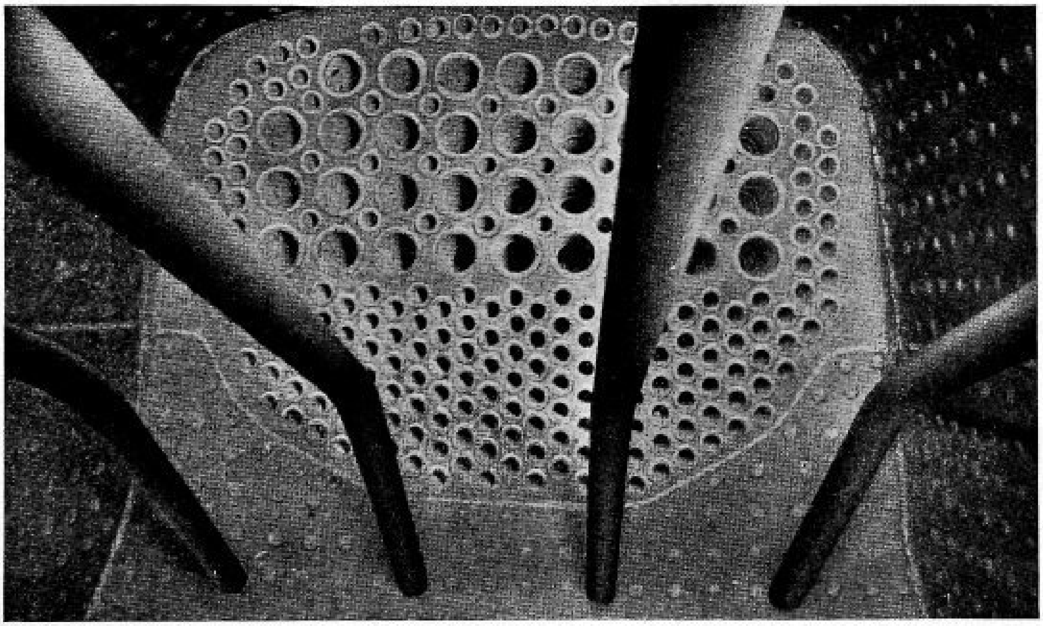


Fig. 1.—Back Flue Sheet, Locomotive Firebox; Tubes and Superheater Flue Beads Welded to Sheet; Patch Applied on Crown Sheet; Side Sheets and New Half Flue Sheets Welded in Place by Metallic Arc Welding

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

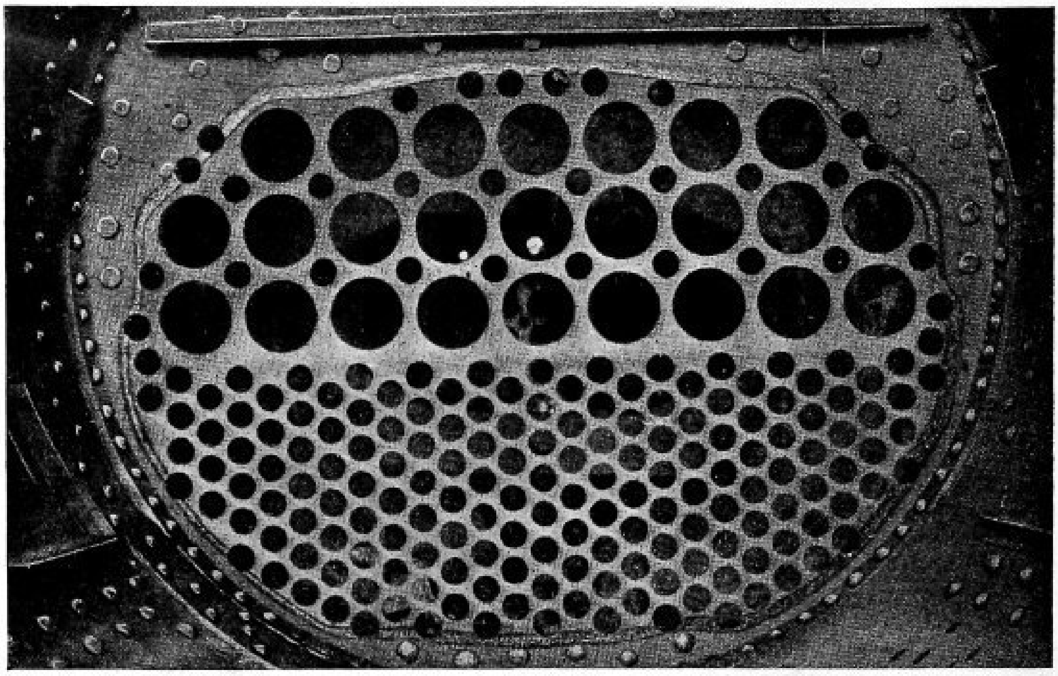


Fig. 2.—Front Flue Head Welded in by Bare Arc Process

(d) Insert all copper ferrules at least 1/16 inch back of the surface of the flue head, otherwise when they are rolled they will protrude from under the bead of flue, which makes it almost impossible to produce an efficient weld. This alone is responsible for more electric welded flue failures than any other cause, as the welding of copper to steel with the electric arc, except under certain conditions, is not practicable.

The flues, before welding, are applied in the usual manner, giving special attention to the above rules, particularly the one referring to protruding copper ferrules. The

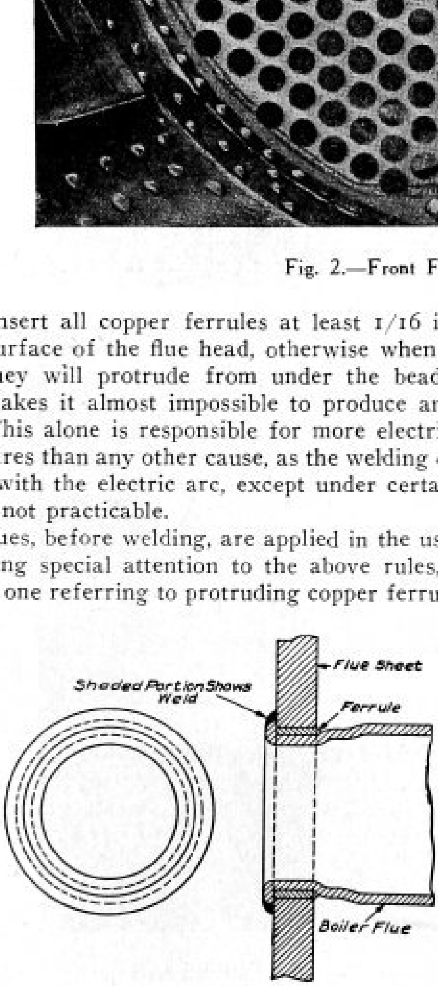


Fig. 3.—Diagram Showing Proper Method of Welding Flues to Flue Sheet

engine is then fired up to a testing pressure or is run at least one trip over a division in order to give the flues a good setting to the head and absorb the oil and grease from off the head and back of the bead of the flue. Then the head is thoroughly sand-blasted, so that the fusing iron will adhere in welding.

The weld is first started at the bottom center of the flue or a little to the right or left, then worked upon one side to the top center and then return and work up on the opposite side, meeting at the top. Lap the weld at the point of completion to overcome the blow and pin holes.

Experience has proved that it is a very harmful practice to begin the weld at the top and work to the bottom. The method that has proved most successful for over three years is that the weld should be equally divided on the head and the flue bead, similar to Fig. 3. See that the weld does not extend over the top of the bead to form a corner in which fire cracks will develop.

The following table shows the increased mileage obtained from welded flues, compared with those that were not welded, by one of the largest railroads on three of its largest divisions:

THE EFFECT OF BARE ELECTRODE WELDING ON FLUE FAILURES BY WELDING THE BEAD TO THE BACK HEAD

	Month and Year	Total Miles Run	Number of Failures	Miles per Failure	
Division A...	Jan., 1914	280,674	11		
Division B...	Jan., 1914	527,349	13		
Division C...	Jan., 1914	682,651	54		No welding
		1,490,634	78	=17,816	
Division A...	Jan., 1915	245,609	3		
Division B...	Jan., 1915	477,799	4		First year flue welding began
Division C...	Jan., 1915	500,205	40		
		1,223,613	47	=26,034	
Division A...	Jan., 1916	294,316	3		
Division B...	Jan., 1916	550,609	2		
Division C...	Jan., 1916	592,983	1		Second year all welded
		1,437,928	6	=239,651	

A careful study of the maintenance of those flues that after welding have developed leaks has been made, and the following method has been adopted as standard:

Remove all of the old electric weld from around the bead and the head and then re-bead the flue back tight to the sheet. Then thoroughly sand-blast the sheet. This will insure a longer life for the flues, as it eliminates the use of the prosser and rolls, which tends to thin the flues and cause horizontal cracks to develop.

Fourth.—This point requires a broad-minded view when referring to an indiscriminate selection. It should not be taken as an undue criticism of the employer. When there is a shortage of men, the first thing that is done is to select a man who is will'ng to attempt it. What is the result? There probably will be placed in a good efficient

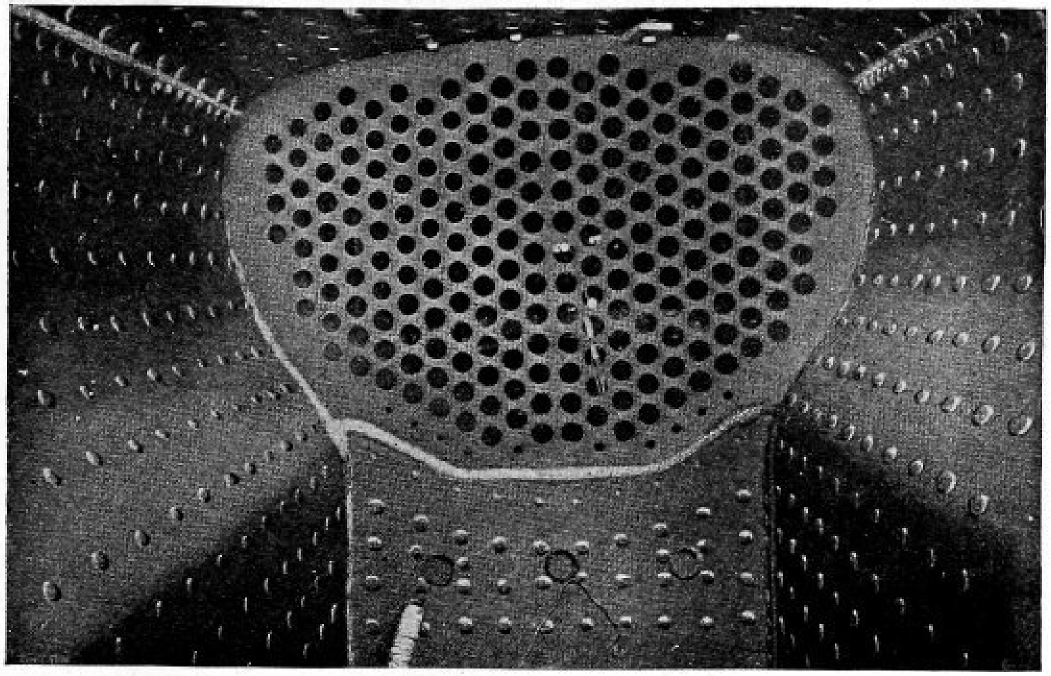


Fig. 4.—Interior of Locomotive Firebox; Back Tube Sheet Welded by Arc Process

welding force a man who, until he is thoroughly educated in the details of welding, will be unreliable and his work must be carefully watched.

Firebox Welding

All firebox welding is being done with the bare electrode, and a big saving is being effected by the various users, some roads not having a single failure in three years' experience on this class of work. It can be readily seen whereby they have obtained increased service from their locomotive fireboxes. An enormous saving in time, labor and material is being made in renewing the bad portion of the head, such as flue heads with a number of cracked bridges; also in converting saturated engines into superheaters. The converted engines have only the part of the head renewed that is necessary to take care of the superheater flues, thereby saving the labor of flanging new sheet, riveting and applying patch bolts. (See Figs. 1 and 2.)

It has been found that in cases where a number of cracks run upwards from the flues in the knuckle of flue sheet it is a good practice to apply a patch the full width of flue sheet, taking in the second row of flues; but where there is only one crack, the method that has proved most successful is to remove the dome cap and "V" out the crack from the *water space side*, filling in with the bare

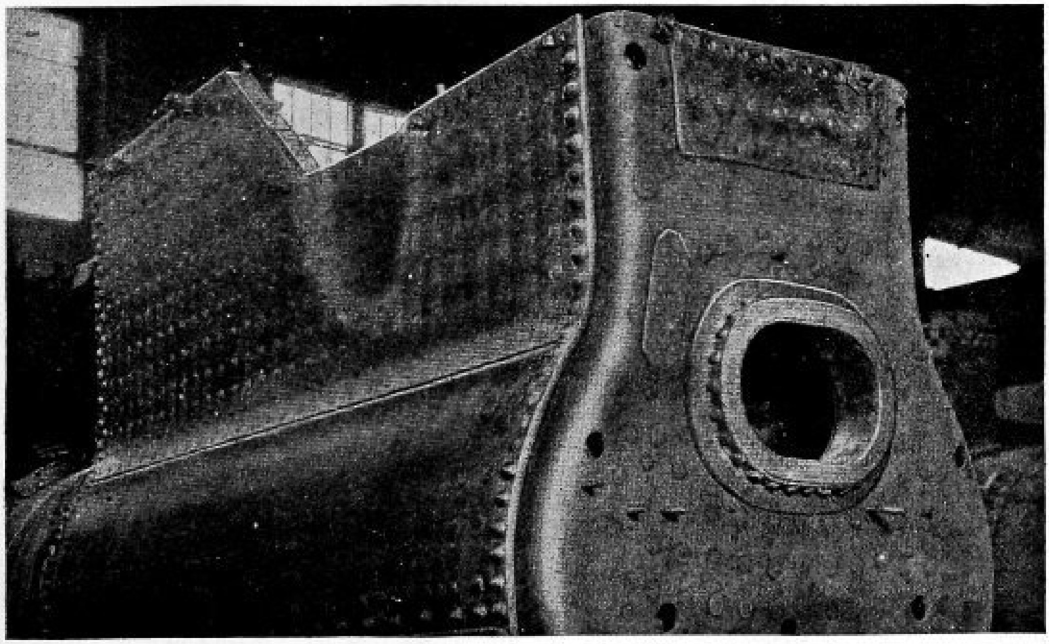


Fig. 5.—Locomotive Boiler Being Changed to Stationary Type, New Half Side Sheets and Patch in Door Sheet; Work Done by Electric Arc Welding

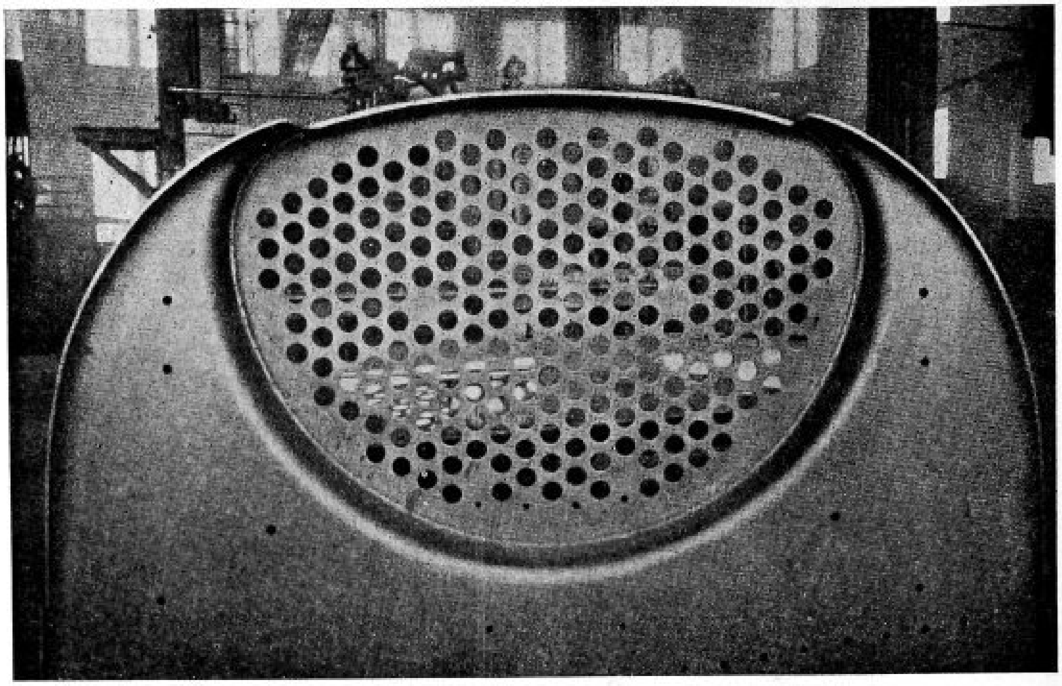


Fig. 6.—Back Tube Sheet Welded to Head

electrode and then reinforcing the sheet 3/16 inch on the firebox side.

MUD RING CORNERS

In welding mud ring corners they should be thoroughly cleaned, removing oil and grease. This can be done by either sand-blasting or with a roughing tool, and then calked before the weld is started. Metal applied should extend at least 6 inches beyond the corner of the ring. This to be applied to both inside and outside corners.

RULES, REGULATIONS AND INSTRUCTIONS GOVERNING ELECTRIC ARC WELDING

Satisfactory electric welding can only be accomplished by following the instructions as hereinafter noted, which have been found to be good practice. The heat required will depend upon the character of the weld being made.

Adjustment of Heat at Weld.—The heat at the weld should be adjusted to suit the class of weld to be made. This adjustment of heat can be accomplished by adjusting the switches or dial on the welding panel.

Current or Heat Adjustment.—Adjustment of switches or dial at welding panel for the various classes of weld should be made in position as indicated on Adjustment Schedule located on the panel.

Method of Handling.—The arc should be kept at a constant and uniform length, so as to heat as large an area as possible, and as few applications of the arc as is possible should be made.

Preparing the Parts for Welding.—The parts to be welded should be free from dirt, grease or slag. Just before the welding is started it should be either sand-blasted or cleaned with roughing tools.

LOCOMOTIVE FIREBOXES

Cracks in side sheets should be chipped "V" shape to an angle of 45 degrees clear through the sheet with 3/16-inch opening. The parts welded should not be more than 1/8 inch thicker after the welding is finished than the original sheet. When welding cracks in side sheets, the welding should be continued until same is finished, thus to prevent the weld from cracking due to contraction. Cracks in side sheets 15 inches or over should never be welded.

APPLICATION OF PATCHES TO SIDE SHEETS

All patches applied in side sheets should be either oval or round, and in applying patch all old metal should be removed and patch made 3/8 inch smaller than the hole in which it will be applied. Side sheets as well as patch should be beveled to an angle of 45 degrees. The patch should be set in position in the sheet with all bolts applied, allowing 3/16-inch opening all around patch. Weld should be started at lower side and welded one-half way

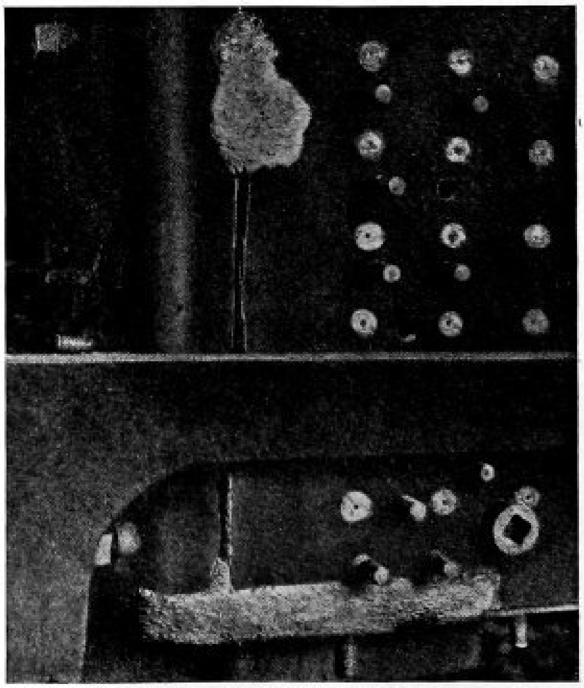


Fig. 7.—Worn Outside Sheet of Mud Ring and Reinforcements Where Rubbed by Spring Hangers

up, then started at lower opposite side and welded one-half way up, then started again on the opposite side and continue the weld to the top. This is necessary in order to provide for expansion and contraction of the metal. After patch is welded flush it should have at least 3/16-inch reinforcement extending ⅛ inch on each side of the weld.

Flues and Superheating Flues

Care must be exercised to see that the copper ferrule is set back in the head at least 1/32 inch, thus to prevent copper from working towards fire side of flue sheet and under head of flue. Before welding is started it is necessary that all oil and grease be removed between the flue head and flue sheet. This can be accomplished by heating engine in shop to steam pressure or running engine one trip. Before welding is started, flues must be sand-blasted.

In welding, the operator should begin welding at the bottom of flue and work up one side to top center, then return to bottom and work up on the opposite side and meet at top (never begin at the top and work to the bottom), this to apply to both superheater and smaller flues.

In applying metal on beads, it should never exceed the height of bead or extend from top of bead to flue corner in which fire cracks will develop.

The best results will be had by making the weld about the same height as the bead, similar to print Fig. 3; but never permit the weld to extend over the top of the bead to form a corner in which fire cracks will develop.

Cracks in Top of Flue Heads

Cracks in top of flue sheet should be chipped to an angle of 45 degrees and an opening of 3/16 inch made through sheet and welded from inside of boiler and reinforced from the firebox side.

Mud Ring Corners

In welding mud ring corners, same should be thoroughly cleaned from oil and grease. This can be accomplished by either sand-blasting or with roughing tools and then calked before the weld is started. Metal applied should extend at least 6 inches beyond the corner of the ring, this to be applied to both inside and outside corners.

Smoke Box and Tee Iron Holes

It is permissible to plug holes with boiler punchings, leaving a space of 3/16 inch or more to apply electric weld on each side of the Tee iron and inside and outside of the smoke box holes.

Washout Plug Holes

In reinforcing washout plug holes, it is advisable to allow plug to remain in holes and apply electric weld around the plug to the desired thickness, removing the plug and retap the holes. The weld will not adhere to copper plug.

The following table shows the work reclaimed at one of the small roundhouses and should not be compared with what can be saved at the larger shops. It will be noted that the savings effected amounted to $379.68 on material reclaimed for a period of 24 days. The actual savings will far exceed $379.68, as the reclamation of these parts enabled the shops to return the engines to service almost immediately.

MATERIAL RECLAIMED BY ARC WELDING FOR A PERIOD OF TWENTY-FOUR DAYS

Description of Work	New Price	Scrap Value	Amount Saved
6—Couplers	$144.30	$39.00	$105.20
28—Branch pipes	53.20	3.36	49.84
11—Worn piston rods	198.00	44.00	154.00
2—Main rod keys	.60	.08	.52
3—Tank valves	7.62	.50	7.12
2—Follower heads	4.80	.40	4.40
1—Crosshead pin	.30	.04	.26
8—Blower pipes	5.40	.66	4.74
3—Feed pipes	2.49	.30	2.19
2—Sand pipes	.28	.03	.25
2—Knuckle pins	.76	.08	.68
1—Equalizer	1.40	.20	1.20
2—Air pipes	2.98	.37	2.61
2—Units	8.40	2.00	6.40
2—Worn side rods	41.66	11.00	30.66
1—Blow-off cock	8.80	1.40	7.40
2—Steam pipes	2.40	.29	2.11
Total	$483.39	$103.71	$379.68

The reason for not showing the cost of welding is that the machine has already more than paid for itself, and at present labor and material is being charged to operating expense, so that it will readily be seen that the work reclaimed is a clear profit.

In conclusion, success or failure of electric welding depends solely upon the men doing the work. If they take a personal interest in the work they can make it a success; if not, it will be a failure.—*General Electric Review.*

Flues—IV

Excessive Use of Expander Detrimental to Life of Flue—Scale Formation and Removal—Flue Spacing

BY GEORGE L. PRICE

I am of the opinion that a flue properly welded has sufficient strength to stand all reasonable requirements, if given proper care. Flues are sometimes worked to death. By this I mean the excessive use of the expander is detrimental to the life of the flue. I have taken out flues that have been expanded to excess, so much so that the copper was cut in two by the expander, and, to justify my conclusions, I made inquiries and found that the engine, according to its mileage record, had fallen far short of what it should be. This shortage I attributed to the excessive use of the expanders.

I am also convinced that the use of blind expanders in the roundhouses will be a large factor in prolonging the life of flues. I would not encourage the continuous use of the blind expander, but I believe that it should be used at least every other time. My reason for using this method is that the blind expander meets the requirements by tightening up the flue to stop the leakage and at the same time is not brought to bear in the same place upon

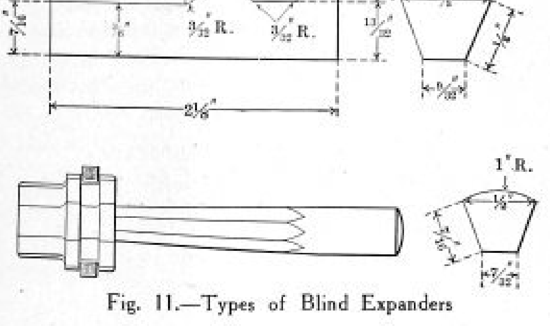


Fig. 11.—Types of Blind Expanders

the flue as is the standard expander, because the toe is ground off. Therefore the logical conclusion is that a tool which fills these requirements and does not always act on the same portion of the flue will not wear out the life of the flue as quickly as a tool that has always been brought to bear in the same identical place.

Excessive Calking Deteriorates Flue

Excessive calking of the flues is detrimental to their life. When a flue leaks badly enough to require the use of an expander, use it, but do not calk the flue, for you are only storing up future trouble for yourself and shortening the life of the beads. Never calk a flue that is squirting; expand it even if it requires the removal of the brick arch. Of course, circumstances alter cases. If you have a flue that is squirting and you know that there is mud around the flue, which has been expanded time and again until the hole is enlarged to such an extent that the expanders are too small, then calk it, for all the expanding you can do will not improve it in the least where there is mud around the flue. By calking, the flue will hold just as long, and the flue hole will not be enlarged by the calking tool as it would by the use of the expander.

Excessive Expanding of Flue

A new flue sheet can be ruined very easily by excessive expanding of a flue that has mud around it. I have known boiler makers to take a 1¾-inch expander and drive the pin into it nearly up to the head when expanding a flue that was squirting on account of being muddy. The next time the engine came in a 1⅞-inch expander was used and the operation repeated. The third time a 2-inch expander had to be used to stop it, and finally a 2⅛, then 2¼, until the expanders gave out and the boss was told he would have to hold the engine and take the flue out to get at the mud. This might all have been avoided by calking the flue until such time as the engine could have been held for its removal and proper repair.

As a general rule, most of the excessive calking which is done will be found at the bottom of the flue sheet near the brick arch. The beads at this point are often poor, for the reason that it is impossible to hold the calking tool at the proper angle on account of the arch; and oftentimes the boiler maker will not remove the arch in order to calk a few flues, but just stabs at them and lets them go. At the next terminal the flues at the bottom get the same treatment, and consequently it does not take long to put the beads beyond usefulness.

Heavy Copper versus Thin Copper

From which do we receive the best service and results—a heavy copper or a thin copper, a long copper or a narrow copper? I have been asked this question many times. Personally, I prefer the long, heavy copper, and I believe that better results may be obtained and longer service from the copper whose dimensions are .095 in thickness, 1 inch long and the diameter as required. A flue with the proper fit driven into this style of copper makes a substantial bearing all around, as it protrudes far enough on the inside of the flue sheet to act as a cushion between the flue and the inner edge of the flue hole, thus eliminating to a large extent the shearing stress of the expanded portion of the flue.

Lipping the Flues Not Advocated

I am not very favorably impressed with the lipping of flues when putting them in, as I consider this method one of the most severe tests that can be given to a flue. It often causes the flue to split in the seam, while the uneven blows of the hammer have a tendency to cause the flue ends much distress. Ten percent of the flues in the front end should be beaded so as to meet the requirements of the law.

I am also of the opinion that all flue holes should be reamed when it becomes necessary to enlarge them, as the rolling of the flue has a tendency to crack the bridges by crystallizing them. I am a great believer in the efficiency of a wide flue bridge because it gives better circulation, and better circulation results in greater power. In addition, they are an important factor in prolonging the life of flues, as the wide bridges do not become congested with foreign matter as quickly as narrow bridges.

Usually flues become congested with scale or mud at the back flue sheet; that is, foreign deposits are in evidence at this point before noted elsewhere. From my knowledge of the subject, there seem to be two reasons why sediment is drawn to this point, and only one why it lodges here. In the first place, I think that the greatest agitation of the water is caused in the vicinity of the firebox, especially near the front portion, owing to the intense heat at this point. Due also to the circulation, the greatest quantity of water is drawn in the immediate neighborhood where the boiling separates the particles of solids, which become, by additional accumulation, heavier than water and settle to the lowest section of the boiler unless retarded by some other element. The lowest portion of the boiler is generally the front mud ring.

Scale Formation

The settling operation occurs most generally when the engine comes to a standstill or when the circulation has diminished, and not when the engine is working. When this settling takes place the retardation of the solids in their passage to the bottom of the boiler is in the flues, and, as the engine cools, the foreign agents adhere to the flues and sheets, forming a scale. This is repeated time and again, until the scale becomes thick enough and is broken off in various ways. In the event that the piece broken off is larger than the spacing between the flues, it becomes lodged there and forms a table or small shelf for additional settlings or solids, which will soon fill the space entirely.

The opening of the throttle also has a tendency to draw settlings in this vicinity in much the same manner. When the circulation diminishes, owing to the stopping of the engine and the cooling down of the fires, these small particles settle over the entire surface of the boiler, and when the throttle is opened suddenly there is a sudden rush of steam to the immediate vicinity, which draws a portion of the water with it. The water thus carries the settlings towards the front part of the boiler and away from the tremendous agitation near the firebox. Although a portion of this same water may be caught up again by circulation and whirled back toward the firebox, yet a portion of it mixes with the cool water injected into the boiler and is drawn back to the lowest portion of the boiler, which is the mud ring. Probably this water, which is of a reduced temperature, travels not altogether completely below the flues in its progress toward the firebox, but a portion of it between all the lower flues while en route.

The blow-off cock in the throat sheet also draws settlings, making it evident that these different forces all strive to drag the foreign matter right where it will do the most harm; that is between the flues at the back flue sheet.

Flue Spacing

We are led to believe that when we have ½-inch, ⅝-inch or ¾-inch bridges our flue spacing at both ends is the same, when in reality it is not; that is to say, up against the back flue sheet the space is much narrower between the flues than it is at the front sheet, and the less the space the quicker will it become congested. Also, as this particular portion of the boiler is designed for given conditions, it is the only reasonable cause why foreign matter is offered such an excellent opportunity of congesting at this particular place.

Let us note how this spacing is narrowed by the expanding of the flues. Take the flue sheet with the ½-inch bridges as an example. We will say that the coppers are approximately 1/16 inch thick and 1 inch long, and that they extend beyond the sheet ½ inch, providing the flue sheet is ½ inch thick and the 2-inch flues are approximately ⅛ inch thick. Now when we expand this flue we will be safe in saying that we expand it about ⅛ inch past the edge of the flue holes parallel with the sheet, or, in other words, the groove made by the expander is about 3/16 inch deep, and, as the adjacent flue is expanded in the same manner, we have brought them more closely together at this point.

How much closer did we bring them? Our copper was 1/16 inch, the flue ⅛ inch in thickness, and we expanded them about 3/16 inch, which makes 6/16 inch, or ⅜ inch of the ½-inch bridge occupied by the expanded copper and flue, leaving us only ⅛-inch space between our flues at this point. How long does it take to congest a space ⅛ inch wide in locomotive boilers? It is one reason why I have always advocated wide flue bridges. The flue sheet with the narrow bridges makes it inconvenient to calk new flues properly, especially when we have ¼-inch stock for beads, as each adjacent flue retards the progress of the beading tool by its striking them during the beading operation.

Washing the Boiler to Dislodge Scale

The boiler should be thoroughly washed after the flues have been expanded. I am speaking of flues expanded in the roundhouses, or old flues, because on expanding a set of flues loose scale that has formed and lodged between them is broken away, and, while we may not be able to dislodge it completely by washing the boiler down, yet we can get a good portion off by the proper use of the washout hose just in front of the flue sheet. A crown sheet should never be washed over the flues, but should be washed off sideways, so that the accumulation will flow down into the water space or firebox legs. We can accumulate sufficient foreign matter with bad water and scale-forming impurities without the assistance of additional agents.

Deterioration of Boilers

When I say bad water, I have in mind water with the following ingredients: Organic and volatile matter, sodium chloride, calcium carbonate, calcium sulphate, magnesium chloride and free carbonic acid. Water so composed is especially bad, due to the corrosive impurities, which will cause rapid destruction of the tubes and plate the moment the boiler goes into service. Scale-forming impurities are found in water composed of the following ingredients: Organic and volatile matter, calcium carbonate, calcium sulphate, magnesia, silica, iron oxide and alumina.

Reducing the Number of Flues

I am very favorably impressed with the idea of leaving out from four to six flues in each set and running a stay rod from the front flue sheet to the back flue sheet. This is not in the interests of safety or holding power, for I consider the sheet sufficiently stayed by the flues to counteract excess pressure should it be applied. This space aids better circulation, and I am strong on that.

Perfect Circulation an Essential Factor

Perfect circulation is one of the most essential factors in boiler operation, and I would offer encouragement to anyone striving to produce it. Were I in a position to carry out experiments along this line, I would support it to the limit. I also think that the brick arch is of advantage in all circulating systems, as it keeps cold air away from the flues and flue sheet, and in order to aid perfect circulation there should never be a sudden change of temperature.

When designing locomotive boilers, a very serious mistake is sometimes made by the boiler designer in getting flue holes too close to the flange of the flue sheet. This item is very expensive for the railroad companies, as it often requires the replacement of new sheets to eliminate the defects, which are caused by flue holes having cracked out.

Designing a locomotive is no small task, and there are a thousand and one things to itemize and take into consideration. Oftentimes the most rigid inspection of specifications will not reveal future defects to the designer or builder. The designer is practical in his line, no doubt, but his work is essentially new construction and, consequently, he is not invested with the practical knowledge of running repairs. Therefore it is up to us to offer suggestions to our superiors in order to eliminate these defects in the future.

Emergency Repairs

Isn't it a fact that the ancient idea of 36 to 1 is detrimental to our flue sheet? When I say 36 to 1, I have in mind 36 square feet of heating surface to one square foot of grate area. As a general rule, with this idea in mind, the designer tries to get as much heating surface as possible in the tube area, and so crowds the flues as close together as he can, thereby making the flue sheet bridges narrow and the flue sheet holes come close to the flange around the outside edge.

What are the results? Possibly they are not immediately apparent, but after the engine has had its flues expanded a few times the flue holes along the sides or across the top of the sheet begin to crack, oftentimes from the flue hole around the flange to the rivet. Then what happens? Well, we patch it, or, most generally in the roundhouse, we plug it, because it is a running repair job and we cannot afford to tie up the engine for any length of time. In other words, it is an emergency repair. However, our trouble has just begun, for nine times out of ten the plugs will leak when the engine goes to work and will blow steam and water down over the flue sheet, stopping up a portion of the flues, in addition to cutting the beads off the flues that are adjacent to it. The trouble goes from bad to worse by blowing the flue sheet thin in the knuckle, so we have to tie the engine up after all and patch the sheet and remove the beadless flues.

To apply the patch properly we will have to plug several of the flue holes in the vicinity of the patch with "sun-flowers," or, in other words, 2⅛-inch or 2¼-inch plugs, which should be tapped out from the inside of the boiler.

After the patch is applied it will not bring the sheet up to 100 percent strength again. If I were to estimate its rating I would rate it at 25 percent, because we still have an emergency repair job, as the patch will not stay tight long when the engine begins to work hard, owing to its location. The contraction and expansion of the flue sheet will loosen the patch, also the "sun-flowers" or plugs, which are sometimes half covered by the patch.

(*To be continued.*)

How to Design and Lay Out a Boiler—IX

Method of Determining the Number and Size of Braces for Segment of Boiler Head—Size of Rivets for Stays

BY WILLIAM C. STROTT*

The most convenient method of procedure for determining the number of braces required to stay the segment is as follows:

Make templates (to the same scale as the tube layout) of the pads on the braces, where these are riveted to the tube sheet, and distribute the templates equally over the surface to be stayed. The braces must be arranged in circular arcs, struck from the center of the head, as shown on Fig. 30.

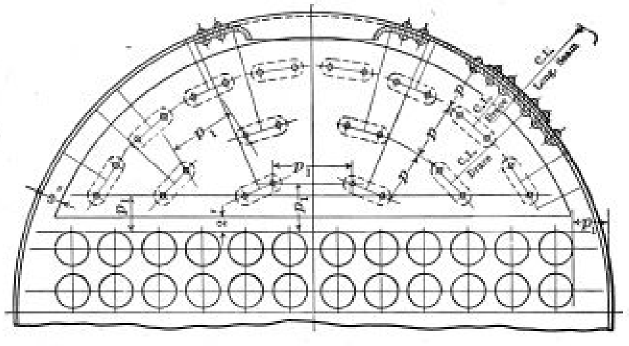


Fig. 30

The dimension p must not exceed that found by the following formula:

$$(5) \qquad p = \sqrt{\frac{175 \times t^2}{P}},$$

in which

t = thickness of tube plate in sixteenths of an inch.
P = allowable safe working pressure.

Substituting, we have:

$$p = \sqrt{\frac{175 \times 9 \times 9}{150}}, \text{ or } 9.72 \text{ inches, say } 9\tfrac{3}{4} \text{ inches.}$$

Also the distance p_1 between the rivets of adjacent braces must not exceed that found by the following formula:

$$(6) \qquad p_1 = \sqrt{\frac{135 \times t^2}{P}},$$

in which the notations are the same as in the preceding formula. Substituting and solving as before, we get:

$$p_1 = \sqrt{\frac{135 \times 9 \times 9}{150}}, \text{ or } 8.54, \text{ say } 8\tfrac{1}{2} \text{ inches.}$$

Formula (6) also applies to the maximum space allowed between the edge of any tube hole and the outside of the head, as is also indicated by p_1 in Fig. 30. This latter condition it was not difficult to overcome in our case, because we had plenty of tubes to distribute over the sheet, and were obliged to keep as close to the shell as possible, but, nevertheless, it presents an objectionable feature not infrequently met with and the designer should guard against it. If it is impossible to decrease the space to the allowable limit, a brace or braces must be applied to the area in question.

We will suppose now that by working to the limits obtained by formulas (5) and (6) fourteen braces can be laid in. The total steam pressure on the segment is 935 square inches × 150 pounds, or 140,250 pounds. The theoretical load carried by each brace is $\frac{140{,}250}{14}$, or 10,018 pounds. We say theoretical, because this is the load that would be carried by each brace if it were a direct stay, but they do not resist in a straight line, the load transmitted to them by the boiler head, because they are placed in a diagonal position. For this reason, the actual pull in each brace is greater than the direct load, as can be proved in "mechanics" by means of the "parallelogram of forces." Fig. 31 illustrates how diagonal braces are attached to a boiler.

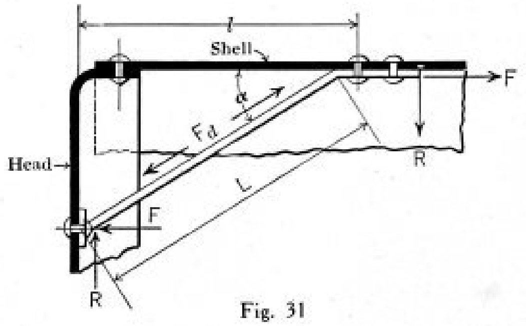


Fig. 31

Suppose that a certain arc of braces in our boiler is set at an angle of 30 degrees. F represents the theoretical direct load, which was found to be 10,018 pounds; then the actual stress F_d in the brace is calculated thus:

$$\frac{F}{\text{Cos}} \text{ or } \frac{10{,}018}{.86603} = 11{,}564 \text{ pounds.}$$

In like manner it can also be proved that, due to this combined diagonal and horizontal stress, there exists a vertical reaction at points R. Although this vertical reaction does not enter into the calculation for the size of the brace, it might be well to acquaint the student with its comparative effect, and how the force is determined.

$R = \sqrt{F_d^2 - F^2}$ or $R = \sqrt{(11{,}564)^2 - (10{,}018)^2} = 5{,}750$ pounds. (Just as simple as finding the base of a right-angled triangle, where the hypotenuse and altitude are known.)

For unwelded diagonal stays, the A. S. M. E. Code allows 9,500 pounds working strength per square inch. If the stays used are *welded*, only 6,000 pounds per square is permissible. The required net cross-sectional area of each brace is found by dividing the diagonal load F_d by the allowable unit stress in the stay material. Hence,

$$\frac{11{,}564}{9{,}500} = 1.217 \text{ square inches.}$$

If round braces of the Scully type are going to be used, this area would be met in a rod having a diameter of 1¼ inches.

---

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

The young boiler designer may be expected to balk at the idea of being compelled to use trigonometric functions (such as sine, cosine, tangent, etc.) when figuring diagonal braces. The foregoing work, however, was given in detail to educate the student and prove to him that even the design of so commonplace a piece of apparatus as a steam boiler is based on sound engineering principles and not by rule of thumb and the following of stereotyped shop standards.

To cut this work short, the A. S. M. E. Code gives the following formula:

$$A = \frac{a \times L}{l}, \quad (7)$$

in which

A = sectional area of diagonal stay in square inches.
a = sectional area of direct stay in square inches.
L = length of diagonal stay, as indicated in Fig. 31, in inches.
l = length of line, drawn as indicated in Fig. 31, in inches.

In the above formula, a is found as follows:

$$a = \frac{W}{C \times N}, \quad (8)$$

in which

W = total load on segment to be stayed.
C = allowable unit stress per stay { 9,500 pounds for weldless. 6,000 pounds for welded.
N = number of stays used.

For the student's convenience we shall apply formulas (7) and (8) to our problem. It is first necessary to find a.

$$a = \frac{140{,}250}{9{,}500 \times 14}, \text{ or } 1.05 \text{ square inches.}$$

Now using formula (6) for A, we get:

$$A = \frac{1.05 \times 36}{31.25}, \text{ or } 1.217 \text{ square inches}$$

which is obtained in a bar having a diameter of 1¼ inches.

(Note that we assumed certain values for L and l, the dimensions given being correct ratios when angle a of Fig. 31 is 30 degrees.)

From what has gone before, it will be realized that angle a could be so great, consequently, putting so high a stress in the stay, that finally the number and size of stays required would be impracticable. In fact, the A. S. M. E. Code states that if the greatest angle made by any stay in the boiler is not over 30 degrees—in other words, when L is not more than 1.15 *times* l—the angularity may be disregarded entirely, and only formula (8) need then be applied; but in that case the value allowed for C must be taken at only 90 percent of that previously allowed, or 8,550 pounds.

The reason for making this allowance when the angularity of the stays is not excessive is because there may be considered a certain inherent strength in the boiler head itself, and it stands to reason that the latter is capable of resisting a considerable part of the load long before the full calculated stress would come on the stay.

We shall now base our calculations on this new assumption. Having established the size of brace to be used, viz., 1¼ inches diameter, the area of which is 1.227 square inches, we may transpose the formula (8) for the number of braces N as follows:

$$N = \frac{W}{a \times C}. \quad (9)$$

Substituting and solving, we get:

$$N = \frac{140{,}250}{1.227 \times 8{,}550}, \text{ or } 13.4, \text{ say } 14 \text{ braces.}$$

(Note that 8,550 pounds is 10 percent less than 9,500 pounds.)

It is always advisable to employ an even number of braces, thus locating half the group on each side of the vertical centerline of the head. This arrangement is desirable, whereas with an odd quantity it always necessitated interposing the odd brace on the centerline, which invariably will pass directly under a pipe flange or nozzle in the top of the shell. This condition might tend to interfere with the rivets attaching such pipe connections to the shell.

The size of rivets attaching the rear end of the brace to the boiler shell must next be determined. Two rivets are employed for this purpose, and, as the student should be aware, they are in single shear. He should also notice that the rivets are actually subjected to a direct pulling out (tensile) force equal to R combined with the true shearing force equal to F. These two forces acting together are really what cause the resultant force F_d through the stay, which, as we proved, is always greater than the actual direct load.

It is impossible, due to this eccentric loading, to figure accurately the true stress in these rivets. It might, however, for all practical purposes be perfectly safe to assume that the force F_d (Fig. 31) acts in full shear on the rivets. Working on this assumption, let us see what rivet diameter would be required. The load per rivet is $\frac{11{,}564 \text{ pounds}}{2}$, or 5,782 pounds. With a factor of safety of 5, the allowable rivet shearing strength in single shear is $\frac{44{,}000}{5}$, or 8,800 pounds per square inch. The required rivet area is, therefore, $\frac{5{,}782}{8{,}800}$, or .6574 square inch, which is equivalent to a diameter of 15/16 inch.

In order to eliminate any possibility of inaccurate assumptions concerning the true stress in these rivets, the A. S. M. E. Code has established the requirement that the combined cross-sectional area of the rivets be at least 1¼ times the cross-sectional area of the body of the stay. Recalling that the area of a 1¼-inch "round" is 1.227 square inches, the rivet area required will be 1.25 × 1.227, or 1.534 square inches. Whence the required area per rivet is one-half of this amount, or .767 square inch. The nearest commercial rivet diameter corresponding to this area is 1 inch, which may be taken as the driven diameter. We must, therefore, call for 15/16-inch diameter rivets with 1-inch holes in the braces and shell plate.

(*To be continued.*)

The Duntley-Dayton line of pneumatic and electric tools will be marketed to Europe and Australia by the Worthington Pump and Machinery Corporation through an arrangement which has just been made between Mr. W. O. Duntley, president of the Duntley-Dayton Company, and Mr. C. E. Wilson, manager of the foreign department of the Worthington people. The Worthington Pump and Machinery Corporation has branches in practically every European center, with a complete chain of agencies subsidiary to these branches.

The Duntley-Dayton Company has also arranged with the Bureau Technique Francais for representation in Japan, China and Siberia.

The International Machinery and Supply Company handles the Duntley-Dayton line in Canada.

The Heine Marine Cross Drum Boiler

Description of New Type of Watertube Boiler Installed on Vessels of the Emergency Fleet—Straight Tubes and Cross Drum

Marine boilers of two types have been built by the Heine Safety Boiler Company in their plants at St. Louis, Mo., and Phoenixville, Pa.—the "longitudinal drum" type and the "cross drum" type. The former is built on the lines of the well-known Heine watertube boiler and the earlier ships were fitted with these, but the later and by far the greater number of ships have received boilers of the "cross drum" type, which has shown itself so superior for the peculiar and exacting marine service that it is now the standard Heine marine watertube boiler.

The boiler proper consists essentially of three pressure elements joined together by a multiciplicity of tubes.

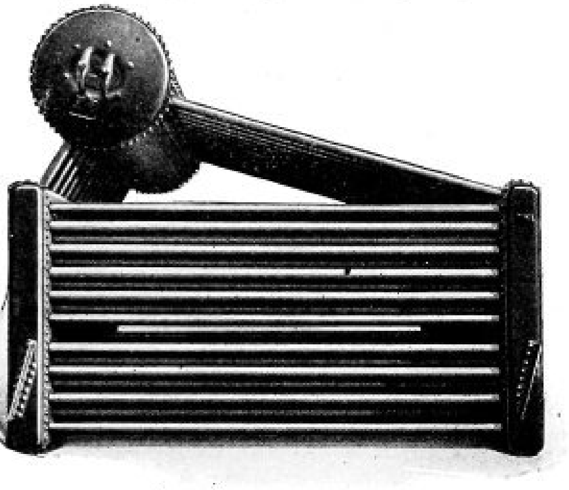


Fig. 1

These elements are two flat rectangular box headers and a cylindrical steam drum as shown in Fig. 1. The main bank of tubes extends between and connects the two box headers, which are set with the flat surfaces a certain distance apart. The connecting tubes are all of the same length, straight and parallel with each other, and when this part of the boiler is set in operating position are inclined at an angle of sixteen degrees to the horizontal. Above the front box header and slightly to the rear of it is placed the steam drum, which is connected to the front header by a row of nearly vertical short tubes or nipples and to the rear header by a row of longer tubes, which are horizontal when the boiler is set. The boiler proper, made up of drum, box headers and tubes, is supported by a strong, rigid, steel structure resting on and secured to proper foundations in the vessel—partly shown in Fig. 3.

Steam Drums

The steam drum is cylindrical and varies in the several sizes of boilers from 36-inch to 48-inch in diameter. It consists of a single plate steel shell of a thickness corresponding to the pressure requirements, rolled to a true circle, fitted with a double-riveted, double butt-strapped longitudinal riveted seam, and at the ends with flanged and dished steel heads which require no braces. In one of these heads is arranged a flanged-in manhole for access to the interior of the steam drum. Where the tubes enter and are secured to the shell of the drum, reinforcing plates are fitted. On top of the drum are fitted heavy pressed steel saddles for attaching the main stop valve, auxiliary stop valve and safety valve.

To the front side of the drum shell are riveted pressed steel flanges for attaching the main and auxiliary feed check valves, surface blow valve, two water gage glasses and three test cocks.

Drum Fittings

Inside the drum, properly secured to the shell and firmly braced in position, is fitted a steel deflection plate. This plate is of sufficient length to cover the ends of the horizontal tubes and extends below the water level, its purpose being to act as a separator for the mixture of steam and water entering the drum through the horizontal tubes. Water thrown violently against this plate runs downward into the body of water below, and the steam passes along and around the ends of the plate and to the dry pipe above.

An internal feed pipe is fitted between the feed check valves. This is perforated in order to distribute the entering feed water uniformly through the water already in the drum to avoid producing undue strains. The same pipe is connected to both checks.

A scum pan of the usual "dish" type, with its cover plate slightly raised to produce an efficient "skimmer" effect, is located at the center of the drum exactly on the water line and piped to the surface blow outlet on the front of the drum shell.

Surge plates are fitted to check the rush of water along the drum as the vessel rolls in a seaway. These plates, together with the deflection plate, make a substantial structure for supporting and securing the various fittings within the drum.

The main steam outlet is provided with a dry pipe of ample area. This pipe is fitted as near the top of the drum as practicable, and has slots cut through its upper side, the area through these slots exceeding the area through the outlet opening. Calorimeter tests show that the Heine marine boiler thus fitted delivers steam containing less than three-quarters of one percent of moisture.

Installation of Zinc Slabs

Zinc slabs are also fitted in the drum of the boiler. The Navy standard of three-quarters of a square foot of exposed zinc plate is provided for each one hundred square feet of heating surface of the boiler. These zinc plates are secured so as to give close metallic connection with the metal of the boiler and yet allow easy renewal. A pressed steel "basket" is also fitted to catch the disintegrated zinc.

The box headers are constructed entirely of steel plate. Each consists of two flanged rectangular heads or end plates to which are riveted a wrapper plate in two pieces. These headers are so designed that all seams are readily accessible for inspection and recalking without tearing away the boiler casing. The end plates are flanged by hydraulic pressure at a single heat and are of the exact shape desired. The two wrapper plates, known as the tubesheet and handhole sheet, have their edges turned over at the top and bottom of the headers, lapped and riveted together with a single row of rivets, with the calking edges facing outward. The flat surfaces of the tube and handhole sheets are truly parallel with the handhole exactly opposite each tube hole, thus permitting access to the tube for cleaning and withdrawal of the tube through the handhole when necessary.

The two flat surfaces of the box headers are stayed to resist internal pressure with large hollow steel staybolts screwed through tapped holes in the plates and with the projecting ends of staybolt riveted over on the outside.

The staybolts are threaded only at the ends, leaving a smooth cylindrical shank within the water space, thus offering no sharp edges or grooves to the corrosive effect of rust. Each staybolt has a hole throughout its entire length of ample size to pass freely a 3/8-inch pipe lance for soot blowing.

SUPPORTING LUGS

Forged steel tee bar lugs (see Fig. 1) of heavy section, about 24 inches in length, are riveted to the outside of each flanged end plate of the headers for attachment to the supporting columns of the casing structure. The flat bases of these tee bar lugs are calked all around, and the edges are always accessible for inspection or recalking without tearing out any part of the boiler support or setting.

Near the bottom of the front (lower) box header and on one side only (except in extremely wide boilers) is riveted a forged steel flange to which is bolted, with copper gasket in male and female joint, a heavily ribbed and

Fig. 2

flanged composition blow nozzle or extension pipe to the outer end of which is attached the bottom blow valve. An internal pipe leads to the extreme bottom of the box header and insures removal of sediment deposited therein.

The standard design of Heine marine watertube boiler has 3½-inch diameter tubes throughout. For oil fuel only, the use of 2-inch tubes instead of 3½-inch tubes in the inclined bank between the headers is recommended, and the company builds a special oil-burning marine boiler so fitted. Two-inch tubes are not recommended for coal fuel because of the great tendency of boilers fitted with small tubes, closely pitched, to "soot up" or become choked. Its superior steaming qualities are recognized. However, it is a fact that by the use of 2-inch tubes equal heating surface can be obtained in a boiler of much less height than is possible when larger tubes are employed.

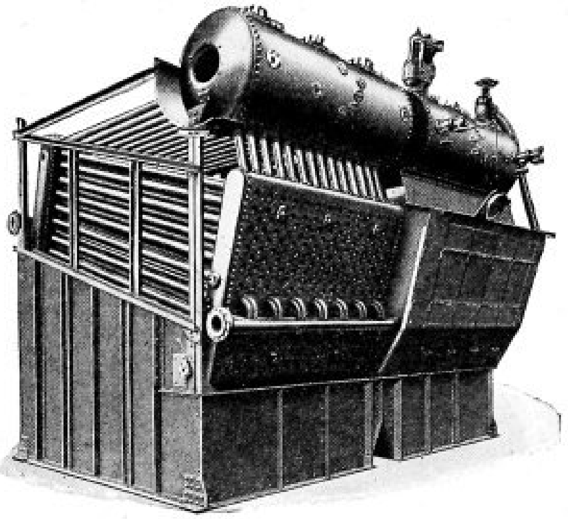


Fig. 3

Heine boilers are fitted with standard lap welded steel, charcoal iron, or seamless steel tubes, as the owner may prefer.

For low or medium superheat Heine marine boilers are fitted with superheaters of the "waste heat" type placed in the base of the up-take, as near as possible to the exit of the gases from the boiler. For higher superheat the elements must be placed where they will be in contact with gases of higher temperature, and are often fitted just below the middle baffle, the superheater elements passing through the 5-inch stay tubes between headers located outside the boiler (see Fig. 2). The right angle bend of the superheater tubes entering the top of the front pipe header is arranged at one end of the boiler only and permits of the tubes being more easily removed and replaced than if they were straight throughout.

APPROVED BY GOVERNMENT INSPECTORS

Heine marine watertube boilers are built in accordance with the rules and regulations of the United States Board of Supervising Inspectors, and are approved by Lloyd's Register of Shipping and the American Bureau of Shipping. When desired by the purchaser, either an insurance company or the purchaser is permitted free access to the works and given every opportunity for inspection and approval of plans and material entering into the construction of the boilers.

SETTING OF THE BOILER

The setting of the boiler consists primarily of a framework of rolled steel shapes so constructed that the four main columns, one each side of each box header, are tied together and braced, and thus secured rigidly against relative motion of any sort. These columns are secured at their bases to settings prepared by the shipbuilder, the structure described forming a cradle within which, secured by the four tee bar lugs, the boiler proper is supported.

A steel plate casing is built upon this framework, entirely surrounding and covering the boiler and furnace with the exception of the drum. That portion beside the bank of inclined tubes is fitted in panels that may be readily removed for access to the brick lining, and a sectional bottom plate, that may be easily renewed, is fitted below. The interior of the whole is lined with fire brick, non-conducting material or a combination of these. All parts are carefully fitted to prevent the ingress of undesirable air.

Where grates are furnished for coal fuel, a watertight pan is also fitted in the ashpit, but for oil-burning installations the furnace space is made as large as possible. The casing about the furnace proper is lined with refractory walls 12 inches thick, and above the lower baffle the lining is 7½ inches thick. The furnace fronts for coal burning are fitted with balanced inswinging doors above and below the grate. For oil burning the front is usually a steel plate with openings of suitable size cut to take the burner castings.

Circulation

When installed and ready for operation the Heine marine boiler is filled to the middle of the steam drum with water. The circulation is downward in the front box header and upward in the rear box header, upward and back in the lower majority of the bank of inclined tubes and downward and to the front in a few upper rows of inclined tubes; the steam parting from the water in the upper portion of the rear header and passing into the steam drum through the horizontal tubes, as before described.

With this steam there is some quantity of free water which is separated and thrown down in the drum, the steam passing about the ends of the deflection plate, to the dry pipe, the water passing down through the short tubes into the front box header together with the fresh feed, where, mingled with the circulating water, it again passes through the lower inclined tubes. Feed water entering the boiler issues from the perforations in the internal feed pipe in jets and is thus thoroughly mixed with the water in the drum before passing downward.

Should oil or impurities enter with the feed the scum formed may be removed by operating the surface blow with the water level at the middle of the glass. Sediment will be thrown down in the front header where the bottom blow is arranged to remove it. Scale is removed from the tubes by using a hydraulic turbine cleaner which, together with the necessary hose, is provided with every boiler.

Assembling and Shop Tests

All boilers that are not too large are assembled complete at the manufacturer's shops before shipment. Usually, however, the clearance limitations of the railroads do not permit of complete assemblage, and the drum and its connecting tubes must be fitted in place at the point of installation. All parts are subjected to a hydraulic test of twice the safe working pressure before shipment. The work of fitting the drum at the ship's side or on board consists merely of inserting and expanding a few tubes. The casings are assembled complete before shipment and knocked down after match-marking the various pieces, so one cannot go wrong in re-erecting them at the shipyard. When provisions at the shipyard for handling the heavier pieces are inadequate and the customer desires it, the boilers will be shipped entirely knocked down. To assemble them aboard the ship will then be merely a job of rolling all tube ends, as the headers and drum will be completed in all respects.

We do many things in a certain way simply because we follow local customs, not because we use real reasoning. It is quite possible that our way may not be as good as we think.

Scotch Boilers Rolled 28 Miles Along California Coast

BY C. W. GEIGER

The accompanying illustrations show the different stages in the movement of six marine boilers aboard the full-powered motorship *Alabama*. These boilers were salvaged from the wrecked steamship *Bear* on the northern coast of California by the Porter Wrecking Company.

It was originally planned to ship the boilers to Shanghai on the steamship *Rosewood* under charter of the Overseas

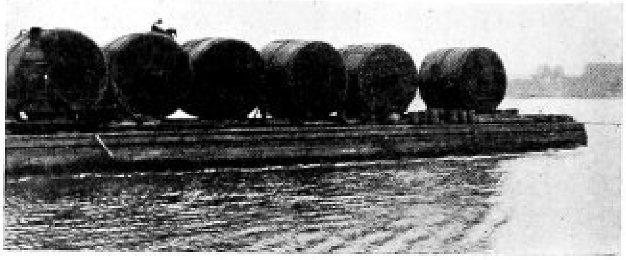


Fig. 1.—Six Boilers Salvaged from S. S. *Bear*

Shipping Company in November, 1917. When the vessel was ready, however, it was found, after repeated attempts, that it would be impossible to get the boilers off the beach at Cape Mendocina, and the *Rosewood* had to proceed to Shanghai without the boilers.

Salvage Contractors

A contract was then let to the Mercer, Frazer Company, Eureka, Cal., to haul the boilers along the beach to Eureka, 28 miles away. After five months the boilers reached Eureka, where they were loaded on the *Alabama*, which carried them to Shanghai on her maiden trip. The boilers will be installed on three steamers which are being

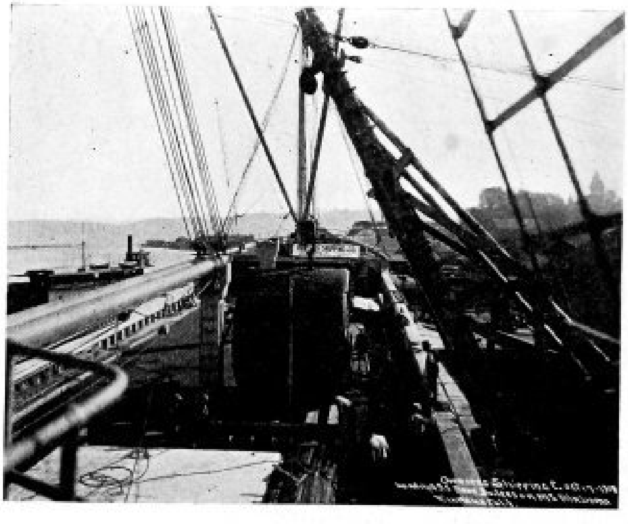


Fig. 2.—Loading Boilers on Motorship *Alabama*

built at the Chinese Government yards at Shanghai for the United States Shipping Board.

The boilers were transported by rolling them around cliffs and along the beach. Barges were also used at three points to float the boilers over rivers and across the southern part of Humbolt Bay to Eureka. Fig. 1 shows the boilers aboard the barge being towed across Humbolt Bay. On reaching Eureka, the boilers were rolled off the barge onto the pier and later loaded onto the *Alabama* by means of the special equipment shown in Fig. 2.

Discussion of Committee Reports at Recent Convention of Master Boiler Makers

Upkeep of Front End Draft Appliances—Bracing Locomotive Tenders—Oxy-acetylene and Electric Welding—Drilling Telltale Holes—Scaling Superheater Flues

Unavoidable delays in the delivery of the official report of the eleventh annual convention of the Master Boiler Makers' Association, held in Chicago on May 26 to 29, made it impossible to print a complete report of the convention in our June issue. Abstracts of the committee reports were printed in the last issue, and the following is a summary of the discussion of the reports which were presented during the last two days of the convention:

TUESDAY AFTERNOON SESSION

Fuel Economy

Mr. Powers: Has any investigation been made in regard to stopping air leaks around the superheater pipes? On our road that is one of the biggest bones of contention we have.

Mr. Austin: The committee made no investigation on that particular phase of it. Packing mixed with boiled oil that does not get too hard is better than a packing that is liable to dry up and work out.

Lew Ebers: We cut a plate that fits right around the steam pipe, and butt them together in an electric weld. In the meantime we put some front end cement in there. If you do that you won't have a bit of bother.

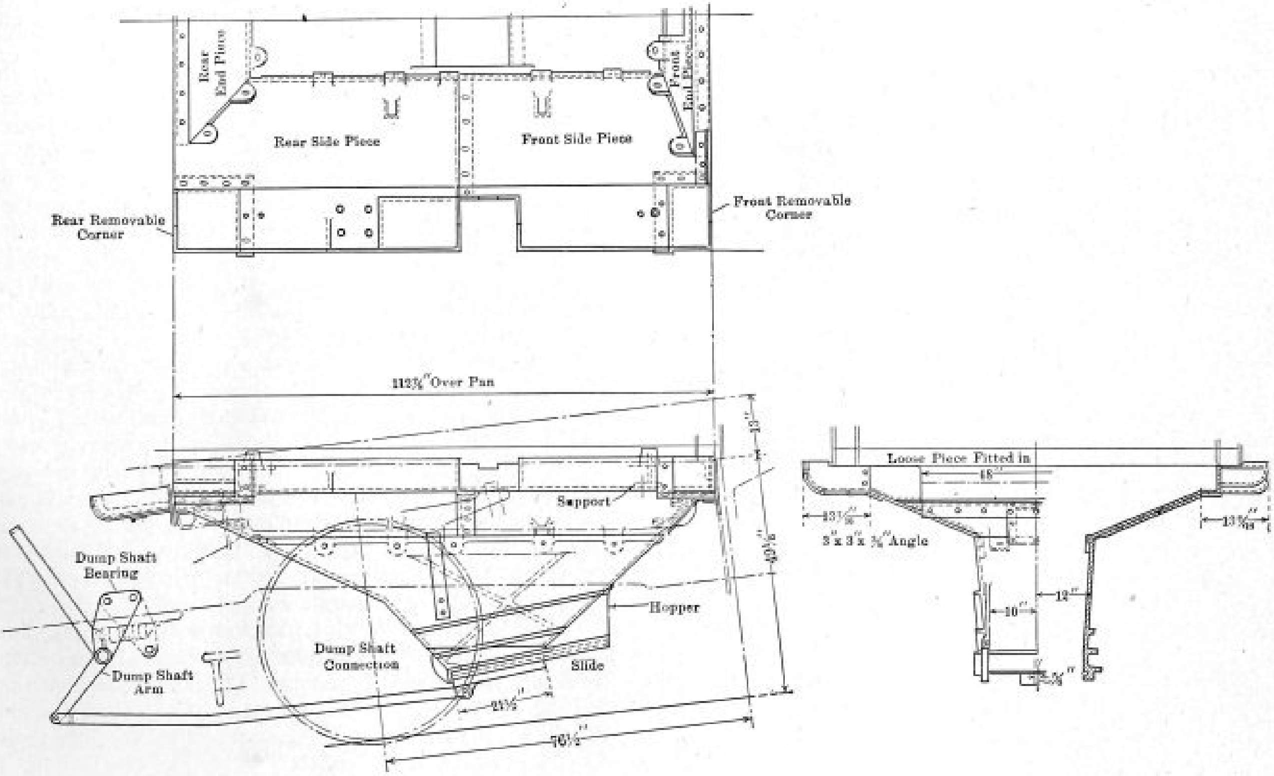
Mr. Powers: Don't you find that the front cement hardens, crumbles, and falls out?

Mr. Ebers: Front end cement won't crumble and fall out.

C. R. Merritt, of Pennsylvania Lines: We have had trouble with superheater pipes in getting air, and the way we discovered it is by holding a light at the top of the cylinder, where the jacket couples on to the cylinder. If the engine gets air at the front end, hold the light there, and it will draw the flame up.

To evercome this trouble make it nearly air tight. Take a piece of jacket steel, and form it to the same shape as the steam pipe, and weld it on to the flange on the smoke box, and bring it down to the steam pipe collar. Then put a band around it there and clamp it tight.

Mr. Whalen: It was suggested at the Fuel Convention last week that air leaks may be prevented by packing the cement with a ring on the outside to hold up the steam pipe and taking a piece of 10-inch iron, cutting two half circles, and placing them around the steam pipes inside the smoke box and electric-welding them.



Cast Steel Ash-Pan Used on New York Central Lines

Mr. Johnson: On the Santa Fe and the Coast Line, where we burn oil altogether, we use a mixture of sand, asbestos and crude oil to pack the pipes. The packing lasts about three months, when it has to be renewed.

Mr. Young, of the Southern: We have experimented along the same lines, only using a mixture of asbestos, coal oil, lamp black and linseed oil. The steam pipes on eighteen engines have been packed between the collar and the casting with the mixture, but the leaking doesn't seem to have stopped.

Mr. Porter, of the Chicago and Northwestern: I am using a rope asbestos, braided and tamped in there, and flake asbestos mixed with front end cement. It is not a permanent remedy, but it stays longer than when mixed with asbestos alone. You can braid it and tamp it in, and get fairly good results.

Mr. Stowe, of the B. & O.: We remedied this trouble by mixing a little sand with the asbestos to pack with and used Portland cement to close up the space on the inside of the pipe. The engine on which this method of repair was used has not given a bit of trouble with leaking in over a year.

Mr. Elkins: An engine with the grate or ash pan partly burnt out or in bad order is not going to be an efficient engine. The ash pan should be designed to give the engine a proper amount of air. We have adopted what is known as the Madden pan, and it has proved to be very efficient. In the old days, we had to renew the ash pan about once a year, but with this type we use one pan about four years.

Mr. Powers: Is there any difference between using the cast iron ash pan and the sheet steel? On the Northwestern we use sheet steel pans, and burn out quite a few of them.

Ex-President Bennett: I have here a cast steel ash pan, sides and all, which has been adopted by the New York Central lines. At present there are over a thousand of them in the service, and the records show them to be a decided improvement over the sheet steel pans. Some of these pans have made over 300,000 miles without repair, and are in as good condition to-day as when they were installed.

The cast steel pan is composed of 59 pieces, whereas the sheet iron or sheet steel, or built-up pan, has 2,459 pieces, including nuts, bolts, washers, etc. One pan will last throughout the life of a locomotive, which is about fifteen years, while the ordinary type must be renewed every two years. The cost of the cast steel is about one-eighth that of the other, during the period of usefulness of the locomotive.

The use of the pan has been approved by the Public Service Commission of New York State.

Mr. Powers: I would like to ask if you use any water in the pan, and if you apply it by the sprinkler system?

Ex-President Bennett: In the fire zone of the Adirondacks the conservation commission during the summer season compels the overflow pipes to be put into the ash pan from the injectors. The change must be made in April.

Mr. Stowe: The matter with our ash pan is that we leave too much under draft, and the air getting under tends to burn it out. Keep the under draft away from your ash pan, and the air out of the bottom of the pan, and it won't burn up.

Mr. Nelson, of the M. P.: The railroads spend hundreds of thousands of dollars every year for fire damage done to wheat crops, etc. During the war period we had a man on the road inspecting front ends and ash pans, and his report showed neglect in the care of pans in various round houses. When the difficulties were remedied, the fire damage and menace were greatly reduced.

We use what is called the master mechanics' front end, and I believe it to be as good as any in existence to-day. The pan has no casting, or cast iron slide, and only one opening in the bottom, where the hopper is tapered and only four seams, so there is absolutely no chance of getting a draft from underneath. If properly constructed, it can be cleaned by gravity. There is a flusher arrangement, whereby you can flush the pipe at any time with water from the branch pipe.

I believe the pan we are using is an ideal one, for with it you can get any air opening you want, and because of its peculiar shape there is absolutely no flat surface. I personally believe that if we will get away from the pan having a lot of openings at the bottom, a lot of this setting of fires will be prevented.

Mr. Seymour, of the Santa Fe: Do you ever have any large clinkers removed from the pan?

Mr. Nelson: On the Mikado class of engine, where you have the trailer, it is necessary to reverse the scoop. Instead of running to the back, you run it to the front, and form a double scoop. On all these engines there is a brace that comes midway to the firebox. We have cut out this brace, and made one to be arched and welded to each side of the frame. You cannot get a bigger clinker through the pan than through the dump, and there is a greater opening in the ash pan than in the dump.

Bracing of Locomotive Tenders

C. R. Bennett, of the P. R. R. Lines: Our trouble exists at the end of the braces, where the sheet becomes cracked. Patching the sheet usually overcomes this defect. Your recommendation is to increase the sheets one thickness where braces or angles are applied.

Mr. Barnes, of Georgia: If you want to get rid of your tank trouble, brace them properly. Drive one or two big rivets home right behind the brace so that the space is entirely filled and you will find that the vibration and accompanying troubles have disappeared.

Mr. Elkins, of the M. P.: We divide the tanks into equal spaces, and fasten jaw braces to T-irons from the side with ¾-inch rivets, run that brace through the splice sheet, and make it fast with a nut on each side of the sheet. There is only one sheet in the center of the tank, so we put the holes where the braces come about 3½ inches apart. We leave the splice sheet about five inches from the bottom of the tank, and put an angle iron through there. This angle is fastened to the coal pit and also the back end of the tank. Use quarter-inch plates, 3-inch by 3-inch angle irons, and quarter-inch rivets. We have some braces that have been in ten years, and they are as solid as the day they were put in.

Mr. Madden: Our tanks crack at the end of the angle iron due to the sharp edge of the angle. I believe it to be a good policy in erecting new tanks to add a little to the cost, and turn up the extreme ends of the angle iron, so that it does not have a flat bearing on the plate.

W. H. Lucas: On the M. C. the T-iron breaks in the last rivet. You get away from that by offsetting the T-irons and go in over the angle iron.

Mr. McManamy: With tanks that have the angle irons standing in a vertical position, they crack at the bottom of the iron. When I patched the sheet the vibration cracked the patch just as it cracked the original sheet. Then I got it fixed. We dug up enough turnbuckles to replace the jaw braces connected with the turnbuckle. It has been about five months since we applied the majority of them, and at the present time we are having no trouble with the tanks.

Charles Duffy, of the K. C. Terminal: We have a tank put up without an angle iron. It consists of 48-inch sheets, wrapped around the tank, and a 3-inch T-iron with the T on the outside of the tank. The bracing is simply partitions forty-eight inches square. Through the center there is a passageway. The back end of the tank is flange riveted to the sides. The front end of the tank is wedge-shaped, with an independent coal hopper. The coal hopper will feed the last scoop of coal down to the gates, and the tank holds 8,000 gallons of water. This tank has been in service twelve months and has not loosened up anywhere yet.

Mr. Powers, of the Rock Island: Eighteen years ago on the old B. C. Railway, there were 5,000 gallon braceless tanks, made up of T-irons. The T-irons were taken from the blacksmith shop and given an offset, so that they could be riveted at both top and bottom. After eighteen years these tanks have not developed a crack.

B. J. Sweeny, of Indiana Harbor Belt: About ninety percent of our tanks are built according to the T-iron and plate system. The vertical T-irons are offset to fit the top and bottom angle iron. We do not have any trouble with the plates cracking or the T-irons breaking.

Oxy-Acetylene and Electric Welding

Mr. Wandberg: Acetylene welding has been in existence for a good many years and so has electric, but I am more familiar with the former, while we are getting good results from the acytelene. As to the method of preparing material for welding. Some men prefer to have the sheets loose, so they will have a chance to come up. Now we have had a practice for a number of years of first putting in all the staybolts, if we have time, during the riveting, and then the welding. Another method used is to put in the staybolts and rivets and weld them in place. As far as the result of the work is concerned there seems to be no preference. Two months ago we installed an electric welding machine and we are doing fairly well with it. Still we are not at present getting the results we expected.

The failure or success of the weld is due absolutely to the operator and the material used. I am satisfied that we can make just as good an electric weld as we can an acetylene weld.

Mr. Lewis: We have to-day on our road about 150 locomotives that have their fireboxes welded.

Ex-President Bennet: I have a photograph that shows a low water case from which the firebox wrapper sheet slipped in spite of about 800 bolts supposed to hold it. It had an electric welded firebox and the back sheet gave out from mud ring to mud ring, causing the death of three people. The water was about 4½ inches below the top of the crown sheet. About three months prior to this accident they had a low water case on the same boiler, but with a riveted firebox. In this instance the water was down about the same distance below the crown sheet, but only 78 bolts were pulled out and the boiler remained on the frame.

We claim that due to this welded firebox this accident was intensified.

Here is another case. The running seam on the firebox was welded. With the water down 4⅞ inches not a bolt was pulled out of the crown, but the running seam gave way the entire length of the firebox, threw the crown sheet back on itself, and looped the side sheet down below the mud ring. Three were killed in this accident.

Mr. Austin: Within the last month, I have seen a crown sheet that had an electric welded seam running across the top come down on account of low water. It had sagged 7 inches, and many of the stays were pulled out. A close inspection of the welded seam failed to disclose the slightest evidence of fracture or weakness in any of its length. It apparently was just as good as the solid metal.

Mr. Nelson, of the M. P.: There is no doubt but what the process is all right. It seems to be a question of the operator and the material.

Our road has both electric and acetylene outfits, and has had them for the last four or five years. We do about forty percent of our firebox welding with the electric, and forty percent with the acetylene. When we use acetylene, we put in all the staybolts and burn them; and when we use electric, we do not apply the staybolts.

We have been welding flues for the past four years, on all classes of power.

Failures do not necessarily condemn a process, for the trouble may usually be traced to the operators.

Mr. Hanlan: I have never seen an electric weld in my life that was not porous.

Mr. Harthill: We had an explosion at our place when the side sheet ripped out from the first row of button head crown bolts down to the mud ring and straight across the mud ring up the flue sheet. The welded sheet had slipped ¾-inch, and the solid sheet all the way through. There were 300 odd bolts pulled right out of the sheet, but not a broken bolt in the job. It showed we had an efficient welder.

A man should not be allowed to weld a firebox unless he can weld a test piece that will give at least 75 percent efficiency in the laboratory.

I have welded something like fourteen hundred sheets since 1910 in fireboxes, with but one explosion, which was not the fault of the weld. As far as the electric welding is concerned, I don't believe it is as good as the acetylene for fireboxes, for I cannot get as high efficiency out of a test piece.

Mr. Harthill: We have an engine that was making fifty to sixty thousand miles a year when ordinary superheater flues were installed. We welded the flues with oxy-acetylene and increased their life from ten and twelve months to eighteen and twenty months, and mileage to 125,000 miles, and have to take them out now only on account of being pitted by the water.

Mr. Clark: The flues on our road are electrically welded to the tube sheets. Before we started welding our tubes, we had an average of one engine failure every day, due to leaky flues. Since we have had them all welded, we very seldom hear of a leaky flue, and never of engine failures.

Mr. Stewart then exhibited a series of lantern slides showing various forms of welding and explained each case thoroughly.

Mr. Hempel, of the U. P. Railroad: I believe that we are among the pioneers in electric welding, and at present we have 15 electric welding plants.

My experience has been that you can tell the condition of the weld and the work a welder is doing by looking at the fag end. If the fag end shows that the middle is oxidized, it is not a perfect weld. If the stick is bright, as bright as a silver dollar, you know he is getting metal. If it is oxidized, so you can break it, it is worth nothing. Welding is nothing more than a purely scientific proposition to be studied out. Use the proper amperage and voltage in your outfit and you will get good results. We have had but two failures in 350,000 flues.

You will find when electric welding flues, that their success depends largely on whether the work is to be used in a good or a bad water district. The reason is the formation of scale in a bad water district rapidly accumulates and is never knocked out of a welded flue with expanders and tools necessary to keep an ordinary flue tight.

Mr. Brown: Do you have the same confidence in acetylene welding?

Mr. Hempel: Yes.

Mr. Wandberg: I am not afraid to say that ninety percent of our failures are due to the fact that we have not the men properly qualified to do the welding.

Mr. Elkins: We have been welding all our flues for approximately the last four years. We have been welding every flue that has gone through the shop, big and little, and have passenger engines that are making a mileage of 100,000 miles with them. They are the heaviest passenger engines we have, and run 22, 24 and 26 months with heavy travel, and come into the shop with the flues just the same as they went out. They are never touched from the time they go out until they come back. We also weld fireboxes.

Mr. Patrick: What kind of water have you?

Mr. Elkins: A good many different kinds, because we operate in a good many different kinds of country. In the southern district they have good water. In our particular plant we do not have the best, and have to treat it. Before we commenced to weld flues we had trouble, but they are practically at an end. I do not remember ever having taken out a weld that had a broken bridge in the sheet.

Mr. Madden: We have been welding flues for the past four years; and although we have had failures, at least 80 percent of the work is satisfactory.

Mr. Patrick: How much mileage do you get out of a set of flues?

Mr. Madden: Our freight engines run 70,000 miles. Our passenger engines make 110,000 miles.

Mr. Pack: I do not want this convention to go on record as putting the Government in the position of opposing autogenous welding, which consists of oxy-acetylene or electric welding, at all. You heard what Mr. McManamy said yesterday about not being able to build a boiler with the oxy-acetylene torch. We are not opposing the methods of welding, but we are going to oppose, and I am going to oppose in particular to the end of my influence any method that is costing people their lives. Excesses, the extremes that some people have gone to with the electric welding torch, are what we object to. I do not believe that welding will get anywhere until it has reached a more perfect stage, that is, in any part of the boiler wholly in tension.

WEDNESDAY MORNING SESSION

At the opening of the morning session on Wednesday, Mr. Bentley, superintendent of motive power of the Chicago & Northwestern Railroad, delivered an address before the convention emphasizing the necessity for good, conscientious workmanship in the boiler shops.

Which Is the Better Method of Drilling Telltale Holes—Before or After Application of the Bolts? Which Is the Better Method for Drilling in Either Case? What Is the Best Style of Drill for Opening Up Telltale Holes in Old Staybolts? Does It Pay to Use a High-Speed Drill for This Purpose? What Is the Best Lubricant for the Drill?

A. N. Lucas: We are punching all our telltale holes in the blacksmith shop with very good success. Where we punch the holes, we also countersink them, so that when the bolt is set in and applied and hammered up it does not close the telltale hole up and it is readily opened with a drill or reamer or pin. Where we drill the telltale hole, we countersink the hole to the full diameter of a three-eighths drill.

Mr. Powers: What is the percentage of failure in bolts that are punched? Is it cheaper to get your engine through the shop by putting all your bolts from the inside and cutting them off, or using hollow iron, or drilling your bolts from the outside?

A. N. Lucas: In punching the telltale hole in the seven-eighths bolt, they do split occasionally, but in the fifteen-sixteenths, or inch, where the punch is used properly and in the center, we do not have much loss through the telltale hole. I believe it would be a good idea to use a hollow bolt as a standard. I believe we can buy them as cheaply as we can make them.

Mr. Madden: I believe the bolt that is punched could be applied from the outside as well as from the inside. Many roads put bolts in that way after they are threaded.

A. N. Lucas: I believe you saved money by squaring the bolt. We went through that to some extent and feel that the best method is the square staybolt.

Mr. Wandberg, of the Chicago, Milwaukee & St. Paul: We square our bolts and put them all in from the inside. We are punching all our bolts, and in some cases it is necessary to open them up afterwards, but not very often.

A. N. Lucas: In applying staybolts, where you are using the tap and passing out the staybolts, many are using an old glove or piece of waste, which is very dangerous, because sometimes men get it wound up with the tap and get their hand hurt or their arm pulled out. We use a piece of old pipe with a tap at the end. The man that handles the tap never touches it; he hands it out over the mud ring or otherwise.

J. L. Diddier, of the Southern Railway: We generally apply the bolt from the inside of the firebox. My idea is to put the bolt in from the side opposite to where you tap the hole.

Mr. Shrenky: We drill all our bolts and countersink them before we apply them from the inside of the boiler.

Mr. Berry, of the Erie: We have been punching bolts in the blacksmith shops for a good many years. I think the punching is all right, providing time and care are taken in doing it, but if you hurry the job you will ruin a good many bolts.

Mr. Fogarty: We apply our staybolts from the inside of the firebox and for a good many years have had good results. We drill all our bolts on a spindle drill and countersink them.

Mr. Ready: We drill our bolts first and apply them from the inside. Instead of countersinking, we counterbore a little bit, which helps materially in opening up your holes.

Mr. Laughridge: I do not believe in changing the metal in a staybolt a particle from the way it is manufactured in the mill. We punched staybolts ten or twelve years ago, and quit it because we did not get a good job. The punch would get dull, the hole would not be of full size, and you could not ream them out because you could not buy enough drills to ream them out. We could drill them cheaper.

Mr. Borneman: I think the drilling of the telltale hole in a staybolt ought to be done away with. Our practice has always been to use the hollow bolt in the breaking zones.

Mr. Tate: The Pennsylvania lines East drill all their holes on a machine in the bolt department. It is strictly a bolt-room proposition with us. There is no heating allowed on a staybolt. The staybolt is squared by a press, cold. It is cut off cold. It is drilled cold. It is riveted cold. All staybolt manufacturers will tell you: "We make staybolt iron to handle cold; we send it from the factory as it should be used." While there may be something in punching staybolt iron, I have failed to see any yet that would not admit that they got a percentage of bad work in punching, besides the deterioration and destruction of the material that they are using. If you handle the steel bolt, it may be another proposition. We handle all iron bolts.

Mr. Powers: This problem has been solved for us and some of us have not taken advantage of it. There are several different kinds of hollow bolts on the market. The best way to handle the telltale holes is to buy hollow iron.


"And this is the result"—
Not one bolt has split in heading, threading or driving.
"Drilled from the solid Bar"
JOSEPH T. RYERSON & SON.
CHICAGO, NEW YORK, ST. LOUIS, DETROIT.
ULSTER SPECIAL
SEAMLESS HOLLOW IRON
IMPROVED PATENT METHOD

then you are sure your hole is in the center—don't care whether the bolt is put in from the inside or outside. The hollow iron is here, and the only thing holding us back from using it is the matter of cost. Whether it will pay us to use it on account of increased cost is for us to say.

The Chair: I think that the proper method of putting in a staybolt is to put your hole in from the outside and run your bolt in from the inside, driving it on the outside first and finishing it up on the inside last. In this way you will get results from your staybolts.

Mr. Young: I am a believer in drilling the bolts first, putting them in from the inside, hammering them up and countersinking them after they are hammered up.

Mr. Borneman: Tapping the holes from the inside of the firebox is absolutely wrong. We used to do that thirty years ago, and it is a back-number way of doing work. Always tap from the outside; the motor always has a tendency to wabble the cap, and there is where you get your large holes.

Mr. Ed. Hunt, I. C. R. R.: The cheapest way to apply staybolts is to drill them before you apply them, and apply them from the inside. The best way to apply the bolt is to drill it from the outside sheet, clamp it on the outside sheet, hammer it on the outside sheet first, and finish it on the inside sheet. If you apply a bolt from the inside sheet, hammer it on the outside sheet first.

The Chair: The question has been asked, can money be saved by using hollow staybolts entirely, over and above the solid bolt, taking into consideration the drilling and all the extras that are on it?

Mr. Cooper: I would like to know whether a punched bolt is as good or better than a drilled bolt.

Mr. Hempel: I am not positive myself that the punched bolt is just the proper thing. My only objection is that you have to heat the metal to too high a temperature to punch the hole. If you could punch that hole at almost annealing temperature, it would be better. I believe in a good drilled hollow staybolt. We are applying them now, and I think it is the coming thing; that is my opinion of the staybolt proposition. The matter of first cost amounts to nothing.

Mr. McGonigle: At the shop where I am, the blacksmith foreman handles the punching of the bolts and uses the five-eighths high-speed punch. As many as two thousand are punched with one punch, and practically none have to be thrown out. As he punches the bolts, he piles them up in a row on a board. When he gets the row two bolts high, he reverses the heat from end to end and lays another board on them and practically anneals the bolts with the heat that he punches the bolts with. From the experience that we have had with the bolts in the six months I have been at that place, we have had no trouble at all from the punched bolts. He has a shoulder on the punch that countersinks the bolt the same as we countersink with a drill. If all the bolts are punched with as good success as he has at that point, I do not see any objection to the punched bolt.

It was moved and carried that the subject be closed.

What Is the Best Style of Grate for Bituminous Coal? Where Should the Dump Grate Be Located (a) in Road Engines, (b) in Switch Engines? What Should Be the Percentage of Opening in Grates? What Should Be the Percentage of Draft Opening in Ash Pans Compared with Area of Grates?

Mr. Laughridge: I regret that I was unable to complete the kind of a report that we should have on this subject. It is a very important subject, and I recommend that the subject be continued and special attention be given to engines with stokers.

Mr. Stewart: The first question is the best style grate. On our road we use a rocking table grate only in all classes of engines. It has a five-eighths wrought iron rod with a grate cast around this rod, so in case the grate should break it does not fall in the ash pan and cause engine failure.

The next question is where should the dump grate be located? We have not used the dump grate on the Atlantic Coast Line in ten years. We used to have so many failures from dump grates that they were discarded. The rocking table grate throws the grate toward the front for cleaning the fires. As to the percentage of opening of the grates, this rocking table grate has an area of opening of 42½ percent, which is all that you can get in that grate without weakening it too much.

The next question is what should be the percent of the draft opening in ash pans compared to the grate area? On our latest engines we provide an air space of 14 percent, equivalent to 15 percent of the grate area of the firebox. In some engines we have 14 percent; in others as high as 16 percent. I do not think it would hurt if the opening was increased. There is a tendency to go in that direction.

A. N. Lucas: We use a small grate that has no dumping capacity at all. For the past year and a half we have gone to the box grate, nine inches high, and we get an opening, when we dump it forward, of about eight inches between the grates. We use no dump grate whatever.

J. G. Reese: We do not use dump grates at all in Savannah. They are a practical nuisance and cause failures of all kinds. We use a box grate and tip the grate over and use a slice bar. I am personally in favor of box grates with a large opening and no dumping whatever.

Mr. Waller: Most of our troubles with dump grates have come from the fact that they were in the forward end of the firebox. I do not think it is necessary, in some instances, to have a dump grate at all, but I think it is very necessary to have a dump grate on a switch engine, and have it in the rear of the firebox. If we put our dump grate in the back end and properly maintain it, we will have no trouble.

Mr. Elkins: In the past we used to put too much confidence in putting the air openings in the front and rear of the ash pan. On the side of the firebox is where the air opening should be. On our road we figure on 14 to 16 percent of the area of the grate for air space and put as much of it as possible on the side. If the dump grate is put in the rear of the firebox, where it belongs, and it is properly maintained, I do not think anyone will have any trouble with the dump grate on an engine.

WEDNESDAY AFTERNOON SESSION

What Is the Best Method for Scaling Superheater Flues in the Boiler? What Is the Best Method of Rattling Flues? What Is the Best Method of Handling Flues In and Out of the Rattler? How Many Revolutions per Minute Should the Rattler Make for 2-Inch and for 5⅜-Inch Flues? Describe Method for Safe-Ending Superheater Flues

A. N. Lucas: In taking care of large superheater flues, as engines come in the shop and the units are taken out, we have a turbine, a Lagonda cleaner, with which we rattle all the carbon from the inside of the flue, and try and hit it hard enough to knock some of the scale loose on the outside. Where we take the small flues out, we have tools that we use with a small air hammer that we work up from the bottom side of the superheater flues, inside the boiler, and get off all the scale possible.

A Member: How do you rattle them?

A. N. Lucas: In a dry rattler, without any water or pebbles or bolts or anything in them. If you put in the bolts or nuts it smashes your flues up pretty badly. I do not think those large flues ought to be rattled any longer than necessary, and if there is any scale left in spots on it you can knock it off with a hammer.

Mr. Whalen: Our road bought thirty-nine engines three years ago, and we have not removed any of the superheater flues out of those engines yet. When the engines go through the back shop we remove all the two-inch flues and the zig-zag flues up among the superheaters. While they are getting the tubes ready we run a four-inch Lagonda flue cleaner back and forth through each of those superheater flues. You get excellent results from "turbining" those superheater flues. We have never done any tumbling of the superheaters yet.

A. S. Greene: We never clean the superheater flues in the boiler at all; we take them out when they are dirty. We generally take all flues out.

C. R. Bennet: What do you think is the proper way to clean a superheater flue in a boiler?

Mr. Greene: That is something we do not do.

A. N. Lucas: Don't you find that the insides of the superheater flue become heavily coated, and when you take the units out you have hard work getting them out, and if they were not cleaned by the turbine you would have a hard job getting the units in again? We get it a quarter of an inch and five-sixteenths thick where it goes on the inside of the flue.

Mr. Greene: We have not found anything of that kind on our road.

A. N. Lucas: How long do they last before you take them out?

Mr. Greene: Eighteen months to three years.

Mr. Sarver: At our plant we run a set of superheating flues just twice as long as we run the small flues, and, while we have no special way of cleaning those flues other than knocking all the scale off from the outside that we possibly can, in so far as cleaning the scale and stuff off the interior of the flues, I cannot say that we have a whole lot of that to do. If he would say that he has a whole lot of that to do, he is not taking very good care of his superheaters, and probably he is losing a great deal of efficiency on his engines by allowing it to get in that condition.

A. N. Lucas: Have you ever had any units collapse?

Mr. Sarver: We have had them leak on the end, but not had any of the tubes collapsed in the body.

A. N. Lucas: Have you had them pit through at the front flue sheet and fill up the flue from a slow leak?

Mr. Sarver: No, sir.

A. N. Lucas: Have you had any large superheater flues collapse, due to light weight?

Mr. Sarver: Not to my knowledge.

C. R. Bennet: I have had them collapse due to mud, because we were not washing our boilers out right.

Mr. Greene: I have had several superheater flues collapse on the hydrostatic test due to light weight.

Mr. Berry: How do you get the scale out from between the flues after it has accumulated?

A. N. Lucas: Take the flues out.

Mr. Austin: If scale was the result of mud settling and then baking, we might conclude that it was on account of poor boiler washing that scale accumulated; but that is not my understanding of it. Scale accumulates on account of the scale-forming solids in the water being precipitated as the water is evaporated, and it accumulates more where there is the most evaporation, and, like any other cement, it will form regardless of the temperature. We cannot wash it out; it forms there and has got to be knocked off—got to be removed mechanically—you cannot do it with washing.

Mr. Powers: We have recently found it necessary to set a limit to the weight of superheater flues, due to the fact that they collapsed when they were perfectly clean when applied to locomotives in shops. We have adopted a standard of seven pounds to the foot for a 5⅜-inch flue.

Mr. Tate: My experience in handling superheater tubes is that they wear out at various locations. If that be the case, how are we going to ascertain a defective flue by the weight of it?

A. N. Lucas: Very easily. If it ought to weigh ninety pounds when it is new and you weigh it when it is second-hand and it only weighs seventy, you can decide right quick whether it ought to go in the boiler again or not.

Mr. Tate: That is good, excepting two, four, six or eight inches at the end, where, by piecing that flue out, we have got just as good a flue as when we started.

A. N. Lucas: I doubt it. I have inspected several flues and they did not collapse at the end, but at the center.

Mr. Tate: The only way to ascertain a defective superheater tube is by the hammer test. An experienced boiler maker can find it.

A. N. Lucas: Is that the way you detect a two-inch flue when it is light? Don't you weigh it?

Mr. Tate: Yes.

The Secretary: Mr. Patrick offers the following motion: That when a superheater flue becomes scaled to the extent that it needs cleaning, the best method of cleaning is to remove the flue and clean it in a rattler.

Mr. Wandberg: I have been taking out in the last three or four months superheating flues that have seen six years' service, and the beads on these flues are good, the flues are good.

The question was called for and Mr. Patrick's motion was adopted.

Mr. Austin: I would like to prevent adopting a practice which I think is a mistake, in that it will be putting us to expense and trouble without any return, or with very little return for the trouble and expense. I refer to the practice of using a knocker or rattler on the inside of the large superheater flues to remove the carbon. What little carbon might be in that flue would not amount to much, and it would be practically a waste of labor to go to this expense and trouble to remove it.

Mr. Ready: I find that the cause of the flues collapsing under the hydrostatic test is that in handling the flues in rattling and handling them from the shop to the locomotive they are not as careful as they should be. In lots of cases the flues become pinched or flattened to a certain extent; it may be only for an inch or two, but if you take into consideration the large diameter of the flues and put 175 or 180 pounds water pressure on them, the chances are that you are going to flatten them—going to collapse them. We make it a practice carefully to inspect every superheater flue after it has been cleaned and gotten ready for the boiler, and if we find any kinks or flat places we straighten them with a mandrel that goes into the flue and use an acetylene torch and a small wooden mallet, and have never had a flue collapse since we put this practice in vogue.

Boiler Manufacturers' Annual Meeting

Progress in Adoption of A. S. M. E. Boiler Code—Discussion of Uniformity in Cost Finding and Estimates—Topical Questions

The thirty-first annual convention of the American Boiler Manufacturers' Association opened at 10 A. M., June 23, 1919, in the Lafayette Hotel, Buffalo, N. Y. President Connelly gave a brief address and introduced Mr. Richard Hammond, of Buffalo, dean of the boiler making industry, who welcomed the members to the city.

Uniform Boiler Laws

Mr. Fish: After the American Society of Mechanical Engineers had drawn up the boiler code, the question arose as to how it could best be enacted into legislation so that it would be uniform. To do this, a number of boiler manufacturing interests formed what is called the American Uniform Boiler Law Society. The problem of promoting the adoption of the code was very largely financial and each of the representatives on the administrative council was assigned the duty of raising a certain amount of money, this being proportioned roughly to the interest that it was deemed each representative's department had. To the American Boiler Manufacturers' Association was assigned the sum of $1,000 each year, and with the exception of one year we have been able to raise that, while for the year 1918-19 we have contributed the amount of $1,207.50.

Mr. Gorton: Legislation was introduced in Alabama, Georgia, Tennessee, Mississippi, Rhode Island, Delaware, Florida, Illinois, Kansas and Michigan.

In Tennessee two years ago a bill was introduced in the Legislature by the Commissioner of Commerce and Labor. On account of friction existing between the labor element in Tennessee and the Manufacturers' Association, the executive committee thought it advisable to lay the matter over temporarily.

The bills introduced in Illinois had overrun the amount set by the council on appropriations, so that it seemed unwise to introduce legislation at this time.

In Kansas the bill was introduced, backed by the Commissioner of Commerce and Labor, but another bill introduced by the boiler makers' union made it almost necessary to fight the original bill. Then there was a compromise bill introduced by the labor interests, but the Kansas Legislature did not feel that it could support the measures incorporated.

Under Section 91 of the labor law of New York, the industrial commission was empowered to adopt the code pertaining to factory buildings only. Through the inspection department, the boiler bill introduced gave the state jurisdiction over all boilers carrying a pressure above 15 pounds, in all classes and types of buildings.

In Delaware the bill was unanimously passed by both Houses. The bill provides for a board of boiler rules consisting of five members: a professor of mechanical engineering, a manufacturer of boilers, a user of boilers, a mechanical engineer, and the fifth a licensed stationary engineer.

The Rhode Island Legislature passed the bill unanimously. The bill carries the following provisions: The appointment of a chief inspector and the appointment of one or more deputy inspectors. The chief inspector must formulate and adopt a standard code of rules for the construction, equipment, installation and inspection of boilers, based upon the standard code of rules published and enunciated by the A. S. M. E. Boilers subject to federal inspection and control, together with boilers carrying a pressure of 15 pounds per square inch of steam or less, of 30 pounds per square inch of water or less, and boilers which are inspected and insured by companies chartered for the purpose of insuring steam boilers and authorized to do business within the state, are exempt from further inspection.

The bill has passed both branches of the Missouri Legislature and is now in the hands of the governor for his signature. The bill creates a board of boiler rules consisting of five members, four of whom shall be citizens of the state and familiar with the construction and use of steam boilers. The fifth member shall be the state factory inspector. The rules and regulations as formulated by the board of boiler rules shall conform as nearly as possible with the Boiler Code of the A. S. M. E.

The Legislature of Michigan in 1917 passed a bill authorizing the appointment of a board of boiler rules to formulate rules and regulations for the construction of boilers, subject to the approval of the governor and attorney-general.

The bill was to be presented to the Georgia Legislature June 27, but no report has been received from it yet.

The general engineering department in the city of Washington specifies that all new boilers be made to the code standard.

Increasing recognition of the value of the code is indicated by its use in technical schools as a text or reference book. It is used in the republic of Argentine, the republics of Paraguay and New Zealand. The following states and cities have adopted the A. S. M. E. Boiler Code:

States

New York	Michigan	Wisconsin
New Jersey	California	Minnesota
Pennsylvania	Missouri	Ohio
Delaware	Rhode Island	Indiana

Cities

Detroit, Mich.	St. Louis, Mo.	St. Joseph Mo.
Erie, Pa.	Philadelphia, Pa.	Chicago, Ill.
Kansas City, Mo.		

County

Allegheny County, Pa.

Letters have come from exporting houses interested in the code, requesting that copies be supplied to their representatives in foreign countries. So far fifty copies of the code have been distributed in foreign countries in order to stimulate an export trade which this association will appreciate.

Methods of Increasing Boiler Room Efficiency

Dr. D. S. Jacobus, advisory engineer of the Babcock & Wilcox Company, presented a paper on "Methods of Increasing Boiler Room Efficiency." This paper will be published in a later issue.

MONDAY AFTERNOON SESSION

At the opening of the afternoon session President Connelly delivered his annual address.

Stamping and Registering Boilers

Mr. Fisher: There seems to have been a good deal of confusion of thought as to how the boilers are to be stamped, and many complaints have come before the officers of the association asking for information.

The code, on page 86, paragraph 332, says: "After obtaining the stamp to be used when boilers are to be constructed to conform to the A. S. M. E. Boiler Code, a state inspector, municipal inspector, or an inspector employed rgularly by an insurance company which is authorized to do a boiler insurance business in the state in which the boiler is built and in the state in which it is to be used, if known, is to be notified that an inspection is to be made, and he shall inspect such boilers during construction and after completion.

"In stamping the boiler after completion, if built in compliance with the code, the builder shall stamp the boiler in the presence of the inspector after the hydrostatic test with the A. S. M. E. Code stamp, the builder's name and the serial number of the boiler. A data sheet shall be filled out and signed by the manufacturer and the inspector; this data sheet, together with the stamp on the boiler, shall denote that it was constructed in accordance with the A. S. M. E. Boiler Code. Each boiler will be stamped with the following items, with intervals of about one-half inch between the lines: First, the manufacturer's serial number; second, the state in which the boiler is to be used; third, the manufacturer's state standard number; fourth, the name of the manufacturer; fifth, the state number; sixth, the year put in service; seven, the maximum pressure when built."

Now if the boiler is made on stock, it can have all the numbers affixed and be put into stock, and when it goes into the state the state number and the year put in service can be put on at the time it is shipped. The confusion seems to have arisen in this way: A great many think that they have to stamp the boiler for Pennsylvania, for Massachusetts, for Indiana, for Ohio and other places. Now, as the different states adopt the rules, the boilers will be plastered all over with stamps.

Mr. Lucke: We insist on stamping after the boiler is installed, not in the shop, and when the final inspection is made and all the appendages are on the boiler, the inspector puts the year on the boiler. He has no right to put it on in the shop.

Mr. Fisher: The year put in service is not put on in this code until the boiler is installed.

Mr. Lucke: Your suggestion was that when the boiler was to be shipped the date could be put on. We would not permit that at all until after the boiler had arrived at its destination, been installed and all the appendages in place.

Mr. Fisher: If the law requires it to be put on after the boiler is installed, the code satisfies that.

Mr. Meyers, of Ohio: It is plain if the rules are followed no trouble will arise. Some of the manufacturers feel that the A. S. M. E. symbol is sufficient for a state to accept the boiler without the standard stamp of the state to which it is going.

A Member: After a boiler reaches its destination, who is authorized to stamp it?

The Chair: The final inspection, after the boiler is delivered, is made by a representative of the state boiler inspection department to see that the valves, fittings, etc., are all right, and the inspector does the final stamping.

Mr. Lucke: It may be made by a representative of the insurance company, as well as the state inspector.

Mr. Jeter: The difficulty is that a manufacturer builds a boiler and does not know in what state it is to be used. If, as the code specifies, the boiler could be stamped with the exception of the name of the state to which it will go, then any authorized inspector could stamp the latter and the difficulty would be overcome. Under the present system the boiler has been stamped in Ohio and Pennsylvania, and maybe it is going to New York, so the New York state stamp has to be affixed. It must be affixed, however, by someone who has seen the construction, and many times this is not possible.

Mr. Williams: Usually the jobber does not know to what state the boiler is going. It leaves our shop, so we cannot stamp it with the state number at that time.

Mr. Meyers, of Ohio: In Ohio, if the boiler is stamped with an A. S. M. E. number, the records in the office indicate the name of the inspector and whether he was qualified in that state. If qualified, he could authorize any other Ohio inspector to stamp that boiler wherever it happened to be.

Mr. Williams: What if a boiler is used in several different states by a contractor, for instance? Would all the states have to be stamped on it?

Mr. Meyers: Under present conditions, yes.

Mr. Gorton: The New York and New Jersey Inspection departments have assured us that a boiler bearing the A. S. M. E. stamp with a data sheet furnished by the state authorities would pass the boiler, so far as New York and New Jersey are concerned. The Ohio law, as it exists to-day, wants the original inspection made by an inspector authorized to inspect Ohio boilers and whose certificate is on file in Columbus.

Rescinding the A. B. M. A. Steel Specifications

The Chair: The next thing is a discussion of the advisability of passing a resolution rescinding the specifications of steel adopted by this association at St. Louis, October, 1898, and amended in 1905, 1909 and 1910, which material has been known as "A. B. M. A. Boiler Steel Specifications," and the adoption of the A. S. M. E. Specifications as the future standard of the American Boiler Manufacturers' Association. It has been brought out by some of the mills who, once in a great while, get an order for boiler plate according to the A. B. M. A. specifications, that the American Boiler Manufacturers' Association at Erie, in 1915, as a body adopted the A. S. M. E. specifications.

The rolling mills have asked us to put it into our records so as to avoid law suits when they furnish A. S. M. E. steel.

Mr. Champion: The A. S. M. E. specifications are as good as can be formulated, and any attempt to go beyond their requirements is bound to be impractical.

The Chair: The only revisions in the A. S. M. E. steel specifications are slight changes in the variances on tensile strength. The original specification on flange steel still exists so far as tensile strength is concerned. On firebox steel, limits between fifty-two thousandths and sixty-two thousandths are required, thus giving a range of ten thousandths to the mill. The new code still allows the mill eight thousandths, but the limits are from fifty-five to sixty-five. The elongation is exactly the same.

The A. B. M. A. specifications were voted obsolete and the A. S. M. F. code for steel formally adopted.

Trade Acceptances Discussed

The Chair: The Heine Safety Boiler Company has led us all in the matter of trade acceptances, and Mr. Fish of that company will explain something of the workings of their system.

Mr. Fish: About a year ago we had our contract forms printed with the terms of payment, which read as follows: One-half payment on the presentation of the bill of lading and one-half of the remainder in thirty days, evidenced by a trade acceptance, and the balance in sixty days, evidenced by a trade acceptance. These are printed in forms purposely, not with the expectation that they will always be accepted by the customer, but being printed it would indicate the fact that they are our standard terms and be more likely of acceptance. The results have been rather gratifying, because in about 75 percent of our contracts no exception has been made to the presence of the requirements for trade acceptances, and they have been given in about that proportion of cases. Of course, those acceptances constitute a promissory note that is accepted at the time it is given, and as such becomes negotiable paper that is of considerable value for banking purposes, and we have no intention of stopping the practice.

Mr. Kellogg: A trade acceptance is different from a promissory note in this way: It is an obligation given of payment on a definite date and means that there was an actual shipment of merchandise in consideration of that trade acceptance. A promissory note may be given on an account that has been running for years and banks may hesitate in accepting it, but the minute you discount a trade acceptance it is more valuable than a promissory note, because it has the implied representation that there was actual merchandise sold.

Mr. Fisher: Does taking a trade acceptance constitute an acceptance in such a way that in case the purchaser gets into financial difficulty it is not possible to get a mechanic's lien or retain the title?

Mr. Kellogg: If your contract provides for the acceptance of a trade acceptance or a note as a condition of payment, it is not a waiver of lien.

Standardization of Pressures for Watertube Boilers

The Chair: When a man wants a 165-pound boiler, he either buys 160 or 180, so that the boiler builder has an opportunity of carrying plates, tubes, etc., in stock for the various pressures.

Mr. Cox: The part that affects us is that starting at 200 pounds, which is our minimum pressure, with the exception of the case where we use 175 pounds with lighter tubes. The headers would be the same for 200 pounds as for 175 pounds.

Mr. Bach: On acount of details of construction in our headers, we have a standard thickness handhold and tube sheet, which makes our standard header good for about 225 pounds. We do, however, vary to comply with certain specifications, but make a minimum of 175 pounds, which covers the 4-inch tube. In any event, all our header construction is good for that maximum. Then we vary the drum and tube details to cover the specifications on which we figure. Header construction does not change with the varying pressures.

Mr. Burton: We originally adopted three pressures—160, 180 and 200 pounds—and in the last six months we have taken on 225 and 250.

Mr. Pratt: The pressures are identically those we follow at the present time, but the greater number are for 200 pounds and 160 pounds. In 1918, 45.4 percent of our total sales were 160 pounds, 3.3 percent were 180 pounds, 38.2 percent were 200 pounds, 4.7 were for 225 pounds, 5.6 percent were 250 pounds, 0.7 were 175 pounds, 1.5 percent were for 300 pounds, and 0.5 percent were for 350 pounds. For the first five months of this year the figures did not run very different, although the orders have been few and far between.

The idea of standardizing pressures at which we build is a good one, because we can materially reduce our costs by sticking closely to the standards, and so can expect not only to sell boilers cheaper, but to build better boilers.

Pressures to Be Allowed in Firetube Boilers

The Chair: It is proposed that the steam pressures of firetube boilers be standardized to 100 pounds, 125 pounds and 150 pounds.

Mr. Scannell: 175 pounds should be added to the variance of pressures as tabulated.

Mr. Barnum: When building firetube boilers, it is policy to keep the plates as thin as possible and still get the pressures. If a man wanted a 160-pound pressure boiler, it would be much better to build for that pressure and not be obliged to make the plate as thick as required for 175 pounds.

Pressures of 100 pounds, 125 pounds and 150 pounds were adopted as the standard for horizontal return tubular boilers.

Minimum and Maximum Heights from Grate to Shell for 72-Inch by 18-Foot Horizontal Tubular Boiler

Mr. Jeter: It is difficult to state any specific height from the grate of a horizontal return tubular boiler to the shell. For safety of the boiler, it cannot be made too high. For the bituminous fuel boilers the shell should be about four feet above the grate and not less than three.

Mr. Kellogg: In the price list adopted by the return tubular boiler manufacturers on June 5 a minimum of 36 inches is given.

Mr. Johnson: We have a city smoke ordinance which calls for a minimum of 42 inches on 66- and 72-inch boilers, and other distances in proportion on smaller boilers.

The Chair: The consensus of opinion seems to be that the lowering of the bridge wall is the tendency to-day, and not to try to throw all the heat against the shell of the boiler at that one point.

Mr. McKewen: It is going to be rather difficult to adopt a standard. The fuel conditions in the various localities must be contended with, and certain ordinances in cities compel a certain height as well.

Mr. Walton: The smoke inspectors' standard is 36 inches. There are some cases where a setting of 28 inches is required, but if a less height is demanded the 36-inch price is maintained.

The minimum height from the grate to the shell on boilers from 54 to 72 inches was adopted as 36 inches.

Minimum Distance from Rear Head to Inside of Rear Boiler Wall

Mr. Drake: We have a standard on the 72-inch boiler of 24 inches, but that is often changed, dependent on the specifications we have to meet. Twenty-four would be the minimum.

The Chair: In Cleveland the minimum is 30 inches for hard coal and 26 inches for soft.

Minimum Height for Stack for 72-inch by 18-Foot Boiler

Mr. Uhrey: Our minimum is about 75 feet; 75 to 100 is what we prefer, using 34 inches diameter.

Mr. Drake: The horizontal tubular boiler manufacturers have a standard specification calling for a 34-inch by 70-foot stack. Of course, conditions are such sometimes that 20 feet is added to that. Seventy is the minimum.

Mr. Wigo: We use a great many different kinds of fuel, especially in the saw mill territory. We work from 60 feet up. In some cases it has to be 100 feet or more.

Relation of Stack Area to Tube Area for Horizontal Return Tubular Boilers

Mr. Scannell: We make the area of the tube the same as the stack area.

Mr. Jeter: The size of stack ought to be based on the amount of fuel to be consumed, and hasn't any relation to the tube area, except if the tube area is reduced, then a higher stack is necessary.

Mr. Bach: There is an old rule that is very practical, that a stack shall be one-fifth of the total grate surface and the breeching one-fourth. The 20 percent excess tube area is not practical, for if, in the case of a heating boiler full of tubes and a correspondingly larger grate, the relation of grate area to tube area is not always fixed, but has one-fifth of the grate area as a standard for stack area and one-fourth for straight-away breeching, it will prove satisfactory.

Dr. Jacobus: In the watertube setting the area is proportioned to take care of the volume of gases from the fuel it is estimated will be burned, and, in addition, the height has to be proportioned to give the necessary draft.

Wall Thickness on 72-Inch Boiler

Mr. Croshell: Chicago uses 18-inch walls on a 72-inch boiler.

Mr. Fisher: In Detroit no standard has been set, but 21 inches and 23 for center walls are used.

The Chair: The smoke ordinance in Cleveland specifies 24 inches for the solid side walls, 9 inches of fire brick for the firebox, and 30 inches for the center wall.

Mr. McKewen: The Government two or three years ago ran some exhaustive tests on that and found that an 18-inch solid wall was eminently efficient, so much so that it has been adopted. They have stated that the 18-inch solid wall is preferable to 22 inches with an air space.

The Chair: In Cleveland air space is not allowed. A 24-inch solid wall must be used.

Mr. Johnson: The Milwaukee ordinance does not prescribe anything for the thickness of the wall. Our own practice is 21 or 22 inches.

TUESDAY MORNING SESSION

Report of Resolutions Committee

The resolutions considered include railroads, telegraph, telephone and other public utilities. Although not in their final form, they are as follows:

"Resolved: That we favor and urge the return of the railroads to their owners for operation as soon as practicable, and that we are opposed to any extension of government operation beyond the end of twenty-one months.

"Second: We favor and urge that Congress, at its special session, enact remedial legislation to enable the railroads to operate successfully on their return to their owners.

"Third: We further urge that during the period of government control Congress immediately provide for adequate upkeep of the railway properties, an ample and vigorous program of railway additions and betterments, and that equitable arrangements be made for the financing of such improvements.

"Fourth: That a government agency be created to assume the administrative duties of the Interstate Commerce Commission, supervise and approve the issue of stocks and bonds, and in general have such authority over the operation of the roads as will prevent any abuses in their operation detrimental to public good.

"Fifth: That subject to such supervision and regulation the railroads privately owned should, in the public interest, be authorized to co-operate to the same extent and in the same manner they have been required and directed to do under the present period of government control and administration."

Taxation

"Whereas, the committee has placed before this association a constructive policy and a program of remedial improvement in the present law.

"Therefore, be it resolved, that the American Boiler Manufacturers' Association, in convention assembled, recognizes that industry must generously contribute to meet the great burden imposed by the necessities of national defense and readjustment, but that no system of taxation can be in the public interest that does not undertake to spread the burden of public support in due proportion over all classes of our citizenship; to disproportionately burden industrial investment and production is to discourage those factors of national life which by their nature contribute most powerfully to social progress;

"And be it further resolved that the present law be amended as follows:

"1. By a repeal of all provisions relating to surtax.

"2. That the present normal tax over and above the proper exemptions provide for a suitable graduated schedule sufficient to raise the required amount of taxes covering all individuals, partnerships and corporations alike.

"3. That suitable provision should be made that all dividends paid should be exempt from taxation when the tax has been paid by the company to the government, to avoid double taxation."

Arbitration by War Labor Board

"Realizing that at times questions will arise between the employer and employee, and that when such disputes do arise that cannot be adjusted between the parties, they should be settled by arbitration; and, believing that no arbitration is satisfactory or of any binding effect except where each one of the parties selects an arbitrator, these two to select a third; and

"Whereas, the National War Labor Board is not created under the above principle and its necessity as a war measure no longer exists,

"Therefore, be it resolved, that the existence of such National War Labor Board cease upon the signing of the peace treaty."

The resolutions were unanimously adopted and it was voted to send copies to the Senate and the House of Representatives.

New Valuation of Plants

President Connelly: The replacement of existing plants can never be made at anything like their present cost, and, inasmuch as the government states that the price of labor will never come down, the cost of your buildings and equipment will stay about as it is. Therefore, the fire risk must be increased to protect yourselves on the new cost.

After a slight discussion, in which the fact that the matter had not been given much attention by members of the association, it was decided to waive further discussion until a definite tax policy had been adopted by the government, when valuations might be properly determined.

Depreciation on Boiler Tools

President Connelly: One of the biggest items with which we have to deal is the depreciation per annum on large tools, such as hydraulic riveters, hydraulic presses, bending rolls, punches, etc.

Mr. Berry: We are depreciating our larger tools from ten to twenty-five percent.

Mr. McCowen: The public accountants are now compiling our tax return. They advised us that they did not think it was safe to try to show a depreciation greater than ten percent. They stated that they were very well satisfied that the department would not permit a greater depreciation.

The discussion brought out the fact that there was no definite rate for the depreciation of tools, but that ordinarily about ten percent was allowed on standard tools of large size, while special machine tools were estimated at twenty percent per annum. Small tools are taken care of in the original valuation and their purchase charged to current expense.

Estimates Presented on 72-Inch by 19-Foot 7-Inch Horizontal Return Tubular Boiler

Mr. Barnum, chairman of the committee on cost accounting, assumed the chair during the discussion of the bids submitted by the members on a boiler of given specification.

In general, the specifications and contract describe the boiler as a 72-inch by 19-foot 7-inch horizontal return tubular boiler to contain 1,674 square feet of heating surface, and to carry 125 pounds working steam pressure. It must be built according to the A. S. M. E. boiler code requirements, so that proper material and workmanship would be used in its construction. In addition, a complete equipment of gages, valves, etc., shall be installed.

The approximate weight is to be 19,200 pounds. A steel stack 36 inches in diameter and 80 feet in height is also required.

Mr. Barnum: Evidently, by some of the figures we have received from members, the overhead has been guessed at, for the estimates could not possibly have produced the results any other way.

In this tabulation on the bare boiler the highest price is $2,570 and runs down to $1,525, a variation of $1,000. The stack varies from $495 to $158, and the total from $3,209 to $2,163. Some of these were not estimated intelligently, and in arriving at overhead production labor was probably estimated. Manufacturing overhead and selling overhead should have been used.

Mr. Fisher: The committee made a mistake in specifying that the boiler be built according to the A. S. M. E. Code and at the same time calling for a 4-inch safety valve, which is contrary to the code. The code states that there shall be two safety valves on every boiler unless it has a discharge capacity less than two thousand pounds. Everybody figured on one 4-inch safety valve, with one exception.

No. 3 figured an inspection at $60, which is nearly double the accepted amount. In addition, he estimated a gallows frame at $139, which was not called for in the specifications.

No. 8 figured a selling expense of $150 in addition to overhead and profit, $40 for fittings, and stack labor at $32.

No. 43 forgot the grates entirely.

No. 46 totally disregarded the specification and figured on seventy 4-inch tubes, no grates, back-stays, damper plates, dampers or clean-out. The total estimate was $2,169.08.

No. 20 figured on 60-inch grates, which are short, and on a stack 34 inches by 60 feet of No. 14 gage steel. Both stack and grates were shorter than those specified.

No. 30 used 20 percent for selling expense and 125 percent on the boiler and 150 percent on foundation figures. Their footing was incorrect as well.

No. 36 just gave the total figures. They did not give a segregated estimate, so we could not get at the detail of the material used in the boiler.

No. 54 forgot entirely the wall plates, damper-frame, rear arch bars, fire and ash door panel and grate. He also figured on a stack 36 inches by 50 feet of No. 12 gage, and he figured 30 pounds of rivets and 200 feet of guy wire.

No. 61 figured 60 percent overhead on labor, but it actually resolves into 180 percent overhead on examination, for various items of administrative and selling costs were added under different heads. He arrived at the correct figure finally.

No. 67 was one foot short on the grates and left off the blow-off valve and did not figure in the stack.

No. 68 figured on McGregor braces, which went outside of the A. S. M. E. code. He figured 84 pounds of rivets and 8 steel lugs at $10. He figured without flanges, with 2,000 pounds on his front casting, 25 pounds of rivets in his stack and then forgot the guy lines, the clamps, painter, sheave and cable.

No. 93 sent a price in on the bare boiler only. He states that 147 percent for overhead is included in the above prices, and that 6 percent, as assessed by the United States Government as a basis for taxation, is also included.

There were only eight that gave the number of productive hours required in their shop to produce the boiler, while the remainder simply stated their labor roughly in dollars and cents. To check all figures, the committee took a rate of 50 cents, worked back to determine the money value, and then converted it into productive hours, to see how the hours varied. This variation proved to be from 300 hours to 600 hours.

Mr. Barnum: There are two things clearly demonstrated in this list, and that is the carelessness and the guesswork that is done in making the estimates. It would be interesting to know if the average rate is determined by adding up the payroll and dividing it by the number of hours. Our boiler shop average rate is 54 cents.

Mr. Wiegler: Ours is 49 cents.

Mr. Bach: We arrive at 150 percent overhead by taking the actual expense on our inventory.

Mr. Barnum: Ours was 180 last year.

President Connelly: The Connelly Boiler Company is 175.

Mr. Ashly: The 100 percent overhead on which we figured is an estimate for this year. It is not far off, because the work, so crowded last year, has fallen off, so we have taken an average of a term of years. We did not feel that this year's business should be penalized by the overhead of last year. We have fifteen to fifty employees.

The reason for many of the variations was that the forms used in estimating were those used by individual firms instead of the ones supplied by the committee.

Mr. Fisher: As long as a purchasing agent sees a variation in estimates he will conclude that the high men are robbers. If this association can work out a plan that will give us a uniform form, and try to systematize the estimating so it will be absolutely correct and furnish what we are asked to furnish and figure it correctly, we will have contributed a great deal toward the good of this whole association.

President Connelly: Out of twenty-nine bids there are only eight that are real bids in accordance with the specifications. We find here some very gross discrepancies.

Monthly Meetings

It was voted that manufacturers of boilers meet at least once a month in various localities to discuss timely questions affecting the boiler making industry.

Election of Officers

The officers of the association were unanimously re-elected to serve another term, as follows:

President, William C. Connelly, of The D. Connelly Boiler Company, Cleveland, Ohio.

Vice-President, C. V. Kellogg, of The Kewanee Boiler Company, Chicago, Ill.

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

Executive Committee, G. S. Barnum, of The Bigelow Company, New Haven, Conn.; E. C. Fisher, of The

Wickes Company, Saginaw, Mich.; W. J. Mohr, John Mohr & Sons Company, Chicago; A. G. Pratt, Babcock & Wilcox, New York; F. C. Burton, Erie City Iron Works, Erie, Pa.; F. G. Cox, Edgemore Iron Company, Edgemore, Del.; A. D. Schofield, of Schofield & Sons Company, Macon, Ga.; W. A. Drake, Brownell Company, Dayton, Ohio.

Cost Accounting

After the discussion on standardizing estimates and the election, E. C. Knoeppel, of Knoeppel & Company, New York, read a paper on "Cost Accounting."

TUESDAY AFTERNOON SESSION

At the opening of the afternoon meeting Mr. Knoeppel continued with the reading of his paper on Uniform Cost Accounting, explaining the use of a system of charts especially arranged to cover the cost of boiler making. Mr. Knoeppel said, in part: "This chart shows just how your materials have been ordered. If you wish, you can put on the chart when the materials are received. You have a normal line of progress and can check your operations. You have an analysis which, in time, is a true analysis of your business, of what the different operations are taking, have taken and what is overtime, and both together, on the front and back side of the sheet, furnish a complete running history, which is a vital point in the production end.

"The main thing I am trying to present is the importance of any cost scheme to the production end. In this way you can give your cost account the reproduction value. By keeping the sheets with your schedules showing when you are behind, you are able to plan your work and get your results in better shape. This particular arrangement, in conjunction with a time report, showing the reasons, having your standardized overhead, will enable you to work to advantage.

"In brief, the story which I am trying to place before you is the comparison and the graphic plan of keeping track of your orders to see whether they are ahead or behind, standardizing your facilities and keeping in mind the progress of your orders."

Mr. Barnum: After having these forms printed, what cost would be necessary to add to the clerical force in the office to do that?

Mr. Knoeppel: Little, if anything. It is simply a matter of making the charts each day.

Mr. Barnum: In determining your overhead, how do you handle the depreciation?

Mr. Knoeppel: That is all built up on the theory of classification and gives you actual expenses at the end of the month.

Mr. Barnum: Do you believe in adding six percent to the investment?

Mr. Knoeppel: No. There was a case before the Federal Trade Commission last May and the counsel for the manufacturers admitted that the interest on investment was not a charge of cost.

Mr. Fisher: You said you closed your books monthly. Do you do that by keeping up an inventory of the raw material?

Mr. Knoeppel: Yes, and you may take your final inventory once or twice a year. That means a perpetual inventory.

President Connelly: As I understand, he takes the items and finds the average rate of productive labor for that item, and then you find your overhead in that department and apportion it against that rate. If you have a fifty-cent rate in your boiler shop and he finds your overhead is a 150 percent, he adds 75 cents to the 50, which makes your shop rate $1.25; is that right?

Mr. Knoeppel: That is on the regular basis. We take the hours productive labor and multiply it by the rate, and take these same hours and multiply them out by the overhead standard.

Mr. Barton: Do you figure your overhead yearly?

Mr. Knoeppel: Preferably every year or couple of years, to reflect normal conditions, and if there is any pronounced condition, like the war, you can adjust the standards.

Standardized Data Report Form

Mr. Jeter: About eighteen months ago the boiler insurance interests got together and took up the question of uniform data report form and a boiler manufacturers' data report form. We finally got down to a standard form, which was to be a standard letter-sheet size, of 8½ by 11 inches. It contained a list of questions that were agreeable to all the states excepting Massachusetts, which had its own form. Ohio also did not adopt them. We now have a standard data form which is available for boiler makers in every state except those two. This standard form was also adopted by the A. S. M. E. code committee.

Mr. Eels: The state of New York notified us that, beginning July 1, all manufacturers' data reports must be on this standard form; no others will be accepted.

Cost Accounting

Mr. Connor, of Ernst & Ernst: I would like to refer to you a booklet I have published which is very complete and concise. There is nothing in it of a technical nature; it is something that you can train any young man to follow and he will produce results for you without additional outlay and clerical labor.

We all have pretty complete methods of gathering the data together on cost of material and of gathering our labor costs, but we have no uniform method of gathering our overhead and distributing it to the product. It is in our overhead where our profits are made or our losses sustained.

In laying out a cost system, we bear in mind two fundamental facts: one what we would call direct charges for producing departments, also auxiliary departments, or those departments leading up to the direct producing. The direct departments in an ordinary boiler plant would be classified as boiler shop, machine shop, smith's shop and pattern shop. The auxiliary departments would be classified as building expense, power plant and general factory expense. In connection therewith the chart of accounts is laid out in alphabetical order.

Going into the chart of accounts and taking it from the manufacturing end, we place the following expenses under "auxiliary charges": Against those we have our depreciation; we have the cost of our heat and light; of the building; we have insurance and repairs to building; salaries and wages in keeping up the buildings, etc. In the power plant we find another group of expenses, each with its different number, which gives the actual cost of repairs or upkeep, as the case may be. In our producing department you will find the various items, according to number, which constitute the actual direct charges to the producing department.

At the end of the month the auxiliary charges are totalled and prorated direct to the operating departments, which establishes your total overhead or factory cost. Now, total overhead or factory cost is your actual cost of operating your factory, but it is not the figure you will use in estimating or in finding costs, for the simple reason that no one particular month is a fair gage of your operating conditions; for this reason we establish what we call the "overhead expense reserve."

There is an account of that nature established for each producing department, to which is charged the entire cost of operation. On the other hand, we have our total productive hours for each department, against which we figure, from actual current expense and from our own experience of what the normal rate should be, we have established a normal hour rate of expense. This hour rate of expense is to be applied to the product as cost and taken into consideration with the cost of the material and the cost of the labor, and will establish our entire and our probable maximum cost before administration and selling expense is added.

Now there is liable to be—and there will be—a variation up or down between the rates so established and the rate that would be found if we were to use a direct actual cost. After we have charged to the overhead expense reserve our actual cost of operating the plant, we credit to those accounts the normal cost, as you would say, which is found by multiplying the actual productive labor hours by this expense rate. The difference in each one of those accounts establishes what has been our loss or gain in manufacturing overhead, which is taken up in our monthly profit-and-loss statement.

The actual cost of operating a system of that nature does not involve any great degree of expert clerical labor. In a plant doing a business of half a million dollars a year, it would not cost over two thousand dollars to install such a system.

Mr. Andrews: We adopted the system that Mr. Knoeppel mentioned, in 1908 or 1909, and have since maintained it in the same form. The fundamentals are the same as mentioned by Ernst & Ernst's representative. We consider it one of the best investments we have ever made.

Committee Appointed to Attend Next Meeting of Massachusetts Board of Boiler Rules

It was moved and seconded that a committee of three be appointed to attend the next regular meeting of the Massachusetts Board of Boiler Rules and present an itemized list of changes desired in the Massachusetts boiler code, so as to bring same into strict accordance with the A. S. M. E. code. The motion was unanimously carried.

Standard Estimate Sheets Approved

It was moved and seconded that the association prepare a standard form of estimate sheet for horizontal tubular boilers, and that this standard form be sent to all of the members and they be instructed to have same printed or altered if necessary to fit their particular district, and that this be used as a standard form of estimate sheet. The motion was unanimously carried.

Labor Cost on Individual Jobs

Mr. Cameron: We take each man's time on the job. He reports to the timekeeper, who records the time, and then his time is checked up against the total time as recorded on the in-and-out clock.

Mr. Bach: About three and a half years ago we installed a clock system, but we found that the men would not punch the clock between jobs. So we discontinued that system and hired three young men, who have been keeping track of that and getting the cost on a standard basis.

Mr. Stewart: We have an in-and-out clock, and in connection with that clock the foreman marks on the time card different job numbers. That is turned in to a cost clerk and all this direct labor is listed and the total is made. To that is added the figure representing the percentage of direct labor, and from that you get your cost.

Miscellaneous Business

Mr. Koopman: What is the common practice about the thickness of smokestacks? If we are going to have a uniform specification for boilers and some men bid on 1/4-inch stacks and some No. 10 and some No. 14, the net result is going to vary.

Mr. Kellogg: The gage of stack on a 72-inch by 18-foot boiler is No. 14; length of stack 60 feet, diameter 34 inches.

It was unanimously voted to increase the dues of the association to $50, beginning on July 1, next.

Legal Decisions Affecting Boiler Makers

PRIORITY OF PATENTS

Where two bona fide applications for patents are pending at the same time, neither is prior in art to the other, for neither can know of the other's confidential communication on file in the Patent Office.

When two patents for the same invention have been issued to independent inventors, the rule is that the dates of their inventions are: (1) The date of the patents; (2) the dates of the applications, provided the application sufficiently describes the invention; and (3) the dates of actual reduction to practice.

As between rival inventors whose applications are pending at the same time the burden of proof is on him whose application is second in date to show that he was the first to reduce the invention to practice. But he is required to establish his priority only by fair preponderance of evidence and not by proof conclusive in character or beyond a reasonable doubt.—(*Willard v. Union Tool Company*, 253 *Fed.* 48.)

Where two or more persons who have conceived a supposedly novel idea respecting a device or combination not theretofore known or used are each seeking to establish the right to a patent as the prior and first inventor, reduction to practice is but an element in an investigation for determining who is the original and first inventor. The concept is not in itself patentable, and it is only after the supposed novel device has been reduced to practice that the inventor is entitled to patent. So it is that the person who is first to conceive the invention, but is later than his rival in reducing it to practice, is not regarded as the first inventor unless he has exercised due diligence in efforts to perfect the invention at and continuously after the time his rival entered the field against him. And it may happen that the first to originate the concept, but last to reduce the device to practice, if he has exercised reasonable diligence under all the circumstances, will be entitled to the patent. It results, therefore, that the original and first inventor is he who has not only first originated the novel concept, but who, through the exercise of reasonable diligence, in view of the surrounding and attending circumstances, was first to reduce it to practice.—(*Hildreth v. Mastoras*, 253 *Fed.* 68.)

L. D. Winters announces that he has opened an office in the Peoples Gas building, 122 South Michigan avenue, Chicago, Ill., where he will conduct a railway specialty business. Mr. Winters will continue to represent the W. S. Tyler Company, Cleveland, Ohio, wire netting manufacturers.

The Boiler Maker

Published Monthly by

ALDRICH PUBLISHING COMPANY, INC.

Member of The Associated Business Papers, Inc.

6 East 39th Street, - - - - New York

8 Bouverie St., London, E. C.

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor.

Branch Office
Boston, Mass., 294 Washington street, S. I. CARPENTER.

During the early months of the current year the boilermaking industry shared in the general trade slump which followed the war. In most sections of the country during this period only about 30 percent of the normal business was contracted for. In May and June, however, boiler manufacturers secured orders for nearly 70 percent of the normal volume of business, showing that, although there is no hope of immediate relief in the high prices prevailing for manufactured goods, the fundamental law of supply and demand is gradually bringing order out of chaos.

Materials and labor in combination have kept values high, and material shows no prospect of falling off. Neither is there any indication that the cost of labor will be reduced, for wages are still being raised and the number of working hours for labor reduced.

One thing must be borne in mind, and that is that there is a limit to the demand in this country for new construction in stationary boilers, and until a definite marine policy has been adopted by the government the marine field is practically closed. There is another outlet, however, for the products of the boiler shops in which the possibilities for business are practically unlimited, and that is foreign trade. As the present needs of Europe and South America are pressing, the boiler manufacturers in this country will do well to avail themselves of this ready market.

Discussion at the recent boiler manufacturers' convention brought out the fact, among others, that a startling lack of uniformity exists in making estimates for new boiler construction. Forms and specifications were supplied to each member of the association, calling for estimates for the construction of a single 72-inch by 18-foot horizontal return tubular boiler, complete with fittings and stack. In submitting bids on this contract, many of the manufacturers discarded the specifications entirely and substituted boilers of a similar size and type which had been adopted as a standard by the manufacturer himself. In some instances the bids failed to include many of the necessary fittings and stacks of a size different from that called for in the specifications were included. As a result, bids for the construction of this single boiler varied by as much as one thousand dollars.

Undoubtedly labor estimates were a great factor in this discrepancy, for, although not given directly in all cases, the hours of labor varied from three hundred to six hundred. While these estimates were probably not given careful attention in every case, due to the press of other business, nevertheless an attempt must be made immediately to standardize the lists of material required, the overhead charges, deterioration of equipment, and profit, for the protection of the boiler industry as a whole.

If the conditions revealed by these estimates continue, purchasers of boilers will have a means provided by the manufacturers themselves to force the legitimate price of boilers down to that of the lowest bidder, who is so unfortunate as to be the cause—not from intent, but from lack of familiarity with existing trade conditions—of demoralizing the industry. Fortunately, however, the remedy appears to be in sight, for the committee handling the matter at this convention is already preparing lists of material, and with the co-operation of the members of the association future discrepancies in estimates should be very largely eliminated.

A resolution has been introduced in the United States Senate providing for the President to call a conference to consider industrial problems and the relationship between management and labor. A similar resolution has been introduced in the House of Representatives. In the Senate resolution the personnel of the proposed conference consists of representatives of labor, capital and the government. Union labor is represented by officers of the unions and also by the Secretary of Labor. The government is directly represented by the Secretary of the Interior, and capital is represented by a group of the leading financiers in the country. Not a single representative of the manufacturing interests of the country is named in this personnel.

Obviously this resolution is another evidence of the fact that manufacturers are ignored in matters in which the government proposes to interfere in industry, and it is imperative that manufacturers, including, among others, the manufacturers of boilers, should take a very direct interest in these resolutions and should submit a most emphatic protest against any conference which excludes those who are vitally concerned with the result of the conference. This is a particularly opportune time for registering the views of the manufacturers and stating plainly that the findings of any such conference will not be tolerated. It is a case of interference by the government with a great body of industry which has been given no representation.

There are always two sides to questions of the kind which it is proposed to discuss at this conference, and satisfactory results cannot be obtained without direct representation of the parties directly interested.

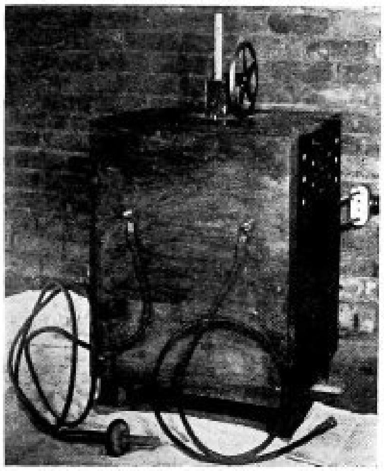
Engineering Specialties for Boiler Making

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

The Zeus Welder

The Gibb Instrument Company, Detroit, Mich., has placed on the market a new type of electric welding apparatus, known as the "Zeus" welder. The current for welding is provided through a transformer instead of from a motor generator. The transformer has no moving parts to get out of order and the manufacturers claim that the current consumption is from 20 to 40 percent less than in a motor generator.

The "Zeus" welder is of comparatively small size; portable; can be adapted to overhead welding and to the welding of cast iron. It is built on the unit system, so that whenever work becomes too heavy for the apparatus a duplicate may be connected in parallel with the original machine. A special feature is the arrangement for regulation. A wheel connected with the secondary and extending through the top of the case raises and lowers the secondary and provides for the regulation of the current necessary for the different sizes of electrodes. It is claimed that the inherent reactance of the "Zeus" welder automatically stabilizes the arc for different arc lengths.



Transformer and Electrodes Which Comprise the Zeus Portable Welding Outfit

New Device for Making Rapid Hose Connections on Pneumatic Tools

Among other exhibits of the Independent Pneumatic Tool Company of Chicago, at the recent Master Mechanics' and Master Car Builders' Convention in Atlantic City, appeared a new device for making rapid hose connections on pneumatic tools and a new type of air hoist. This hose coupling is of the universal sliding sleeve type, with a locking collar at each end. When the coupling is made, these locking collars or sleeves work in opposite directions and cannot be disengaged by coming in contact with rough surfaces, so that locking is always positive. The coupling can, however, be disengaged instantly by a straight pull on the sleeve at each end. There is no necessity for twisting, because the bevel jaws separate as soon as the locking shoulder moves back. The sleeves, as well as the operating spring, are heavy and made to stand rough usage. Should it become necessary, the spring may be replaced readily by moving a washer at the back end. An L-shaped gasket is used and held in place by air pressure. This gasket cannot be blown out when the coupling is disconnected, because of a shoulder holding it. Ribs are provided on the coupling shank for applying a new hose clamp, also an addition to pneumatic equipment produced by this company.

Other devices exhibited at the convention were piston air drills and reamers, close corner drills, one-piece pneumatic long stroke riveting hammers, single valve chipping, calking and flue beading haammers, scaling hammers, staybolt drivers, sand rammers, pneumatic hoists, portable pneumatic grinders, electric drills and grinders, pneumatic tool hose, hose couplings, riveting sets, chisel blanks and other pneumatic tool accessories.

A Convenient Rivet Gage

A device for determining the diameters and lengths of rivets, suitable where the diameters of holes vary considerably, has been invented by Ludwig Junker, Sheffield, Ala. Relatively movable scales or tables arranged with relation to a rivet grip measuring slide automatically indicate the proper rivet lengths for various diameters of rivets and the thickness of material to be allowed in each case. A further object is to facilitate the measuring of the length of rivet holes by providing a slide scale with a hook end which may be easily inserted in the hole to be measured. After being adjusted, it automatically indicates the depth on the gage by means of a slider carried on the scale.

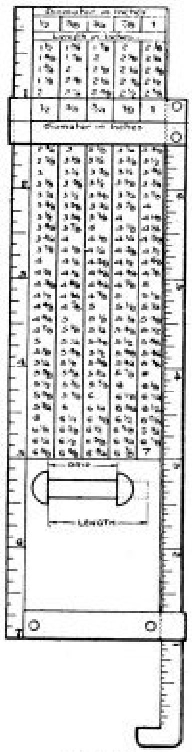


Fig. 1

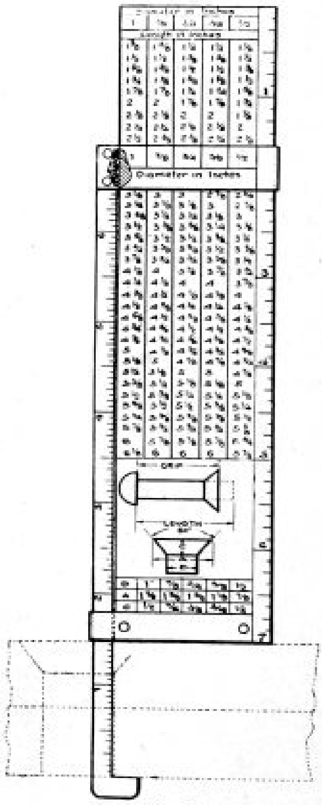
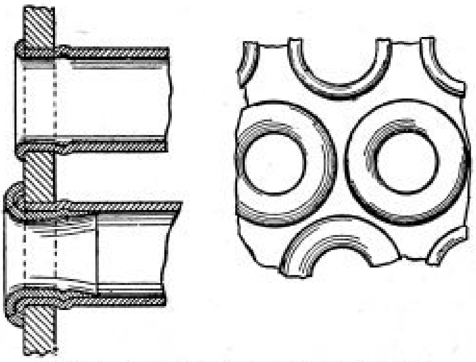


Fig. 2

Fig. 1 shows the sliding scale at the one-inch position of the indicator; Fig. 2 represents the operation of the gage in determining the length of the countersunk rivet. Arranged laterally across the top of the gage is a transverse column of figures indicating the different standard rivet diameters, each of which forms a heading for a column of vertically arranged figures giving the correct rivet lengths for that diameter and required to fit a certain length rivet hole. The scale on the reverse side is similar, but intended for use in determining the lengths in the case of countersunk holes.

Thimbles for Boiler Flues

A new thimble for the protection of the exposed ends of boiler flues has been invented by John F. McKenna, foreman boiler maker of the New York, New Haven and Hartford railroad at Providence, R. I. In addition to this primary use of the protecting tube ends, several of the thimbles may be carried in a repair kit conveniently



Method of Installing Boiler Flue Thimble

and used in defective tubes to stop leaking. It accomplishes this by spreading the edges of the tube against the tube sheet.

The body of the thimble is tapered to a thin entering edge, so there is no shoulder near the end of the tube to collect mud or sediment. By preventing such action, it is claimed that the corrosion of tube ends may be eliminated to a great extent.

By providing a heavy lip which completely covers the tube bead, the action of fire and corrosion which would ordinarily affect the bead is taken by the thimble, which can be easily renewed. It is possible to repair a leaky tube in a locomotive while under way, by placing a thimble on the end of a rod and forcing it into the defective tube, where it may be expanded sufficiently to stop the leak. Later in the shops the repair may be made permanent.

Thimbles have given satisfactory service in locomotive boiler flues and flues for marine boilers, as well as those of the stationary type.

New Flexible Staybolt

An addition to the present types of flexible staybolts has been made by Harry A. Lacerda, of Jersey City, N. J., boiler inspector for the Emergency Fleet Corporation.

The flexible sleeves of the new bolt have three internal slots, so that a standard drop forge tool may be utilized for running them in and out of the sheets.

A new cap permits the application of a single length standard sleeve instead of the various lengths now used. Only 3/8 inch of the threaded sleeve projects from the sheet. This cap may be seated without striking the sheet in confined spaces or where the bolt holes run at an angle. In addition, the cap has a one-inch square hole in the top so that the plug wrench may be used instead of the socket, which always has a tendency to slip off the present square head. The cap is of the ball seat design, so that the use of a copper gasket may be eliminated.

The staybolt may be readily seen in the sleeve, so that there is never any question whether or not it is seated properly. This insures an equal tension on all bolts throughout the boiler. At present, bolts which cannot be seen are many times cut off and driven before the fact that they are not properly seated is discovered.

It is claimed that the cost of installation, as well as the necessary tool equipment, may be cut 50 percent by the use of this new flexible staybolt, and that the bolts can be applied in a much shorter time than is required for other bolts.

PERSONAL

J. E. Wiese, formerly with the Gem City Boiler Company, Dayton, Ohio, has accepted a position with the Interstate Car Company, Indianapolis, Ind., as head of the Steel Car Department.

W. D. Hoxie, formerly vice-president of the Babcock & Wilcox Company, manufacturers of watertube boilers, 85 Liberty street, New York, has been elected president of the company.

F. G. Echols, for many years general manager of the small tools department of Pratt & Whitney Company, of Hartford, Conn., has accepted a position as vice-president of the Greenfield Tap & Die Corporation, Greenfield, Mass.

The Central Steel Company, Massillon, Ohio, has opened up new offices in Detroit in the Book building, 35-57 Washington Boulevard, Rooms 948-49-50. Arthur Schaeffer, former assistant director of sales at the home office, Massillon, Ohio, has been appointed district manager of sales, with Frank Gibbons as his assistant.

J. W. McCabe, who until recently has been district manager of sales for the Chicago Pneumatic Tool Company at Buffalo, N. Y., has been appointed special representative for the company's foreign trade department and will depart shortly for an extended trip throughout the Orient, Philippine Islands and Australia. W. H. White has been appointed acting district manager of sales at Buffalo to take charge of that territory during Mr. McCabe's absence.

C. S. Coler, graduated as electrical engineer from Cornell University in 1911, after which he entered the graduate student course of the Westinghouse Electric & Manufacturing Company at East Pittsburgh, Pa., has been appointed manager of the educational department of the Westinghouse Company and president of the Casino Technical Night School in Pittsburgh.

Benjamin G. Lamme, chief engineer of the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa., has been awarded the Edison Medal by the American Institute of Electrical Engineers for "invention and development of electrical machinery."

The Keller Pneumatic Tool Company, Grand Haven, Mich., and Chicago, announces the appointment of W. H. Woody, formerly master shipfitter at the Norfolk Navy Yard, as manager of its new Washington office, located in the Munsey Building, Room 509. The opening of this office and the consequent appointment of Mr. Woody as manager was necessitated by the rapid growth and development of the company's navy yard business.

Questions and Answers for Boiler Makers

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

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *6 East 39th street, New York City.*

Three-Way Pipe Development

Q. Please illustrate how the patterns are to be laid off for a pipe connection shown in accompanying sketch. The pipes are of equal diameter, the *Y* branches intersecting a vertical pipe at oblique angles. How is the true miter between such a connection developed? A. M.

A. The perspective in Fig. 1 shows the general arrangement of the pipes *A, B* and *C*. Sections *C* and *B* lie in the same plane, but intersect *A* obliquely so that any main view plan or elevation shows these pipes foreshortened.

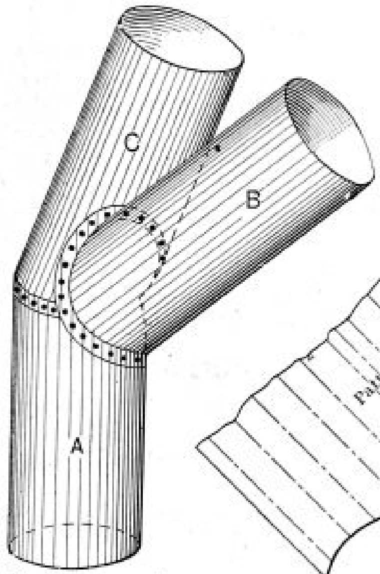
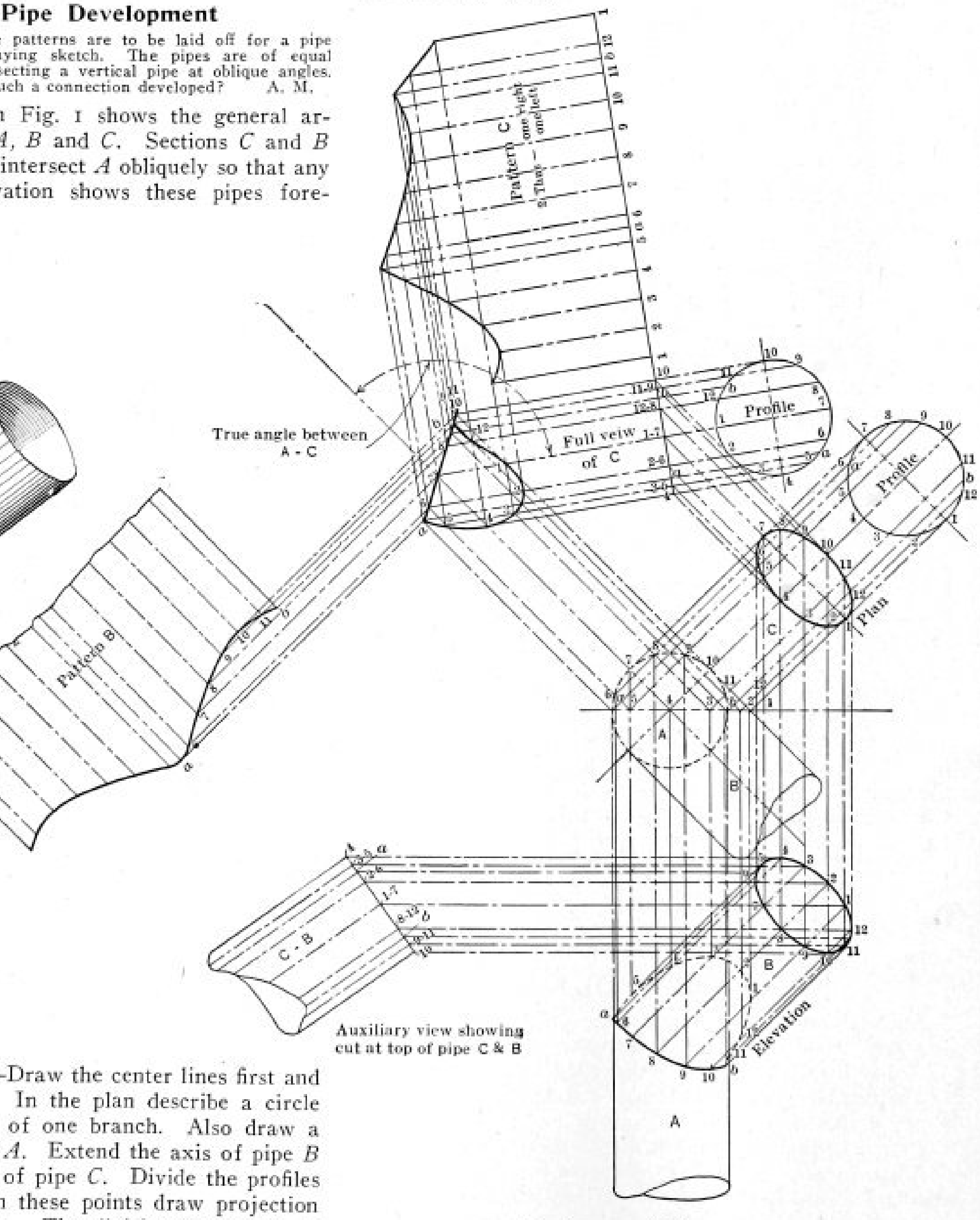


Fig. 1.—General View of Pipe Connection

Construction of Views.—Draw the center lines first and in their proper positions. In the plan describe a circle representing an end view of one branch. Also draw a circle in the plan for pipe *A*. Extend the axis of pipe *B* and construct a full view of pipe *C*. Divide the profiles into equal parts, and from these points draw projection lines parallel with the axes. The divisions in profile of view *C* must be numbered relative to those in the plan. Where the projectors drawn from the circle in the plan intersect those in the full view at *C*, locate points on the miter line between the three pipes. The plane of intersection between the two inclined pipes is straight and is represented in the plan by line *a-b*. The intersection between the inclined pipes and the vertical pipe is a curved meter, as will be seen in the elevation. The top of both inclined pipes is perpendicular to their axes, as shown in the auxiliary view.



Development of Connection

The patterns may be laid off directly from the full view *C*. The stretchout length for the patterns equals the circumference around the pipes plus material for laps.

Layout of Patterns for Oblique Pipe Connection

Q.—I would like to know how to lay out a branch pipe fitting to a cylinder at an angle of 30 degrees in plan and elevation and development of opening, as per sketch. C. E.

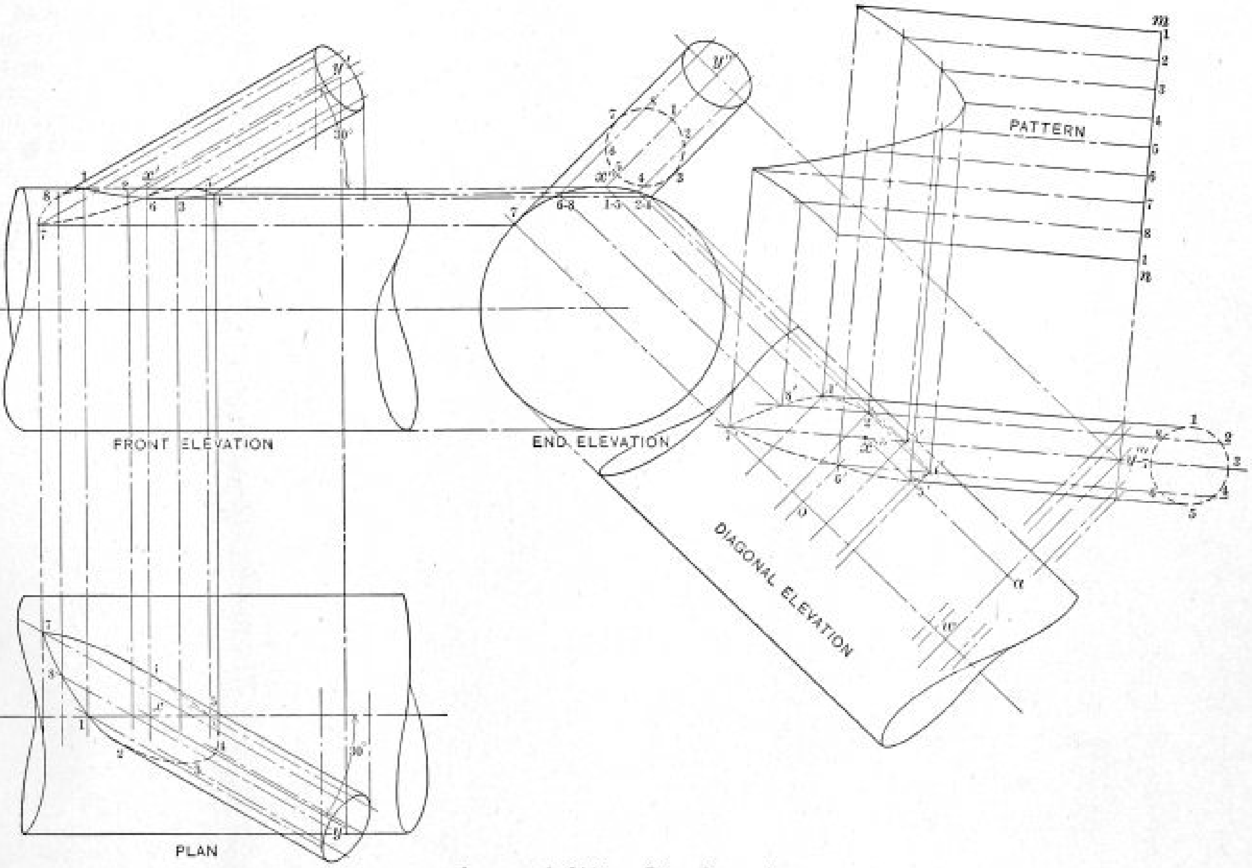
A.—In this development a complete set of views is given showing the construction of the miter lines in plan, front and side elevations. The drafting required in representing these views is unnecessary, as the layerout works entirely from the dimensions for the main axes of the pipe connections. In this construction, however, it is interesting and of value to know how the miter line between the pipes is developed. To show intersections in planes at right angles to the view of the observer, as in a plan, front and side elevation, and when the true size, shape and inclination of the connecting objects are represented in those views, the projection drawing operations are quite simple. When, however ,the connection between objects is such that the principal views are all foreshortened, that is, when they are not seen in their true size, shape and position from a top, front or side view, it seems to the person judging the projection that the drafting requires a complicated system of drawing to prepare the necessary plan and elevations. This is not the case, as will be understood from the explanation given briefly for this problem.

Assume that the location of the axis of the small branch is fixed as at x'-y' in the front elevation, x''-y'' in the end elevation, and at x-y* in the plan. The projections of the axis in plan and front elevation make angles of 30 degrees respectively with the front and horizontal planes. To construct the miter, first develop a diagonal elevation at right angles to the axis x''-y'' of the end elevation. Lay off the large cylinder to the required dimensions in this view, and on its axis locate the horizontal distance between points x-y of the plan, as indicated at o-w. Lay off the right angle triangle x'''-y'''-a, and x'''-y''' is the true length of the oblique pipe, showing in this view the true angle it makes with the horizontal plane.

Draw the circle using any convenient point on the axis x'''-y'''. Divide it into any number of equal parts. Parallel to x'''-y''', and through the points 1-2-8-3-7, etc., draw lines of indefinite length. On the axis x''-y'' in the end view draw a circle with a radius equal to one-half of the small pipe diameter and divide it into the same number of divisions as in the corresponding circle in the diagonal view. Draw parallel lines through the points of the circle to intersect the large circle. These intersections on the large circle locate points on the miter. Now project them to intersect the corresponding line in the diagonal view. Then draw in this view the complete line of intersection between the two pipes.

Project these points to the horizontal centerline as shown, also those at the top of the pipe, and transfer them to the plan view to the horizontal axis of the larger pipe. Then erect vertical projectors to the front elevation, and from the end view project horizontal projectors to intersect the vertical ones in the front view, thus locating in that view the points on the miter. The miter in the plan is completed in a similar manner.

* The distance x-y is in each case taken along the center line of the branch pipe. Point x is the intersection of this line with the surface of the main pipe.



Layout of Oblique Pipe Connection

Lay off a stretchout line at right angles to x'''-y''' of the diagonal view and make its length equal the circumference of the smaller pipe. Divide it into the same number of equal parts as in the circular profile and draw lines at right angles to *m-n* from the points 1-2-3-4-5, etc. Then 1-1, 2-2, 3-3 and 4-4, etc., in the pattern equal corresponding length between the points in the side view. The opening in the pattern of the larger pipe is also fully developed. The arc lengths between the points 1 to 2, 2 to 3, etc., are taken from the end view on the arc between points 3-7 of the intersection.

Marine Stay Tubes

Q.—Can you tell me where I can get information as to the best method of tapping holes for stay tubes of marine boilers in front head and combustion chamber? The tubes are 3 inches outside diameter, with a taper thread at one end and a parallel thread at the other. The distance from head to head, or the overall length of the tubes, is about 8 feet. Would like a sketch showing how the tap will be made, including spindle, taps and means of securing taps in place on spindle; also whether the tap has to be part way through the parallel thread before the taper tap begins to cut so as not to strain or twist the spindle by taking too heavy a cut.
D. M.

A.—Stay tubes for marine boilers are usually ¼ inch in thickness. One end is upset and threaded, the other end is threaded but is not upset. A thread of the former kind is a *plus* thread and the latter a *minus* thread. The

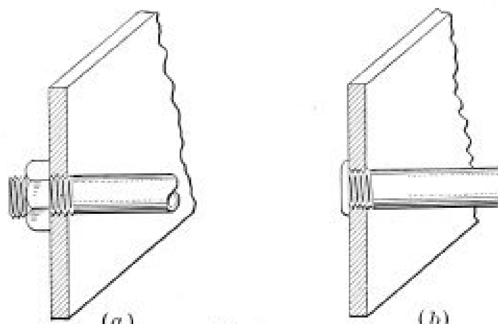


Fig. 1

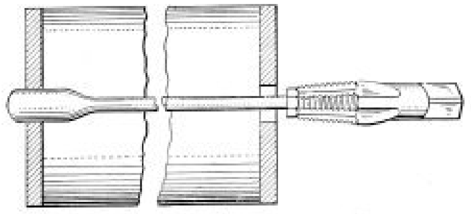


Fig. 2

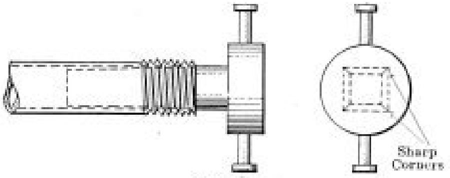


Fig. 3

Installation of Stay Tubes

threads on both ends should be continuous, having from 10 to 12 threads per inch. By making the front head tube holes larger than those in the combustion chamber end, or back head, the tubes can be installed and removed to advantage without disturbing the adjoining tubes. The tubes are secured either by a nut on the outside or beaded over as shown in Fig. 1, (a) and (b). It is unnecessary, however, to use nuts.

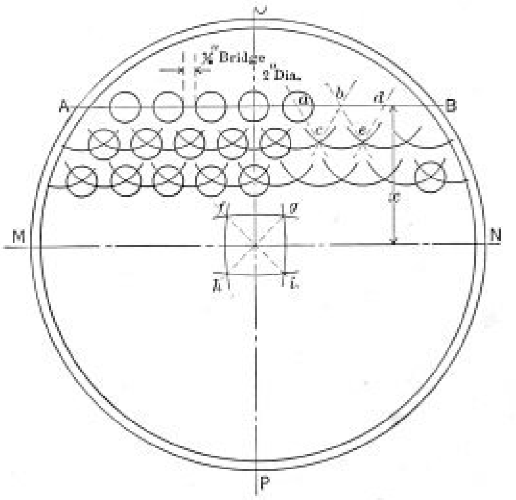
The tube holes in the back and front heads are tapped separately. By tapping the back head first, a guide rod can be used in conjunction with the tap while tapping the front head. This rod is screwed into the end of the tube taps and holds the tap in line with the tube hole cut in the back head or combustion chamber, as shown in Fig. 2.

To turn the tubes into position, special tools are required; a handy one is shown in Fig. 3. This object is a tapering drift having the corners ground sharp, as illustrated in the end view. The drift should not be driven in too hard. If it is, it will injure the tube. To relieve the strain in turning the tube, another drift should be employed at the back head after the tube has entered the hole.

Tube Sheet Layout—Back Pitch—Expanded Metal

Q.—How is the development made for locating centers of tubes in a front tube and firebox tube sheet? What is meant by "back pitch"? When is metal expanded?

A.—Complying with your request for the method of laying out the tube holes in the front and firebox tube sheets, I am furnishing you with a sketch illustrating the method for locating the centers of tubes that are staggered. The first step is to locate the center of the circular tube sheet. This is readily done with a pair of trammels by describing arcs from points *M, N, O, P* taken along the sides or flange of the head. The intersections of the arcs are shown at *f-i-g-h*. Connecting the points *f-i* and *h-g* locates the required center. Then draw the required horizontal centerline and vertical centerline on the tube sheet. Lay off from the horizontal centerline *M-N* the line *A-B* equal



Method of Laying Out Tube Holes

to the distance that the top row of tubes is above the center of the tube sheet. This distance is shown at x in this case. Then space off on this line the required distance on the pitch between the tubes, in this case 2⅞ inches. The diameter of the tubes equals 2 inches; the bridge or distance between them ⅞ inch. To locate the tubes in a staggered position, proceed as follows:

With points *a-b-d* on line *A-B* as centers, describe arcs intersecting as shown at *c-e*. You will note that the points *c* and *e* stagger or lie between the distances *a-b* and *b-d* respectively. Continue in this way until the required centers for the tubes have been laid off. The firebox tube sheet must be centered to correspond with the center of the front or circular tube sheet. Then the centerlines are drawn and about them lay off the required centers.

With reference to the term "back pitch," I will say that it means the distance measured at right angles between any two horizontal rows of rivets.

The expression "expanded metal" means that the metal has been stretched or expanded beyond its original size; tubes are expanded when rolled in the tube sheet.

Letters from Practical Boiler Makers

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

Home Made Measuring Tools

In my time I have noticed many home-made contrivances for measuring large inside diameters and tramming of large work. Three of the best ones that appealed to me and that I adopted are shown in the sketches.

The pipe tram in Fig. 1 is an excellent substitute for a real finished one. It is easily made from old pipe and fittings. As may be seen in the sketch, a tee, a cross and a couple of pipe plugs constitute the needed fittings. The plugs *A* have steel-pointed pins screwed into them. The cross *B* has its threads reamed out so that it will slide

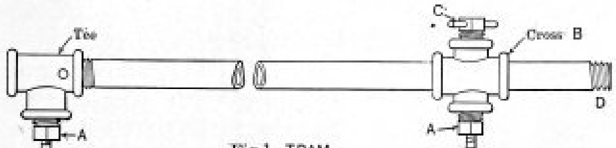


Fig 1 TRAM

Fig 2 LENGTH GAGE

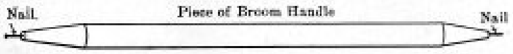


Fig 3

Tools for Measuring Large Diameters

on the pipe. The plug *C* has a small rod through it, and this plug, when tightened down, clamps the tee in place. By using a pipe coupling on the end *D*, the tram can be lengthened.

Fig. 2 shows a very handy inside distance gage consisting of a round steel or iron rod sliding into a piece of pipe and clamped into position by tightening a split reducer that screws into a pipe coupling. The other end of the pipe has a pointed steel pin secured in it. By having spare rods of different lengths, the tool reaches quite a range of sizes; also with a right-angled tip to the rod, as indicated by the dotted line, a tram can be made.

Fig. 3 shows a makeshift that comes handy to get a size with—a piece of broom handle with a nail or brad in each end. By tapping in the nails and keep trying, the size can be obtained. C. H. Willey.

A Page from the Inspector's Note Book

In a great many instances, after the power boiler has outlived its usefulness, as such, it is sold for heating purposes. So that its appearance will not entirely condemn it the dealer renovates it in a variety of ways.

The most commonly practiced methods are to fill the pitted surfaces with cement, to calk a false edge along corroded seams, to make up rivet heads where corroded, and to fill broken braces with cement. Oftentimes old tubes from longer boilers are cut and placed in the top row to create the impression that all tubes are in good condition. A coat of paint is then given the shell and the inside treated with dry cement, lime or dry mud.

When the boiler is to be passed upon, care is taken that the inspector understands the fact that only a few pounds' pressure will ever be created by the steam used for heating purposes, and many times some such statement as the following is made to lend the argument weight, "This boiler carried 100 pounds recently and so must be good for ten or fifteen pounds now." Many boiler failures are listed due to no other cause than the careless examination of heating boilers by the inspectors.

In one instance at hand, after the combustion chamber of the horizontal tubular boiler had been relined and new tubes installed it was found that a piece had corroded and broken out of the rear course where the boiler formerly rested on the brick pier. The discovery was made by the boiler maker, who happened to step on the defective place and broke through.

Two heating boilers were recently condemned after being four years in service because the inside and outside sheets of the fire box, as well as the water legs, were completely corroded away. Corner and side patches put on two years previously had also corroded.

The mud drums of the two watertube boilers were found to be cracked. In another instance trouble developed in a locomotive boiler soon after its purchase, and on inspection the side sheets in the firebox proved to be nearly eaten through. In the case of a vertical tubular boiler about to be utilized for heating purposes, all the tubes were pitted at the water line, the majority of the staybolts broken, the shell badly damaged below the grates, the bottom tube sheet bulged and the space between the tubes plugged from top to bottom with scale.

These are a few examples of the conditions found in certain boilers to be used for heating purposes only.

Wm. F. Odenheimer,
Inspector.

Welding Staybolt Sleeves to the Wrapper Sheet of Locomotive Boilers

The matter of electric and acetylene welding in connection with boiler and locomotive construction has come into great prominence during the past few months. For this reason, a short discussion of the application of welding to the flexible staybolt sleeves on locomotive boilers will not be out of place.

Until recently it has been the accepted practice to tap out the wrapper and throat sheets to receive the flexible staybolt sleeves. Unquestionably there are boiler men and master mechanics doing locomotive work throughout the country sufficiently interested in this matter to give some of their experiences in welding these sleeves and the service that the locomotives so equipped give on the road.

The writer has inspected electrically welded firebox sheets, door sheets, patches and tube sheets of locomotives, in cases where the best operators did the work, yet many of the welds have proved to be unsatisfactory in service.

Usually the locomotive with electrically welded sheets comes back after two or three months on the road to be patched up. The worst defects are found in places along the fire line. One very good instance within my experience of welding was that of the sleeves for flexible bolts on the wagon tops of one hundred and fifty locomotives for the French Government. Under rigid tests pin holes which had to be calked developed in practically all the welds. In hammer testing staybolts near electrically welded firebox sheets, a light blow is often sufficient to start a crack from 18 to 20 inches in length.

Among other matters that might be discussed in connection with the welding of sleeves is that of the cost as compared with the usual methods of tapping. After the engine is in service what will happen to a leaky weld under the locomotive jacket? At all times the best of materials and the most able operators is a necessary combination to give acceptable results, but at present there do not seem to be many men properly trained to do electric welding.

Inspecting Telltale Holes in Staybolts

One other subject that invites a certain amount of attention is the lack of definite requirements for telltale holes in the staybolts. A hole running the length of the bolt cannot be depended upon, and is bound to cause trouble after the boiler is installed. Usually this means tearing out the brick arches to reach the bolts causing trouble and open up the holes. It is bad enough to keep them open on the outer sheet to the required depth of 1¼ inches without attempting to handle the inner ones.

At present the practice is to remove the plug and cap applied to the internally threaded sleeve. Certain difficulties attend this operation, for the cap has to be heated and hammered to be removed readily for inspection. Naturally this method takes a very great time on a complete installation and seems to be hardly practicable.

Suggestions on these subjects may prove to be helpful to inspectors and boiler makers in general.

Jersey City, N. J. Harry R. Lacerda,
Inspector of Boilers and Machinery,
United States Shipping Board.

Slinging a Load

In the fifth instalment of "How to Design and Lay Out a Boiler" in the issue for March, Mr. Strott has fallen into a very usual but grievous error. Right at the commencement he gives a diagram showing two spring balances at an included right angle supporting a beam with a load W. He says that under these conditions the two balances will each register half W and proceeds upon this assumption to reason out its application to the stress in a riveted joint. By reason of practical assumptions duly noted by him later on, and also by reason of the layout of the normal seam, there is small danger of misconstruction. Apply the same reasoning to lifting a weight by a double-part sling and the reasoning is erroneous.

It is commonly assumed that the two legs of a sling carry half the load, each irrespective of how they are placed, and this has itself resulted in cases of fatality by reason of such assumption. A simple demonstration of the variability of load due to angle devoid of trigonometry, which gives the actual stress in the limbs of sling, is given in the formula:

$$S = \frac{W \times L}{2 \times P},$$

where S = stress in sling.
W = weight lifted.
L = length of one limb of sling.
P = perpendicular distance.

Expressed in words, as the perpendicular distance from the crane hook to the top of the load is to the angular length of the sling, so is half the weight to the load on chain. In another form, $P : L :: \frac{1}{2} W : S$.

A graphical method of determination is shown in the diagram herewith. It is our old friend the triangle of forces. By reason of its direct practical application and the importance of the subject gives it an enhanced value.

Call Fig. 1 the "lift diagram" and Fig. 2 the "stress diagram." In Fig. 1 let the sling be suspended from

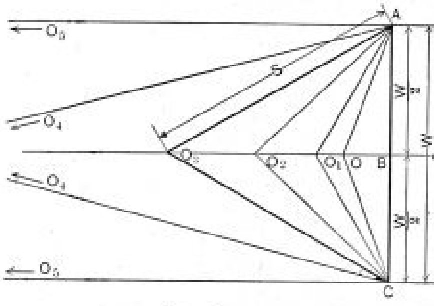


Fig. 2

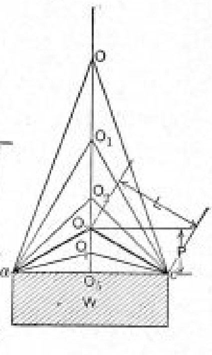


Fig. 1

O_3. Then aO_3 and cO_3 represent the inclination to the horizontal of the two limbs of the sling.

In the stress diagram, Fig. 2, draw a vertical line and on it mark off AC to any convenient scale to represent the weight W, this being equal to the pull on the lifting chain or the weight lifted. From the point A draw a line parallel to O_3a, and from C a line parallel to O_3c; these lines intersect at O_3. Then the lines AO_3 and CO_3, measured by the same scale as AC, give the tension on the slug. Repeating the determination for varying positions of sling, it will be seen instantly that, although W remains unaltered, the stress in the sling is increased or diminished as its total length is altered.

The effect upon the sling when the crane hook is at O_4, O_1 or O can be plotted, and the considerable difference made by shortening the sling is apparent.

To obtain the formula cited directly from the diagrams is simple. The triangle having sides marked L and P, i. e., $cO_3 O_3$ in the lift diagram, and that having sides marked S and $\frac{W}{2}$, i. e., $B O_3 A$ in the stress diagram, are similar.

Hence

$$S : \frac{W}{2} :: L \times P.$$

$$S \times P = \frac{W}{2} \times L.$$

$$S = \frac{W \times L}{2 P}.$$

It is perfectly evident that the only case where the spring balances of Mr. Strott would indicate half W is where they are themselves vertical. Also that the spring balances would indicate an infinite load if they were horizontal. At every angle between they would indicate in excess of half *W*. The instance chosen by Mr. Strott, i. e., 45 degrees, gives .7 *W* nearly, or 40 percent greater stress than half load.

So important is this matter that it should be strongly impressed upon all who have to deal with lifting tackle, the diagrams to a large scale ought always to be adjacent to tackle storage and those responsible instructed in their use.

The shorter the sling the greater the load, the longer the sling the less the load; nothing less than an included angle of 60 degrees should be permitted.

It is a pity that Mr. Strott has spoiled his otherwise admirable demonstration by this fundamental error, and nothing less than the vital importance of its all too common acceptation in lifting tackle would have led me to point it out.

London, England. A. L. HAAS.

Some Ideas on Making a Tubular Boiler More Safe and More Efficient

In discussions concerning boiler making, engineering departments and boiler inspectors are putting a great deal of time on the efficiency of butt straps, riveted joints and bracing of boilers. As there is not much chance, however, to lengthen the life of a shell boiler through efficiency of riveted joints, etc., it seems to me that they should also put some time and thought on the settings of a tubular boiler so as to give it more efficiency.

Take a new tubular boiler, for instance, put it to hard work with an overload, and in a short time a straight edge, if placed on the shell above the grates, will show that the shell has bulged. This is only natural, for any plate of steel will bulge over a hot fire. It is expected, however, that the water in the boiler will keep these plates from bulging, which, in fact, it does if the boiler is not fired too hard. When a boiler has a hot fire under it the water becomes heated so fast that it cannot keep the plates cool enough to hold them from giving way, and, besides, there is scale and other substances which form on the shell which also tend to keep the water away from the boiler.

There ought to be some way of protecting the shell from this direct heat over the grates. Orosco C. Woolson, engineer and contractor, makes a cover for the blow-off pipes that stands the heat. Why cannot this covering be lapped around under a tubular boiler over the grates and as far back as the bridge wall which would protect the shell, the seam and rivets from being exposed direct to the fire? With the shell being protected by a layer of some kind of covering about three inches thick, a tubular boiler could be fired harder and a higher pressure could be carried. If such a covering could be obtained, it would not be a very expensive job to make the connections to hold it on the boiler.

With so much demand for high-pressure boilers, the tubular boiler will soon be a thing of the past unless some improvements are made, for they are not as safe as a watertube boiler, and it is because the shell and riveted seams are exposed to the fire.

A tubular boiler that has to carry 120 pounds of steam only lasts a few years, because the shell becomes crystallized and weak; also the flue end will not stand the heat which it takes to develop 120 pounds of steam. It would be just as easy to make a covering to protect the flue ends as it would be to protect the shell. I would like to see this considered in some of the engineering departments, and I would also like to know whether they do not think that such a plan would tend to give more efficiency to a tubular boiler, as well as make them more safe in operation.

This same process could be used on firetube boilers around the flanges of tube sheets and would have a tendency to keep the flange from fire checking, especially on locomotive work. This is a subject that the boiler inspector could consider and, in states where there is a boiler ordinance, it could be tried out.

Bay City, Mich. GLENN LACEY.

Hints to Young Boiler Makers

In my rather extended experience as a boiler maker I have often met young boiler makers who are inclined to speak of the boiler making trade as not being as good as any other trade. All trades have their disagreeable side as well as their pleasant side. This is true of any trade. There is, however, no other trade as healthful as the boiler making trade. Young boiler makers do not need to attend a gymnasium, as they can procure all the exercise necessary at their trade. Boiler making also keeps a man in good condition. I have never in my experience seen a sickly man working at the trade, which proves that the trade is a healthy one to follow.

ONLY ONE FAULT

The only fault that I can find with the boiler making trade is that the excessive noise of riveting, etc., affects the hearing. Twenty years ago most of the riveting was done by hand, such as the finished rivet and the snap rivet, as there was very little machinery to speak of at that time. In most of our modern boiler shops to-day there is no hand work to contend with, and a good bit of noise connected with the trade is eliminated.

COMPARISON OF TRADES

The machinist trade is a good one, but a person is confined indoors too much and does not get enough fresh air.

The pattern making trade is also hard on the lungs, as the work is indoors at all times, and the fine dust, coming from the wood when sawing, enters the lungs, thereby causing consumption. The molding trade is also bad for the lungs, especially at casting time. The dust and gases arising from the mold while pouring metal enters the lungs. Dust also arises while taking a pattern from the castings just poured.

SELECTING A TRADE

I am of the opinion that the right course to pursue in choosing a trade is to select a healthy one. Some, of course, prefer the machinist trade, or some other trade, according to temperament, but, where there is no real preference, I would suggest that boiler making is as healthy an occupation as one could desire. Therefore, I would say to young boiler makers, do not get discouraged on cold winter mornings when you get hold of a cold plate—remember that your trade is a healthy one.

Youngstown, Ohio. WILLIAM J. KELLY.

Hanna Engineering Works Successor to Vulcan Engineering Sales Company

The Vulcan Engineering Sales Company, sales agent for the Hanna Engineering Works, Mumford Molding Machine Company, Q M S Products, and the J. C. Busch Company, has been dissolved as of June 30, 1919, and on and after that date all business formerly done by the Vulcan Engineering Sales Company as sales agent will be transacted by Hanna Engineering Works, Chicago.

It is believed the dissolution of the sales agency and consequent elimination of a third company will enable the Hanna Engineering Works, by dealing direct, to more promptly and efficiently serve the trade.

Selected Boiler Patents

Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney,

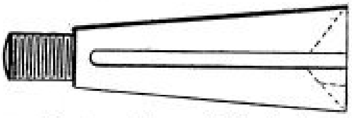
Washington Loan and Trust Building,

Washington, D. C.

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

1,283,850. CLEANER FOR BOILER TUBES AND THE LIKE. CHARLES WILLIAM MATTHEWS, OF COWES, ISLE OF WIGHT, ENGLAND.

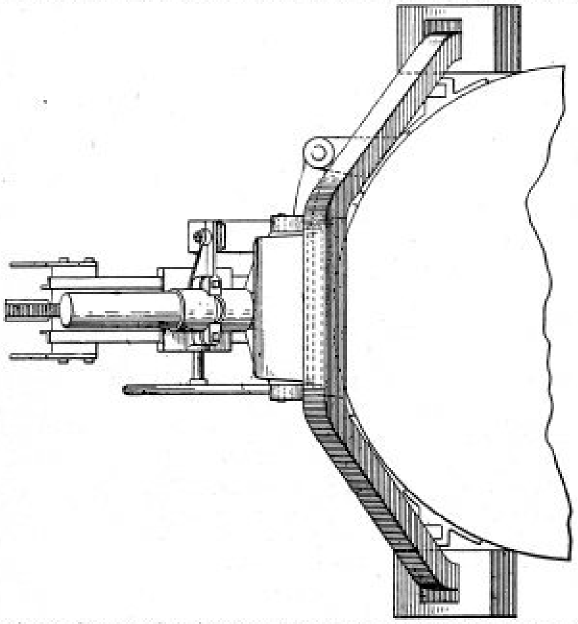
Claim 1.—A cleaner for boiler tubes comprising a single solid conical member slotted diametrically from its front and free end to near its



rear end to form resilient members, said slot having its opposed walls parallel with one another. Two claims.

1,286,604. FURNACE DOOR. JULIUS R. HALL, OF OAK PARK, ILL., ASSIGNOR TO BOOTH-HALL COMPANY, OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

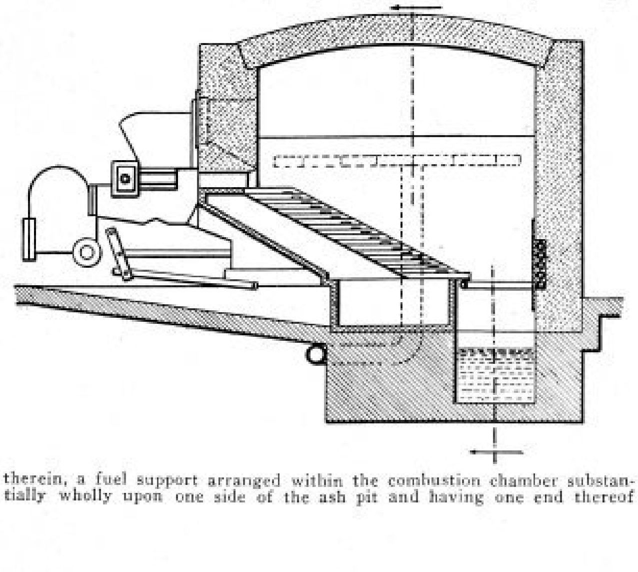
Claim 4.—In means of the character set forth, the combination with a furnace-wall provided with a door-opening, of a door adapted to said



opening and mounted to be swung to a position away from the opening, an extension on said door, equipped with a guide, a slide mounted on said guide and equipped with electrode-clamping means, and means for moving said slide on said guide. Twenty-five claims.

1,287,602. FURNACE. LEWIS METESSER, OF NEW ORLEANS, LA.

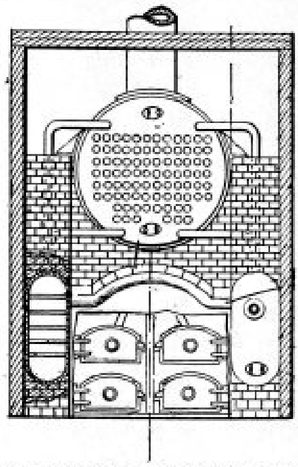
Claim 1.—In a furnace of the character described, a shell having therein a combustion chamber, an open top water sealed ash pit arranged



therein, a fuel support arranged within the combustion chamber substantially wholly upon one side of the ash pit and having one end thereof projecting across the open top of the ash pit for a slight distance for providing a protecting member, a wind box disposed under the fuel support and having one side thereof serving as a portion of one wall of the ash pit, and a perforated pipe disposed under the protecting member in proximity to the outer wall of the wind box to supply water thereto and to the ash pit. Two claims.

1,288,186. BOILER. WILLIAM RADCLIFF, OF PHILADELPHIA, PA.

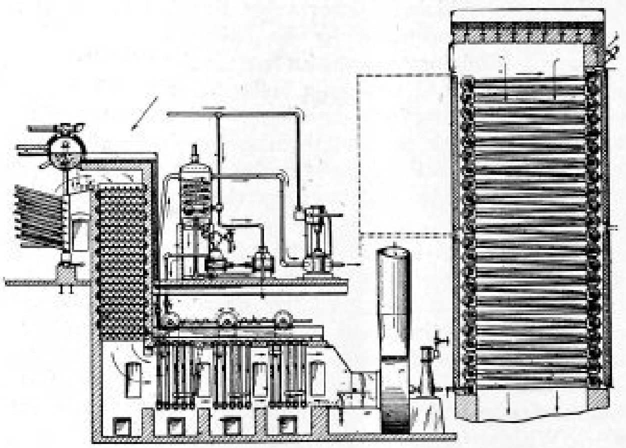
Claim.—In a boiler setting, the combination with the boiler proper, of side walls made up of upper and lower masonry portions and an intervening portion in each side wall formed of flattened water drums upon



which the upper masonry portions are supported, and which water drums form the side walls of the combustion chamber, circulating connections between the water drums and the boiler, arched tubes extending over the combustion chamber and connecting the water drums, and masonry supported on said tubes and forming a top for the combustion chamber.

1,289,182. STEAM-BOILER ECONOMIZER PLANT. DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

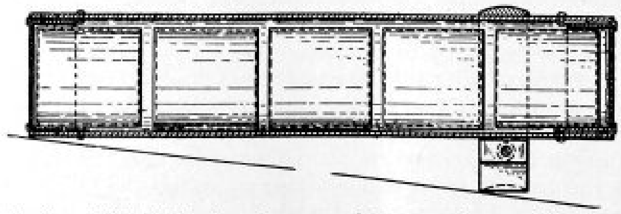
Claim 1.—A steam boiler having an offtake flue with a vertically disposed portion and a horizontally disposed portion, an economizer in said flue comprising a high pressure part or section in the vertically disposed portion thereof and having a series of horizontally extending tubes in-



clined upwardly to the horizontal in the direction of the flow of the water, horizontal headers to which said tubes are connected, a low pressure part or section in the horizontally disposed portion of said flue and having a series of separated banks of vertical tubes, and means for maintaining the water in said economizer sections under different pressures. Six claims.

1,300,829. BOILER COMPOUND HOLDER. ROBERT E. DORNING, OF AVALON, PENNSYLVANIA.

Claim 2.—A boiler compound holder comprising a barrel having closed side walls and open ends, a number of closed receptacles within the barrel, and having perforations in their opposite ends for controlling



the flow of liquid therethrough, spaces between and around the inner receptacles within the barrel forming a mixing chamber, perforated plugs closing the ends of the barrel adapted to control the flow of the completely mixed chemicals and fluid through the barrel, and means for locking the said plugs in the ends of the same. Six claims.

The Boiler Maker

AUGUST, 1919

New Boiler Shops of the Staten Island Shipbuilding Company

Expansion of Shipyard Requires Additional Boiler Making Facilities —General Shop Arrangement—Equipment—Type of Boilers Built

During the rush of war construction, the facilities of the boiler shop at the Port Richmond yard of the Staten Island Shipbuilding Company, Staten Island, N. Y., became inadequate to the needs of the ships being built in the yard at Mariner's Harbor, Staten Island. To meet the requirements for these ships and to supply a growing outside demand, two boiler shops were erected at the Mariner's Harbor plant.

Both the main boiler shop and the auxiliary are built of brick and steel with modern daylight window arrangements. The main plant is 250 feet by 60 feet and has an extension at one side 40 feet by 60 feet for the flanging machinery and heating furnaces. About half of one of the walls of the building is built of tile, so that additions may be made to care for future expansion without the necessity of tearing down the brick work.

Boilers up to a diameter of 17 feet can be built without difficulty, and at the present time one boiler is being completed a week. With certain additions to the equipment and space planned in the near future, the desired capacity of seventy boilers a year will be easily attained. Marine Scotch boilers have been specialized upon, and all the work of the shop is devoted to this type. All repair work is carried on in the old plant at Port Richmond. About eighty men are employed in the two shops.

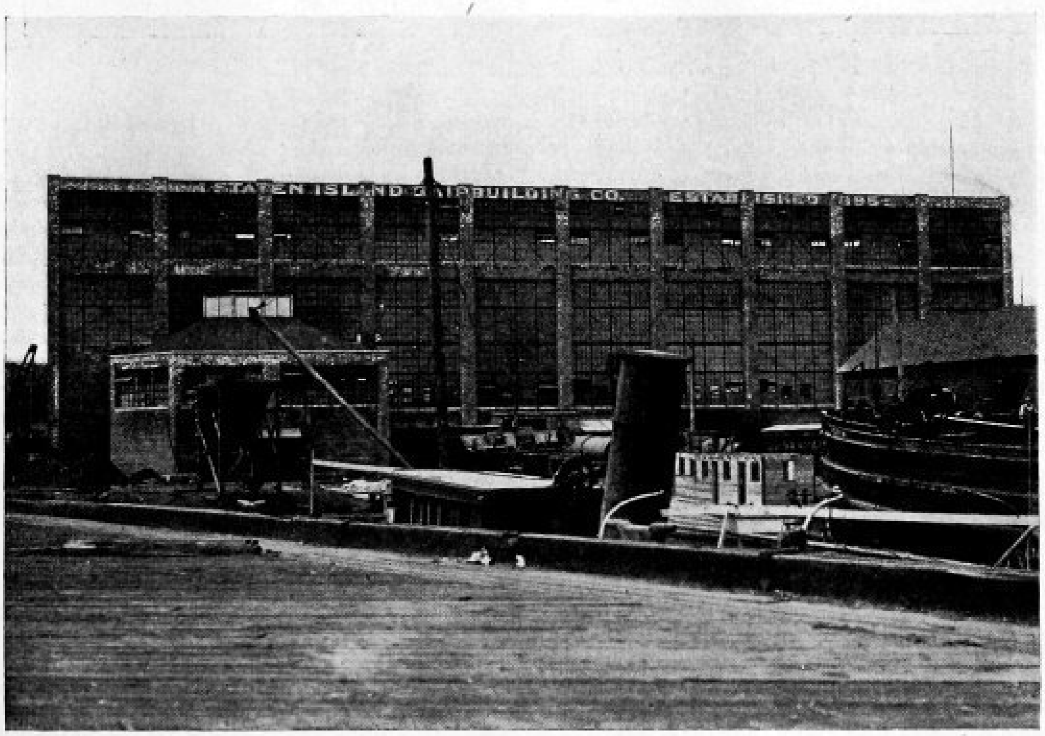


Fig. 1.—Main Boiler Shop, Showing the Extension in Which the Flanging Equipment is Installed

Soon after the erection of the main shop in 1918, it was decided that the entire capacity would be required for boiler work, so that it became necessary to erect an auxiliary shop for building tanks, stacks, uptakes and the like required by the ships under construction in the yard. This shop is smaller than the main one, being 40 feet by 200 feet. It has only such equipment as punches, drills and pneumatic riveters for handling the thin metal used in stack work. A great deal of this consists in building small type funnels for tugboats and mine sweepers, although stacks as large as 9 feet in diameter and 40 feet long have been fabricated for freight ships. A 10-ton Milwaukee traveling crane is used to handle

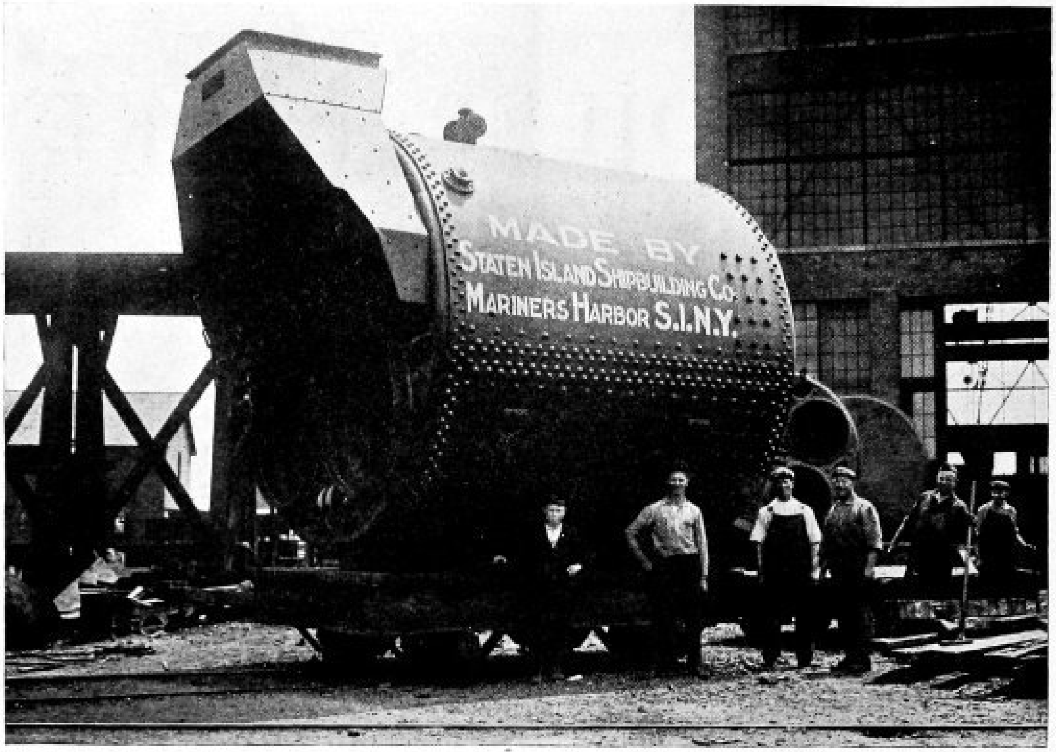


Fig. 2.—A Typical Marine Scotch Boiler Turned Out in the Main Shop

material in this shop, while two jib cranes facilitate the work of punching plates by holding them in position.

Since completion, the boiler shop has supplied all the boilers necessary for ships constructed in the yard, and in addition has turned out boilers for the Downey Shipbuilding Corporation, Texas Company, Standard Oil Company, Providence Engineering Corporation, and others.

Equipment

The same difficulty of getting the desired equipment during the war period was experienced here as elsewhere, but practically all of the machines essential to good boiler work have been installed. The entire machine installation is of the most modern type, and the crane equipment is exceptional. The accompanying floor plan will indicate the general layout of machinery for efficiently carrying on the work.

A list of machines includes: One 8-foot radial Ridgeway drill; one 6-foot radial Ridgeway drill, both manufactured by the Niles-Bement-Pond Company; one 21-foot Niles-Bement-Pond plate planer; two Garvin turret lathes; one Hurlbut-Rogers staybolt cutter; three Acme screw machines, one of which is of the double type; one Morgan 100-ton flanging press; one Morgan 100-ton, 12-foot gap hydraulic bull riveter; one Morgan 100-ton, 6-foot gap hydraulic bull riveter; one 1,500-pound pressure hydraulic accumulator, designed by the engineering department of the Staten Island Shipbuilding Company. One Milwaukee 20-ton traveling crane handles lesser weights, while a two-hook Pawling & Harnischfeger crane has a capacity on one hook of 35 tons and on the other of 75 tons. The latter is said to be one of the largest cranes near New York.

Power for the entire yard is supplied by the Richmond Light & Railroad Company, at 6,600 volts and transformed to 400 volts and 220 volts for the machinery in the yard. The boiler shop requires about 200 horsepower. Air is supplied to the pneumatic tools at 120 pounds pressure by a 9-inch by 8-inch high-speed Chicago Pneumatic Tool Company compressor. The equipment of the shop does not include gang drills, so that a great deal of the drilling must be done with pneumatic hand drills. Tracks are laid to the doors of each of the shops so that locomotive cranes from the yard can handle material until taken care of by the cranes in the shops. The completed boilers are loaded onto special trucks by means of the plant crane and carried on tracks to the docks. If they are to be installed in company ships, they are dropped into place by lighter cranes, while if intended for shipment they are loaded on the lighter.

Methods Employed for Laying Out and Assembling Boilers

The yard for storing materials is at the east end of the main boiler shop and conveniently near the auxiliary shop. Plates are supplied to the laying-out floors on trucks. Here the shell plates are laid out to size, lines drawn indicating the position of the manhole, rivets, etc., and all are center-punched. The plates are then planed, the back and front ends being slightly beveled for calking between the heads and the shell. All holes are then drilled on the radial drills, burrs removed and the plates made ready for rolling. All plates up to 1¼ inches thick are shaped on a set of Niles Tool Works 18-foot rolls, while all heavier plates are generally rolled at the Standard Shipbuilding Works, Shooter's Island, N. Y. The shell is then assembled, the outer butt straps, which have been previously drilled, bolted to the shell and inner butts, and pneumatic drills used to line up the rivet holes. After this, the shell is taken apart, burrs cleaned off, the manhole chipped for calking, reassembled and riveted.

In the meantime, the heads have been laid off, the centers for rivet holes, tubes, screw stays, braces and stiffeners indicated and punched on the back head. The front head is marked for the tubes, furnaces, manhole plates, stays and stiffeners. Both heads are flanged and annealed to relieve strains in the metal. Next the edges are planed

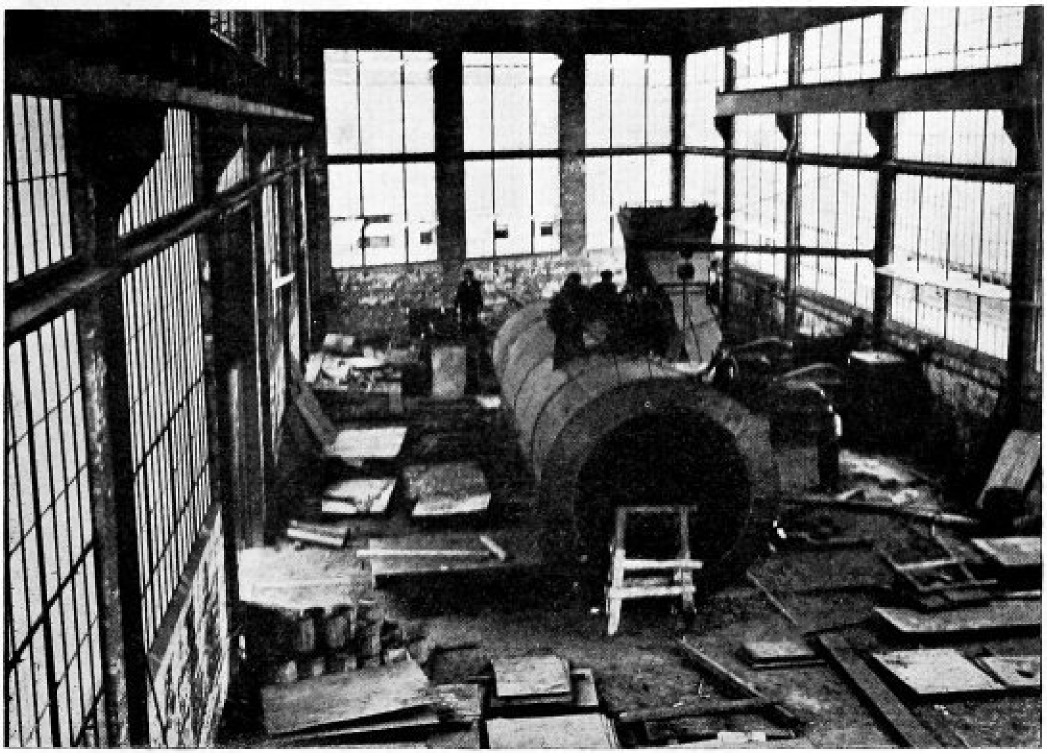


Fig. 3.—Auxiliary Boiler Shop, Used for Tank and Stack Work

and rivet holes in the flanges center-punched. The flanges for securing the furnace to the front head are also made at this time. Tube sheets are next laid out for flanging, as well as the furnace joints, centers for tubes and braces indicated. Holes for the tubes are drilled and cut to size later. Stay tube holes are tapped when the connections are assembled, so that the threads may be continuous.

The back heads of the combustion chambers are next laid out and flanged t,he edge is chipped off and calked. stays, and then properly shaped in the rolls. The next operation is to fit them in place with tack bolts, drill the flanges and counter bore them so that the holes may be calked, if necessary, at any time. The same work is necessary for both the center combustion chamber and the wing chambers.

After the back connections are all riveted and calked, the furnaces are fitted and riveted, the stays between the combustion chambers screwed into place. Then the con-

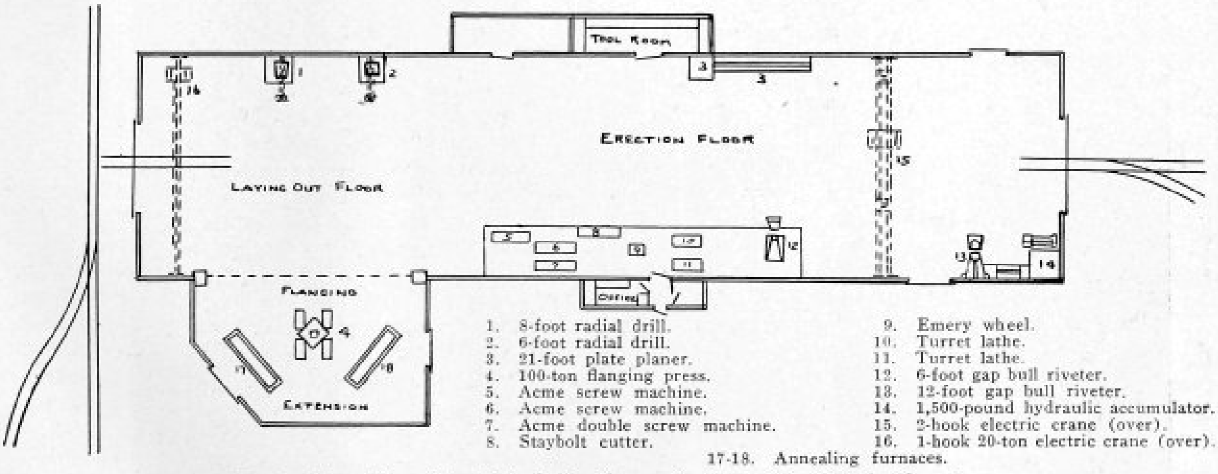


Fig. 4.—Floor Plan of the Main Boiler Shop at the Staten Island Shipbuilding Company

The two sections of the back head are then tack-bolted in place and drilled across the seam for the rivets. Holes for the screw stays are also tapped. The front head is secured in the shell, the flange drilled in position, after which it is removed, burrs cleaned off, and then the head is made ready for the assembly of the combustion chambers, furnaces, etc.

Wrapper plates for the combustion chambers are next laid out, the edges planed, drilled for rivets and screw nections are dropped into the shell, the corresponding holes in each lined up and riveted and the head driven and calked. Finally the boiler is turned down, the fore and aft stays and stay tubes screwed in place and the braces, crown bars and ordinary tubes are fitted. Stay tubes vary in diameter, so that, although each end is upset and the threads cut, it is possible to screw them into the continuous threads in the heads.

Next the fronts are riveted to the furnaces and the

Fig. 5.—Locomotive Cranes Are Utilized to Handle Material in the Yard and Supply the Laying-Out Floor

bearer bars or dead plates secured to them. The furnace doors are then fastened in position, the grates installed and fire brick linings built upon the plates extending from the back end of the bridge wall to the back plate of the combustion chamber.

The uptakes are made in the auxiliary shop, according to the best design, for rendering them sufficiently stiff and rigid for attachment to the boiler. Sometimes the air space around the uptake is filled with carbonate of magnesia, asbestos, or other non-conducting material. When treated in this manner, the ends and edges are arranged so that the packing will not drop out. The uptakes are fitted and stiffened with angle bars.

All that remains now is the addition of the smoke box, valves and stokers or oil burners. If forced draft is to be used, the *Howden* system is installed at this time.

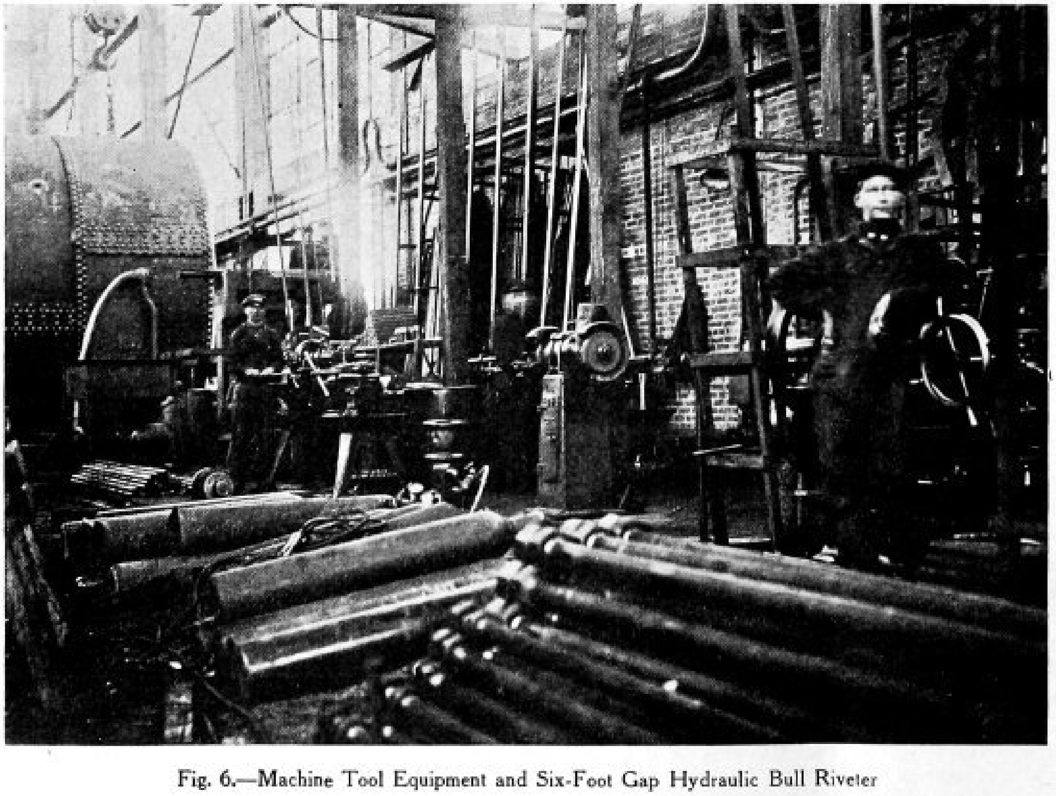


Fig. 6.—Machine Tool Equipment and Six-Foot Gap Hydraulic Bull Riveter

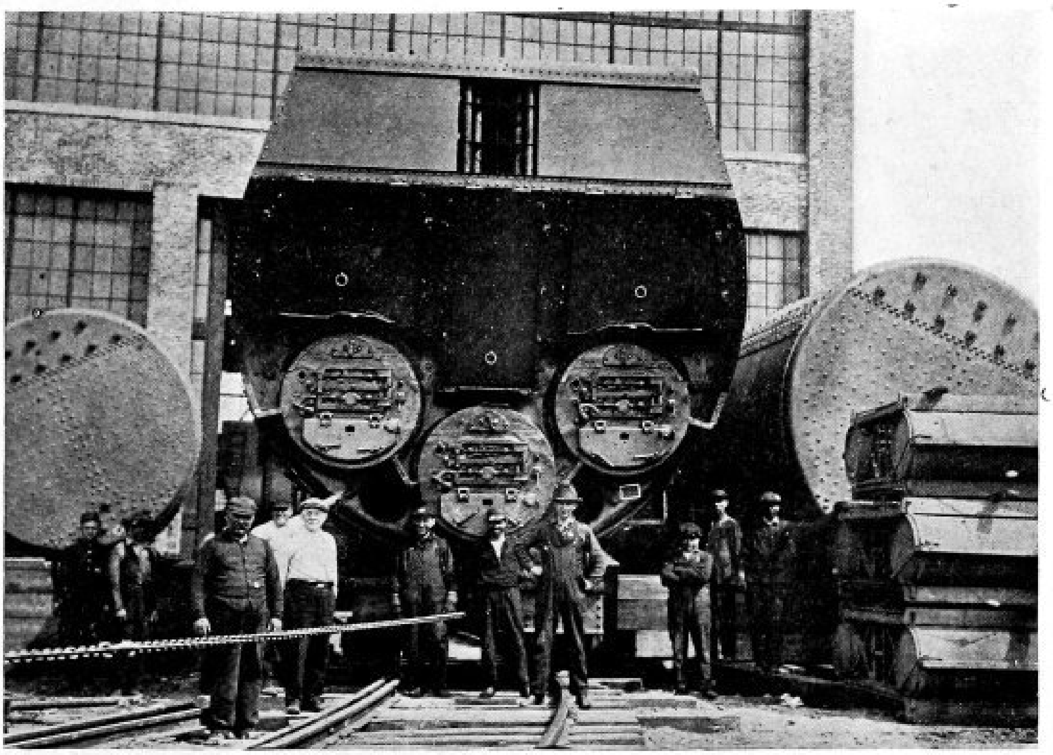


Fig. 7.—One of Three Scotch Boilers Built for the Standard Oil Company

Staybolts—Notes and Suggestions

Although there are various methods of staying combustion chamber crowns, the simplest and easiest of these especially where the external shell is flat above the crown, is by the use of vertical screw stays. In the water space, stays with the center portion reduced are advisable for various reasons. The threads may be cut and shaved and cut away when this reduction is made or the diameter may be reduced before threading.

Many times horizontal stays which are of no great length are fitted with continuous threads. Should the vertical type of stay to the combustion chamber crown be completely threaded, the work of screwing them into place becomes very tedious, for they are rather long. Because of this the threads on most of the latter are removed to the bottom diameter, thus making the operation of installing them much simpler.

The brutal method of clipping excess staybolt lengths, or the worse practice of knicking it with a set and breaking it off with a hammer, do not induce good workmanship. Here the telltale hole may be used to advantage by locating either an electric or an air drill in the center and machining away the excess length. This method is simple and economical, if the length to be machined is not greater than half an inch.

In drilling the holes for the bolts, one method practiced is to mount the firebox on a circular table between two horizontal drill spindles. After all the holes are position drilled, another box is dropped on the jig. Only two settings at right angles on the horizontal table, revolved through 90 degrees, are thus needed. The external shell of the box receives much the same treatment on the second table adjoining the first. Then the base ring is fitted to the box, if it happens to be a double flanged stamping. This ring is drilled in position, and the various parts assembled and riveted, after which the completed box is returned to the machine, where the base ring holes and water space staybolts are also drilled. The holes in the outer shell become a jig for those in the inner box.

If the box is properly clamped to the table the same machine can conveniently tap the staybolt holes, as well as machine away any excess in length.

The method outlined may be used to advantage in the case of full size locomotive boilers, as well as those of portable or stationary type.

Another question arises in the matter of telltale holes. If they are necessary, it might be well to increase their size and utilize the hydraulic riveter by slinging the completed box so that the taper drift may be forced into a 5/16-inch hole, for example, and open it to 3/8 inch. On condition that the thread is slack enough to place easily, a method of press tightening from the center of the staybolt would fix it so that it could stand all necessary machining. Further, if a stay should turn under the flat drill when being machined it would indicate a tendency to leak under test.

The ordinary method of staying and the workmanship involved are adequate where repair connections are to be made in simple stays, but they are hardly worthy of modern, productive resources. Here, as in other matters, the boiler shop seems to lag behind other mechanical trades.

The foregoing suggestions are not commonly practiced, but there seems to be no particular objection to their use in fabricating new boilers, and they certainly are conducive to increased production.

If they are a trifle more costly, they are certainly superior to the present methods, which tend to induce stresses in the material at the outset. Advanced methods in the machine shop have not increased costs, but have, on the contrary, reduced them in many cases, at the same time aiding efficiency, control and uniformity of product.

This example might well be followed in boiler shop practice.

A. L. Haas.

How to Design and Lay Out a Boiler—X

Method of Proportioning Braces and Determining the Number and Size of Rivets to be Used—Locating the Manhole

BY WILLIAM C. STROTT*

For the student's convenience, we append Table 8, giving the areas and ultimate unit shearing values (both double and single shear) of all the commercial rivet sizes. Dividing these values by any factor of safety desired gives the allowable safe shearing resistance in pounds per square inch.

TABLE 8

Diameter of Rivet before Driving, Inches	Diameter of Rivet after Driving, Inches	Cross Sectional Area, Square Inches	Rivet Value, Single Shear, 44,000° per Square Inch	Rivet Value, Double Shear, 88,000° per Square Inch
5/8	11/16	.37122	16,334	32,668
11/16	3/4	.44179	19,439	38,878
3/4	13/16	.51849	22,814	45,628
13/16	7/8	.60132	26,418	52,836
7/8	15/16	.69029	30,373	60,756
15/16	1	.7854	34,558	69,116
1	1 1/16	.8866	39,010	78,020
1 1/8	1 3/16	1.1075	48,730	97,460
1 1/4	1 5/16	1.3530	59,532	119,064

The next thing to check up is the width and thickness of that part of the brace called the "palm," which is riveted to the boiler shell. It should be evident that the net section of the "palm" through *X-X* (Fig. 29) must be at least as strong as the body of the brace. This is accomplished by having the net sectional area of metal through *X-X* at least equal to that of the body.

Table 9 gives the general dimensions of the standardized sizes of Scully braces; the notations refer to Fig. 29 (b).

TABLE 9

Diameter of Body Inches	Size of Head End Inches	Size of Shell End Inches	Area of Body in Square Inches
1 1/8	6 1/2 x 2 5/8 x 7/16	8 1/2 x 3 1/4 x 1/2	0.994
1 3/16	6 1/2 x 2 5/8 x 1/2	8 1/2 x 3 1/4 x 9/16	1.108
1 1/4	6 1/2 x 2 5/8 x 5/8	8 1/2 x 3 1/4 x 11/16	1.227

Lengths vary from 24 inches to 108 inches by increments of 6 inches.

Referring back to Fig. 30, and the work in connection therewith, we find that, disregarding the holding power of the tube plate itself, the direct stress on these two rivets is 10,700 pounds and on one rivet 5,350 pounds. The required rivet area is, therefore, $\frac{5,350}{7,000}$, or .7650 square inch, which, according to Table 8, is obtained in a rivet 1-inch diameter after driving. This result is exactly in line with the A. S. M. E. requirements, viz., that the combined cross-sectional area of the rivets be at least 1.25 times the cross-sectional area of the stay.

Proportioning the head or crowfoot end of the brace is not a difficult matter. The combined net cross-sectional areas through *Y-Y* should, on account of this peculiar method of loading, be 1/3 in excess of that in the body of the brace. For our case, this combined area must, therefore, be 1.333×1.227, or 1.64 square inches. With reference to the notations on Fig. 29 and Table 9, we check up as follows: $2 \times (2.625 - 1 \text{ inch}) \times .625 = 2.03$ square inches, being 0.39 square inches to the good.

The net section through *X-X* for our case is $(3.25 \text{ inches} - 1 \text{ inch}) \times .6875$, or 1.525 square inches, which is on the safe side, thereby proving the design to be correct.

The size of the rivets in the head or crowfoot end of the brace must also be calculated. Referring again to Fig. 31, we see that these rivets are very much more in tension than in shear. Although the rivet shanks are capable of withstanding tensile stresses up to the limit of their cross-sectional area, there is grave danger, however, when they are stressed in this manner, of breaking off the rivet heads; in fact, rivets are not intended to be placed wholly in tension, only bolts being permitted to be so loaded, because the nuts and threads of the latter are proportioned accordingly. About 7,000 pounds per square inch is the safe working strength of rivets when in tension, which is based on a factor of safety of approximately 8 for steel rivets; for iron rivets a lower value—say 5,000 pounds per square inch—should be employed.

Although the foregoing work was performed on the Scully type of diagonal brace, the same conditions hold good on any other form. Note that when the flat-bar type, McGregor or Houston, is employed, all calculations are based on the net section *X-X*, for, as can readily be seen, this is the weakest part of the brace. Width *W* is ordered to suit, and the thicknesses *t* range from 3/8 inch to 1/2 inch, varying by sixteenths of an inch. The sizes are specified as 2 1/2 inches by 3/8 inch, etc., as required, and the lengths may be obtained from 24 inches up to 78 inches, varying by 6-inch increments. It should be remembered that the brace, or braces, making the greatest angle with the shell need only be figured, and all the others are then made the same size.

When laying out the holes in the shell, care must be taken to keep the body of the braces radial with the centerline of the head (as indicated by the dot-and-dash lines of Fig. 30), which emanate from the center of each brace and terminate at the shell. Sometimes, however, one or more braces may come in close proximity to the longitudinal joint, as shown, in which case the shell end of the brace would have to be taken up by two rivets in the seam. Probably a slight twisting of the brace is here absolutely unavoidable and may be resorted to in order to meet the nearest row of rivets. Of course the spacing of the rivets in this end of the brace must coincide with the rivet pitch in that row. Under no circumstances, however, should a brace be connected to the rivets in either of the two outer rows, unless the pitch be within the limit of the "palm" of the brace, which is usually not over 6 inches. If this were done, the longitudinal joint would be ruined, because, on account of interposing another rivet in the line of maximum pitch, the required net plate section would be destroyed. Therefore always attach the braces to the rivets of the joint which are in double shear.

In boilers over 40 inches in diameter a manhole must be placed above the tubes, which may be located either in one of the heads or in the top of the shell. It is usually more convenient to enter a manhole when it is located on the top of the shell, and that is the way we shall design our boiler. In that event the bracing of the segment above the tubes of the rear head will be identical with that provided in the front.

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

Occasionally, however, a specification for some essential reason or other will call for the manhole in the front or rear head, in which case it may be placed in the same relation to the head, as previously explained in connection with Fig. 28. Fig. 32 illustrates by means of cross hatching the surface for which bracing must be provided.

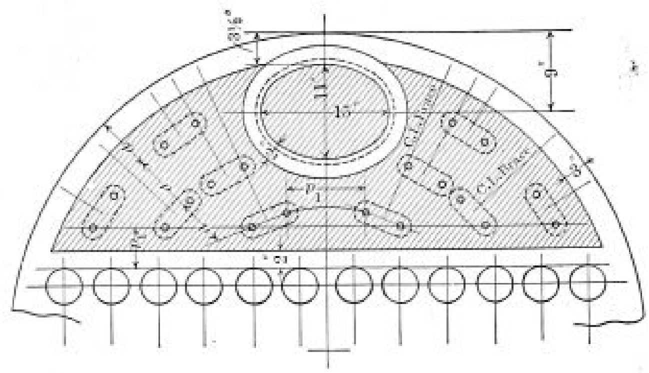


Fig. 32

It should be noticed that, due to the reinforcing action of the manhole flange, the same is good for a distance of 2 inches all around the hole. The area of this 2-inch strip may be deducted from the total area of the segment. The apprentice draftsman or layerout sometimes asks why bracing is figured for the manhole. He should not lose sight of the fact that a heavy reinforced cover is securely bolted to this opening and the pressure acts against this area just as if no metal had been removed from the head. Although no braces can be attached to the manhole cover, sufficient staying must, nevertheless, be provided to carry the total load on the segment.

The area of an ellipse is found by formula:

(8) $$A = (D \times d) \times .7854,$$

in which

A = area of the ellipse in square inches.
D = major axis of ellipse.
d = minor axis of ellipse.

We have two ellipses, one being 11 inches by 15 inches, the other 15 inches by 19 inches.

The difference between the areas of the two will be the area of the 2-inch strip around the manhole.

Substituting in formula (8) for the 15-inch by 19-inch ellipse, we have:

$$A = (19 \times 15) \times .7854, \text{ or } 232 \text{ square inches.}$$

For the 11-inch by 15-inch ellipse, the area is:

$$A = (11 \times 15) \times .7854, \text{ or } 130 \text{ square inches.}$$

The allowance for the manhole flange is, therefore, 232 — 130, or 102 square inches, but the A. S. M. E. Code fixes the allowance at an even 100 square inches.

The distance from the top of the tubes to the shell being 26½ inches, we find from Table 7 the area of the segment to be 968 square inches. The net area is 935 — 100, or 835 square inches.

Having thus been shown how the area to be braced is found, the student should have no difficulty in figuring the number and size of braces required. It is here absolutely necessary to use an even quantity, because no brace would be allowed to extend up to the shell in front of the manhole, which would be the case with an odd number.

In addition to the diagonal "crowfoot" style of brace, diagonal stays of the gusset plate type are sometimes employed. They are not as flexible as the former, are clumsy and present too much corrosive surface. In short, they are used only in the cheaper classes of work, or whenever it is impossible to obtain the regular diagonal braces.

Fig. 33 illustrates in detail how such stays are constructed.

The student should see that the maximum stress is in

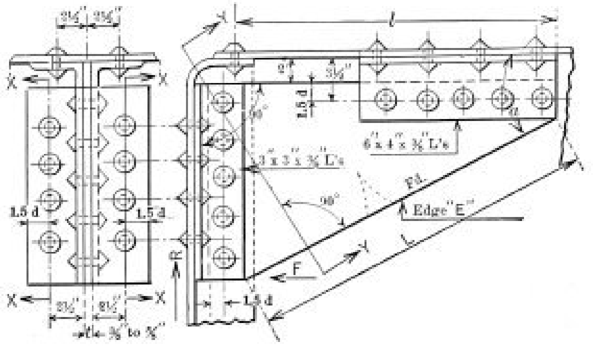


Fig. 33

the longest edge of the plate (denoted in Fig. 33 as edge E), and that failure would occur by splitting this edge as shown by the dotted lines.

Edge E is considered as if it were the centerline of an ordinary diagonal crowfoot stay, and the stress is calculated the same way. As was stated with regard to diagonal braces, the angle a, which the edge E of a gusset brace makes with the shell, should also be not much over 30 degrees, and less, if possible.

When gusset stays are to be used, the first thing to decide on is the quantity. This is done best by laying out the segment to be braced to a good scale and drawing in the braces. Although Fig. 32 gives a few detailed dimensions, such as size of angles and clearances from atop of stay to inside of shell, these figures are arbitrary and are governed by the size of the boiler. The braces are layed in similar to Fig. 33, and by using a little judgment to secure equal distribution the designer may readily decide on the maximum number which the segment will take. The maximum pitch between the rivets of adjacent braces must not be in excess of that found by means of formula (5), previously given.

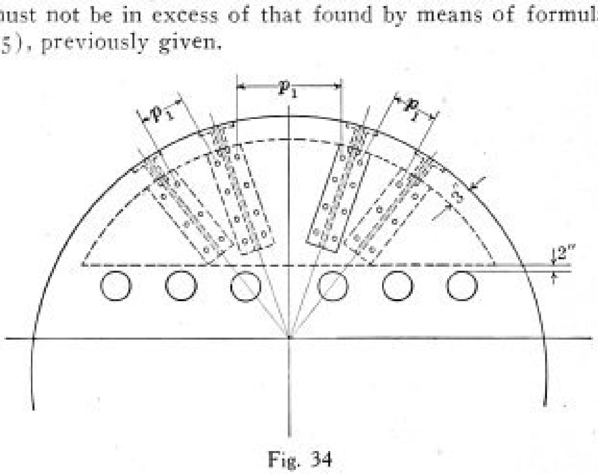


Fig. 34

By dividing the total pressure on the segment by the number of braces assumed as a beginning, the quotient will be the theoretical direct load F on each gusset plate. After having arranged the braces similar to Fig. 34 to a convenient scale, the designer may next make a side view of each brace and determine the approximate angle a which edge E makes with the shell and from which he may either calculate or scale the dimensions L and l. The latter bear the same relation to the strength of a gusset brace as do the corresponding dimensions of Fig. 31, previously discussed.

If the designer is well up in trigonometry he may now calculate the stress F_d as we did in the beginning of this discussion or he may determine what area of direct stay would be required if there were no angularity and then apply formula (6), in which the calculations are based on dimensions L and l. The cross-sectional area of a gusset brace is taken through the line Y-Y in Fig. 33. It should be noticed that this line is drawn at right angles to edge E at a point where it will pass through the square corner of the web plate.

The same engineering principles that were employed in the discussion of diagonal crowfoot stays are applicable to this form also, but, in order to guard against varying opinions which usually lead to inaccurate assumptions, the A. S. M. E. Code lays down the following rules in the design of gusset braces:

(a) The net cross-sectional area of the web plate through the line Y-Y shall be at least 10 percent greater than the calculated section required.

(b) The net section X-X shall be at least two-thirds of the net section Y-Y.

(c) The combined cross-sectional area of the rivets attaching the brace to the boiler head shall be not less than the net section Y-Y. This rule also applies to the rivets attaching the brace to the shell.

Of course the designer must check up these proportions by means of figures, if the Code requirements give a design that is too light; then the calculated dimensions must govern.

In the case of very small boilers, where braces of the diagonal type cannot be placed, on account of inability of access, the Code permits the use of steel angles riveted to the inside of the head over the segment to be stayed. This form of bracing is applicable to boiler shells not larger than 36 inches in diameter.

Fig. 35 illustrates how these angles are applied.

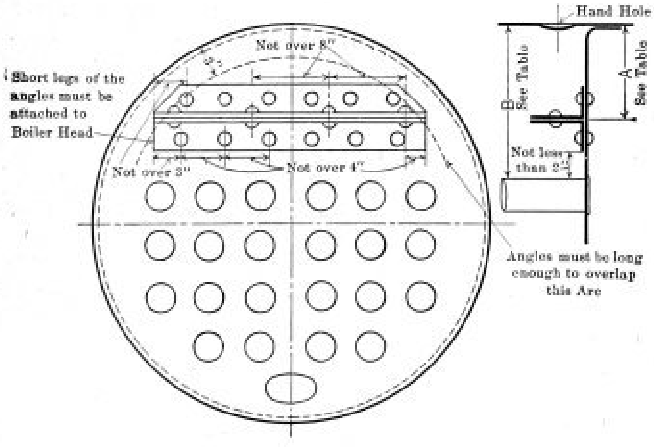


Fig. 35

The method of determining the size of these angles for a given boiler is based on the design of a beam uniformly loaded. The beam formula will be taken up later under the discussion of bracing below the tubes and will not be attempted in connection with these small boilers. For convenience, the Code has prepared Table 10, which lists the standard requirements for boilers 30 inches, 34 inches and 36 inches diameter inclusive. Use of the table in connection with Fig. 35 is self-explanatory and will require no further explanation. For intermediate boiler diameters use the tabular values for the next larger size of rivets.

TABLE 10

Height of Segment, Dimension B in Fig. 35	30" Boiler			34" Boiler			36" Boiler			Dimension A in Fig. 35
	Angle 3"x2½"	Angle 3½"x3"	Angle 4"x3"	Angle 3½"x3"	Angle 4"x3"	Angle 5"x3"	Angle 4"x3"	Angle 5"x3"	Angle 6"x3½"	
	Thickness, inches	Thickness, inches	Thickness, inches	Thickness, inches	Thickness, inches	Thickness, inches	Thickness, inches	Thickness, inches	Thickness, inches	
10	3/8	5/16	5/16	—	—	—	—	—	—	6½
11	7/16	3/8	5/16	7/16	5/16	5/16	—	—	—	7
12	9/16	7/16	3/8	1/2	7/16	5/16	7/16	5/16	—	7½
13	—	9/16	7/16	11/16	1/2	5/16	9/16	3/8	—	8
14	—	—	1/2	—	5/8	3/8	5/8	7/16	3/8	8½
15	—	—	—	—	—	1/2	3/4	1/2	3/8	9
16	—	—	—	—	—	—	—	5/8	7/16	9½

(*To be continued.*)

Single Riveted Lap Joint Prohibited in Vessels Under Pressure

In the fifth installment of the article "How to Design and Lay Out a Boiler," the matter of riveted joints was discussed. As a fitting conclusion to this subject, the author has deemed it advisable to present the following explanation of the reason why the use of lap joints are practically prohibited in the longitudinal seams of pressure vessels.

In a plain lap joint, such as illustrated in Fig. 18a, the plates are eccentric to each other, the eccentricity being equal to x, as indicated at (a). Hence the stress pulling across the joint in the direction of the arrows has a tendency to bring the plates into line, with the result that the joint, originally at (a), assumes or tends to assume the distorted form shown at (b).

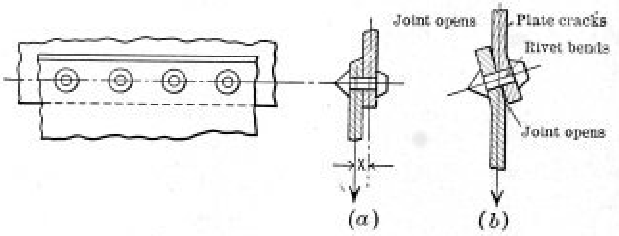


Fig. 18a

It is obvious that the rivets are subjected to considerable tension, as well as shearing stress, since they may be truly assumed as minute cantilever beams of length x.

This bending action is liable to open up the seams, and leakage and cracks may occur when the distortion is most severe. So many boiler explosions have been traced to lap cracks that in modern practice the lap joint (regardless of the number of rows of rivets) has been condemned for use in boilers designed to carry pressures exceeding 100 pounds per square inch. By a further examination of the section of a double-butt-strapped joint it will be seen that the abutting edges of the shell plate are exactly in line and that there can possibly be no distortion of the joint as in (b), Fig. 18a. WILLAM C. STROTT.

Water space stays are more quickly installed if they are threaded discontinuously. Any additional cost in their production will be counterbalanced by the greater speed of installation.

It has been suggested that stays having a reduced section be rolled to the required diameter, in order to conserve material that would otherwise be cut away by machinery.

Methods of Increasing Boiler Room Efficiency*

Effect of Stoker and Furnace on Boiler Operation—Impure Feed Water—Bonus System Discussed—Gas Engine and Steam Installations Compared

BY D. S. JACOBUS

The recent war conditions have brought prominently before the public the possibility of preventing the waste of coal. The United States Fuel Administration developed a campaign for fuel conservation which extended over the entire country, through which a vast saving was effected. The efforts made in this direction and the increased cost of fuel have brought the subject prominently before engineers, and there is an active movement to obtain better efficiencies in existing plants and to install plants of higher economy.

In saving coal or other fuel it must be borne in mind that other factors than the boilers and furnaces enter the problem. The return of waste heat to the system that would otherwise be carried off in exhaust steam or hot water will often effect a considerable saving. Again, the use of the steam in certain instances, such as in heating buildings and for certain process work, as well as the use of the power developed, may greatly influence the problem.

Importance of Economy in Boiler Room

My remarks will be limited to that part of the general problem of fuel saving which is met in the boiler room. I have said many times that more is often to be lost or gained in the operation of the boiler room than in any other part of a power plant. The problem that usually confronts the operator is to secure the best results from a given installation. Often the simplest and most apparent requisites are neglected. To secure efficiency and capacity we all know that the following features must be looked after:

The surface of the boiler must be clean inside and out and the gas passages and flues must be free and unrestricted from the deposit of soot or ashes.

The baffles and settings must be reasonably free from leakage.

The fuel must be properly fired.

All of us who have had much to do with increasing the efficiency of power plants know that, especially in the smaller plants, the simplest requirements are often disregarded, a lack of capacity and efficiency being due in great measure to dirty boilers and leaky baffles and settings. Although these requirements are so simple as to be self-evident, it will do no harm to emphasize them, in view of the great number of times they are disregarded.

Requirements for Efficient Operation

After making sure that the boilers, baffles and settings are in proper condition, the next feature to look after is the firing. Here there is often an opportunity to effect a great saving. The fireman has often been blamed as a potent factor in fuel waste. The source of trouble is seldom the fireman, but his superiors. In many cases, especially in the smaller plants, the fireman has nothing to guide him except what might be classed as tradition and intuition. Having been taught or having developed a given system of firing, he will continue in that way unless there is some tangible reason for causing him to change his practice. I know of one instance where a number of boilers were operated by hand-firing where the firemen took particular pride in maintaining thin fires of a certain character and were trained to regard thicker fires as wasteful. A careful series of gas analyses indicated that the average amount of carbon dioxide was in the neighborhood of 5 percent. This was a number of years ago, when proper gas analyses were not regarded of as much importance as they are to-day, and it took a great deal of persuasion, combined with the club of authority from headquarters, to introduce a system of firing where thicker fires were carried. The fireman was surely not at fault in this case, neither is the fireman at fault in most cases. The trouble is in having no particular way of showing whether he is proceeding properly or not, so that all he can do is to use his best judgment, which may be in the wrong.

In the larger modern power plants more and more attention is being given to providing proper apparatus for guiding the fireman. Again, more attention is being paid to securing engineers of the right type for supervising the operation in the boiler room. In the old days there was a prevalent feeling that the boiler room was a place from which the engineers should graduate to the engine room. It is now being appreciated that it is a mistake to assume that as able a man is not required in the boiler room as in the engine room.

Influence of Stoker and Furnace

The efficiency obtainable through the burning of fuel is influenced through the stoker and furnace, and in many cases the operator is handicapped through not having the best form of installation to work with. To secure the best efficiency the fuel or any combustible elements distilled from the fuel must be completely burned within the furnace chamber. Again, the combustion must be such that the gases which pass from the furnace are uniform in composition; that is, some of the gases must not contain a considerable amount of excess air and others possibly a deficiency of air. If the gases are burned entirely within the furnace chamber, the entire surface of the boiler is effective in absorbing heat. If there is secondary combustion between the boiler tubes, which may occur to a considerable extent if there is a laneing action in the bases and possibly extend entirely through the setting, all of the boiler surface is not effective after combustion is complete. The result is an increase in the temperature of the flue gases over what it would be should the gases be burned within the furnace and a corresponding loss of efficiency. Again, in some instances there is a loss through combustible elements, such as carbon monoxide, passing off in the flue gases.

Another loss that is experienced in coal burning is through the unconsumed fuel in the ashes. Excess of combustible in the ashes is often due to poor operation, and should be guarded against in the proper operation of

* This paper was read by D. S. Jacobus, advisory engineer of the Babcock & Wilcox Company, at the recent American Boiler Manufacturers' Convention.

a plant, if it is possible to do so under existing conditions.

It is a mistake not to provide proper instruments to guide the firemen. A general impression prevails that test results are one thing and operating results another, and that the operating results necessarily fall considerably below the test results. It is a fact that the operating results do, as a rule, fall considerably below the test results, but there is no reason why this should be so in the great majority of cases. In securing the test results the experts will use a number of instruments, and when through with the test will take the instruments away with them. Without the instruments the experts could not have secured the proper efficiency, and it goes without saying that the fireman when left to himself cannot do any better than could the experts without the instruments. In the best operation of boiler plants high-grade indicating and recording instruments are provided, and the firemen and operators take great interest in maintaining the proper working conditions. We are installing plants to-day that, in view of their complex character, would not have been considered a few years ago, and the success in operating these plants depends in a great degree on providing proper instruments for the guidance of the firemen.

Flue Gas Analysis and Combustion

It is often assumed that the average flue gas analysis combined with the percentage of carbon in the ash is a measure of the efficiency of a furnace, and that if these features are known the boiler man should be able to guarantee the boiler efficiency. Such is not the case, as a great deal depends on whether all of the combustion is or is not completed within the furnace chamber. If there is delayed combustion between the tubes of the boiler it will have an influence on the flue gas temperature and efficiency, and it can readily be appreciated that if two plants are operating with the same average flue gas analysis and percentage of carbon in the ash, and in one of the plants there is secondary combustion between the tubes and the other there is not, the plant where all of the combustion is completed in the furnace will have the highest efficiency.

Often great stress is laid on carrying a high percentage of carbon dioxide, irrespective of the other operating conditions, and in certain instances the firemen are paid bonuses based on the percentage of carbon dioxide. If all the other conditions of operation are watched after, this system will give good results, but if the carrying of a high percentage of carbon dioxide is made the sole aim of the firemen there may be wastes in other directions that will counterbalance any gain through minimizing the amount of excess air. One loss that may occur is through the presence of carbon monoxide. There may also be a loss through producing an undue amount of secondary combustion between the boiler tubes when a high percentage of carbon dioxide is carried.

Where a high percentage of carbon dioxide is carried, it is often found that carbon monoxide will be present. In some installations it is impossible to carry more than a certain percentage, say 13 percent of carbon dioxide, before having a material amount of carbon monoxide. An analysis with coal firing which indicates 13 percent of carbon dioxide and no carbon monoxide is more faverable from a heat loss standpoint than one which gives 15 percent of carbon dioxide and ½ percent of carbon monoxide. As the carrying of a high percentage of carbon dioxide is apt to lead to secondary combustion between the boiler tubes, thereby involving an additional loss through increasing the temperature of the flue gases, it can readily be seen that it is often a mistake to aim for too high a percent of carbon dioxide. How high a percentage should be aimed for depends upon the form of furnace and the furnace volume. Ordinarily with coal it does not pay to exceed about 13½ percent.

It can be readily appreciated from what has just been said that in striving to obtain the best efficiency great care should be exercised to make sure that the flue gas analyses properly indicate the amount of carbon monoxide. The general tendency is to show a lesser amount of carbon monoxide than is actually present. The Hempel apparatus, where the gases are shaken up with solutions, is, as a rule, more reliable in indicating the amount of carbon monoxide than the Orsat, and in accurate work it is well to check the Orsat apparatus against the Hempel.

Where the firemen are paid a bonus based on the percentage of carbon dioxide they will often build up the fires to such a thickness and so operate the stokers that there is a considerable amount of carbon monoxide present; in fact, I have seen so much carbon monoxide present where the firemen were paid such a bonus that blue flames would pass inward from the sides of the setting on opening an inspection door, the flames, of course, coming through the mingling of the air which entered the setting with the gases within the setting. Again, in some instances, the firemen will wet the coal an undue amount in order to increase the percentage of carbon dioxide.

Impure Feed Water

The use of impure feed water is entirely too prevalent. This naturally leads to a loss in efficiency through incrusting the inner part of the heating surface and through making it necessary to blow down the boiler an undue amount. There is an added loss through having to cut out the boilers a large part of the time for cleaning and for replacing leaky tubes. Greater attention is now being given to securing clean feed water, especially in the larger plants. In many instances it pays to install evaporating apparatus for supplying the make-up water. Naturally, this can be done only where surface condensers are used, but where it can be done good results are bound to follow. As the modern tendency in power plants where there are peak loads is to force the boilers harder and harder, the importance of using clean feed water is being more and more appreciated. In certain instances the boilers are forced to above 300 percent of their normal rating over peak load periods, and in such cases it would be folly to endeavor to operate without having the purest of feed water.

Fuel Loss Caused by Banking Fires

A considerable loss in plant efficiency in coal firing often comes through the carrying of banked fires. There is a corresponding loss in burning other fuels, and the operation of a given plant may cause this element to greatly affect the results secured. In one particular case where I was active in securing the best results the economy of an oil-burning plant was raised over 25 percent simply through operation and by going over the plant to eliminate heat losses through drips, losses in efficiency of the feed water heaters and various other plant losses, all the efficiency being gained without making a radical change in any part of the plant.

In oil-burning plants a mistake is often made in keeping the steam pressure as steady as possible by changing the firing conditions one way and the other to such an extent that it is impossible to maintain the best furnace efficiency. The best results are secured by feeding the oil to the burners at a reasonably uniform rate, varying the oil pressure one way and the other slowly to meet the demands of the power, even though this may result in a less steady steam line than would be secured through jumping the oil pressure one way and the other in order to maintain a practically constant steam pressure. A recording pressure gage placed on the oil line where the steam pressure is maintained at a constant figure will often give illuminating results in indicating a broad band with the oil pressure varying 200 or 300 percent one way and the other, whereas for best operation the oil pressure will be represented by a reasonably steady line, which will follow in a general way the power requirements. A good guide for efficient operation in running with oil fuel is the amount of superheat obtained, which should be about uniform in all of the boilers. If the superheat in a boiler becomes high it is due either to running the boiler harder than the others or to excess air, either of which conditions should be corrected in order to obtain the best results.

Another good guide in oil burning is to observe the appearance of the gases as they pass through the setting. If the gases are clear it indicates excess air, and if too smoky, an insufficient air supply. For the best results there should be a slight haze throughout the gases. The appearance of the gases leaving the stack is also a good guide, as too clear a stack indicates excess air, whereas a smoking stack shows insufficient air in one or more of the boilers, the best conditions being indicated by a slight haze.

Value of the Bonus System in the Boiler Room

A bonus system will often give good results. The best results are secured by basing the bonus on the overall boiler room efficiency rather than on the records of individual firemen. It is entirely feasible to set a figure for efficiency higher than that which would ordinarily be secured and pay the operating crew a certain bonus based on the increase in efficiency above this figure. In this connection, Mr. Edward N. Trump has said the following:

"If you give a bonus to the firemen you will be sure to have some improvement in efficiency. I have found at least 10 percent saving by paying bonuses to the firemen."

Mr. Trump has secured record efficiencies in the plants of his company. With boilers of about 300 horsepower, fitted with economizers, run at from 100 to 120 percent of rating, he has secured plant efficiencies, measured by the monthly operation, of 85 percent. In his boiler plants with very large units he has obtained a corresponding efficiency of 88 percent. The load on the boilers in Mr. Trump's plants is nearly uniform and does not vary to the extent that it does in the average electrical power generating station.

There have been, and still are, cases where waste fuel, so-called, is employed and where the capacity of the boilers and not the efficiency is the main consideration. In some cases boilers are operated with wood refuse where there is more wood refuse than needed for generating the required amount of steam, and where the excess of wood refuse is burned in destructors. Not so very long ago blast furnace gas was regarded as a waste fuel and no particular attention was paid to securing high efficiencies. Today we are supplying boilers fired with blast furnace gas where an efficiency of over 75 percent is obtained, as compared with about 60 percent as the best result secured in the older practice. Mr. A. M. Diehl, who made a special study of the older practice, concluded that the average efficiency of a blast furnace boiler plant using common burners and operating without the aid of technical supervision was not over 50 percent, and frequently much lower. In the older practice it was felt that all complication must be avoided in steel mill boilers. In the high efficiency units we are now installing for this work, induced draft apparatus is employed that in the old days would have been regarded as leading to a prohibitive amount of complication. Under the changed conditions of today, with proper instruments, the same classes of men—in fact, the very same men that operated the more simple boilers—have secured good results with the more complicated plants.

Co-operation of Firemen Necessary

One often hears that firemen evince a lack of interest in following out suggestions for improvements. I have never found any lack of interest or any tendency to do other than the very best in an endeavor to co-operate. The fireman is as human as any of us and will co-operate if he can see that there is something in the ideas that are to be tried out and he is given something definite to work to. He will be particularly anxious to co-operate if he can see any chance of advancing his position or increasing his pay. On the other hand, if he is given a lot of arbitrary instructions which he is supposed to follow like an automaton, not knowing whether or not his efforts amount to anything, there is every reason why he should show a lack of interest. It is indeed a pleasure to note the interest that will be taken when the results are compared day after day and how anxiously the men will go over everything to find out what is wrong in case the efficiency begins to fall off. It is only by maintaining a spirit of co-operation and by having tangible evidence of the results secured that the operating crew can get the best work out of a plant. This practically amounts to a continuous test of the plant, which, if the operation is what it should be, is not anywhere near as great an undertaking as might be imagined. Results of the highest degree of accuracy are not needed in work of the sort, and it is a comparatively simple matter in most cases to secure results that are substantially correct.

New Apparatus Often a Factor in Increasing Efficiency

So far I have dealt with the savings that may be effected in a plant with the apparatus existing in the plant. In certain cases adding new apparatus will give a good return through the added economy; for example, it is possible in some instances to install economizers with good results. In other cases waste heat is available that can be used in connection with waste heat boilers. There has been a marked advance in the design of waste heat boilers. For a long time there were many instances where the use of the older type of waste heat boilers would not lead to a good return on the investment. Since developing our modern type, where the boilers have a considerably higher draft resistance than in the older type and where this draft resistance is overcome through the use of an induced draft fan, we have installed over 100,000 horsepower of such boilers in connection with open hearth furnaces alone, and the steam generated by these boilers represents a saving in the neighborhood of 1,000,000 tons of coal per year. This is only one of the fields where waste heat boilers may be applied to advantage, and it shows the magnitude of the savings that can be effected.

When it comes to designing a new plant there is usually a much greater margin for effecting savings than can be accomplished through changing to a better system of operation in an old plant. As the cost of fuel increases, it pays to install apparatus of higher and higher efficiency, which, as a rule, leads to more complication than in the older plants.

Defects of Stokers

The furnace and stoker are important factors. Most furnaces are now made of a considerably greater volume than formerly, and when taken in combination with the stokers the form of the furnace must be such as to properly mingle the gases within the furnace. It is impossible with most forms of stokers to avoid some excess air passing through a part of the fuel bed, and the furnace should be so arranged that this excess air will be mingled with the combustible gases within the furnace and so mingled as to thoroughly burn out the combustible elements before the gases pass from the furnace and enter the spaces between the tubes of the boiler. If this feature is not watched after, both in the design and in the operation, there may be a lane of excess air passing completely through the boiler setting. Again, a lane of excess air may mingle with the combustible elements in the gases at certain points within the boiler setting, which, if sufficient temperature is present, may lead to secondary combustion. Furnace design therefore cannot be divorced from stoker design when the best obtainable results are aimed for. After designing the stoker the next feature bearing on economy is the disposition of the surface of the boiler. With a given boiler arrangement, tube spacing, etc., it usually follows that to secure a high heat transfer the draft resistance will be greater than with the same amount of surface arranged and provided with baffles that will give a lower rate of heat transfer. If the arrangement of heating surface and baffles is such as to lead to too high a draft resistance the capacity developed by the boiler with a given draft may be lower than desired. If the arrangement is such as to give a low draft resistance, the efficiency may be less than it should be. In providing a proper design, one of these features must be balanced against the other and an arrangement provided which will give the best results.

The addition of an economizer will add, say, 5 to 10 percent to the economy, and now that the price of fuel is increasing a greater number of economizers are being installed.

Relative Economies of Gas Engine and Steam Installations

The idea prevails in the minds of many that it is possible to obtain a considerably higher efficiency with a gas engine plant than with a steam turbine plant. For plants of certain small sizes the efficiency may be higher with the gas engine plant than with a steam plant. When it comes to large plants the efficiency obtainable with a modern steam boiler and steam turbine installation under certain conditions of service is as great as could be secured through gasifying the coal in producers and using the gas in gas engines. This may be a surprise to some, but it is nevertheless the case. A large steam turbine plant of the best modern design can be built to generate a kilowatt hour with a heat consumption based on the heat in the fuel of 17,000 British thermal units per kilowatt hour. This is a round figure for plants of the best modern construction throughout with a load factor of, say, 60 percent and steam pressure of 300 pounds per square inch. By increasing the steam pressure and raising the superheat, the figure could no doubt be reduced to the neighborhood of 15,000 British thermal units per kilowatt hour. There are no reliable records of plant efficiencies obtained with large gas engines that will give more economical figures than those just quoted if the assumption is made that the gas for operating the gas engines is obtained by gasifying the coal in producers and the heat consumption is based on the heat of combustion of the coal. In the comparison just made of steam turbines as against gas engines, no account has been taken of the cost of operation, cost of repairs, relative sizes of plants, etc. When these figures are considered it will be found that under present conditions a large steam turbine plant will for most conditions of service be more economical than a gas engine plant, assuming that the same gas as that used in the gas engines is burned under the steam boilers. It will be apparent therefore that there is no possibility of the gas engine displacing the steam turbine for large power generating station work for some time to come.

In many cases the older steam plants are handicapped to such an extent through not being of modern design that the efficiency could be raised 50 to 100 percent by installing a modern and up-to-date plant. We will surely be called on to make these savings. The old idea has been to balance the cost of the apparatus for securing additional efficiencies against the fuel saving to be expected. Now that the saving of fuel has been brought so prominently before the country we may have to go farther than this—in fact, it may not be long before there will be laws to avoid excess waste. The field of the designer of boilers and power plants for securing high efficiency will be an active one. We should all pull together in guiding this movement and endeavor to secure the best results.

Flues—V

Precautions Observed in Expanding Flues—Method of Removing Scale—Applying Arch Tubes—Welding Superheater Tubes

BY GEORGE L. PRICE

These plugs and the patch will allow steam and water to be blown over the flues and stop up a portion of them. Thin spots will develop in the flue sheet and rivet heads will be blown off. Such defects, of course, do not all occur during one or two trips, but I have known them all to occur while the engine was making from 20,000 to 30,000 miles.

Why Patches Are Tolerated

We are compelled, however, to make the best of the above defects, as the company demands from 40,000 to 50,000 miles, at least, out of the flues before the locomotive goes to the shop for a general overhauling. For this reason about every ten days a beadless flue is replaced, another crack plugged, a blown-off rivet head with a patch bolt renewed. The patch continues to blow out, in spite of everything, and a few more stopped-up flues are added to the list, while the engineer continues to report that the flues need boring.

Method of Expanding Flue Sheets

Great care should be used when expanding flue sheets where the holes are close to the flanges. That is, the expansion of the flue sheet must be distributed as evenly as possible, or, in other words, it must be worked down to the bottom of the sheet. The following method has been found satisfactory:

Tram the flue sheet before expanding the flues. Commence at the top of the sheet in the center and expand the outside rows across the top and down the sides first; then start at the top on the right side and expand down, always working toward the center. Do the same on the left side, after which tram the sheet again. This will equalize the expansion by distributing it over the sheet, instead of driving it all to the top and sides.

The outside rows of flue holes should be at least 3½ inches from the flange, as I have found that the expansion obtained or produced in a flue sheet by expanding a set of flues varies from 3/16 inch to 5/16 inch.

Flue Leakage

I have often been asked the reason why the bottom flues are the first to begin to leak. There are several causes for this: (1) Cold air from the fire door, although this is eliminated to a certain extent by the use of the brick arch. (2) The most intense heat is to be found at the top of the firebox or along the front portion of the crown sheet, entering the flues in the top portion of the flue sheet, especially in the case of a firebox containing a brick arch. Oftentimes, after the fire has become heavy, the heat is modified to a certain extent under the front part of the brick arch. The exhaust of the engine draws cold air up through the fire at the front dead grate or front firebox corners. This air striking the lower portion of the flue sheet, in combination with other elements, hastens contraction, causing the flues to leak. (3) The feed water entering the boiler through the boiler checks rushes to the lowest point of the boiler, generally the front mud ring, on account of being at a lower temperature than the water in the boiler. This water, rushing back to the mud-ring, strikes the back flue sheet in the vicinity of the bottom, and, because the sheet is much thicker than the flues, the temperature is reduced at this point, thereby causing contraction of the flues, which will produce leakage.

This leakage was very much in evidence when boiler checks were located on the sides of the boilers, but since they have been carried on the top this condition has been improved, as the feed water, owing to its passage through a greater quantity of water before reaching the bottom of the boiler and the back flue sheet, becomes of nearly the same temperature as the rest of the water in the boiler.

Keeping a Record of Flues

A valuable amount of data for use in estimating the life of a boiler, comparing costs, etc., could be obtained if a complete record of all flues were made, such as when and where they were applied and expanded; when and where removed, and the number removed: whether they were new or old flues with new safe ends. Every railroad company expects the maximum flue mileage from each engine. A fair average is from 40,000 to 60,000 miles for the large engines, although some small engines have been known to make over 100,000 miles to a set of tubes.

Water Conditions

When figuring flue mileage, water conditions must be taken into consideration, and I am speaking of fairly good water conditions when I say we can get 60,000 miles out of a set of tubes. On our western division we have exceedingly bad water, and, naturally, flue mileage out there is much lower.

On the M. & St. L. R. R. lines, which run through Illinois, Iowa, Minnesota and South Dakota, we used 600-class engines of the Mikado type of the following dimensions:

Firebox heating surface	204 square feet
Tubes	2¼ inches and 5½ inches
Heating surface of tubes	2,721 square feet
Arch tubes	27 square feet
Total heating surface	2,952 square feet
Grate area	54 square feet
Boiler	extended wagon top
Firebox	108⅛ inches by 73¼ inches
Flues	170, 2¼ inches by 19 feet and 32, 5½ inches by 19 feet

These engines went into service in January, 1915, and in July we began to experience some trouble with excessive leakage of the flues on three of these engines, and upon investigation found that they were congested with mud and scale.

An Interesting Incident

The dome cap was ordered removed and a thorough internal inspection made of all three boilers, from which it was found that the formation had collected exactly in the same place in all of them. This formation was located directly beneath the lower row of superheater flues and on top of the 2¼-inch flues, as shown in Fig. 12. We were compelled to remove the top row of 2¼-inch tubes in this section of the flue sheet in order to clean out the accumulation. After four or five flues were fixed, another inspection was made to determine the cause of the formation at this particular point. It was found that the scale had broken loose from the large flues in pieces of such size that they could not pass through the spacing of the smaller tubes. This scale rested upon the small tubes, making a shelf, or table, which caught and held both large and small pieces, in addition to all later settlings. These engines were working on the extreme end of our eastern division, and all three had the same deposit. The scale was of a hard, flinty nature and had a tendency to break from the flues in extraordinarily large pieces.

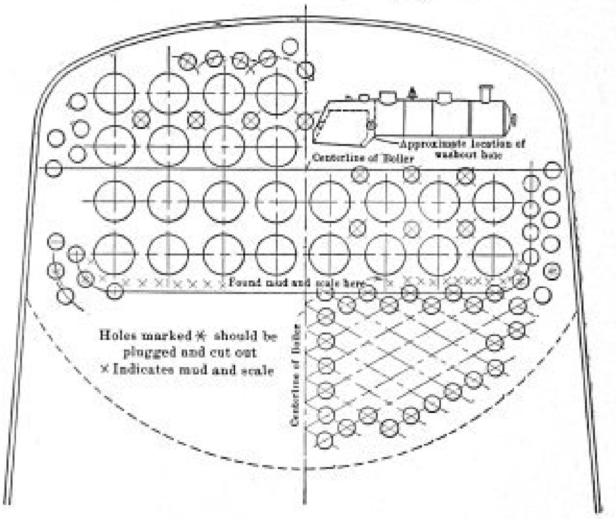


Fig. 12

I also inspected three or four other engines of the same class working on the north end of our eastern division and found that the flues and plate were coated with about the same amount of scale, but of a different character—softer and quite sandy, with a large amount of silica. This scale would break off in small pieces, which readily passed between the flues and consequently gave no trouble.

Because we had no further trouble with scale in these engines, I am of the opinion that they did not receive the proper amount of soda ash in the first place to keep large scale from forming. It may have been possible that the water conditions on this east end division necessitated the use of a larger proportion of soda ash in order to eliminate this hard, flinty formation and substitute in its place a scale of softer nature which would break up into smaller pieces and readily pass out during washout periods. To guard against future trouble, I would suggest that a washout hole be made in the barrel of the boiler opposite this particular location in order to facilitate the washing out of the flues. Two flues could then be left out on each side of the flue sheet, as shown in the sketch, which would give access to that section of the boiler giving trouble.

Holding Power of Flues

The average force required to pull a 2-inch, 11-gage beaded flue out of the sheet is 26,750 pounds. The shell of a boiler may be out of round, and the internal pressure will have a tendency to round it out into a true circle, but this is not so in the case of a flue, for the internal boiler pressure bearing on the external area of the flue will have a tendency to crush and flatten it. The maximum intensity of pressure allowable on lap-welded flues up to 6 inches in diameter with proper thickness is 225 pounds per square inch. The collapsing pressure of a flue may be figured from the following formula:

Where P = the collapsing pressure in pounds per square inch.
D = the outside diameter of flue in inches.
T = the thickness of metal.

Therefore,

$$P = 86{,}670 \frac{T}{D} - 1{,}386.$$

New flues are generally tested at a pressure of 1,000 pounds per square inch.

Arch Tubes

Arch tubes are again coming into favor, and, while this form is generally disliked by all boiler makers who work in round houses, yet the arch tube is a source of economy for the railroad companies. With the existing methods of cleaning the interior of arch tubes with specially constructed pneumatic cleaners, it is found that they give entire satisfaction. The former defects, such as mud spots and blisters, have been entirely eliminated by the assiduous use of this cleaner.

Manner of Applying Arch Tubes

The applying of arch tubes should, in the opinion of the writer, be applied in some standard manner. For example, the tube holes in the sheets should be 3 3/32 inches in diameter with sharp edges slightly rounded with a file or reamer; copper ferrules, 3 inches outside diameter and ⅝-inch long and 0.095-inch thick, should be expanded on a round mandrel made to fit the hole; ferrules, set to project 1/16 inch on each side of the sheet, and secured in place by roller expanders; arch tubes, 3 inches outside diameter and 0.18-inch thick, of cold-drawn seamless steel, cut to project ½ inch into the water space before turning over and to be securely fastened by the roller expander, then flared and half beaded at both ends, as shown in Fig. 13; the bottom of the bead should stand 1/16 inch clear of the sheet. The arch tubes should be examined at each washout of the boiler, and in case any scale formation is in evidence it should be removed with a mechanical tube cleaner.

In discussing the tube question it may be well to take into consideration the subject of superheater tubes. I find that the superheater tubes on our road have outlasted nearly two sets of small tubes, and from the general condition of the tubes and the beads in the firebox I am inclined to believe they will outlast the third set, if given a good cleaning.

Superheater Tubes

I am informed that the methods of handling superheater tubes in most railroad shops are very crude, due prin-

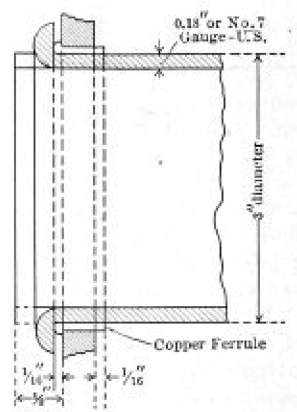


Fig. 13

cipally to the fact that they have tried to use flue cutters to cut off the large tubes. When the roller cutters were tried the tube ends were so greatly enlarged that there was difficulty in getting the tubes out through the holes in the sheet.

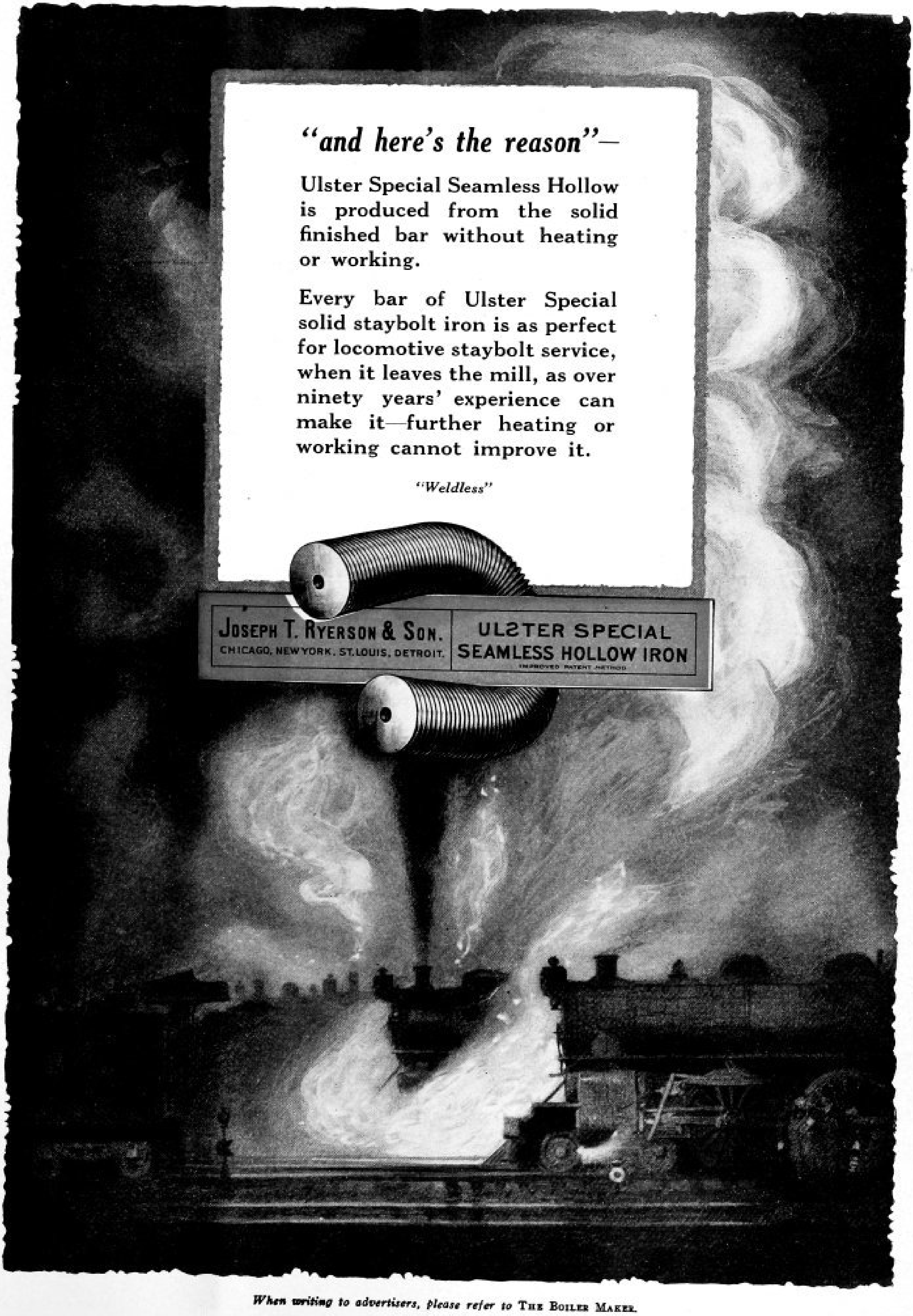
The most common practice has been to split the tube with a ripper or chisel bar and crush down the end. In some places the oxy-acetylene flame is used and the tube is cut from the inside of the front flue sheet and taken out through an enlarged hole.

Best Method of Removing Superheater Tubes

I would like to hear from some of our boiler maker foremen opinions as to the best method for removing superheater tubes. Personally, I favor the cutting off of the tube by the oxy-acetylene process and passing it out through an enlarged hole. A cutter that will make a clean cut and not bruise or enlarge the tube should be given the preference, but up to date I do not know one that will cut these large tubes satisfactorily. In removing superheater flues when the dry pipe is not removed, it is necessary to enlarge the flue sheet holes. It is an easy matter to remove the tubes through the dry pipe hole when this pipe is out.

Welding of Superheater Tubes

The welding of superheater tubes is an interesting subject for discussion, and one that I would like to see threshed out in the columns of THE BOILER MAKER. Railroads employ various methods in welding these tubes, but the most common practice, and one recommended by the superheater companies, is to make from one to four welds on the reduced end of the flue at the firebox. Starting with a safe end about four inches long, continue this operation until the superheater tube is reduced by welding on new pieces as far back as can be done without interfering with the ends of the inner superheater units. Some roads weld the front end of the tube only. If there happens to be a defective weld, it will be farther removed from, and of the least danger to, the men in the cab. There is also an objection to a long swedge at the


"and here's the reason"—
Ulster Special Seamless Hollow is produced from the solid finished bar without heating or working.
Every bar of Ulster Special solid staybolt iron is as perfect for locomotive staybolt service, when it leaves the mill, as over ninety years' experience can make it—further heating or working cannot improve it.
"Weldless"
Joseph T. Ryerson & Son.
Chicago, New York, St. Louis, Detroit.
Ulster Special
Seamless Hollow Iron

firebox end, for after each weld the length of this swedge is increased, until it becomes a defect in itself.

Method of Welding

The following method of welding superheater tubes is, in my opinion, a good one to follow: Cut off the reduced end of the tube just back of the taper and weld on nine or ten inches; then swedge this new end down to the standard, namely, three to five inches parallel and three inches tapering. This will cut off all metal that has been subjected to the heat and crystallized. Then bring a new piece of metal where it is most needed. The second time the tube is welded I would suggest putting on a six-inch safe end at the large end of the tube, and if it is possible have the material 5 9/16 inches, and then it will not be necessary to enlarge the front end of the tube, nor will it be necessary to swedge the tube at the firebox end, provided there has not been too much of the tube wasted in cutting off crop ends. There will still be enough of the swedged end left to allow the prossering operation. The third time the flue is welded, repeat the operation. By following this method each alternate weld brings a new piece of metal, thickened by the swedge, to the place it is most needed, namely, the firebox end.

It is bad practice to weld as short a piece as five inches at the firebox end, for this short piece is subjected to the melting heat at a point where it will meet the most severe stress of beading, rolling and prossering, and the steel tubes will crystallize under such conditions and allow cracks to form when they are rolled or prossered. In advocating this method I am assuming that the superheater companies have adopted a standard in regard to enlarging the front tube end to 5 9/16 inches. I do not consider this method good practice for the railroads when it becomes necessary to remove the tubes, for when the tube is badly scaled a 1/16-inch hole is not large enough to be of any material benefit. However, if one of the lower holes in the flue sheet were enlarged from ⅛ inch to 3/16 inch, the tubes could be passed out through this enlarged hole and thus save a difficult operation of enlarging each tube.

Another good practice in welding superheater tubes is to remove the bumper from the back end of the furnace and station an operator at this point to watch the heat from the inside of the flue. He should have a light hand bumper and hold it against the safe end until it sticks with a welding heat, then bump it slightly. After some practice the operator can tell just how much to bump the safe end to get it well set. This should be done from the front side of the furnace, for these flues are too heavy for one man to handle.

It is impossible when watching from the front side to know when the flue is heated properly; but a man watching the heat from the back, seeing the melted metal run freely on the inside, knows that it is at a welding heat all through. At a signal from the operator his helpers turn the flue rapidly to keep it from burning while he steps to the front of the furnace to complete the operation.

Manufacture of Modern Boiler Tubes

The modern boiler tube is made from a special grade of open hearth steel, either seamless or lap welded. The material used for this purpose is of the highest standard in the physical and chemical properties, which are necessary to produce strong ductile tubes to meet the strenuous every-day service to which they are subjected. The inspection and testing of boiler tubes is most rigid, so that the finished product will be adapted to stand excessive expanding, beading and flanging.

The development of the locomotive boiler tube has been most remarkable when considering its durability under the excessive strain and abuse of locomotive service.

Development of Locomotive Boiler Tubes

Formerly, copper tubes were used, but a demand was created for a less expensive type, which resulted in the use of butt-welded charcoal tubes made of iron. These were used for some time, but later on the lap-welded process of manufacture was invented and this improvement was applied to tubes for boiler service. This style of tube was better adapted to stand the required manipulation of turning over the flue ends for beads and increased steam pressure. The next step was the manufacture of the seamless steel tube, which was in turn followed by a special process in the manufacture of the spellerized seamless tube, and today we are using this tube extensively in locomotive service. The spellerized steel tube is a tube of exceptional density, having a uniform surface which resists corrosion to a great extent, especially corrosion in the form of pitting. However, there remains to be invented a tube which will resist this form of deterioration absolutely, and it would not surprise the writer if one were perfected in the near future.

Our present-day market produces practically three classes of boiler tubes for locomotive service—lap-welded, charcoal iron, seamless steel, hot rolled and cold drawn, and spellerized lap-welded steel.

What's the Real Reason?

While glancing over some back numbers of The Boiler Maker I noticed an interesting article regarding boiler explosions, entitled "What's the Real Reason?" We all know, of course, that there is no *real* reason why a boiler should ever explode, but there are many reasons why a boiler does explode, as, for instance, lack of proper care, carelessness and ignorance in operating. These causes will lead to the explosion of any style of boiler.

Effects of Inattention

Why should there be excessive grooving, cracked plates, broken stays, scale, oil, etc., in a boiler? If the boiler were standing still, we might not have to contend with such conditions. Therefore, we assume that these various troubles are caused by wear and tear on the boiler while under pressure. If a horse is loaded down too heavily when young he is not much use in after years, and the same theory applies to the boiler. If we do not look after conditions closely, we will have to make repairs, thereby lowering the insurance, while, at the same time, lowering steam pressure.

Breaking of Stays

There is no preventive known that will stop a stay from breaking, caused by excessive stress on the boiler. These conditions will always exist as long as boilers are used. They may, however, be prevented to a certain extent by carefulness on the part of the boiler inspectors and by attendants of boiler rooms.

Locomotive Boiler Stays

Take, for instance, the stays on a locomotive boiler; by this I do not mean the flexible stays, but the solid stays. Is there any known remedy that will prevent them from breaking when the greatest strain occurs? One reason why the stays in the water space break is because of their being small and unequal. Steam reaches to these different weak points and the result is—broken stays.

Youngstown, Ohio. William J. Kelly.

Boiler Water Treatment*

The Formation of Scale and Its Effect on the Boiler—Methods of Softening Boiler Feed Water

A source of unnecessary waste of fuel originates in the use in boilers of so-called "hard" water. This leads to the deposition upon the boiler metal of insulating material contained in the water, which retards the flow of heat from the furnace to the water to such an extent that the amount of heat escaping through the stack is materially increased.

How a notable reduction in factory heat losses may be effected through the substitution of "softened" for "hard" boiler water is clearly shown in the following†:

If you cover a steam pipe with asbestos, magnesia, or other heat-insulating material, you keep the heat in the steam; if you line or coat a boiler tube with scale or other heat-insulating material, you keep the heat out of the boiler water, and send it to the stack. By lagging your pipes you save fuel easily. By lining your tubes with scale you waste it continuously and needlessly.

Nature and Origin of Scale Formers in Boiler Water

All natural waters contain more or less of this heat-insulating material, partly as suspended matter (such as clay, fire sand, insoluble forms of iron, aluminum, etc.), partly as dissolved matter, such as compounds of calcium, magnesium, sodium, potassium, and other mineral salts.

Much of the suspended matter, as well as most of the dissolved matter, may form scale, but the suspended matter may generally be removed by filtration, which will be discussed later.

Dissolved Matter Which Forms Scale

Of the material commonly in solution in boiler waters, the bicarbonates and sulphates of calcium and magnesium are the most important scale formers. Natural water containing in solution bicarbonate of calcium or magnesium or both exhibit what is called "temporary" or "carbonate" hardness; those containing dissolved calcium or magnesium sulphate or both possess "permanent" or "sulphate" hardness. In the case of the sulphate scale the temperature required to separate it is too high to make it removable by heating alone a practical means of treatment. In the case of water exhibiting carbonate or temporary hardness great improvement in its properties may be effected by the use of open heaters of the exhaust steam type. As a rule sulphate scale is denser in structure with a higher heat-insulating value than carbonate scale, but the conditions of formation affect this considerably. Where a porous structure permits water to penetrate the scale its heat-insulating effect is greatly reduced.

The Effect of Scale

In many respects the effect of an increasing deposit of scale on the passage of heat through the walls of a boiler tube is very similar to the effect on the passage of water through a tube of continually decreasing bore. In the case of the watertube, the only way to get a uniform volume of water through it in a given time, in spite of its diminishing bore, is continually to increase the pressure in the water; so in the case of a boiler tube covered with a dense scale the only way to maintain a constant flow of heat from the furnace to the boiler water is to increase the "heat pressure," so to speak; that is, to burn more fuel.

Heat Loss.—The most important effect of scale is due to the fact that in certain forms it is a wonderful heat insulator. Its chemical composition seems to have little to do with its heat-insulating power, the big question being the density or mechanical structure of the scale. A series of experiments by Professor Schmidt, of the University of Illinois, gives the following results, showing decrease in heating transfer efficiency to tubes coated with scale of different thickness and composition:

Character of Scale	Thickness, Inch	Composition	Loss of Efficiency, Percent
Hard	1/50	Mostly carbonate..........	9
Soft	1/32	do	7
Hard	1/32	do	8
Soft	1/25	do	8
Hard	1/25	Mostly sulphate...........	9
Do	1/20	do	11
Soft	1/16	do	10
Do	1/16	Mostly carbonate..........	11
Do	1/16	do	12
Hard	1/16	do	12
Soft	1/11	do	15
Hard	1/9	Mostly sulphate...........	16

This expressed in dollars and cents means that with a deposit of 1/9 inch of scale, 16 cents of every dollar paid for coal is lost.

The data just given must not be regarded, however, as indicating that the decrease in the heat-carrying capacity of scale covered tubes can always be calculated with the accuracy that these figures would indicate. The important facts are, though, that the loss is easily prevented and that the advantages of soft water abundantly justify all expenditure necessary to secure it.

Just what the loss is in any particular case could best be determined by comparing the fuel consumption with clean and then with scale-covered tubes, other operating conditions being kept uniform.

Means of Removing "Scale Formers" From Water

The methods employed in softening water may be divided into two main classes, (*a*) those in which the scale-forming property is removed before the water enters the boiler, (*b*) those in which the softening is effected within the boiler itself by means of so-called "boiler compounds."

As to which one of the two classes of methods should be employed in any particular case would depend on the size of the plant, and on the character of the water to be softened. In the case of waters of abnormal composition, it would frequently be impossible to produce a satisfactory water by either method and a new water supply would be necessary.

It cannot be too strongly emphasized that this question of water treatment is one in which the employment of competent chemical and engineering knowledge is both absolutely necessary and highly profitable, and it would be far wiser to omit all forms of water treatment (involving the use of chemicals) rather than to undertake such without knowing accurately the composition of the water and of the material used to soften it. It is most important to remember that the quality of the water, even when secured from the same source, varies widely from time to time. These variations are not only seasonal and

---

* Reprint of Engineering Bulletin No. 3; prepared by the United States Fuel Administration in collaboration with the Bureau of Mines.

† For a very elaborate discussion of this subject, see Bulletin No. 1752, University of Texas, by W. T. Read and E. P. Shoch. The table showing the calculated reduction of heat-transfer efficiency was taken from this source, and the discussion of the zeolite process is based on data furnished by that bulletin.

monthly, but daily and even hourly. A condition of excessive concentration of the water after a protracted drought may be changed within an hour to a correspondingly excessive dilution by a summer storm. The result would be to decrease enormously the percentage of dissolved matter and to increase, probably to a much greater degree, the amount of suspended matter.

As a consequence, a prescribed treatment of the water based on its analysis at any particular time might not lead to satisfactory results if applied at some other period.

As an instance of the serious danger of an unintelligent "dosing" of boiler waters may be cited the result of a long series of investigations, which has, apparently, shown that carbonate of soda in solution produces brittleness in boiler steel. Carbonate of soda (soda ash) is used in most water-treating processes and its unintelligent use may readily lead to a very dangerous condition in a boiler.

When Boiler Compounds May Be Used

Boiler compounds afford a very useful means of boiler-water treatment in plants whose size or value of output would not justify the use of a more expensive method. This would be true of a large percentage of the plants of the country.

In spite of a great variety of trade names a very large percentage of all boiler compounds consist most largely of carbonate of soda, to which caustic soda is sometimes added, and occasionally phosphate of soda. Starchy materials and those containing tannin are frequent ingredients. The supposed effect of these last two materials is to coat the particles of precipitated incrusting material and prevent its cohesion into compact scale.

Objections to the Use of Boiler Compounds

The chief disadvantage (assuming that they are used intelligently) is the necessity of frequently blowing down the boiler to prevent the accumulation of "sludge" and of alkaline (sodium) salts in the water, both of which cause foaming. Furthermore, this blowing down must be supplemented by washing out, and occasionally closing down the boiler to complete the removal of the sludge and of the boiler compound itself.

Whenever competent supervision of boiler-water treatment is available within the plant organization, it is preferable to soften the water before it enters the boiler, and this must be done when the percentage of scale-forming ingredients is high.

Water Softening by Other Chemical Means

By treating the water before it enters the boiler.—The removal of scale-forming components from water by chemical means, whether before or after entering the boiler, is accomplished by converting the calcium or magnesium compounds into practically insoluble forms, causing them to separate from the water and allowing the material to be removed by blowing down, filtering, or sometimes by settling. Lime and soda ash are generally used for this purpose when the softening occurs before the water enters the boiler. The lime combines with the carbon dioxide which held the calcium and magnesium carbonates in solution; these are no longer soluble in the water after removing the carbon dioxide, and therefore separate from it. In a similar way the sulphate scale is removed by its conversion to insoluble carbonate by the soda ash.

The lime-soda process.—There are in current use in power plants practically only one lime-soda process, of which there are two varieties differing chiefly in the temperature of the water when treated. In all essential respects the two varieties are similar. The treatment consists of adding to the "raw" water softening agents in carefully controlled amounts (which must agree with the composition of the water), mixing these thoroughly within the water, and permitting sufficient time to elapse for the separation of the "sludge" before the water is fed to the boiler.

In the case of the "hot-continuous" process this separation is effected more rapidly, which permits of less storage capacity than in the case of the cold-continuous. In all cases, though it is of the utmost importance to provide sufficient storage space to allow the sludge to be completely deposited before the water is fed to the boiler; otherwise the partially completed softening process will be completed within the heater, and the purpose of the treatment will be largely defeated. Another advantage of the hot process is that it expels the air from the water and so reduces the corrosion.

The zeolite process.—This is entirely unlike the processes described above and (unlike them) gives a water of zero hardness. The softening agent is an artificial material composed largely of sodium compounds, which are exchanged for the incrusting (scale-forming) material of the water; that is, the water dissolves sodium compounds from the softener and replaces it by the calcium and magnesium which had caused the hardness of the water. The hard water simply flows over the permutit packed in a cylinder or is forced up through it and flows from it with all scale-forming material removed. After a time the softener must be regenerated by allowing a solution of salt to flow over it, restoring its original composition and activity. The "permutit" process is a well-known efficient variety of the zeolite treatment.

Advantages and Disadvantages of Zeolite Process

The construction and operation of this softening equipment are extremely simple, and, as already stated, water of zero hardness is furnished. On the other hand, in the case of water of a high degree of temporary or carbonate hardness there is a correspondingly large amount of sodium salts introduced into the water, so that foaming is liable to occur (as is liable to occur when softening water of a similar composition by means of boiler compounds). In such cases the following modified form of the zeolite process is used.

The Lime Zeolite Process

In this an intermittent or continuous tank equipment, as described already under the lime-soda process, is connected through a filter to a zeolite softener. Only lime is used in the tank, the soda compound being secured from the zeolite. The filter is placed between the tank and the zeolite softener to avoid any sludge coating the permutit particles and so impair its efficiency.

Filters.—No process of water softening is satisfactory unless the amount of suspended matter is reduced to a minimum. In the case of very finely divided matter this may be done by adding so-called coagulants—alum, for example—but these should be used with extreme caution and always under expert direction. Ordinarily, though, such suspended matter is removed by filters, of which the sand filter with a downflow of water is the most satisfactory type. They are not expensive either in original or maintenance costs.

Removing Scale Already Formed

The purpose of the methods described above is to prevent the formation of scale. There is another class of water-treating material used largely to remove scale already formed and to some extent prevent the formation of new scale. Graphite and kerosene are most often used for these purposes. Their action seems entirely mechanical.

Opinions as to the desirability of their use vary from enthusiastic commendation to absolute condemnation, though their use seems generally approved by practical men. Neither should be used, however, in boilers in which there is already a heavy deposit of scale, as the loosening of this and its accumulation in the bottom of the boiler is apt to lead to blistered and bagged boiler metal. Both graphite and kerosene should be used very cautiously. Kerosene, if used in excessive quantity, is apt to distil over and attack gaskets.

Some Examples of Economies Effected by Softening Water

There is a very direct relation between softening water and saving fuel; the following are a few cases reported of such economies:

1. A marble company reports a saving of 21 percent of fuel by softening its boiler water.

2. A crucible steel company, by substituting soft for hard water, effected a saving of 3,600 tons of coal per annum, which based on current prices would be valued at about $22,000.

3. The Chicago & Northwestern Railroad Company, comparing its operating expenses in 1902-3 before and after softening its water supply, reported a saving of $75,000 per annum. This saving was effected at a period when coal cost probably less than one-half the prices charged to-day (1918).

4. In addition to these, other cases have been reported in which profits resulting directly from the substitution of soft for hard water have been reported as varying from 32 percent on an investment of $7,200 to 71 percent on an investment of $7,000. These profits resulted largely from the elimination or reduction of operating costs, such as cleaning heaters, piping, and economizers, cost of cleaning instruments, interest, and depreciation on spare or idle boilers, etc.

5. Furthermore, it has been estimated that the use of hard water in a great number of the locomotive boilers of the country involves consumption of 15,000,000 tons of coal more than would be needed were soft water only used.

6. A steel company, whose annual output is 50,000 tons, reports a saving of 200 pounds of coal per ton of steel resulting from the softening of its boiler water.

The above are convincing evidences of the opportunity presented to power-plant operators for saving, by means of water softening, a very considerable proportion of the coal which will be mined during the current year.

The United States Fuel Administration feels that it can count very confidently on the adoption by all power-plant operators of this simple and effective means of fuel economy which is of such specially vital concern at present.

Legal Decisions Affecting Boiler Makers

BY JOHN SIMPSON

It is somewhat difficult to formulate a satisfactory definition as to what constitutes manufacturing from the decisions of the courts, or to say when it begins. The primary meaning of the word "manufacturing" is something made by hand as distinguished from a natural growth; but, as machinery has largely supplanted this primitive method, the word is now ordinarily used to denote an article upon the material of which labor has been expended to make the finished product. Ordinarily the article so manufactured takes a different form, or at least serves a different purpose, from the original materials, and usually it is given a different name. Raw materials may be, and often are, subjected to excessive processes of manufacture, each one of which is complete in itself, but several of which may be required to make the final product. Thus logs are first manufactured into boards, planks, joists, scantlings, etc., and then by entirely different processes are finished into boxes, furniture, doors, widows, sashes, trimmings and a thousand and one articles manufactured wholly or in part of wood. The steel spring of a watch is made ultimately from iron ore, but, by a large number of processes or transformations, each successive step in which is a distinct process of manufacture, and in which the article manufactured receives a different name.

When property which would otherwise be personalty, such as the machinery of a plant, has become a part of the realty, depends, first, upon whether it has been attached or annexed to the realty, and, secondly, on the intent with which it was so attached or annexed. The intent in cases like this is the controlling factor. By intent is meant not the secret and undisclosed intent of the actor, but the intention manufactured by all the facts and circumstances which tend to show the purpose, whether temporary or permanent, of annexation, the object to be accomplished, the adaptation to such object, the degree and mode of annexation, and whatever else may tend to show what the party or parties annexing the machinery had in mind in regard to its relation to the realty.

Each case depends on its own facts. While the fact that machinery annexed to the freehold could not be removed without great injury to itself, or to the property, would go far to show that it had become a fixture, the fact that it could be removed without material injury to itself or the property has little tendency to show that it had not become part of the land.

It is doubtful whether the mere fact that a foundation has been prepared for a machine is sufficient in and of itself to constitute the machine a part of the freehold. But where a substantial part has been permanently set up on foundations specially prepared for it from plans by the vendors, in the place in the plant intended for it, and firmly fastened to such foundations with the intent that it shall remain where it is placed as a part of the equipment of the plant, and where the work of completing the setting up of the machine is going on at the time of the filing of a petition in bankruptcy, and has not been abandoned, and the parts necessary to complete the machine are at hand, and the machine is for manufacturing purposes, a unit, and the parts set up and annexed will be of no use without the other parts, it was held that the more reasonable view is that the machine should be regarded as having been so far annexed to the realty as to constitute a part thereof.—(*In re Russell Falls Company*, 249 *Fed.* 260.)

Human Agency in Patents

The mere fact that human agency intervenes in an operation does not render a combination unpatentable. Nor is it necessary that the action of the elements be simultaneous, nor that one of the constitutional elements shall so enter into the combination as to change the character of the others. It is sufficient if there be some joint operation performed by the elements producing a result due to their co-operative action. The result itself need not be new. It is sufficient if an old result be produced in a more "facile, economical, or efficient way."—(*Willard v. Union Tool Company*, 253 *Fed.* 48.)

Audible Electric Signals in Industrial Plants*

BY V. KARAPETOFF†

No industrial plant of any magnitude may be considered fully efficient unless means are provided for promptly locating any important employee, no matter where he may be within the plant. A private telephone system, however extensive, serves this purpose only as long as the needed man is at his desk, but as soon as he leaves his desk the problem of locating him becomes a hit or miss proposition. On the other hand a superintendent, a foreman, a millright, a repair man, etc., is ordinarily useful only in so far as he can freely move about the shop without the fear that someone of importance may need him. Thus, within the last few years, under the tremendous impetus of the pressure for an enormous increase in the production of munitions of war, audible electric signals have been introduced into many industrial plants.

Such an electric signal is usually similar in construction to the familiar electric "horn" used on automobiles. It consists of a diaphram with an anvil at its center. A toothed wheel driven by a small electric motor strikes the anvil many times a second and causes it to vibrate vigorously. These vibrations roduce the well-known warning tone, which carries over a considerable distance. The device is provided with a projector or horn the shape of which depends on whether it is desired to scatter the sound, to intensify it in a horizontal direction, or to deflect it downward. Such motor-driven signals are now made much more powerful than automobile horns, and are would for 110 or 220 volts, direct or alternating current, so that they can be connected to a lighting or power circuit, and do not require a separate low-voltage battery.

With such electric audible signals scattered throughout the plant it becomes an easy matter to locate instantly any person to whom a code number has been assigned. For example, when the manager wishes to speak to one of the assistant superintendents, who may be anywhere in the plant, he simply tells the telephone operator to sound this particular man's call. As soon as this assistant superintendent hears his call, he comes to the nearest telephone, and reports, whereupon the operator connects him with the manager.

It would be rather inconvenient for the telephone operator to sound various calls by hand; therefore a special code-calling automatic instrument has been developed for this purpose. The operator merely sets the desired person's code number on a dial and pulls a lever, a contact-making mechanism is thereby set in motion, which closes the electric circuit and operates the code signals throughout the plant the required number of times (usually three times), and then stops automatically.

In noisy and in open places, or in large factory lofts, the electric horns mentioned above constitute the most suitable type of signal. In offices they may be replaced by less loud electric gongs, bells, buzzers, air whistles or incandescent lamps. In some cases two separate circuits are run from the code-calling mechanism, one circuit for ordinary calls, the other for fire-alarm gongs, or for some other special purpose. Sometimes two allied plants are operated side by side with a separate staff in each. Then the same code combinations can be assigned in both plants, but the horns in one or the other plant will sound according to which of the two circuits is closed.

A further application of loud electric horns in industrial plants is for extensions to telephone bells. The ordinary telephone ringer is not loud enough in many shops when the foreman is away from his desk. In this case, a relay is connected in parallel with or in place of the telephone ringer, and when it is actuated it closes a secondary circuit, which causes an electric horn to sound. This call

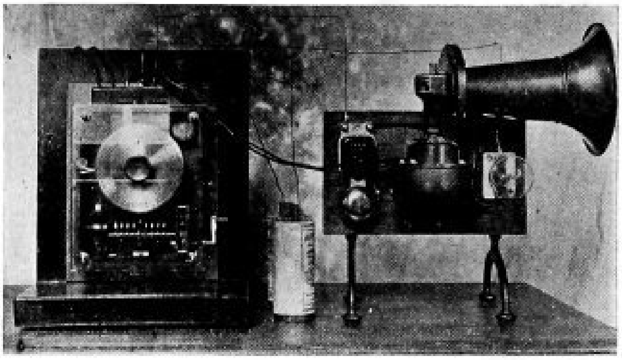


Fig. 1.—A Code-Calling Instrument (Klaxocator), and the Signals Which It Actuates, viz., an Electric Horn, a Bell and an Electric Lamp

should be a single blast to distinguish it from code calls.

Audible electric signal systems are also used in various plants as warning signals on cranes and hoists, also to call a shifting locomotive, to indicate the beginning or the end of a certain operation, and for other local purposes. Like in the case of any convenience, once such an electric signal system has been installed, the superintendent, the foremen, and even the operatives themselves will find new uses for it.

* Extract from a paper presented before the Rochester, N. Y., Section of the American Institute of Electrical Engineers on April 25, 1919, and before the Erie, Pa., Section on May 13, 1919.

† Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.

Repairing a Broken Vise

The vise had been broken off at *A*, as shown in the drawing, by using a pipe on the handle.

The two parts were lined up and fastened together, as shown by the rod. A groove, *B*, was next ground all

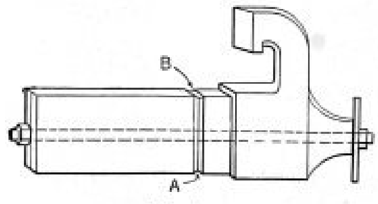


Fig. 1

around at the line where it was broken, after which it was welded together.

Waynesboro, Va. F. H. SWEET.

Announcement is made of the removal of the Minneapolis office of the Chicago Pneumatic Tool Company from the Metropolitan Bank Building to Fifth avenue and Fifth street south, Minneapolis, Minn. A complete stock of pneumatic and electric tools, air compressors, oil engines and rock drills and parts will be maintained at this office.

This company also announces the appointment of Mr. L. C. Sprague, formerly district manager of sales at New York, as manager of western railroad sales, with headquarters at the Fisher Building, Chicago, and Mr. H. G. Barbee as manager of eastern railroad sales, with headquarters at 52 Vanderbilt avenue, New York city. Mr. Nelson B. Gatch, formerly district manager of sales at Chicago, has been appointed district manager of sales at New York, succeeding Mr. Sprague.

The Boiler Maker

Published Monthly by

ALDRICH PUBLISHING COMPANY, INC.

Member of The Associated Business Papers, Inc.

6 East 39th Street, - - - - New York

8 Bouverie St., London, E. C.

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor.

Branch Office
Boston, Mass., 294 Washington street, S. I. Carpenter.

The letter on "Defective Workmanship Encountered in Boiler Shops" in this issue of The Boiler Maker indicates a condition that is not confined to the boiler making industry alone, but is none the less an unfortunate situation. Undoubtedly there are two sides to the question; but, since many inspectors have spent long years in the shops as boiler makers and have a very complete knowledge of the trade, their advice and judgment should be listened to with respect by foremen. Production should never be considered if the material turned out is not up to the required standard. Carelessness and lack of interest in the work are mostly responsible for defects. The tendency to cover up mistakes is a failing certain individuals in nearly all trades have, but in the case of the boiler maker it is criminal to hide weak points that may later cause loss of life. For this reason alone foremen should insist on the highest grade of workmanship in all materials under their supervision.

Differences of opinion between the inspector and the foremen as to the best method for performing a particular operation will always occur, but can easily be settled if both men are reasonable. The only point to be considered in an argument is the possible advantage certain ideas have in constructing the boiler.

During the war many inspectors appeared who had not the advantage of long years of experience in the shops and inspecting. These men have no doubt caused a great deal of the hard feeling that exists between the two departments. As conditions go back to normal such inspectors will be gradually displaced, so that this cause of trouble will cease to exist.

The only way to eliminate misunderstanding completely is for the foremen and inspectors to get together and compare notes, so that the inspectors will appreciate the point of view of the men, and they, in turn, will realize the necessity of carrying out the suggestions of the inspector, so that boilers of the highest standard will result.

During the period from 1916 to 1918 the percentage of lives lost in locomotive accidents, due to boiler explosions, increased from 41 to 90 percent. These accidents were due mainly to low water. A list of the causes for low water in locomotive boilers, compiled by the Chief Inspector of Locomotive Boilers for the Interstate Commerce Commission, indicates trouble with leaky water gage fittings, improperly located gages, defective crown-bolt heads. Failures have occurred in crown sheets, crown-bar braces, mud rings and boiler stays. The combination of poor workmanship and incompetent inspection permitted the vast majority of these defects to appear in the boiler.

All reports of the inspection department are available and should at all times be carefully studied by the designers, foremen and all others carrying on the construction of boilers, so that past trouble may be eliminated or avoided in new work. The inspectors, too, should keep informed of any advance in methods employed to increase the safety of boilers for the final say as to the advantage of new features lies with them.

Until recently there seemed to be danger of a bad slump in the boiler making industry, particularly in domestic orders for locomotives. Fortunately, the past week has improved the situation. The United States Railroad Administration has placed orders for eighteen Santa Fe type and seven Pacific type locomotives with the American Locomotive Works. Private concerns have placed about the same number of orders with the American Locomotive Company, and there are prospects for more in the near future.

The big field for the products of the boiler making industry is Europe. Rolling stock on Continental railroads is in bad shape and must be renewed. America is the only nation in position to supply this demand, and assurance has been given that, as soon as satisfactory credit arrangements can be made, orders of magnitude will be placed here.

Every effort should be made by the members of the industry to further any project having as its object the spread of American boiler products to foreign countries. If legislation for such trade is necessary, a little united pressure from interested associations will accomplish a great deal.

Operating efficiency of boilers, which means conservation of fuel, is of particular importance at this time, when the country seems to be on the verge of an extensive coal shortage. The only way that economy can be obtained is in having properly designed and constructed boilers operated by competent firemen.

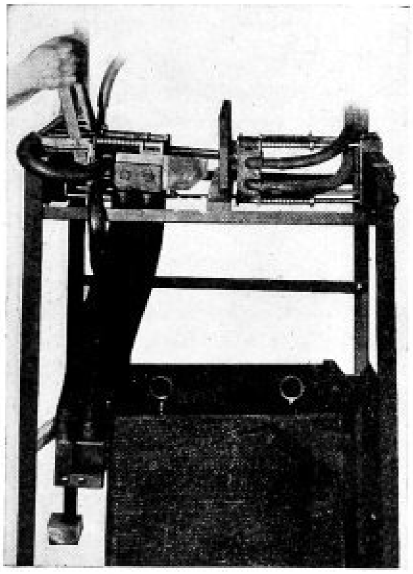
For another reason, the matter of boiler efficiency should be given particular attention. Internal combustion engines of various types are proving more efficient in certain lines of service than steam boilers, and if the boiler is to retain its present position of usefulness it is necessary that every attention be given to the details of its construction and maintenance.

Engineering Specialties for Boiler Making

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

Electric Rivet Heating Device

An electrical heating device for rivets, which may be used as an attachment on "bull" or gap riveting machines or on portable hand riveters, has been produced by the United States Electric Company, New London, Conn. For use with "bull" riveters the device is arranged so that a hot rivet is kept in front of the plunger during the riveting operation. The rivets are placed in the rivet holes cold, and the work to be riveted is moved along in front of the electrodes, which may be brought in contact with the rivets either by the motion of the plunger or by the use of a hand lever. The attachments are built to heat rivets of 1/4 inch to 1 1/4 inches in diameter. On recent tests two 3/4-inch rivets, with 2 1/2-inch shanks, were heated in 15 seconds; two 7/8-inch rivets, with 2 1/2-inch shanks, in 23 seconds, and two 1-inch rivets, with 2 1/2-inch shanks, in 30 seconds.



New Rivet Heating Device Used With Gap Riveting Machines or Hand Riveters

The electrodes are so constructed that two rivets may be heated at once in about the time generally required to heat one. This is accomplished by bringing one rivet to the proper heat while the other is being pre-heated, so that a continuous line of hot rivets is kept on the way to the plunger of the gap riveter at all times during the operation.

ATTACHMENT APPLIED TO PORTABLE RIVETING MACHINE

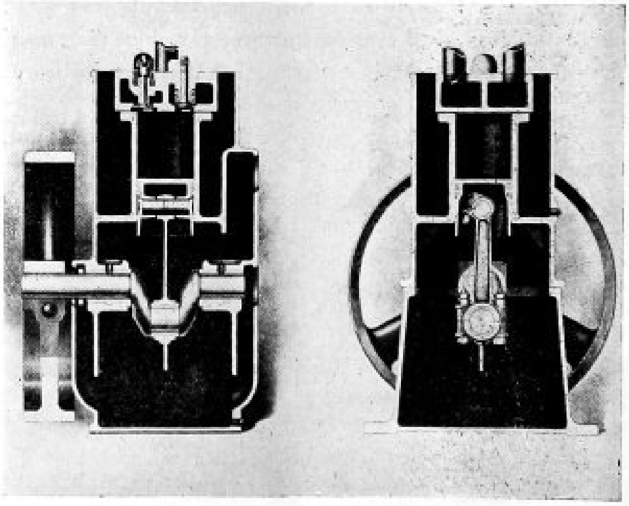
In the case of portable riveting machines the device is designed for use with rivets not over 5/8 inch in diameter. It is made to operate in conjunction with the pneumatic hammer.

The operation is rather simple, the tool being attached to either the riveting hammer or the holder-on. Cold rivets are placed in holes shaped to size, the holder-on comes in contact with the rivet as in an ordinary case, but here the electrode is brought in contact with the head of the rivet. Heat is maintained until the desired intensity is reached, then the rivet is headed by turning the air gun around.

The electrode is attached to the side of the riveting gun, allowing two rivets to be heated at once by the use of a bridging conductor, which makes the device useful in heading rivets from one side of a plate, the outside of a boiler or in restricted spaces. Equipments are available in all sizes and for use with 110-volt and 220-volt currents.

Imperial "Fourteen" Small Air Compressor

On April 15 the Ingersoll-Rand Company, 11 Broadway, New York, placed on the market a small air compressor of new design, known as the Imperial Fourteen. These new standard compressors, which are built in four sizes, provide a capacity ranging from 3 to 45 cubic feet per minute at pressures to 100 pounds per square inch, although they can be used for pressure requirements up to 200 pounds by increasing the horsepower. They are single-acting, belt-driven machines of the vertical type. Where they are designed to be driven from a line shaft, however, tight and loose pulleys are supplied. When designed to be used with an independent motor, they are furnished as a unit complete with the motor, endless belt and short-drive attachment. In the latter case, a hardwood base plate is included.



Section of Imperial 14 Compressor

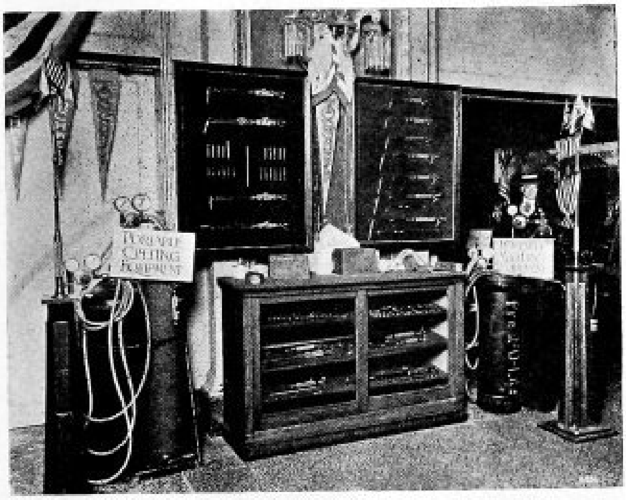
The smallest size is built with an air-cooled, ribbed cylinder for intermittent service, and with water-cooled cylinder of the reservoir type for continuous operation. The larger machines are water-cooled only; in the case of the largest size, a closed jacket for connection to the pressure system is optional.

Telltale holes are sometimes drilled after the stays are in place. This would seem to be poor practice, for the holed staybolt bar serves the dual purpose of conservation and economy. It is possible to drill both ends simultaneously, either before screwing the bolt into place or after.

Oxy-Acetylene Welding Torches

An interesting exhibit of acetylene welding devices was that of the Torchweld Equipment Company, of Chicago, at the recent Master Boiler Makers' convention held in Chicago.

It included welding and cutting torches, many of which were designed for particular services. All torches have



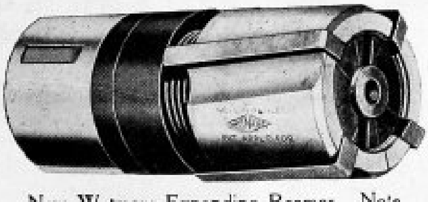
Torchweld Exhibit at the Master Boiler Makers' Convention

an extension which, it is claimed, increases their range of usefulness. Special valves are arranged so that frequent adjustments of the welding flame are not necessary.

New Expanding Reamer

The Wetmore expanding reamer illustrated is a commercial development of an adjustable type reamer, supplied by the Wetmore Reamer Company, Milwaukee, Wis., to shell manufacturers in the United States and Canada during the war. The left-hand spiral cutting angle of the blades is probably the most advantageous feature of the design, and is clearly shown in the illustration.

In production work of any kind, such as shell, automobile or gear making, where speed in cutting and accuracy are essential, it is claimed that this reamer is of special value. Adjustments to required limits may be made by means of a special wrench provided to manipulate a graduated screw collar in the reamer body. Each graduation on the screw collar indicates one thousandth of an inch



New Wetmore Expanding Reamer. Note Left-Hand Spiral Cutting Angle of the Blades

in the diameter. The body of the reamer is solid and may be attached to any arbor, although arbors for various machine operations are provided.

Standard reamers are made in sizes from 1 inch to 4½ inches, and blades are packed so that they may be conveniently stored and identified. Four blades are used on reamers up to 3 inches in size, and six blades on larger ones.

New Line of Agrippa Turning Tools

A new line of set screw pattern turning tools with right- and left-hand offsets and straight shanks is being placed on the market by J. H. Williams & Company, Brooklyn, N. Y. This company manufactures drop forgings and

Agrippa Turning Tool Holder

drop-forged tools at its plants in Brooklyn and Buffalo, N. Y. The company's line already includes a wide range of sizes of Agrippa tool holders for all regular machining operations. Several of these styles are fitted with a cutter-fastening device using a cam instead of the usual set screws, as illustrated. The cams are furnished with hexagonal head, or are headless.

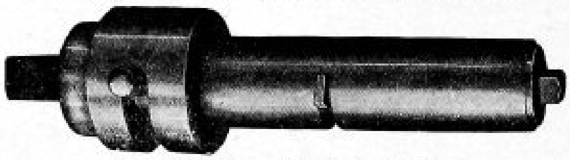
Set Screw Pattern Tool Holder

The nose of the holder of either cam or set screw turning tools is beveled to permit its use in close quarters. The tools are drop-forged and carefully heat treated. The cutter-holding channel is broached to accurate size, and accordingly provides a rigid seat for the cutter. For usual mill practice the makers recommend turning tools of the cam fastening pattern. However, since this arrangement limits the range of contact, the makers are offering the new line of set screw pattern turning tools. The "diamond point" form or bevel of Agrippa cutters provides for all ordinary requirements with a minimum of grinding for either right- or left-hand usage.

New Tool for Cutting Out Flues

A new spring return flue cutter which attracted considerable attention to the recent master boiler makers' convention has been placed on the market by the Lovejoy Tool Works, Chicago, Ill. This tool was designed with the idea that the time taken in cutting out flues might be greatly reduced.

Its operation during the working stroke is similar to that of all good railroad flue cutters, but the return is



Tool for Cutting Out Railroad Flues

made by means of a spring arrangement the instant the cut is completed. By its use the necessity of reversing the machine is eliminated, so that the operation may be made continuous. The cutter operates in conjunction with an air drill. As one flue is finished, the knife springs back to the starting position and is then inserted in the next one to be cut.

It is stated that its action is smooth and that it will cut the flue square and without burr in one and one-third revolutions of the knife. Sizes up to 2¼ inches are available.

Questions and Answers for Boiler Makers

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

This department is open to subscribers of The Boiler Maker *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of The Boiler Maker, *6 East 39th street, New York City.*

Intersection Between Scalene Cone and Cylinder

Q.—Please give a layout for the enclosed sketch. P. R.

A.—The plan and elevation, Fig. 1, show the cylinder intersecting a scalene cone at an angle and off center as illustrated in the plan view. The first requirement in its

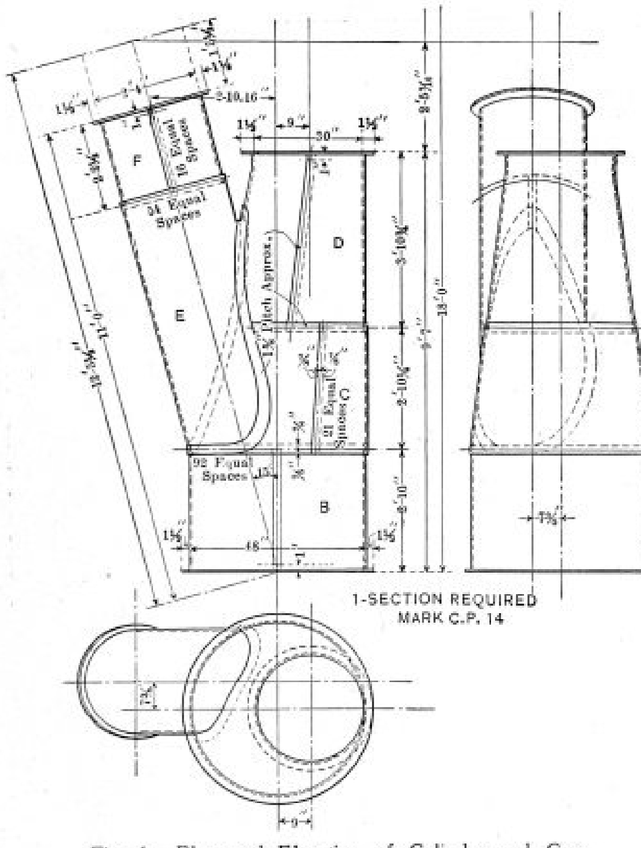


Fig. 1.—Plan and Elevation of Cylinder and Cone

development is to find the true line of intersection between the objects.

In heavy plate work lay off the development lines to the neutral layer of the plate by first drawing the plan and elevation, Fig. 2, to dimensions taken at the center of the metal. Lay off as shown in the first step the outline of the cylinder and cone, and divide the circles into equal parts, numbering them as shown. From the points on the circle in the elevation draw lines parallel with the axis of the cylinder and of an indefinite length. Divide one quadrant of the circle representing the base of the scalene cone into three equal parts in this case, and connect these points with the center *o* with straight lines. Then locate their position in the elevation.

Consider that planes parallel with each other are passed through the cylinder and cone and which lie in the plane of the lines, drawn from points 1-2-3, etc., of the circle in the elevation. Where these planes cut the surface of the scalene cone the intersections are curved. In the plan the curves are foreshortened and are represented by the dotted curved lines.

To lay off these curves, consider the sections taken at *a-b-c-d* and *e′ f′ g′ h′*. These points are the intersection between the planes or projectors of the cylinder and the radial lines of the cone. Vertical lines are drawn from these points to intersect the corresponding radial lines in the plan at *a′ b′ c′ d′* and *e′ f′ g′ h′*. With a piece of pliable material or batten the curves are drawn in through these points. The intermediate sections are developed in a like manner.

The irregular-shaped opening in the plan is the shape of the miter in that view, and it is developed by drawing horizontal lines from the circle to intersect the corresponding curved sections as shown at 1-2-3-4, etc., on the irregular curved outline. Fig. 3 illustrates how the cutting planes pass through cylinder and cone.

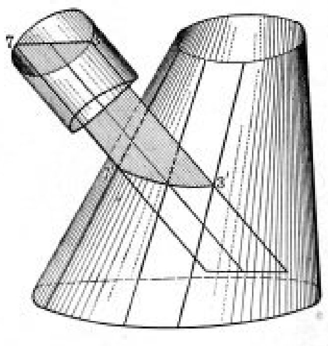


Fig. 3.—Planes Cutting Cylinder and Cone

In the *second step* the plan view is the same as shown for the first step, except that the radial lines used for developing the curved lines are omitted. This view is shown for the purpose of illustrating how the miter is laid off in the elevation. Vertical projectors are drawn from 1-2-3-4, etc., of the plan to intersect the projection lines drawn from the circle in the elevation, which locates the required points on the miter. Through these points radial lines are drawn in, in both views. In the plan they intersect the circle at 1, 2, 3, 4, etc. Find their true length as in the diagram by transferring the lines in the plan to the base of the triangles, and then connect them with the vertex of the triangle. The height of the triangles is equal to the vertical distance of point *o′* above the base of the cone. Parallel to the base of the scalene cone project the points from the miter to intersect corresponding lines in the diagram of the true lengths.

The stretchout of the lower base is equal to the circumference of the base, but it is necessary to develop the arc,

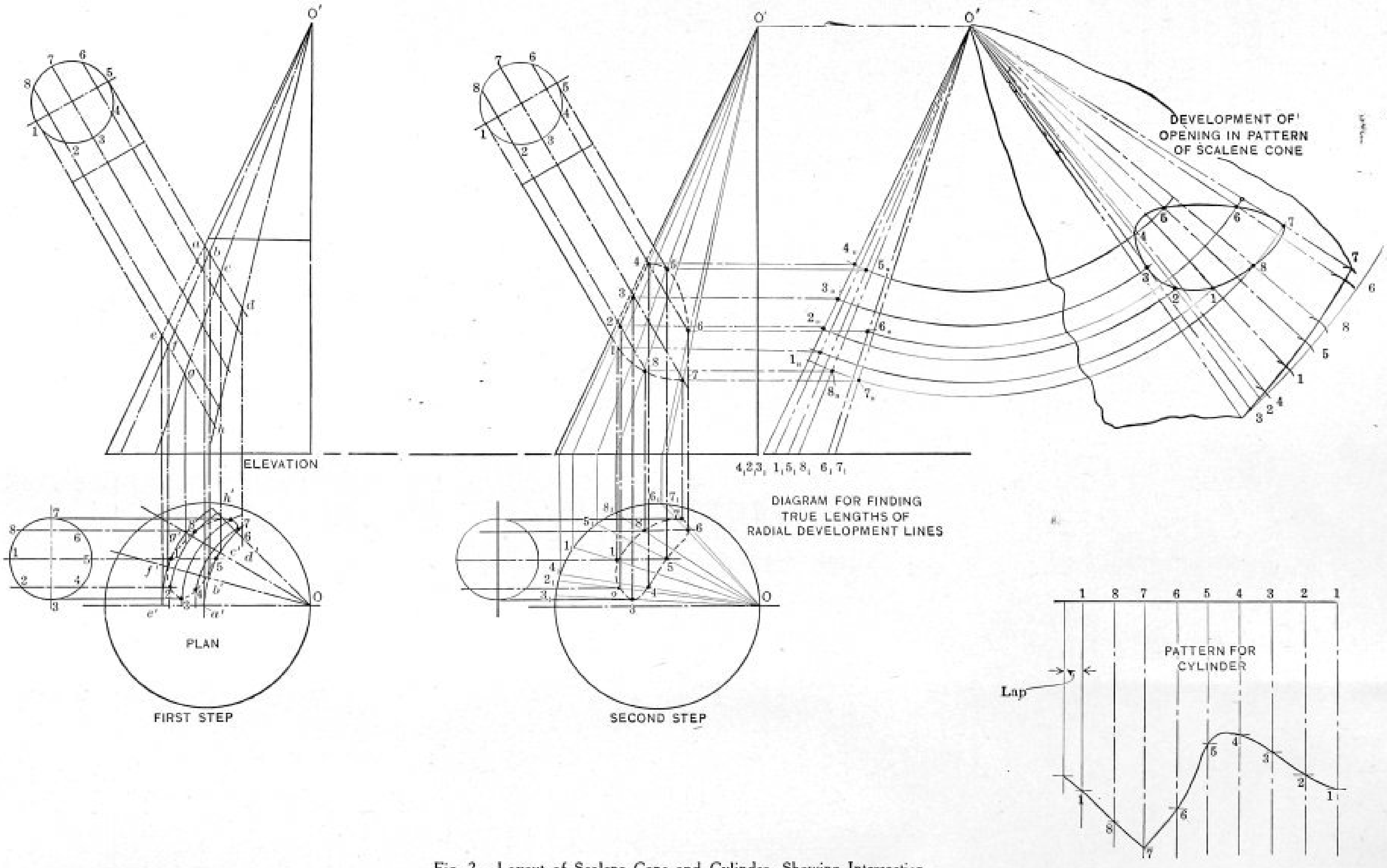


Fig. 2.—Layout of Scalene Cone and Cylinder, Showing Intersection

as it cannot be generated with one radius. To illustrate, consider the quadrant in which the cylinder intersects. Draw an arc with a radius equal to O'-3. In the pattern draw the straight line O'-3. From point 3 in the pattern lay off the arc length 3-2 of the plan shown in the *second step*, and with O'-2 of the diagram draw an arc, locating point 2. Continue in this way until point 7 is located. Locate points 1-2-3-4, etc., for the opening by using the radii O'-1', O'-2', O'-3', etc., of the diagram and laying these distances off on the corresponding radial lines in the pattern.

PATTERN FOR CYLINDER

The line 1-1 equals the circumference of the cylinder, and it must be spaced into the same number of equal parts as the circle or end view of the cylinder. Lines 1-1, 2-2, 3-3, etc., are equal in length to the same lines shown in the elevation of the cylinder in the second step of the construction.

Autogenous Welding and Laminated Plate

Q.—I have been a constant reader of THE BOILER MAKER for a number of years and would like to ask three questions to be answered in THE BOILER MAKER Question and Answer Department at your earliest convenience:

1. What is meant by autogenous welding?
2. Name the methods.
3. What is a lamination? R. H. L.

A.—Autogenous welding is the process of melting the edges of metal to form a cast or *fused* joint. If the work of welding is properly carried out, there is practically a uniform union of the metals. There are several methods of producing welded joints, and in cutting metals these processes are the *oxy-acetylene, electric* and *blau gas*. The heat-producing compound in the oxy-acetylene process is a mixture of calcium carbide gas and oxygen. When this compound is properly mixed it produces a very intense flame of approximately 6,300 degrees F., this heat being sufficient to melt the most refractory substances, as brick, stone, concrete, lime and the hardest kind of metals.

Lime and coke fused in a furnace produce calcium carbide. This material will slack like lime and give off a gas having a pungent odor. If the gas is confined it is liable to explode in coming in contact with flames.

Acetylene generators of high- and low-pressure types are employed for generating the gas. Oxygen is prepared in containers by various processes and sold to the trade. Suitable welding torches must be employed for welding and cutting purposes. These torches are so constructed as to control the proper mixture of gases. A metal filler of good quality must be used in making the welds, but before the welding can be properly done the work must be prepared and cleaned for the operations. For most seams the edges must be beveled, especially in thick plate work.

In the electric method either a carbon (graphite) or metal electrode is used. The principle of this welding is to pass a current of electricity at the point of welding, which produces an arc of intense heat, causing the metal to fuse with the metal filler or electrode. The temperature of the electric arc ranges from 6,500 to 7,000 degrees F.

Direct and alternating current is employed for welding, each having its advantages for certain classes of welding. For spot welding, alternating current is used, and in boiler and plate work, direct current.

By the direct arc method the Bernados or carbon electrode and the Slavisnoff or metal electrode are employed. The latter is especially suited for overhead and vertical seam welding, as the metal can be controlled to better advantage than by the carbon method. Both processes are used for heavy welding. The carbon method is also used for cutting purposes, but the metal electrode cannot be used.

The edges of plates should be beveled if they are over 1/8 inch in thickness; if less than 1/8 inch, the edges should be turned up, forming a standing seam equal to the plate thickness. This provides some material for the joint. The included angle between the beveled edges is usually 90 degrees.

In the *blau gas* method a gas composed from mineral oil is used in conjunction with oxygen. It is non-poisonous and very rarely explodes. It is used in the same manner as the oxy-acetylene, but does not produce as high temperature.

The term *lamination* as applied to sheet iron and plate means that the metal in the sheets or plates is split, forming thin layers of metal. This condition is due to slag or other impurities in the metal, which, when rolled from the ingot, flatten out and later blister or swell out when heated in the fire.

Tank Problem

Q.—Please give development of pattern for a tapering course of a large tank, 115 feet diameter and 35 feet high. Seventeen sheets are used in a course and six courses to the tank. C. M.

A.—In this construction it is unnecessary to take into consideration the camber, because the difference between the diameters of the ends of the section is so slight that it is practically negligible, as will be understood from the following calculation:

The outside diameter of the section Fig. 1 is 115 feet and the neutral diameter is 114 feet 11¾ inches. At the

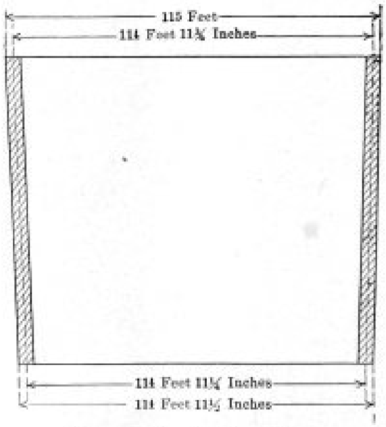


Fig. 1.—Section Elevation

small end the outside diameter equals 114 feet 11½ inches, neutral diameter equals 114 feet 11¼ inches, circumference or stretchout of large and exclusive of lap equals 114 feet 11¾ inches × 3.1416 = 1,379¾ × 3.1416 = 4,334.62 inches. Dividing this product by 17, the number of sections for one ring, equals 254.98 inches, stretchout for the large end of pattern exclusive of laps.

For the small end we have:

114 feet 11¼ inches = 1,379¼ inches.

1,379¼ × 3.1416 = 4,330.52 inches, circumference of smaller base.

4,330.52 ÷ 17 = 254.88 inches, length of pattern at small end exclusive of laps.

From the difference between the stretchouts 254.98 inches and 254.88 inches, which is 254.98 — 254.88 = .10 inches, approximately 1/8 inch, it will be seen that the camber line would be practically a straight line in such lengths.

Tank Welding

Q.—Please state the best and cheapest method of building gasoline tanks 36 inches by 96 inches. Tanks are to be electric welded, heads slightly dished; made from galvanized iron ⅛-inch thick. Can I weld galvanized iron as well as ordinary sheet iron? It is impossible to use anything but galvanized iron, as we have no galvanizing outfit. I figure on buying the galvanized iron in the flat and ordering the head with about one-inch flange and lapping my seams about one inch. Could I go right ahead after assembling the tank and weld, or would it be necessary to grind or file off galvanization at laps where welded? Also, would it be necessary to weld inside and out? The tank is tested to six pounds air pressure. Please describe just how to go about this proposition, also showing the best method of assembling tanks. C. A. H.

A.—Steel sheets from 1/16 inch in thickness and heavier are readily welded together by the electric arc method. Metals lighter than 1/16 inch in thickness cannot be handled to advantage by this method, as the metal being so thin is easily burnt, resulting in a poor fused joint. Steel sheets 1/16 inch to ⅛ inch in thickness may be lap welded, and butt welds may be made on plates as thin as ⅛-inch. On heavier plates, from 3/16 inch to ⅝ inch, the metal is beveled on one side so that the included angle is 90 degrees. Heavier plates are beveled on both sides of the seams.

Very little preparation is needed for welding steel sheet by the arc method. The main thing is to arrange the pieces so that they can be held together by clamps, and be sure the edges to be welded are clean, as grease scale and rust prevent the operator from making good welds. Allowances must be made for expansion in the metal along the edges of the seam.

Before galvanized sheets can be welded satisfactorily, the zinc coating must be removed from ¾ to 1½ inches on each side of the seam. The heated zinc produces poisonous vapors which are injurious to health. Also a slag is formed that will prevent the proper fusion of the metal electrode and the metal of the plate.

The diameter of the metal electrode required for plates ⅛ inch in thickness is 3/32 or ⅛ inch. The metal in the electrode should be uniform and of good quality; "Swedish" iron is recommended. Suitable hand and head coverings must be employed, as the electric rays are so intense they burn the skin and injure the eyes if no protection is employed.

In Fig. 1 is shown the position of the cylindrical shell for welding. If the seam is of great length, the plate at

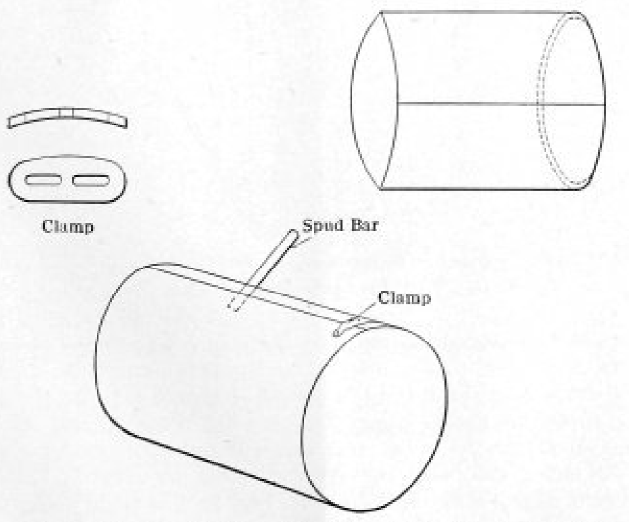


Fig. 1.—Showing Position of Cylinder and Heads for Welding

the end from where the weld is started must be separated to allow for expansion. An allowance of about 2 percent of the plate length to be welded should be made. The plate is butted together, leaving about ⅛-inch clearance between the edges of the plate at the starting point. Then clamp the ends so that the seam is in proper alinement.

The heads should be dished (Fig. 2), as this curvature in the head assists in taking care of the expansion and

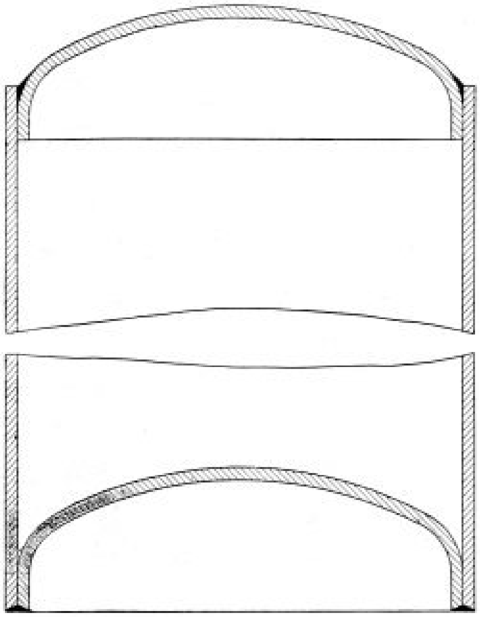


Fig. 2.—Sectional View, Showing Arrangement of Heads and Location of Welded Seams

contraction stresses set up in the metal surrounding the welded section. The head should be tacked; that is, spots should be welded at equal distances apart so as to hold the head in position. Weld in between one set of tacks; then on the opposite side of the head weld in between corresponding tacks. Continue in this way until the head is completed. This method relieves the stresses somewhat, preventing buckling of the shell.

Leaky Tubes and Staybolts

Q.—What causes engine flues to leak and honeycomb after each trip made when the flues are in good shape and the work of expanding and calking has been done twice and sometimes three times upon starting out? About the same flues come in, in that condition each time. Also the staybolts along the fire line leak a trifle. A. W.

A.—Leaky tubes may arise from either of the following causes: (1) Improper installation of tubes; (2) irregular tube holes (that is, tube holes that are not true circles their entire depth); (3) too much expanding and rolling, which thins the metal of the ube; (4) the collection of scale, mud, etc., around the tubes, causing the tubes to burn or scorch from the intense heat; (5) a poor grade of tubes or split tubes; (6) unequal expansion and contraction stresses due to heating and cooling the boiler; (7) forcing the boilers to carry a heavier pressure than their rated capacity.

Honeycombed tubes or plates arise from corrosion, but if the outside or bead of the tube has this formation it is evidently caused by water leaking about the bead and the gases coming in contact with the moisture set up a chemical action, producing a scale which attaches to the tubes.

Leaky staybolts on the crown sheet at the waterline may arise from overheating of the crown sheet, which, if badly affected, becomes burned, due to low water, mud or scale. The stresses arising from expansion and contraction of the crown sheet very often produce leaks.

Letters from Practical Boiler Makers

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

Defective Workmanship Encountered By Inspectors in Boiler Shops

The sketches shown herewith illustrate graphically various specimens of bad workmanship which boiler inspectors repeatedly find in supposedly up-to-date shops.

When approaching the foreman in charge, the following conversation usually occurs:

Boiler Inspector: Now, Mr. Assistant Foreman, the gang is starting to rivet up a back head on the boiler (Fig. 1) and I wish to inform you that the head is not properly

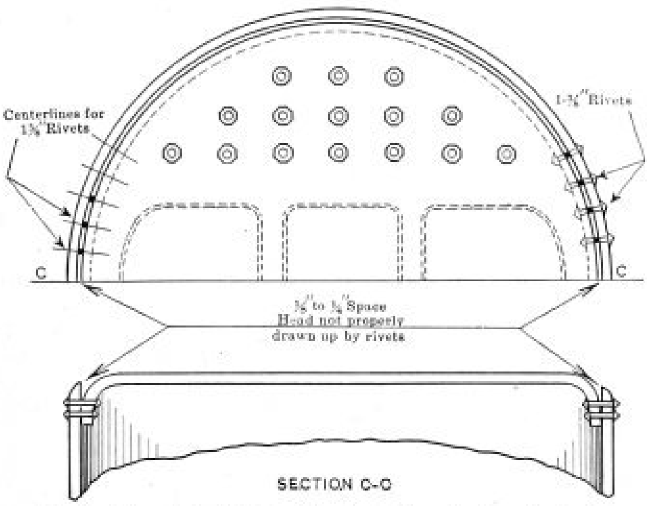


Fig. 1.—Poor Fit of Boiler Head and Laps Led to Re-riveting

bolted in place, and if you don't look after it in a hurry, the rivets will have to be cut out."

Assistant Foreman: "You don't know what you are talking about. That shell was squeezed up on the "bull," and I know those men would put in enough bolts to pull it into place."

Boiler Inspector: "Better not rely too much on those

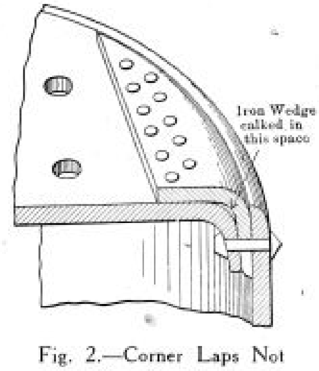


Fig. 2.—Corner Laps Not Properly Fitted

men. Go and see for yourself. You will find that the head stands off at the rivet holes from ⅛-inch to ¼-inch."

"Mr. Assistant Foreman, I find that you have paid no attention to that improperly laid up boiler head, and now it is all driven up. I am sorry to have to inform you that there is no use having those two men up there split-calking that shell plate to the head with a side set chisel; or having the rivets calked inside and out. Those rivets will have to come out."

Assistant Foreman: "Oh, no! It is not necessary to take them out. I will make such a good job of it that neither you, nor any of the inspectors, will see the difference after the painters finish with it."

NEXT MORNING

Boiler Inspector: "Sorry, Mr. Assistant Foreman, but I shall have to tell your "boss" in the office the kind of work you are giving us, although I know he is not much better himself. He does considerable talking when he knows you are in trouble—but especially when enjoying his morning

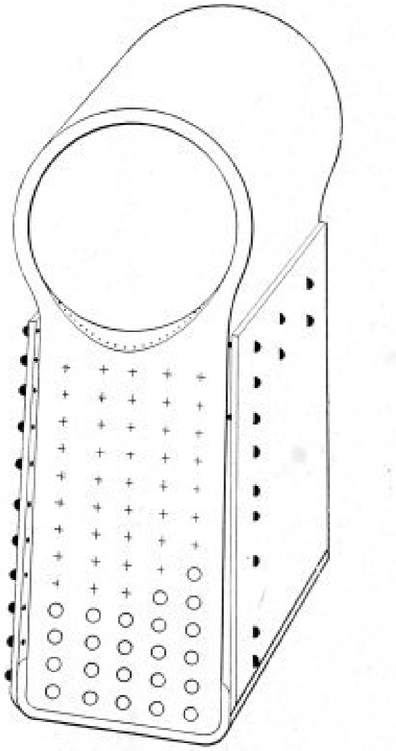


Fig. 3.—Wrapper Not Bolted Correctly; Work Had to be Riveted Again

smoke does he dislike to be disturbed. All he thinks about is to have his assistants "shoot" boilers out of the door before the inspectors have a look at them."

After all the painting, the plan did not work out successfully, so the boiler was rejected and later made good.

During the following day the boiler inspector makes a further report on boiler head (Fig. 2) and finds that the cover lap is not laid up in place, but stands off ⅜-inch at the knuckle of the flange. He also finds that the boiler maker is getting ready to drive the two corner rivets and tries to stop him, but is reassured by the remark:

"That's all right. What do you want? We build boilers and not watches. The calker will make a good job out of that!"

Boiler Inspector: "Oh, yes; the calkers are up to your instructions and always well supplied with iron wedges to drive in corners where the plates are not up.

"Will you kindly tell me why you allow them to use ¼-inch and 5/16-inch square calking tools to calk up these boilers, when a ⅜-inch and 7/16-inch round-nose fuller should be used? In calking the rivets I also notice that they are calking the sheet with a tool that looks more like a gouge than a rivet tool. Not only this, but there is a fence left around the rivet when it is calked with these special tools."

Riveting a Center Combustion Chamber

Boiler Inspector: "I am sorry to have to disturb you from your work in the office, Mr. Foreman, but I would like to have you come out on the floor and see for yourself just how the boiler makers have riveted a center combustion chamber (Fig. 3). They sure never struck a blow in laying up that sheet. Your assistant told them to go ahead and drive away."

The foreman admits that the job doesn't look very well, but says he will get the torch on the job and heat the flange and lay it up to the wrapper sheet. The boiler inspector then suggests that such a job would hardly be called boiler making, as all the rivets would be loosened while the flange was heating. Upon a response from the foreman that "We will harden them afterwards," the boiler inspector says:

"By the way, will you please explain to me just what this rivet hardening is that I hear so much about around here? When I served my apprenticeship in boiler making, there was no such word as hardening up. If I drove rivets in a firebox, or any place on a boiler where the plates were

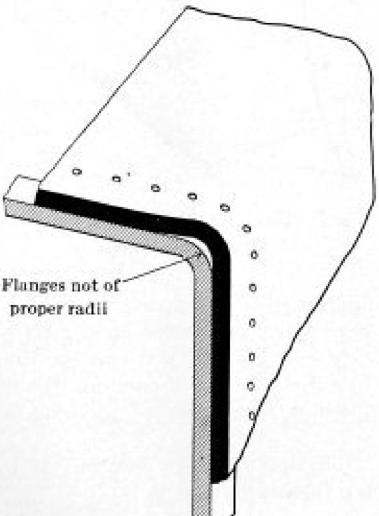


Fig. 4.—Result of Not Heating Back Head and Flue Sheet When Being Fitted

not tight, I had to cut the rivet out and properly bolt up the plate, iron-to-iron, and I would suggest the same remedy for this job (Figs. 3 and 4)."

Inspecting the Hydraulic Flanging Machines

The boiler inspector then pays a visit to the hydraulic flanging machines and admits that the firm has the very best up-to-date equipment for flanging properly and in a workmanlike manner. He says, however:

"I don't know what to make of the flanging done on some of the tube heads (Fig. 5). The men are up there now flanging a tube head, and I'll swear when they pulled the head from the fire it was only cherry red. You know that in flanging those heads, especially around the corners, the metal has to be properly heated in order to allow for the upsetting of the metal when the flange is turned. Not only this, but they are not flanging them to the flange line, the flanges are very sharp, and this will never do."

Assistant Foreman: "Oh! that is all right. That's *my*

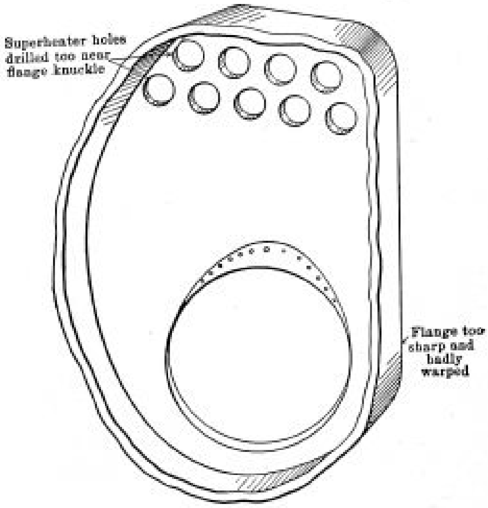


Fig. 5.—Improper Flanging of Heads

business. We don't need any boiler inspector to show us how to build boilers. When that head goes through the annealing furnace, we will set it out so that you will never notice the difference."

Inspection of the Flange Work

Boiler Inspector: "Mr. Assistant Foreman, you have not lived up to your promise to go around the flange fires and see some of your fancy corrugated flanging. This head went through the annealing furnace and nothing was done to it. The head is 1⅜ inches under size. The drillers are now drilling the tube holes, and they come right close to the knuckle of the flange. You know the drawing calls for 1⅝-inch radius on the flanging. When the head is flanged to the right size, the tube holes will be 1¼ inches away from the flange."

Assistant Foreman: "We don't bother about trammeling those heads to the right size. That would take up a lot of the flange turner's time."

Boiler Inspector: "I know this style of flange doesn't bother you in making up the boxes, because you do not put all the holes in your wrapper sheets, only tack holes; you also drill the laps right through wherever they meet, and you know this accounts for some of the trouble in the staybolt holes at the butt straps of your boilers not being properly in line (Figs. 6 and 7).

"I see that I will have to call again on the 'boss' in the office and tell him just how careless you are in calking the boiler (Fig. 6) on the test block and what little attention you are giving the staybolts."

A Visit to the Office

Boiler Inspector: "Mr. Foreman, you know the boiler laws were made to live up to. I am sorry, but I must inform you that the law, as well as our specifications, requires that all staybolts be drilled with holes 3/16 inch in diameter, extending to a depth of ½-inch beyond the sheets. Now this is not being done. They are being drilled at all depths, but very few to the proper depth (Fig. 7). I find also that in driving the bolts you are not opening them after they are driven."

Foreman: "We take a center punch and open up those holes to suit ourselves, just enough to permit entering a small gage wire. This suits the steamboat inspector. Why do you always find something out there on those staybolts that doesn't amount to a d——n? What good are those telltale holes you are always complaining about? Staybolts very seldom break on marine boilers!"

Boiler Inspector: Oh, no, Mr. Foreman. I don't agree with you. I have found many a broken rigid staybolt on marine boilers, as well as on locomotive boilers, and I want to tell you that you are not allowed any special privileges in drilling telltale holes on the staybolts and properly opening them up to 3/16-inch gage. When doing this, you must comply with the specifications."

Foreman: "Now you know I have put men out there trying to open them up and they break up a lot of drills doing it. I want to keep the boilers going out that door, and, if you don't stop tantalizing me about loose and badly-threaded staybolts, and the opening of telltale holes, I'll have you removed from your job!"

Boiler Inspector: "Just look, Mr. Assistant Foreman, at what your man over there is doing to that boiler (Fig. 7). He is driving iron wedges. Along the side of the staybolts are the butt straps, where I reported to you some time ago those bad holes and which you promised to tap

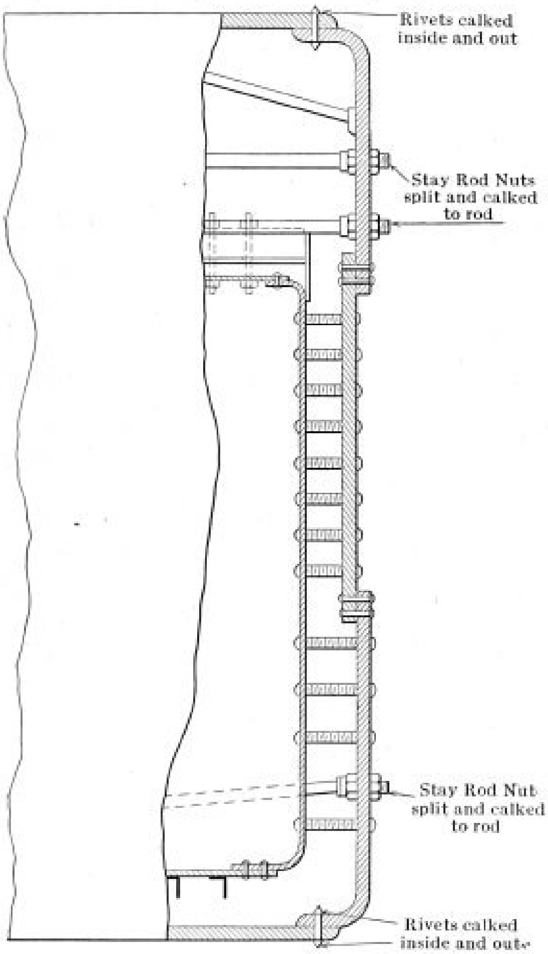


Fig. 6.—Side View of Boiler, Showing Defective Staybolt Nuts and Rivets

larger and put in bigger bolts. Now those bolts must come out!"

Assistant Foreman: Oh, no; those bolts will not come out. The other fellow will never see them after they are driven."

Boiler Inspector: "Look at that boiler which your men are supposed to be testing (Fig. 6). Your gage shows 340 pounds. The tubes are very poorly rolled. Looks like a sprinkling wagon! You know the stay rods are to be made tight on the boiler head, either by calking the sheet to them or by forcing packing under the nuts. The practice of split calking the nut to the stay rod must be cut out. That nut is there only to take care of the tension in the rod."

Assistant Foreman: "There is nothing wrong with that practice of calking. We have done it in a good many shops and were never criticised by the inspectors."

Boiler Inspector: "Well, it is about time somebody should correct you."

Threading Staybolts

Boiler Inspector: "You say you have a good fit in threading your staybolts, Mr. Foreman? You have a gang over there now driving bolts on that boiler. They are driving

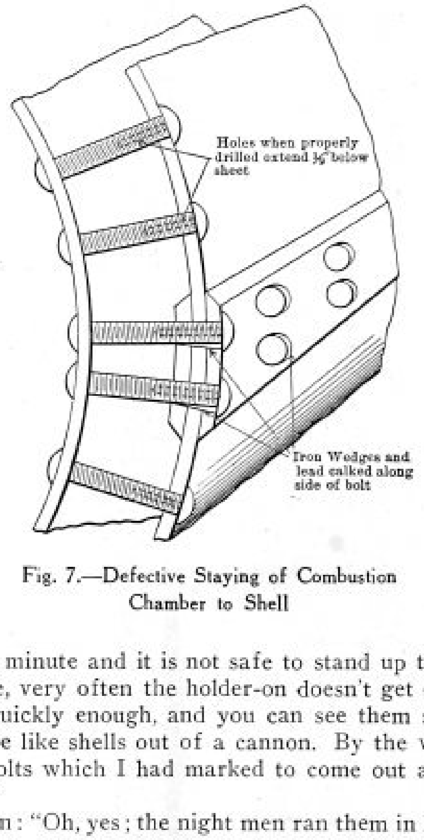


Fig. 7.—Defective Staying of Combustion Chamber to Shell

seven per minute and it is not safe to stand up there. As you notice, very often the holder-on doesn't get on to the staybolt quickly enough, and you can see them shoot out of the hole like shells out of a cannon. By the way, they are the bolts which I had marked to come out and go to the heap."

Foreman: "Oh, yes; the night men ran them in last night and I will jack them up about it."

Revised Boiler Shop Regulations

1. The Assistant Foreman shall run the shop to suit himself.

2. No high priced boiler makers are to be hired, for that increases the cost of production.

3. No boiler inspectors are permitted to notice bad workmanship, or check up any work pertaining to the construction of the boilers, at the time of testing.

The foreman shall call the inspector and advise him of the test which he desires made on the boiler. Upon any violation of this rule the foreman will use every effort immediately to have the inspector removed from duty.

It is hoped that the foregoing will prove of interest to all practical boiler inspectors who take pride in their work. INSPECTOR.

Practical Demonstration of the Stresses in Riveted Joints

Concerning Mr. A. L. Haas' article in the July issue of The Boiler Maker, wherein he discovered an error in the fifth installment (March, 1919, issue) of "How to Design and Lay Out a Boiler," I wish to thank Mr. Haas for bringing this matter to not only mine but also to the readers' attention. I am sure the error is inexcusable, involving, as it does, an important fundamental principle. I should at least have said that the stress in the diagonals is always *greater* than one-half the vertical load on the beam. However, as Mr. Haas stated, the work which directly followed bore out the correct theory, and there was no opening left for this error to cause trouble in the design. For the benefit of our younger readers, who might have been led astray, or at least will be, unless this principle is correctly presented, I have revised that part of the chapter accordingly.

In conclusion, I wish to state that Mr. Haas' presentation of the force-triangle as applied to lifting tackle is splendid. I again thank him for his kind co-operation and hope to hear from him often through the columns of this magazine.

Type of Joint Failure

The second method of joint failure which must be provided against in the design, but for which, through lack of positively accurate analysis, no definite formula can be derived, is depicted in Fig. 14.

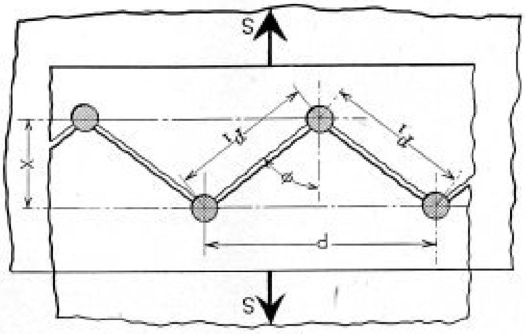


Fig. 14

This illustration of a double-riveted lap joint is used solely for convenience. The condition exists wherever there is staggered riveting. When stress is applied to the joint in the direction of the arrows *S-S*, a diagonal stress of probably a pure shearing nature occurs between the rivets. This stress tends to rupture the plate along lines p_1, as is clearly indicated by the broken sections of plate between the rivets. The combined diagonal stress is always greater than the true tensile stress horizontally between the rivets, as at *P*.

By setting up practical conditions, this fact may be proved experimentally, as in Fig. 15.

Let two ordinary spring balances be suspended between strings from two points some distance apart, and to the lower ends of the strings attach a known weight, *W*. The weight should not, however, be such that it will stretch the springs beyond their capacity.

Suspend the model (Fig. 15) flat against a drawing board or on the wall of a room. On paper conveniently placed project a line vertically upward from the point of intersection of the strings, equal to the weight *W*, drawn to some convenient scale, as one inch to the pound. This line will, of course, represent the magnitude of the vertical load *W*. From the upper extremity of this line erect perpendiculars to the diagonals, as indicated by lines *C* in the illustration. We shall have represented what in applied mechanics is termed the *parallelogram of forces*, and the length of the lines *B* will represent to the same scale as line *A*, the magnitude of the stress in the diagonals, and should equal the reading on the scales. For example, assume the weight *W* to be 15 pounds and the length of the

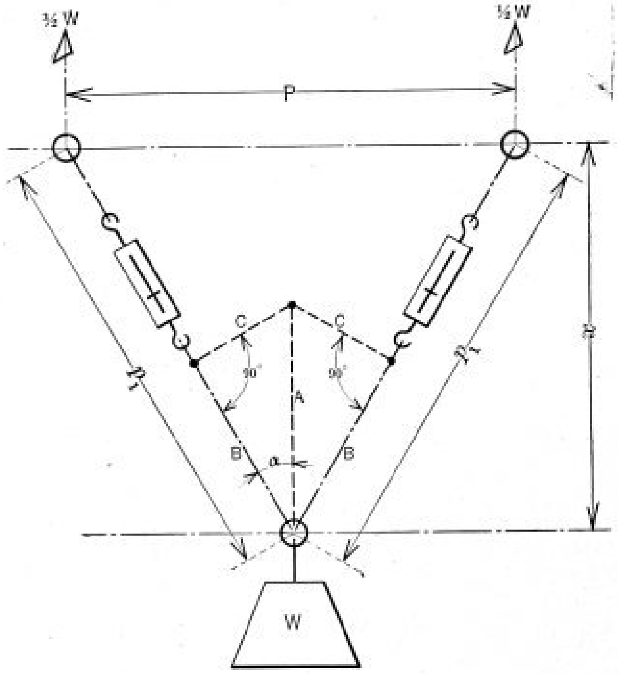


Fig. 15

vertical line *A* 15 inches. Then after completing the force diagram, if the length of each diagonal measured 10 inches, the stress would be 10 pounds, for it will be remembered that we are working with a scale of one inch to the pound. Any other convenient scale would serve the purpose, and in some cases a rather small one would be necessary, for it might not otherwise be possible to include great weights on an ordinary drawing board or wall.

William C. Strott.

The Page Steel & Wire Company has opened a branch office in Chicago, at 29 South LaSalle street. This office will handle all *Armco Iron* products, including welding rods, twisted pairs, plain and galvanized strand, bond wires, iron fence and barbed wire and other brands of fence manufactured by the Page Steel & Wire Company.

This company has another branch office in the Book Building, Detroit. Distribution in Canada is in the hands of Taylor & Arnold, Ltd., Montreal, Toronto, Winnipeg.

Raymond D. Lovekin, formerly managing director of the American Screw Propeller Company, has disposed of his interest in that concern and will specialize in engineering advertising. He will occupy offices 610, 611 and 612 Penfield Building, Philadelphia, Pa.

Because of his past engineering experience, the advertising and popularizing of mechanical devices will be handled in a particularly efficient manner. In addition to regular advertising, he is in position to act as advertising manager for several large engineering enterprises.

If continuous telltale holes in staybolts admit too much air to the fires, an easy remedy is to force steel balls to the center of the holes, and the trouble will immediately disappear.

Selected Boiler Patents

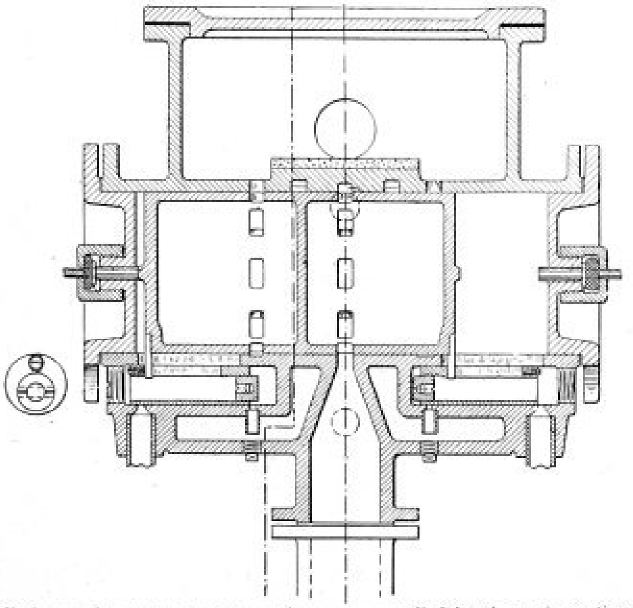
Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,302,329. WATER FEED APPARATUS FOR STEAM BOILERS OR THE LIKE. LEONID DOUNAEW, OF NEW YORK, N. Y.

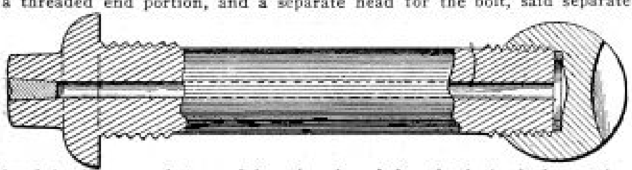
Claim 1.—In a water feeding device for steam boilers or the like, the combination of a hollow reciprocating member, having two separate compartments suitably disposed to alternately receive feed water and discharge it into the boiler by such reciprocation, means for supplying steam from the boiler alternately to each of said compartments as it



discharges its water contents, and means controlled by the reciprocation of said member for directing the steam supplied to said compartments alternately behind the ends of said member to cause its reciprocation. Seven claims.

1,298,305. STAYBOLT FOR BOILERS. ETHAN I. DODDS AND CHARLES HYLAND, OF PITTSBURGH, PENNSYLVANIA, ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

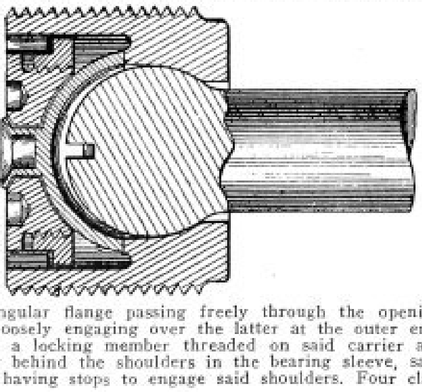
Claim 2.—A flexible staybolt comprising a body portion having a tell-tale bore extending throughout the length thereof, said body having a threaded end portion, and a separate head for the bolt, said separate



head having a socket receiving the threaded end of the body portion and closing one end of the tell-tale bore in the latter. Two claims.

1,293,366. STAYBOLT STRUCTURE. ETHAN I. DODDS, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

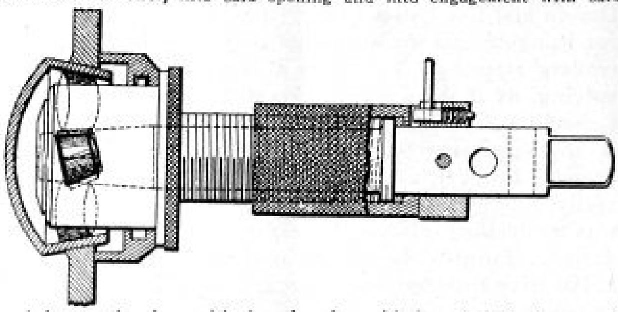
Claim 4.—In a staybolt structure, the combination with a bearing sleeve having internal shoulders at its free end portion, of an externally threaded cap carrier having an opening therein, a cap or closure



having an angular flange passing freely through the opening in the carrier and loosely engaging over the latter at the outer end of said opening, and a locking member threaded on said carrier and having lugs to enter behind the shoulders in the bearing sleeve, said locking member also having stops to engage said shoulders. Four claims.

1,302,175. METHOD OF SECURING HOLLOW TAPERING BOILER PLUGS. FREDERICK E. KEY, OF ST. LOUIS, MISSOURI, ASSIGNOR TO KEY BOILER EQUIPMENT CO., OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

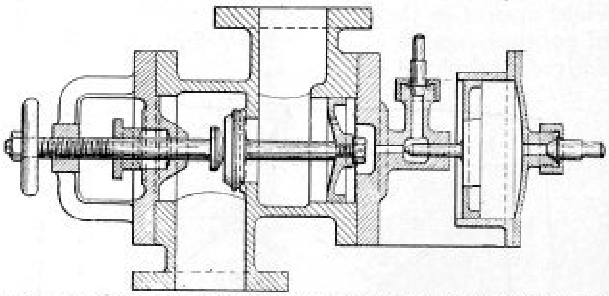
Claim 1.—The method of securing hollow tapering boiler plugs which comprises beveling a circular plug-receiving opening to make it conform approximately to the taper of the plug, thereby forming a beveled annular seat for the plug, inserting the hollow tapered plug, from the inside of the boiler, into said opening and into engagement with said



beveled seat, thereby positioning the plug with its relatively large end inside of the boiler where it will be exposed to the boiler pressure, then exerting outward pressure within the plug by rolling an annular portion of the inner face of the plug directly opposite said beveled annular seat, and at the same time advancing the tapering plug in the correspondingly formed opening, so as to tighten the tapering plug on its beveled seat. Four claims.

1,297,288. SAFETY DEVICE FOR OIL-FIRED BOILERS. HAROLD E. YARROW, OF GLASGOW, SCOTLAND.

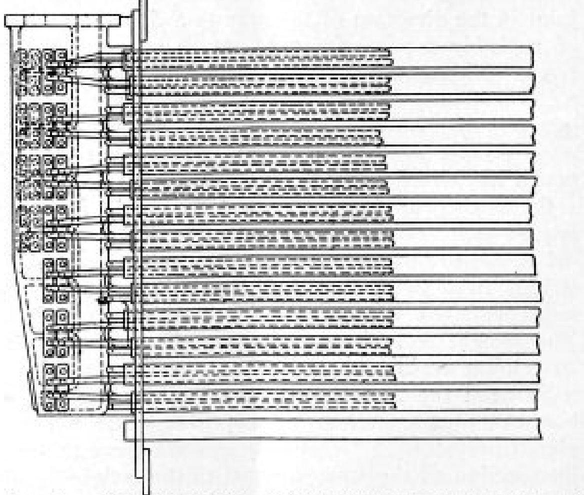
Claim 1.—An automatically operating device for preventing the passage of flame from the furnaces on an oil fuel boiler to the stokehold, comprising an oil fuel valve, a seat therefor, a stem carrying the valve, a cylinder, a piston movable in said cylinder and secured to said valve stem, means for the admission of oil fuel to the cylinder, means for



the passage of the fuel from said cylinder to the furnaces when the oil fuel valve is open, a chamber connected with the cylinder at the end farther from the oil fuel valve, said piston having an opening communicating with said chamber, a passage from said chamber, a controlling valve adapted to close the passage, second stem connected to said controlling valve, and a member connected with said last named stem for operating said controlling valve, said chamber being exposed on one side to the pressure of the air in the stokehold and on the other side to the normal atmospheric pressure. Three claims.

1,301,606. STEAM SUPERHEATER. JOHN GEORGE ROBINSON, OF MANCHESTER, ENGLAND, ASSIGNOR TO SUPERHEATER CORPORATION, LIMITED, OF LONDON, ENGLAND.

Claim 1.—In a superheater, a header provided with holes for steam in its side wall, superheated elements having their end portions arranged at an angle to their main portions, screwthreaded studs which project



from the side wall of the header, fastening blocks secured to the end portion of the superheater elements and provided with holes for engaging with said studs, said blocks having also slots or channels formed crosswise in them at the ends of their stud holes and slidable literally over the studs, and nuts on the studs for securing the blocks to the header. Two claims.

THE BOILER MAKER

SEPTEMBER, 1919

Boilers of the Simple Mallet Locomotive

Typical Belpaire Construction Designed With Abnormally Large Firebox and Combustion Chamber Spaces

A new locomotive has recently been completed in the Pennsylvania Railroad Company's shops. It is of the 2-8-8-0 simple Mallet type and designated as class H C Is. The design was carried out in the office of James T. Wallis, general superintendent of motive power at Altoona, Pa., and was practically finished at the time the United States Railroad Administration assumed control of the railroads. One of the locomotives was authorized by the Administration and the order for it placed in the Juniata Shops of the Pennsylvania Railroad. On account of the difficulty universally experienced during the war in obtaining labor and material, the work progressed very slowly, the locomotive not being completed until May of this year.

In general, the special features of the design are the application of the half-stroke principle to the heavy Mallet locomotive, which gives it a tractive force of 135,000 pounds, an abnormally large firebox and combustion chamber space, a type E superheater, a new design of power reverse gear, a float system of water level indication and a multiple stack and exhaust nozzle arrangement.

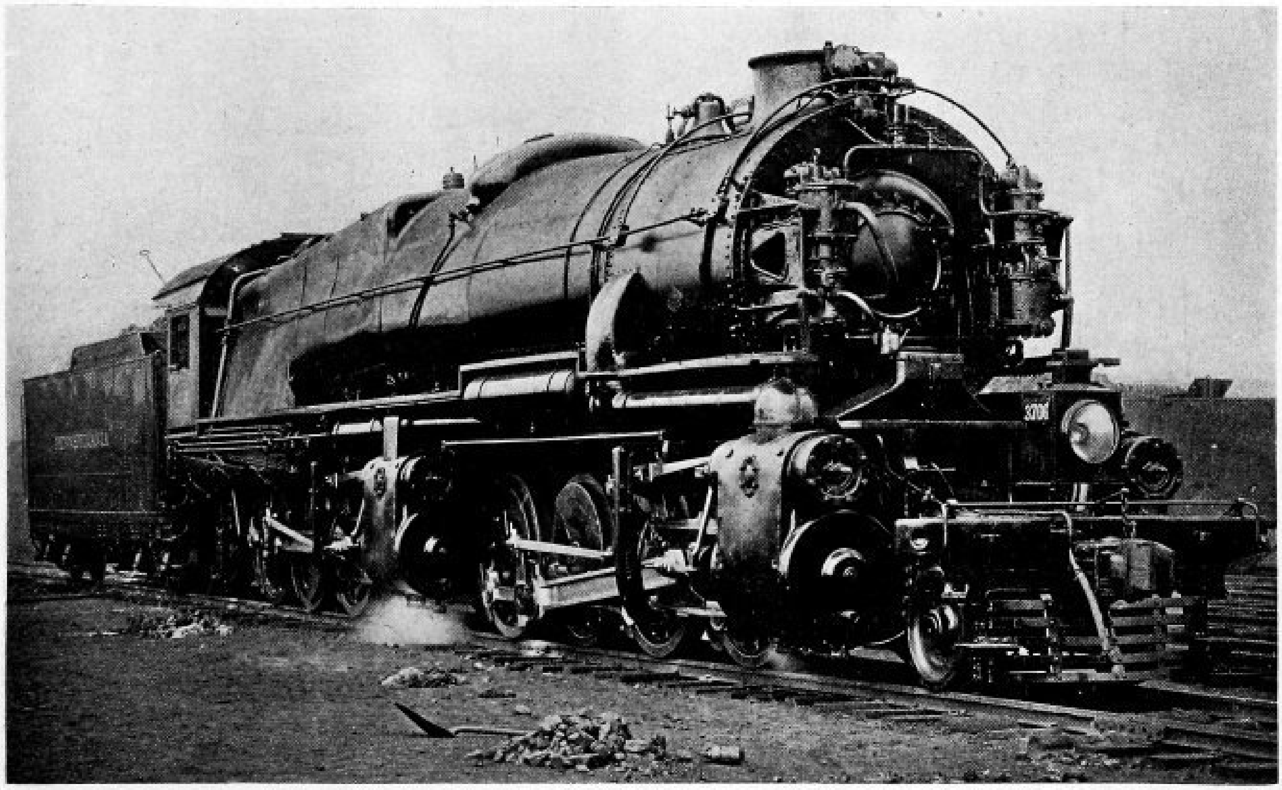


Fig. 1.—Heavy Freight Locomotive of the Mallet Type, Built by the Pennsylvania Railroad

The boiler for this locomotive is of the Belpaire type. The outside diameter of the first barrel sheet immediately back of the smoke box is 8 feet. This part of the barrel is conical, and where it joins the second barrel sheet its outside diameter has increased to 8 feet 11⅜ inches. The second barrel section is cylindrical, 9 feet 2 inches outside diameter, and back of its middle carries a pressed dome 10¼ inches high. Immediately in the rear of this second barrel section the Belpaire construction begins, the "corners" of the Belpaire top being pressed into the upper portion of the second barrel sheet. The rear tube sheet is located about 2 feet 9 inches to the rear of the center of the steam dome and is at the front end of a combustion chamber about 12 feet long, which is a continuation of the firebox proper and is separated from the latter by a steel fire-wall, which contracts the fire area to about 18 square feet, and also serves as an expansion joint. In the rear

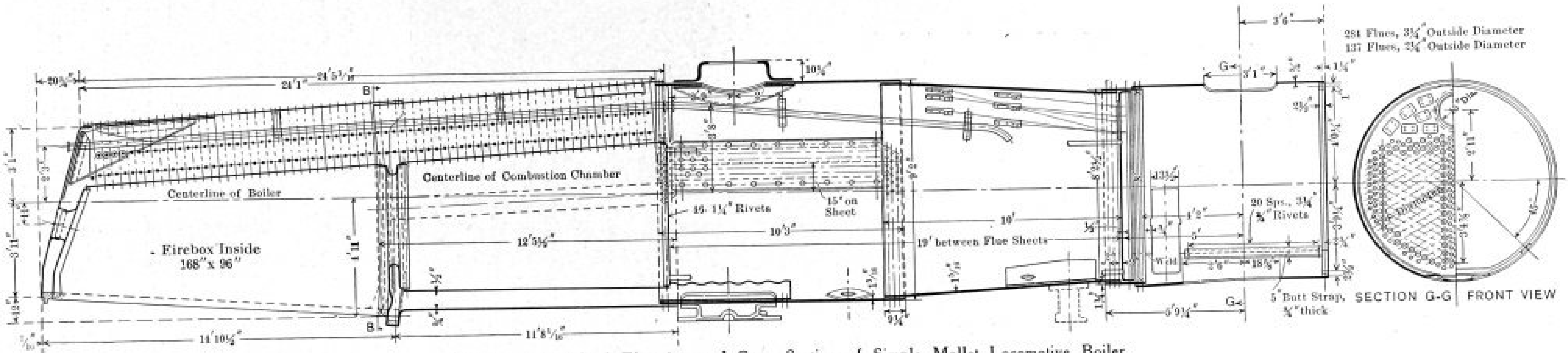


Fig. 2.—Longitudinal Elevation and Cross Section of Simple Mallet Locomotive Boiler

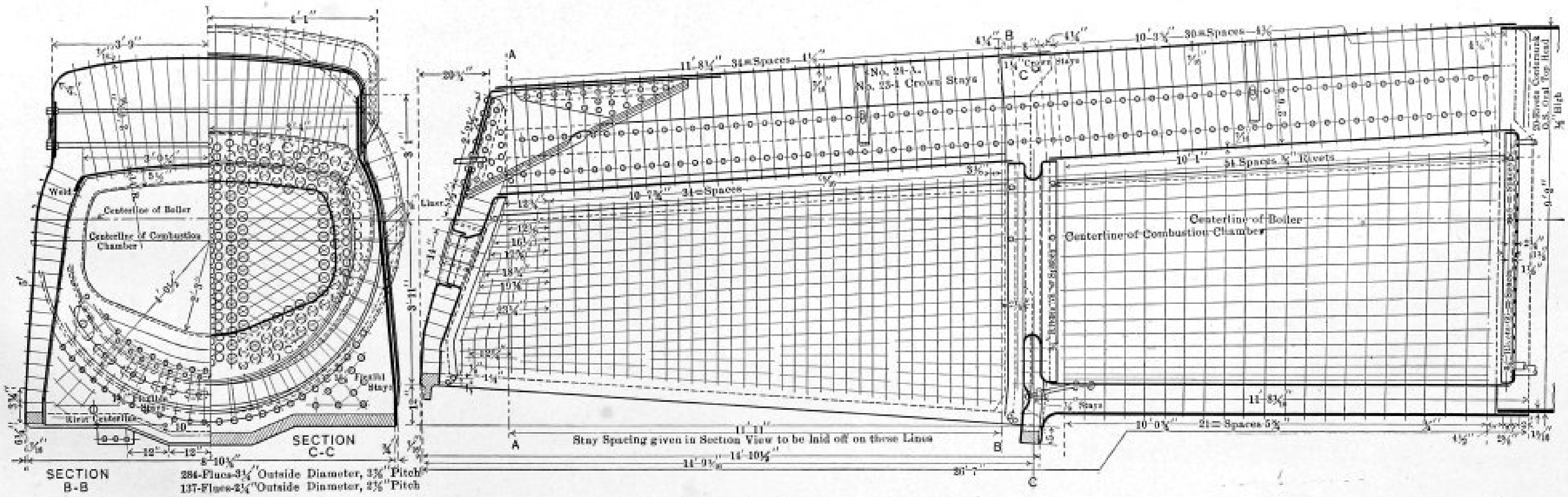


Fig. 3.—Details of Firebox and Combustion Chamber

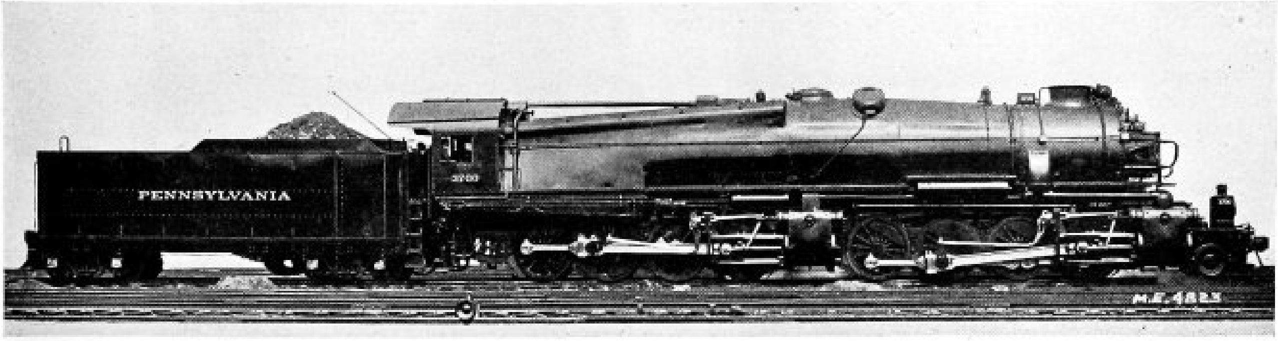


Fig. 4.—Side View of Locomotive and Tender

of this fire-wall is the firebox, 168 inches long and 96 inches wide, providing 112 square feet of grate area. There are four drop grates operated from the sides of the engine.

The grates are of the usual Pennsylvania Railroad finger type and are operated from a shaft attached to the rear part of the foundation ring. They are divided, for shaking, into four sections and are operated by a Franklin steam grate shaker, but may also be operated by hand should this device fail. The ash pan follows the standard Pennsylvania Railroad lines and is equipped with standard doors, etc. It has been carefully worked out and is believed to be the best that circumstances and room will admit of. The firebox and combustion chamber are of 7/16-inch sheets, except the tube and fire-wall sheets, which are ½-inch material. All longitudinal firebox seams are welded, as are also the fire hole seams.

The mantle sheets, which throughout the length of the combustion chamber gradually merge from a cylinder with a Belpaire top to a sloping-sided firebox with a continuation of this top, are 7/16-inch sheets. The throat sheet is pressed into the bottom mantle sheet of the combustion chamber. The barrel sheets are 1 5/16 inches thick; all longitudinal seams have 1½-inch rivets in 1 9/16-inch holes, and circumferential seams have 1¼-inch rivets in 1 5/16-inch holes.

Superheater and Safety Devices

The tubes are 19 feet long and consist of 137 2¼-inch tubes and 284 3¼-inch tubes for the superheater units, the boiler being equipped with a type "E" Schmidt superheater.

The boiler is designed for 225 pounds working pressure, but carries only 205 pounds pressure at present. It is protected by three standard 5-inch Coale muffled safety valves mounted on the roof sheet over the front of the combustion chamber.

The water level is observed by four devices: The usual water glass of the Klinger type mounted on the back boiler head; a "Sentinel" low-water alarm, so arranged

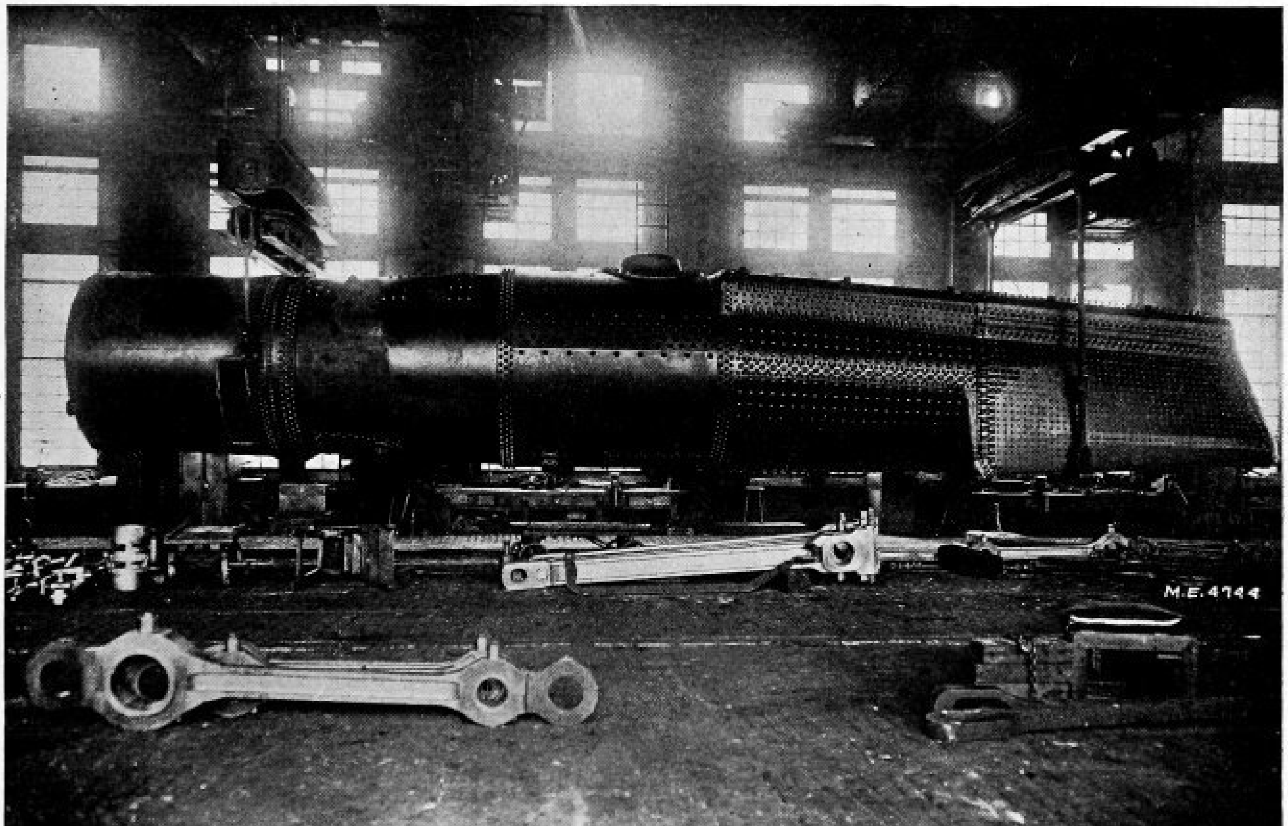


Fig. 5.—Boiler, Firebox and Combustion Chamber Assembled Ready for Installation

that when the water falls below a predetermined level, steam is admitted into a copper pipe, which, by its expansion, operates a steam whistle located on the backhead; a float indicator, consisting of a counterbalanced float mounted on a lever attached to a shaft, a second arm of which is attached to a rod which actuates an indicator moving in a casting mounted horizontally on the backhead of the boiler. The observations are made through glasses of the same type as are used on the Klinger device. Provision is made for removing the glasses while the boiler is under steam.

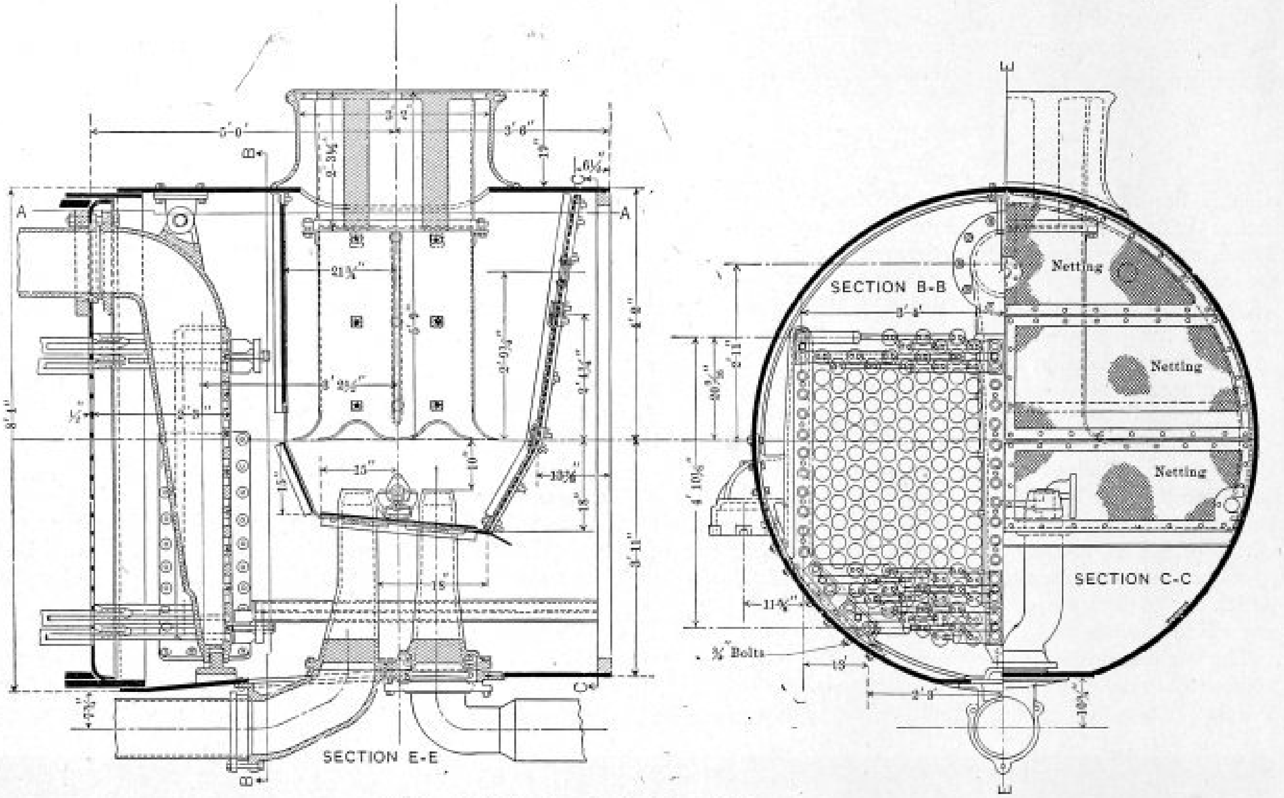


Fig. 6.—Self-Clearing Smoke Box of Special Design

Gage and Piping Arrangements

Just back of the Coale safety valves, on the combustion chamber roof sheet, a casting is riveted to this sheet, which opens into the boiler, and on the inside of the roof sheet is a baffle arrangement to separate entrained water. A pipe leads from this casting to a bridge pipe mounted in front of the cab, and from this steam is taken for injectors and other devices requiring dry steam. The Pilliod safety whistle device is also mounted on this front casting at an opening especially provided for it. In the rear of the bridge pipe just mentioned, by means of suitable castings, three gage cocks are mounted. From these cocks three ⅜-inch copper pipes are led through the bridge pipe, the bridge supply pipe and into the boiler and are led over the highest point of the crown sheet, where they are very securely clamped. The pipes are cut off 4 inches, 7½ inches and 11 inches above this point of the crown sheet.

It will be seen from this short description that, on account of their location, all the water level devices, except the Klinger water glass, will give the water level over the highest point of the crown sheet regardless of the position of the engine with respect to a grade.

When standing, the fire may be stimulated by a blower and a smoke lifter. The valves for operating these devices are mounted on the left side of the smoke box about its center. The valves are of a rotary type and held closed by small helical springs. On each valve shaft is mounted a section of a grooved pulley. Light wire cable is led over these pulleys and fastened at the front side. The cables are then led back through the hand rail to the cab, where each is attached to an operating handle that moves along a notched guide so that the valves may be opened to any extent desired and held in this position as long as necessary.

The engine is equipped with a Duplex stoker, but may be fired by hand in case of trouble with the stoker.

Water is supplied to the boiler by a Sellers No. 16.7 non-lifting injector on the right side and a Nathan Simplex No. 17 non-lifting injector on the left side. The feed water enters through the backhead check valves and from there is piped to about the middle of the first barrel section of the boiler. Steam is furnished to the injectors from the bridge pipe in front of the cab, and in addition to the shut-off globe valves at the bridge pipe there are two lever-operated throttle valves conveniently placed. Steam is also taken from the bridge pipe for lubricator, stoker engine and jets, and shaker engine.

Bridge Pipe

There is a second bridge pipe located at the extreme front of the boiler. It is supplied with steam by a 3-inch dry pipe which reaches well up into the steam dome and is carried through the barrel of the boiler to a bridge pipe located inside of the front barrel section of the boiler at its top, and just back of the front tube sheet. A shut-off valve for this bridge pipe passes through the top of the boiler shell at this point so that steam can be stopped when repairs are needed. The front of this bridge pipe passes through the front tube sheet near its outer circumference at a point 2 feet ¼ inch to the left of the center of the boiler. Beyond this a 3-inch steam pipe continues

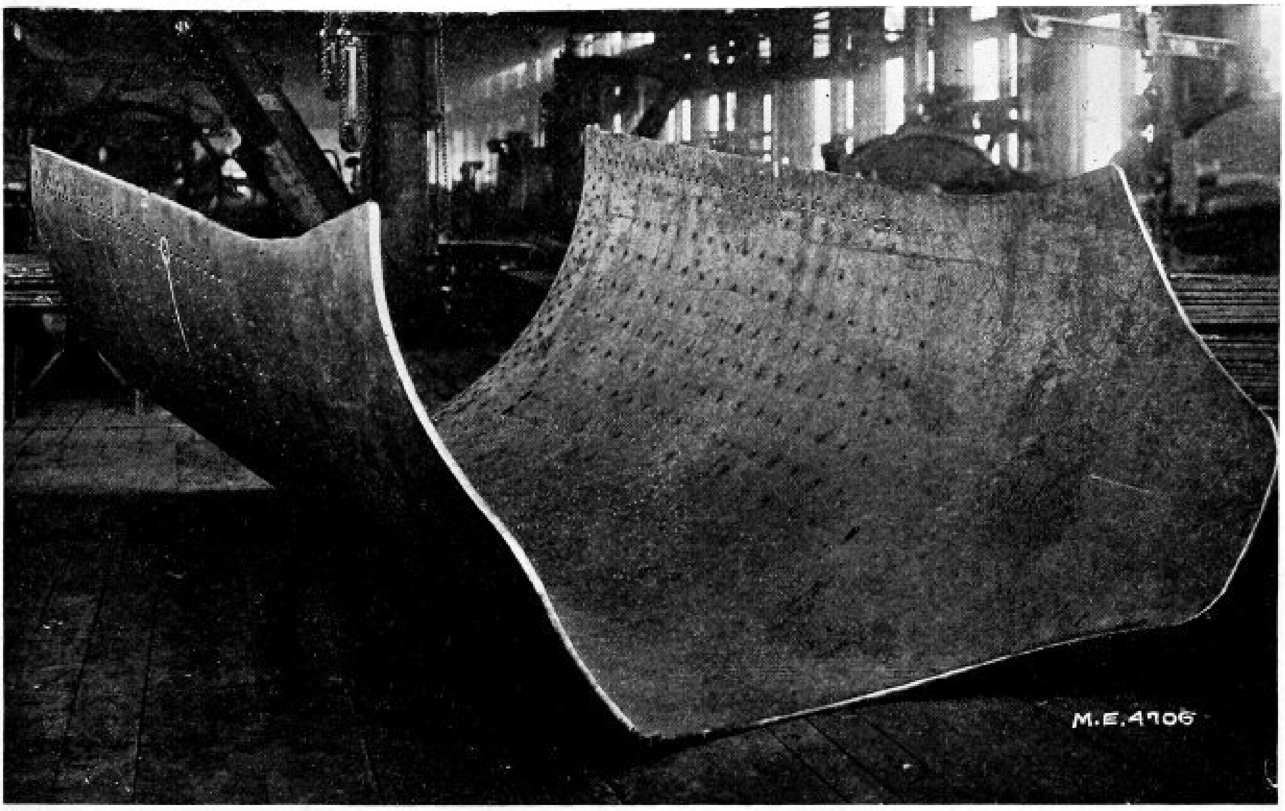


Fig. 7.—Section of Crown Sheet

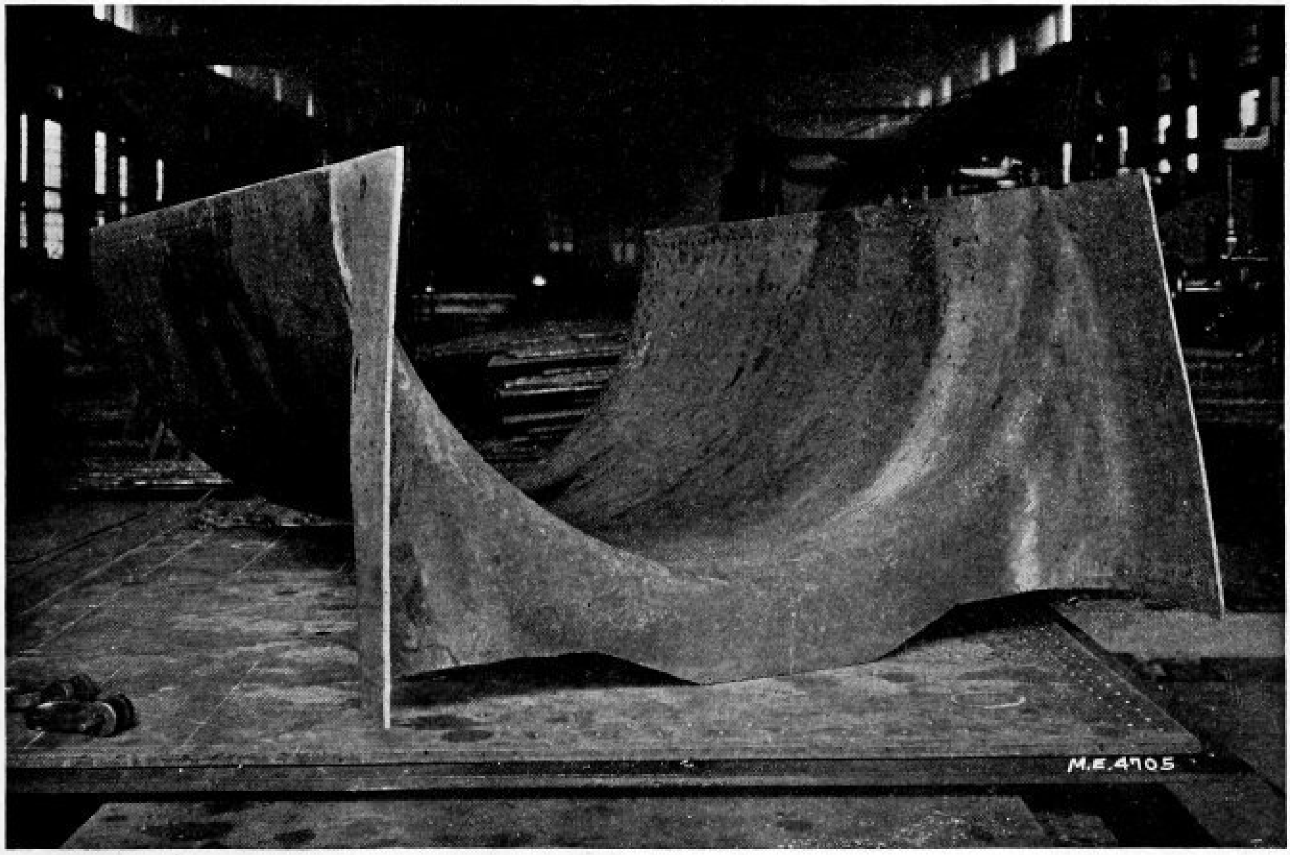


Fig. 8.—Throat Sheet

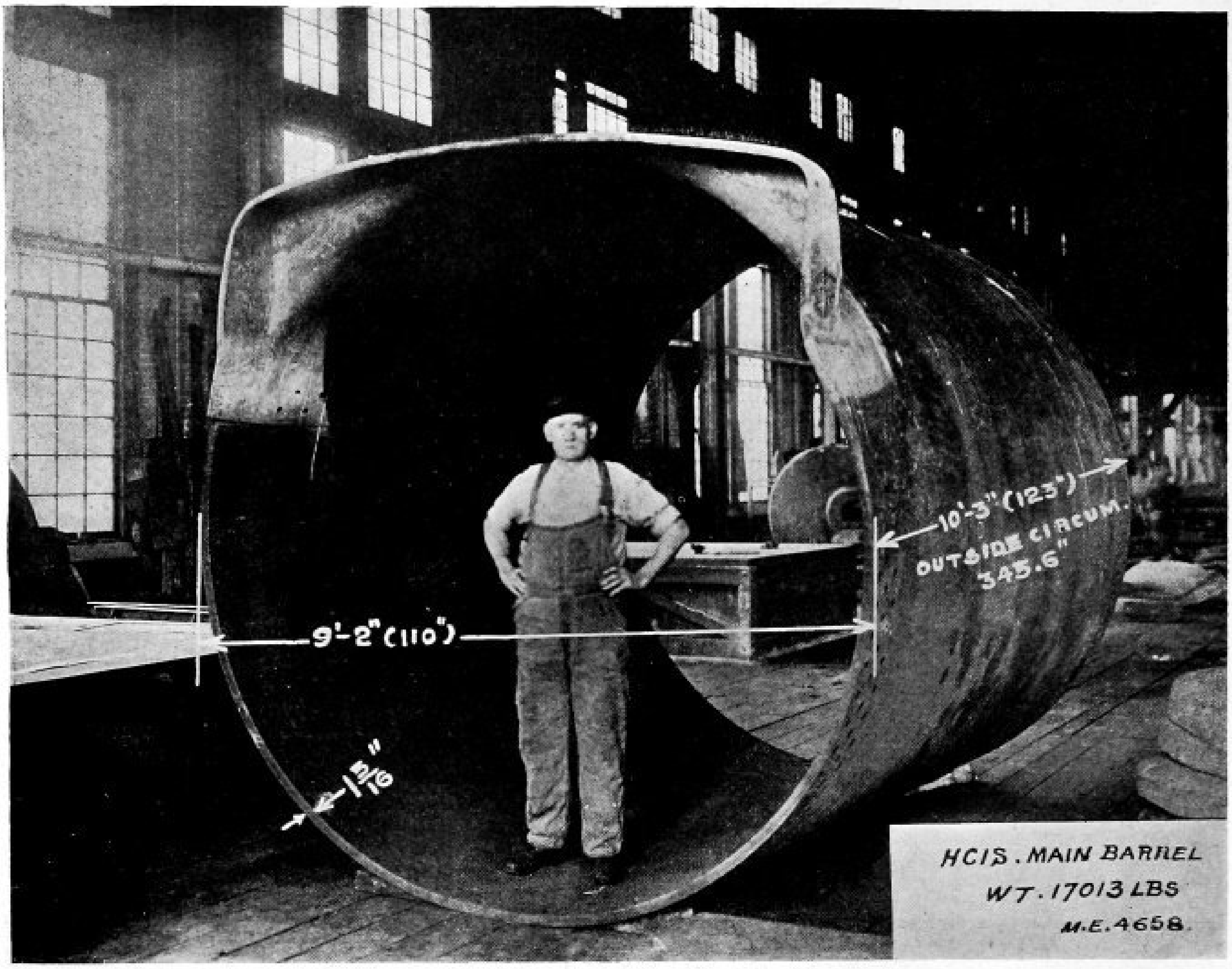


Fig. 9.—Relative Size of the Main Barrel of the Boiler

through the smoke box to a cast iron flanged "T," which has a 1¼-inch outlet to supply the blower valve and smoke lifter valve referred to above, and a 2-inch outlet which is piped to the center of the smoke box front 2 feet 9¼ inches above the horizontal centerline of the smoke box and finally terminates in a cast iron header outside of the smoke box front, to which the pipe is fastened by a flange connection and ball joint. This header has two ¾-inch outlets, both vertical, and a 1½-inch horizontal end outlet. The ¾-inch pipe from the outlet nearest the smoke box constitutes the steam supply for the turbo-generator for the headlight and other electric lights used. The other ¾-inch outlet is piped to a bull's-eye lubricator, the top steam connection for this lubricator being made just back of the smoke stack through the boiler shell; thus when steam is being taken from the 1½-inch outlet for two 8½-inch cross-compound air compressors mounted one on each side of the smoke box front on appropriate brackets, the lubrication of the steam cylinders of these pumps is cared for as just described. A common duplex pump governor and a throttle valve for each pump is provided in the 1¼-inch steam supply pipes. The exhaust from the pumps is carried by a 2½-inch pipe through the front end on each side to a special casting located near the engine exhaust nozzles, which provides properly directed nozzles for the pump exhaust. This same casting also provides properly directed blower nozzles connected with the blower operating valve. There are four air pump exhaust nozzles and four blower nozzles. Steam for the smoke lifter is piped to the top of the smoke stack, which is tapped for the pipe.

Cylinder and Saddle Construction

Each pair of cylinders and the cylinder saddle are of three-piece construction; the cylinder seat mentioned when describing the frame, passing between the cylinder and the saddle, the whole being securely bolted together. The construction of the rear cylinder saddle is different from the usual type, inasmuch as it is attached to the barrel of the boiler and must be steam-tight. The boiler pad is, therefore, cast separately and very securely bolted to the boiler, which is reinforced at this point. The pad is bolted to the saddle so that if necessary the saddle can be removed without taking the tubes out of the boiler. The attachment between the boiler and frames is the usual Pennsylvania Railroad type. A flexible diaphragm plate is installed between the rear of the foundation ring and a casting between the frames. Pads are attached to the front of the foundation ring that have a fore and aft movement in clamps secured to the frames. The pad of the cylinder saddle of the rear engine above referred to is attached to the second barrel sheet back of its center, and this constitutes the last rigid attachment between the boiler and the frames.

The steam supply for the cylinders is taken from the dome through a 12-inch diameter throttle valve and a dry pipe which delivers steam to the superheater center header.

from which it passes through 568 1⅛-inch tubes having 3,136 square feet of heating surface. From these, by means of cross headers, the steam passes to the side headers. Each side header has two openings; the lower of these openings is provided with elbows with flanged ball joints, which are connected by 6-inch seamless steel tubes to elbows bolted to the tops of the steam chests of the rear cylinders. The rear ends of these elbows are open and fitted with "snifting" valves. The steel tubes enter the front end of the elbows and are packed, thus providing a slip joint to care for any expansion or contraction.

Two sand boxes are used, one of large capacity just in front of the dome to supply the front of the drivers of the rear engine and one over the front cylinders to supply the front wheels of the front engine. All are operated with Leach pneumatic sand traps.

A pyrometer is applied to the right rear cylinder steam pipe to indicate the temperature of superheated steam used.

The tender is carried on two four-wheel trucks having "Crown" cast steel side frames. The wheels are of forged steel and mounted on axles having 6½ by 12-inch journals. The truck bolsters are of cast steel and are supported at each end by six class H-138 springs.

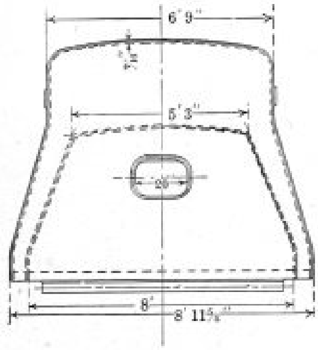


Fig. 10.—Section at Rear End of Firebox

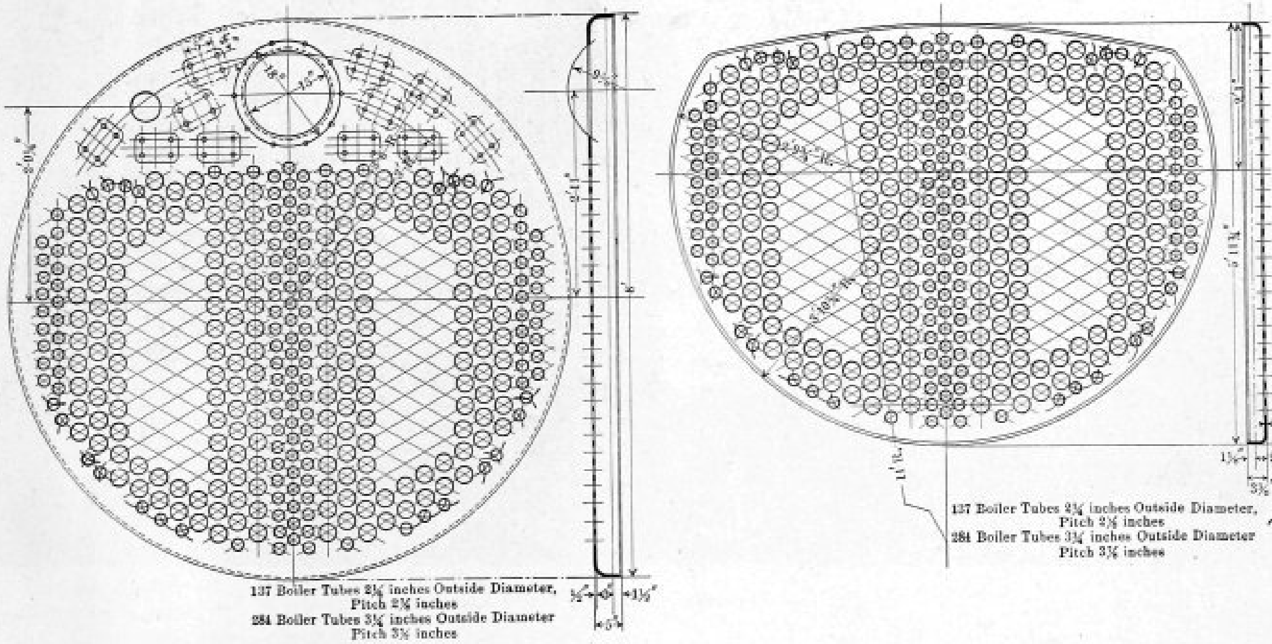


Fig. 11.—Front and Back Flue Sheets

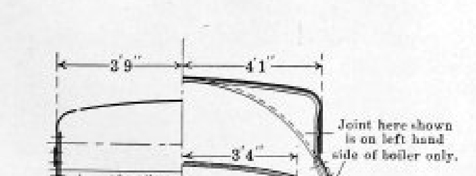


Fig. 12.—Sections of Firebox and Combustion Chamber

The body bolsters are made up of steel castings between the center sills and between the center and side sills, top and bottom cover plates being applied and the whole assembly securely riveted together. The body bolsters are spaced 25 feet center to center. Seven feet four inches back of the front body bolster is a cross member of similar construction to the body bolsters and used to support the scoop mechanism.

The center sill consists of two 10-inch H-beams, 54 pounds per foot, spaced 21 inches center to center, and runs continuously from end to end of the frame. Between the ends of these H-beams the front and rear draft castings are securely riveted. The side sills are 10-inch channels, 25 pounds per foot. These are secured to ends of the three bolster castings and to the end sills. A pair of pressed steel braces stiffen the side sills mid-way between the rear bolster and the scoop bolster. Diagonal braces are carried from the body bolster to the end sills. The front end construction consists of a very heavy draft casting securely riveted to the center sills. This casting combines a buffer and pockets for the two draw-bars. Between the center and side sills at the front end are two cast steel braces; attached to these at the corners are convenient steps extending upwards, so one can reach the

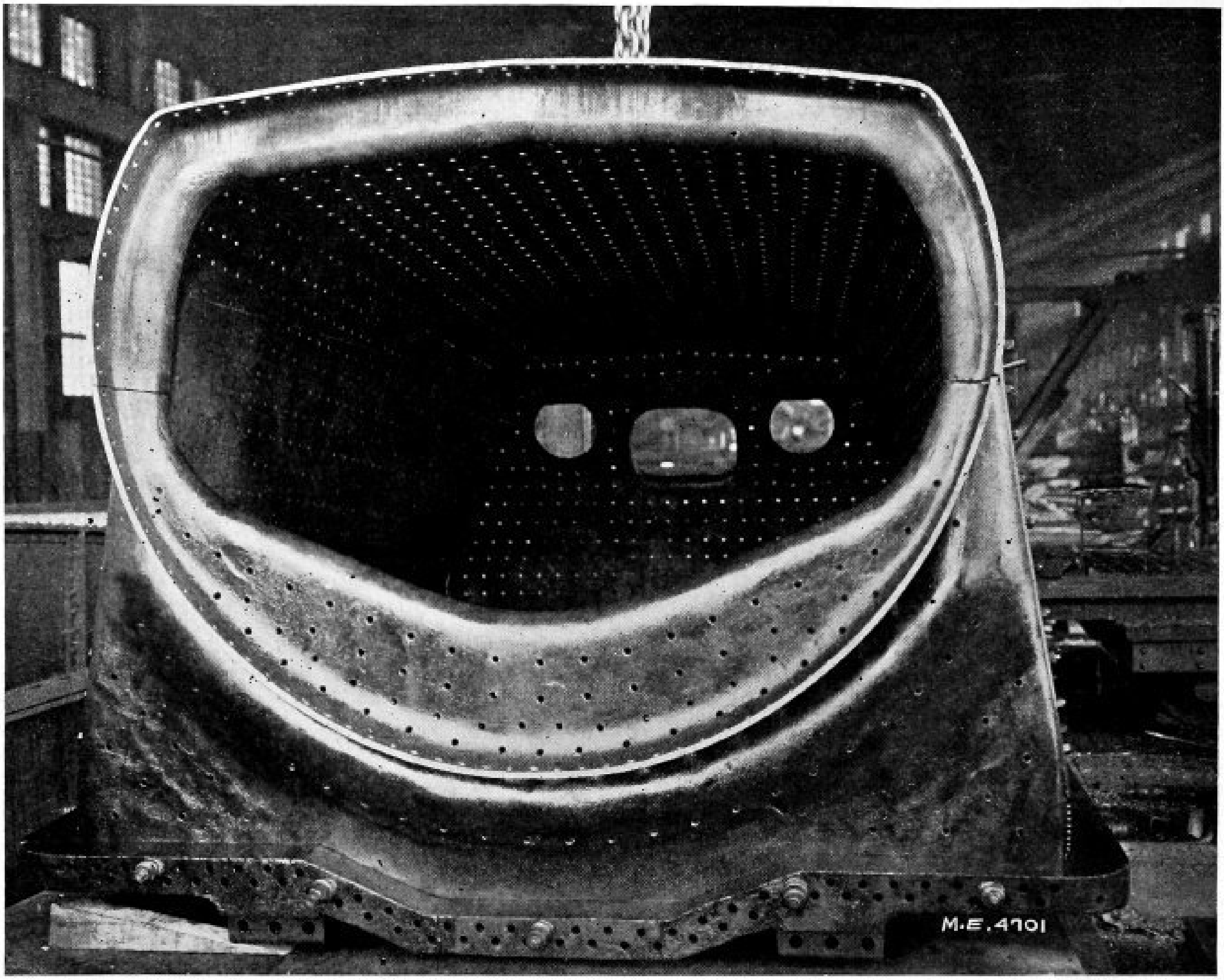


Fig. 13.—Firebox of the Simple Mallet Locomotive

level of the coal space floor. This construction is decked over with a steel plate which extends 18 inches to the rear of the front castings, where two angle irons extending from side to center sills are fastened to its top, which marks the beginning of a wooden floor, laid over the entire frame, and extends to a similar angle iron on the rear end construction.

The tank, the extreme dimensions of which are about 30 feet 9½ inches long, 10 feet wide and 7 feet high, rests on the wooden floor and is securely fastened. The rear of the tank is provided with a manhole for filling and with two overflow pipes to carry superfluous water to the ground.

Beginning about 18 feet 6 inches from the rear of the tank, a coal space 44 inches wide and 48 inches deep is formed, the rear side consisting of a sloping sheet reaching to the coal floor. This floor consists of removable plates, and under it the conveyor for the Duplex stoker is located. The front of the coal space is closed by heavy iron gates to confine the coal to the space intended. As the coal is used, the opening through the floor to the conveyor can gradually be moved towards the rear by taking advantage of the movable floor plates. Throughout the length of the coal space the sides of the tank extend 12 inches higher.

Just back of the slope sheet forming the back of the coal space is the filling pipe from the water scoop. Tank valves are located at the front of each water leg forming the sides of the coal space. The water scoop mechanism is operated by air, the operating valve being located at top water leg, on right side. In front of the water legs, tool and supply closets are located.

The following data describe the boilers and the tender in detail:

BOILER

Style	Belpaire
Working pressure (designed for 225 pounds)	205 pounds
Outside diameter of first ring	96 inches
Firebox	168 inches length, 96 inches width
Firebox plates, thickness	7/16-inch and ½-inch
Firebox, water space	5 inches
Tubes, number and outside diameter	137—2¼ inches
Flues, number and outside diameter	284—3¼ inches
Superheater tubes, number and outside diameter	568—1⅛ inches
Tubes and flues, length	226 inches
Heating surface of tubes and flues	6,125 square feet
Heating surface of firebox	531 square feet
Heating surface, total	6,656 square feet
Superheating surface	3,136 square feet
Equivalent heating surface = total heating surface + 1.5 superheating surface	11,360 square feet
Grate area	112 square feet

TENDER

Tank	Standard for Duplex stoker
Frame	Rolled and cast steel
Weight (empty)	83,790 pounds
Water capacity	12,900 gallons
Water, weight	107,457 pounds
Coal capacity	27,753 pounds
Total weight	219,000 pounds

Foreign Demand for American Boilers

Establishment of Liberal Foreign Credit Necessary to Open Up Great Field for American Boiler Products

BY L. W. ALWYN-SCHMIDT*

It was pointed out in a recent article that the foreign demand for American boilers noticeable towards the end of last year most likely would continue, and, in fact, might increase in the near future. This expectation has been confirmed, and the United States boiler industry is on the way to a very prosperous foreign trade.

This development is not surprising considering the generally very good quality of the American-made boiler and the great progress which has been made in this country in recent years in the application of steam as a power producer. In no country of the world has the problem of power conservation received more attention than in our own, and our engineers have without doubt been very successful in perfecting steam generators for all domestic and industrial purposes.

This rapid development in the design of the steam engine and the boiler has for a while retarded somewhat the foreign demand for American boilers. The American equipment would not always fit well with the more old-fashioned equipment used in other countries, and, being more expensive, the foreign buyer would be inclined to return to the known models of the European makers. This has been noticeable especially in the British colonial and the South American markets, where European engineering is dominating.

Foreign Representatives

Our boiler makers have been hampered in this respect also by the lack of sufficient representation. Most of the foreign engineers employed in South America are either Europeans or they have at least had their engineering training in European technical schools. The railroads would put European engineers in the leading positions out of principle, and the chief engineers would pick their staff accordingly. These engineers were men accustomed to European equipment, and they would give it preference whenever the occasion arose for a new order or for additional machinery. Being only superficially acquainted with the American boiler and boiler equipment, they were mostly afraid to employ it, not liking to risk their professional reputation with their employees. As our own boiler makers were not represented in great numbers locally, they had no means of counteracting the latent influence of the European engineer and the agent of the European boiler maker, with the result that by far the largest percentage of all boiler and steam equipment contracts went to Europe. Everything, in fact, appeared to be hostile to the introduction of American equipment.

No doubt this situation was as much the result of intentional animosity as lack of knowledge about the quality of the American equipment. While it held back the American manufacturer from a very promising market, it also deprived the South American steam consumer of the chance of widening his knowledge of American methods by seeing American boiler equipment in actual operation.

The war has ended this monopoly of the European steam engine in the world. When the European steam users outside the Continent found suddenly that they could not rely any more upon the supply of European boilers and boiler equipment they were thrown at first into consternation. How could they keep their factories running with no possibility of securing additional boilers or replacing those worn out? As a rule, the South American is not especially particular about his steam generating plant. Any old boiler will do. But the interruption of the European connection happened at a time when the industrial equipment of South America was unusually run down.

New Equipment Necessary

South America and most of the other markets outside Europe and North America had seen a rather lean period. Europe had collected money for the coming war and the Balkan war had made necessary great expenditures in other directions. So the European markets had not found their usual credits, and in turn had not been able to do very much to improve upon their industrial equipment.

But the equipment was not only inefficient, it was also insufficient in quantity. The same causes which acted to close the European supply of steam boilers and equipment made an end to the usual shipments of all other commerce. To make up for the loss of European supplies, the domestic industries had to work overtime, resulting in an extremely extensive demand for power. The depleted existing steam generation equipment proved entirely inadequate to the demand, and new equipment was not to be had in Europe. No other source was to be found than the United States. To the United States, therefore, came many orders which under different circumstances would have gone to Europe.

Our engineering firms have been able to trace closely this effect of the war upon our steam equipment exports. There have come thousands of specifications for factory equipment into the hands of our consulting engineers, indicating clearly boilers copied from the existing European equipment in other factories. Not only were the measurements essentially European, but the specifications described English, French and German boilers which had to be duplicated in one way or another by our own makers. Naturally this duplication was not always possible. Our exporters were hunting all over the place to find boilers fitting in with the demands of their foreign customers, until they hit finally upon the very excellent and correct idea of advising these gentlemen not to insist upon their European specifications but to have their whole steam equipment made on American lines.

There is always much in favor of having a power installation made as uniform as possible. A single boiler may be replaced to go with an indifferent equipment, but when a new equipment is installed it is decidedly an advantage to have the whole made from the beginning according to a uniform specification worked out by one directing mind. Our exporters were not always successful with their proposals. However, they have succeeded in the majority of cases, and many industrial power equipments supplied to South American and other countries during the last years are of exclusive American design embodying all the novelties and improvements of the modern American power equipment.

The advantages of this policy for the American industry began to show very soon. The American equipment made

* New York Economic Service Bureau.

good. We have on record a great many expressions of satisfaction with the American equipment. It was stated in the annual report of a well-known Chinese enterprise that they had reluctantly decided a few years ago to replace their European power equipment with an American installation. They were, however, much satisfied with the change, and planned to make future additions and replacements with boilers manufactured in the United States, notwithstanding the higher cost of the product.

European Conditions

Similar conditions have been experienced in other markets. No doubt the high cost of the American equipment is acting somewhat as an impediment against its general introduction. Before the war the average European equipment was 20 percent cheaper than the same equipment made in the United States. The chances are that this difference will not be more pronounced in the future. The European manufacturer will have to pay wages very similar or at least approaching those paid by our own manufacturers, and materials will be just as expensive or cheap in the United States as anywhere in the world. So our manufacturers will be more competitive as to cost. But even if they should have to charge still more, they will not be at a greater disadvantage than formerly. With our foreign banking system expanding all over the world, our manufacturers will be enabled to counteract the effect of the higher price of the American equipment by a more lenient credit policy than that employed generally before the war.

Cost of Equipment

The initial cost very often is of deciding influence in placing an order. If an equipment can be bought for $20,000, it needs a good deal of persuasion to make a man pay $25,000, even if the latter equipment should be comparatively better. Now the American manufacturer has always had on his side the argument of greater economy in use. He has claimed that his equipment will last longer than any other and that it will consume less fuel and human energy, being more scientifically constructed. If this claim holds good, the buyer might be induced to capitalize the financial effects on factory cost, but the seller should be willing to assist in this operation. Let an equipment be sold under the following conditions: The first installment of the payment to be made exactly as that demanded by the European competitor, but let the future installments run somewhat longer. If the difference between the European price be $5,000 and the first installment $15,000, it might be advisable to spread the remaining payment over three years instead of the usual one and a half. This would enable the buyer to reimburse himself for the higher outlay in the savings of the operation and he would then still have the satisfaction of operating a more efficient equipment. This is a proposition well worth entertaining, especially as the difference in price by no means will be as high in the future as that indicated by the example. It will be up to our banks to make possible such an arrangement by giving to our manufacturers the credits necessary for carrying out the transaction between the manufacturer and the buyer.

If we would follow a plan like this, or a similar one which might be made part of our general sales policy, we would soon feel its effect on our exports and it would enable us to make a very good use of the excellent position we have gained abroad during the last years. The repeat orders for American boilers and boiler equipment have come already, and the four to five million dollars' worth of American boiler equipment which has been shipped for new installations in other countries during the last few years begins to bear fruit. The American boiler industry has, in fact, been rather successful in its foreign dealings during the last four months.

The development of the exports is a very satisfying record to the industry. During July, 1918, for instance, the export of boilers had a value of $976,438, and that of boiler equipment tubes, etc., amounted to $478,202. For the rest of the year the export values of boilers moved as follows: $464,044 for August, $509,745 September, $222,-844 October, $450,404 November, and $333,862 December. Exports of boiler equipment, tubes, etc., were $554,527 during August, $737,946 September, $529,174 October, $846,539 November, and $660,416 during December.

Foreign Markets Since the War

It will be noted that the demand for American boilers has even kept at a fairly high figure over the signing of the armistice, which is rather satisfactory considering that many of our exports have shown a weakening tendency since that date. It proves that the demand for boilers was not dependent upon the war entirely, but had become already predominantly a peace demand towards the end of 1918. This is borne out still more by the following export movement during the early months of the present year. Statistics are still somewhat incomplete and the record so far has reached only the end of March. During January the boiler exports were valued at $444,326, and that of the equipment and tubes at $553,972. The somewhat erratic state of the market is easily explained by the chaotic condition of the American shipping situation durthat month and the extensive strike movement in South America. The market steadied, however, again during February, when the export value for boiler equipment rose to $912,026, boilers still keeping low at $423,175, and during March with boiler exports valued at $511,403 and equipment at $778,000.

Proof seems to have been given that the American boiler industry is well able to compete in the foreign markets. It has stood the test of a very difficult time and it has steadily increased its hold on the business in other countries. It remains now to secure the present favorable position by a continuation of the same methods which have won the appreciation of our customers during the war, as well as for the period after the war. To do this we must endeavor to make still more perfect our foreign organization. We must see that our boiler makers are well represented wherever this is required and secure at least the admission of American competition to all new enterprises, even if we should not always be successful competitors.

The Chicago Pneumatic Tool Company plans moving its general offices from Chicago to New York, and toward this end is erecting an office building at 6-8 East Forty-fourth street, New York City.

The structure, built by the Westinghouse-Church-Kerr Company of combination steel, brick and limestone, will comprise, initially, ten stories, all to be occupied by the company. The ground floor is to be a permanent exhibition room, containing a display of the Chicago Pneumatic Tool Company's products. In conjunction, a completely equipped service station will be maintained. The new building is to be ready for occupancy early in 1920, at which time the transfer will be effected.

N. S. Braden, former sales manager, has just recently been elected vice-president of the Canadian Westinghouse Company, Ltd., of Hamilton, Ontario. H. M. Bostwick, assistant sales manager, has been appointed sales manager, to fill the vacancy thus created.

Jimmie and His Chum Plan to Combine Theoretical Instruction With Practical Work

BY W. D. FORBES

Athletics at the school where Jimmie was studying were a source of great enjoyment to him, and, as he was quick, strong and very good natured, he soon made good in LaCrosse and became what the fishermen call "high line." In his daily life Jimmie met conditions that puzzled him greatly. His mother had died when he was ten years old, his father married again in a few years, and the advent of a half brother and sister had made his home-life congested; so when he got through the eighth grade at school, he went to work and had supported himself ever since.

As may be imagined, Jimmie had had little chance at what might be called social life, and he found himself ill at ease at the entertainments in school that followed the big games, where he was made much of by his fellow players, and especially by the girls.

One day, after a very hotly contested game, which, by a brilliant play, he won, Jimmie was swept off his feet and carried to the dressing room by his chums. The game had been played away from the home grounds, so Jimmie had to dress and, not finding his clothes just where he had expected them to be, he was delayed and had to make a run for the train. About one hundred yards from the station he saw a young man trying to hobble along with the aid of a cane. The young man was small and looked ill, and was evidently suffering from his efforts to make the train. Jimmie, recognizing him as a senior, without stopping to think, picked him up and landed him in a seat in the train just as it pulled out.

This incident brought about a friendship that resulted in Jimmie's going to live with Wade, who was wealthy. His parents had insisted on their son taking the entire lower floor of a house and having an old family cook keep house for him. This saved Jimmie's room rent, as Wade insisted that Jimmie's help amply repaid him for the use of the room.

Engineering Work Versus Mechanical Work

The seniors were having but little class work, as a part of their final year was devoted to getting their theses ready, and the boys were racking their brains for subjects on which to write. Jimmie and Wade were seated at the study table at their work, when Wade suddenly closed his book and, looking at Jimmie, said:

"What do you make of it all, Jim?"

Jim was surprised and answered, "What do you mean by that?"

"I want to know what you think of this entire course in engineering and the whole outfit?"

"Well," Jimmie answered, "I must say I am rather disappointed."

"That's just the way I feel," was Wade's quick rejoinder, "but why?"

"I did not feel that way until the last few weeks," said Jim. "It began after I went with you and the other fellows with a professor on that inspection tour."

"What happened then?" inquired Wade.

"Just this," answered Jim. "I saw that the Professor knew his little book but nothing else. He was not teaching us what he knew, but what he had learned from books. That feazed me a lot! Why, he did not know how to talk boilers. We saw the men smiling all of the time when they could hear what he said. He spoke of "boring the shells of the boilers together to insure alinement," Now that is not boiler talk. You drill holes in boiler plates, or punch them. Then he called the tubes "flues." Gee, but it made me sore to think what a fool he was making of himself, and all of us. Besides, he was doing harm to our college by making us look like monkeys. I tell you, Wade, I almost felt like quitting right there."

Wade said, "I saw the men grinning, but I did not know why. So that was it, was it?"

"It's mighty presumptuous on my part to sit here and criticise this great school of engineering, especially as I have been here so short a time. I can't be right, but it does seem to me that something is wrong. Most of the professors are graduates of the institutions and few have had any actual experience in real commercial life. Now that is absolutely wrong; too much "inbreeding," I should say.

"Not all the professors make such breaks as did, that fellow I was talking about, however. There is Professor Meyer in the physical laboratory; he knows just what he is talking about, but his father had a machine shop and the professor was a good machinist before he started his studies here. The Assistant Professor of Drawing is all right, but I found out that he was a pattern maker before he started in. I think I have learned more from him than anyone else."

The Value of Mathematics

All these mathematics come dead easy to me because I can see how it will help me in many ways. Yet, when I was packing a radiator valve stem in old Professor Webber's class-room, I listened to what he was talking about, and, if I "doped" it out right the problem he had been talking about could not be solved, but, if it could, the answer would be zero. I began to think that that talk was a waste of time. Perhaps I did not catch on, but that is the way it sounded.

"Then again, look here, Wade, after a fellow gets all through and has his sheepskin about the best thing he can do is to get a job at fifteen per perhaps, figuring discounts or hanging over a drawing board. Not much of course, but it is a starter and we will have the "punch" to carry-on farther; but should we not be taught enough here in four years to be worth more?"

Jimmie was almost breathless after this long outburst because he was so much in earnest.

Wade was silent for quite a while, seeming to ponder deeply, then he said:

"To a man in my position the pay part does not 'cut any ice,' but most fellows come here to get an education by which an income can be made. With you, you have a trade to fall back on; but, take the mass of students and I feel that you are, in the main, right. You know that money does give a fellow a position, and having it will allow him to do things and not get in 'Dutch' with the

'Powers-That-Be,' so a while ago I went to Prexy and put what we have been talking about right up to him."

"Whee!" exclaimed Jimmie, "what did he say?"

"A lot, but it all simmered down to this, as far as I could figure. Engineering is one thing and mechanical work is quite another. The mechanic drills a hole of a size given him and at the place he is told—that takes skill. The engineer determines the size of the hole and its position—that is engineering, and requires no skill but mentality. The workman is a dynamic force, while the engineer is static, and the two must not be confused.

"Why, Jim, the absurd amount of shop work I have had here tells me that the professor cannot be right. Only the other day I was making a drawing and I saw a sort of a lump in the sketch which had ½-inch pipe tap opening marked in it. I had not noticed this boss the day before, so I hunted up the Assistant Professor and asked him about it. He pointed out that the ½-inch hole went through the wall of the casting at an angle and, if the boss were not put there, the hole could not be drilled, nor would there be a continuous thread. Then I "loosened up" and told him what Prexy had said. He replied:

"Well, I cannot very well say much about my superior's ideas, but look here," and he took me over to a casting of the engine cylinder which the junior class is building and pointed out the two lugs for the back columns. There, he continued:

"To cast these as they are we have to make three core boxes and the cores have to be pasted together so that two castings a day would be a good day's work for a man. Now, by making those lugs to core from the other side and set them straight instead of at that angle, a man could get out at least four castings a day. Where to put a hole, and its size, are engineering questions; to produce it is a question of skill, and, further, it is a commercial one. All three lines of thought and experienece must be worked together or no true engineering is accomplished."

APPRENTICESHIP

"Now to my mind," continued Wade, "that is all right, but we are not getting this co-ordination, as far as I can see. Is it not possible to do just that? Would it not be better to take even one more year at this school and leave better-equipped than to be sent out 'half baked'?"

Jim shook his head as he answered, "I would not like another year. I had rather cut the vacations all out and make the course three years, but I would not allow a man to enter unless he had had at least one year at some trade. See here, Old Man, I have had but little trouble with my studies because I knew how to use what I was taught; most of the fellows have better brains than I have, yet they actually suffered in trying to understand what it was all about. Now here's another thing—all the professors who have made good, to my mind, have had some experience. Professor Rumsey has seen a great light and he is going to work all next summer in a boiler shop as an apprentice."

"Is that so," exclaimed Wade. "Bully for him! Where?"

Jimmie told him.

"I can see," Jimmie continued, "that we are young and may be way off, but just now I must say I do not see where. Anyway, I shall stick to it now,—but I will miss you, Wade."

Wade did not seem to notice Jimmie's last remark as, for some time, he smoked away at his pipe in silence.

When Wade spoke again, he said:

"It does seem queer to talk as we have, but we have a right at least to consider the question. Jimmie, do you think that I could get a job at your old shop drawing for the summer? I mean without pay?"

Jimmie sat up and turned very red, and answered, "Look here, Wade, you will not get mad at what I am going to say, I'm sure. It is this, I have a job to take out and replace all the heating plant of three of the Knight mills, and I must have two draftsmen, and, if you will take the job, I will be mighty glad. You get fifteen per. What do you say?"

"Say, why that is fine, and I will be glad to take the job, you just bet," was Wade's enthusiastic reply.

"Here is one trouble," said Jimmie. "The mills are three miles from where we will have to board, and there is a walk of over a half a mile. How can you make that? You see, I will have to be on deck at seven o'clock, but you need not turn up before nine."

"Oh, that is dead easy. I have bought a car and will be able to run it by that time. I don't mind the seven o'clock start, and we can all go over together and come home at night, so that is all well settled."

(To be continued.)

Feed Water Heating*

Fuel Saved by Use of Properly Designed Feed Water Heater—Short Description of Heater Construction

BY A. R. HODGES

Fuel economy is the prime motive in the consideration of the subject of feed water heating. There are a number of other beneficent results which will accrue from the use of a successful feed water heater, but they are of secondary consideration and yet vitally associated and inseparably connected with it.

In the discussion, I wish to deal with every phase of the matter so that a comprehensive view of its importance may be obtained, to attract attention to its merits and almost unlimited possibilities, and to make some slight contribution to the successful performance of the locomotive.

Fuel economy on the railroads has called forth the best efforts of everyone dealing with fuel consumption. It has compelled the selection of the brainiest and most practical fuel experts to be found on the great railway systems of the country, organized them into a great army of efficient workers and clothed them with full authority. They have gone into this fuel proposition with a willingness and a thoroughness which is very commendable, and there is no question but that a great reduction in fuel consumption has been obtained through their efforts. Furthermore, they have penetrated every avenue where there was a

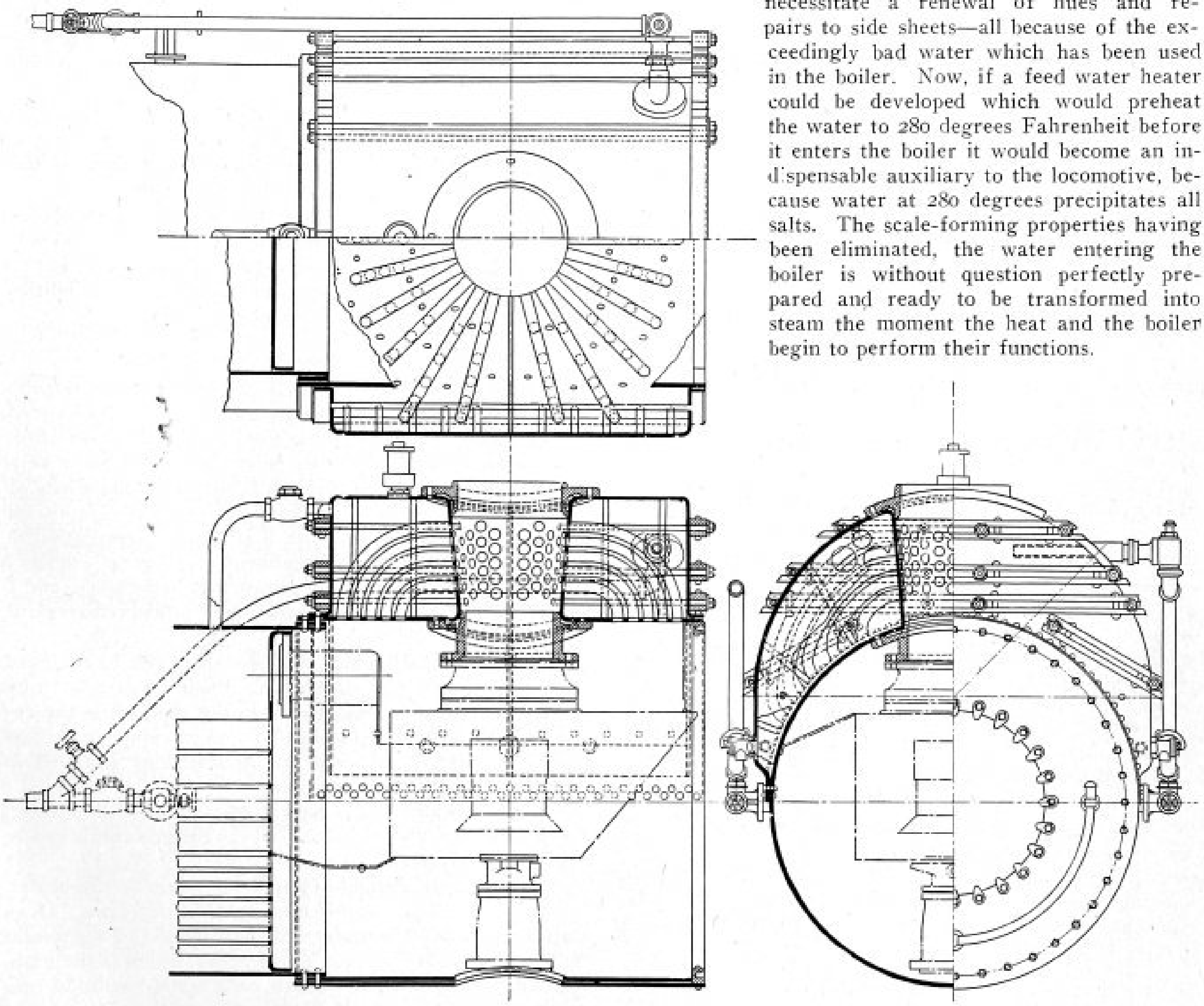
* Paper read before the Master Boiler Makers' Association, Chicago, Ill.

possibility of waste in fuel. They have encouraged economy and inaugurated a system of instruction in the economical handling of coal. They have urged upon mechanical departments the importance of keeping the locomotive in first-class shape so that a minimum of fuel is required for its successful performance. The superheater has come in for its proper upkeep and functioning. Emphasis has been laid upon the brick arch, a dry firebox and a clean boiler. Attention has been given to the 22 percent of wasted fuel which passes into the atmosphere. How to stop this waste and turn it into serviceable fuel seems to be a problem.

UTILIZING WASTE HEAT

Feed water heating by utilizing this waste heat has been suggested as a possible remedy. This fact has been recognized by some of the best mechanical men in the country. Several attempts have been made to produce feed water heaters, but with no permanently successful results, until there seems to be hesitancy of further pursuit along this line. Yet the field is so inviting and the possibilities so great, it is hardly right for mechanical men to stop short of success. It may cost some money and persistent effort to develop a successful feed water heater, but the reward is so great that it should spur us to great efforts in this direction.

In the second place, a boiler free from scale, corrosion and mud accumulations is an important factor which should be considered in the saving of fuel. So long as a boiler is clean the heat units meet with no resistance in being transmitted to the water, but the moment the flues and firebox sheets become covered with scale the heat units fail to penetrate as they should. It logically follows that an increased number of heat units will be required to perform the same amount of work formerly accomplished when the heat-absorbing plates were free from scale. This means that there must be an increase in fuel consumption to develop this extra amount of heat; and as the scale becomes thicker and mud deposits greater, the fuel must of a necessity be constantly increased without a corresponding increase in steam production. Not only this, but the mud and scale accumulated, tend to produce leaky flues and firebox plates, often causing cracks in side sheets, bulges and mud pockets, which defects ultimately necessitate a renewal of flues and repairs to side sheets—all because of the exceedingly bad water which has been used in the boiler. Now, if a feed water heater could be developed which would preheat the water to 280 degrees Fahrenheit before it enters the boiler it would become an indispensable auxiliary to the locomotive, because water at 280 degrees precipitates all salts. The scale-forming properties having been eliminated, the water entering the boiler is without question perfectly prepared and ready to be transformed into steam the moment the heat and the boiler begin to perform their functions.



Type of Feed Water Heater

In the absence of any sort of a device attached to the boiler to heat the water and to prepare it for steam production, some few railroads have erected (especially in bad water districts) hot water treating plants, and others have treated the water in the boiler by chemical process. Both of these methods have produced good results, but they are not entirely satisfactory as a universal proposition, for they are too expensive.

The feed water heater which the writer has designed to be permanently attached to the locomotive is simply a miniature hot water treating plant whose function is to thoroughly prepare the water by extracting all salts and scale-forming properties before the water enters the boiler. If this feed water heater can do this, then we have a great fuel saver and a boiler preserver, the life of which would be extended indefinitely. This heater would not only save a very large percent of fuel which now enters the front end and passes out through the stack into the atmosphere, but it would greatly reduce the cost of the upkeep of the boiler, and I believe more than double the life of the firebox and reduce repairs to a minimum.

Description of Heater

The feed water heater is in the form of a crescent, including the upper half of the entire smoke box. The bottom sheet of the heater not only forms the base, but also the top half of the smoke box sheet, in the center of which is located a cylinder made of half-inch steel, flanged outward at the base and welded around its entire circumference. This cylinder is a substitute for the smoke stack is flanged outwardly and welded to the outer shell, offset at the bottom and riveted to the base sheet running in a circular form to the opposite side and riveted there in like manner. In the center at the top the so-called smoke stack is flanged outwardly and welded to the outer shell. On the top is located a casting representing the top of the smoke stack, which forms a protection for the top of the feed water heater. The same idea is embodied in the base. At each end of the feed water heater are located crescent heads flanged outwardly at the base and inwardly at the outer circumference. This flanged head is welded at its outer radius to the exterior shell as indicated and riveted at the base to the front end door ring and at the rear to the shell of the boiler.

The base of this feed water heater, as well as the cylinder which forms the stack, are perforated with 2-inch holes. From the holes in the base to the holes of the stack are inserted 2-inch flues, through which the gases pass from the smoke box and re-enter the smoke stack after performing their function. Through the center of the feed water heated transversely is located a ¼-inch sheet with one large hole at its top on each side of the stack. This forms an interior partition or two water chambers—one in the front part of the feed water heater and the other in the rear. The water from the engine tank or cistern, by the use of an injector or feed water pump, forces the water through a feed pipe into a water check, thence into a front chamber of the feed water heater, where it is held by the partition until it overflows into the second rear chamber and rises to outflow through the water check at the rear of the feed water heater and thence into the boiler. The hot gases passing through the flues from the smoke box into the stack and the base of the feed water heater heat the water before it goes into the boiler.

Scale Formations

The pop valve located on top is placed there for safety purposes only. On each side of the heater near the offset portion is located a blow-off cock and wash-out plug, used to keep the heater clean.

As is obvious, also the feed water heater suffers the ill effect of scale-forming properties of bad water, and therefore protects the boiler from these elements.

A record of tests indicates that an average of 600 degrees of heat obtains in the front end of the smoke box under the normal working conditions of a locomotive, but this often reaches 1,200 degrees when the locomotive is heavily worked.

This degree of temperature can be maintained by lagging and jacketing the smoke box and can be further conserved by applying a false liner on the inside of the front end door and a ring filled with asbestos cement.

The top part of the smoke box constitutes the zone where heat is bound to be located, and not at the bottom or even the sides.

The hot gases directly from the firebox form the logical heating element, which will undoubtedly produce a higher degree of temperature than the exhaust steam. A combination of both is still better.

It is a very conservative estimate to state that 22 percent of the fuel in the form of hot gases passes out through the stack into the atmosphere unused and is therefore an utter waste of fuel.

In order to be effective, a feed water heater must be located directly in the path of these hot gases, and at the same time must not impair the draft on the firebox.

The successful feed water heater must heat the feed water to at least 212 to 280 degrees Fahrenheit, or it will accomplish but little economy.

A feed water heater must be designed so as not to interfere with the front end arrangements, nor form a barrier in the execution of repairs to other parts of the boiler and appurtenances located in the front end.

It should be of simple design and construction in order that it may facilitate examination, cleaning and overhauling, and be extremely economical in upkeep.

It must be of such design as to exclude the possibilities of engine failure, should it become defective.

Benefits of Feed Water Heating

It is needless for me to tell of the beneficent results which may be obtained from the use of the successful feed water heater. It will prolong the life of flues in the firebox, as well as conserve the boiler by extracting a very large percent of the precipitated matter in the form of scale and mud deposits, which otherwise must be deposited in the boiler. This being true, it is bound to revolutionize the method of feed water treatment. The great economy effected in fuel is an item of paramount importance, and I believe that the feed water heater will produce marvelous results in this direction.

The rapidity with which the locomotive can be equipped with this heater is an item which should be greatly in its favor, for it can be constructed in the shop while the engine is still in service and can be applied complete in four days. It can be removed and another one installed in about the same length of time.

This feed water heater cannot be affected by low water, as the flues are all welded and all the flanges are or can be welded satisfactorily.

As to the best method of supplying water to the heater, I am not prepared at this time to definitely state. If an injector is used, the water will be supplied to the heater at a temperature not over 140 degrees, which is the highest obtained by a series of tests on a certain railroad running out of Chicago. However, the water going into the feed water heater at this temperature will not detract from the steam pressure in the boiler.

A good pump may prove more advantageous and more economical in supplying the heater if it is reliable, and I have been assured that a pump has been constructed which can be relied upon.

The Detroit Seamless Steel Tubes Company has just completed a new $3,000,000 plant in Detroit for the manufacture of its products.

How to Design and Lay Out a Boiler—XI

Problem of Bracing Heads Below Tubes—Advantages of Weldless Through-Rods — Designing Rod Ends

BY WILLIAM C. STROTT*

Having completed the bracing of the heads above the tubes and acquainted the student with all of the usual methods of staying employed for this purpose we shall now take up the bracing of the heads below the tubes.

On first thought there would seem to be no reason why diagonal braces would not serve the purpose at this point as well as they do above the tubes. It is obvious, however, after another glance at Fig. 1, that the palm-ends of the braces by which they are attached to the boiler shell would

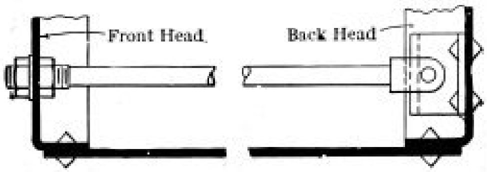


Fig. 36

be directly over the furnace. This fact brings us squarely up against the former proposition of having too much metal in contact with the flame. It would not be long before the rivet heads burned off. Some other method of staying must, therefore, be resorted to, and this is effectively done by means of the direct or through-stay illustrated in Fig. 36.

The rod passes through an open hole (not threaded) in the front head and is secured with nuts inside and outside of the plate, as shown. As far as strength is concerned, this same method might also be employed for attaching the rods to the back head, but the practice is prohibited on account of the injurious action of the hot gases on the projecting rod and nuts. At the front end,

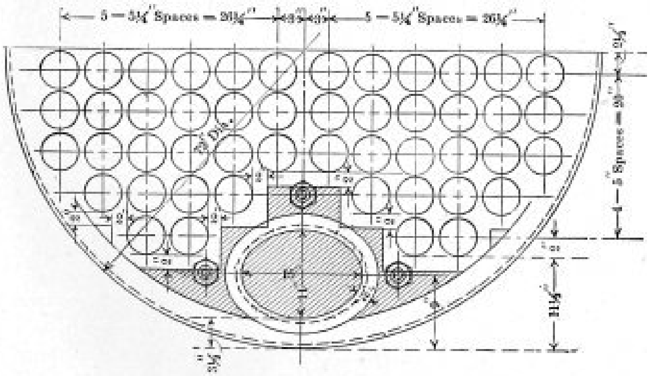


Fig. 37

however, the gases are quite cool by the time they have been returned through the tubes; and, furthermore, the rods being below the tubes, the gases do not actually impinge directly against them but pass over them. For this reason the rods must be anchored to the rear head by means of a pressed steel crowfoot or other efficient device riveted to the inside of the head.

We shall now proceed to design in detail the through rods for our boiler, but the first thing necessary is to find out how much area we have to brace below the tubes. The shaded portion of Fig. 37 clearly indicates how this surface is determined.

The previously determined allowance of 3⅝ inches from the shell and 2 inches around the tubes and manhole prevails. The surface of the back head for our case consists distinctly of one circular segment having a net radius of 32⅜ inches and net height of 5⅜ inches. Formula (3) may now be applied to find its area. Substituting figures for letters in the formula and solving, we have:

$$A = \frac{4 \times 5\tfrac{3}{8} \times 5\tfrac{3}{8}}{3} \times \sqrt{\frac{2 \times 32\tfrac{3}{8}}{5\tfrac{3}{8}} - 0.608}, \text{ or } 130 \text{ square inches approximately.}$$

In addition to this circular segment there are also two rectangular surfaces, each of which is equal in width to the vertical tube pitch, or 5 inches, and their lengths are 8½ inches and 20 inches respectively. The sum of the areas of these two rectangles is 8½ × 5 + 20 × 5, or 142½ square inches. The total area to be stayed is 130 + 142.5, or 242.5 square inches. The total pressure acting on the surface is 242.5 × 150 pounds, or 36,375 pounds.

The number of rods that will be required is most readily determined from the tube layout, since the bracing must be uniform. Although two rods could be put in and designed sufficiently strong to carry the load, the distribution would not be as uniform as would be the case with three.

It is the practice of some boiler manufacturers to base their calculations for the size of the braces on the segment below the tubes of the front head only. It should be remembered that the area there is 100 square inches less than at the rear head, which is the allowance given the stiffening value of the manhole flange. This would permit of employing somewhat lighter stay rods, but at the rear head this extra 100 square inches must nevertheless be provided for. The builders who follow such practice take care of this by inserting two ordinary diagonal braces. There is really nothing to prohibit the practice unless it be the old argument that the rivets attaching the palms of these braces to the shell would be in the path of the hot gases and products of combustion. They present the claim, however, that these braces may be located at the sides, well up from the bottom of the shell, and, since the flames do not reach as far back as the rear head, there is no danger of burning the rivets. The A. S. M. E. Code makes no mention of this design, merely stating that the *front head below the tubes must be stayed with through rods.* It is, nevertheless, not in accordance with the very best modern practice in boiler construction to employ any diagonal stays below the tubes of boilers of this type. The argument is then advanced that it is possible to obtain a more uniform load disribution by interposing these extra diagonal braces, but this is accomplished just as efficiently by increasing the size of the crowfoot connections at the rear head to which the rods are anchored.

The required net sectional area per stay is found from the formula:

$$A = \frac{W}{C \times N}, \qquad (9)$$

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

in which A = the net cross-sectional area per stay in square inches.
W = the total pressure in pounds on the area to be stayed.
N = the number of stays being put in.
C = the allowable working stress in pounds per square inch on the stay. To be taken from Table 10.

TABLE 10

Description of Stay	—Stress, Pounds per Square Inch— For Lengths Between Supports Not Exceeding 120 Diameters	For Lengths Between Supports Exceeding 120 Diameters
Unwelded steel stays.........	9,500	8,500
Welded steel stays...........	6,000	6,000
Unwelded steel stays exceeding 1½ inches diameter.....	10,400	9,000

(NOTE.—Length between supports to be taken face to face, inside, of stayed plates.)

As it is not known what stay rod diameter shall be required, the best method of procedure in such cases is to assume that the rods will be less than 1½ inches in diameter. Then, if after applying formula (9) it is found that rods much larger than 1½ inches diameter are required, the proper value for "C" may then be substituted in the formula. If this also results in a diameter greater than 1½ inches, then the calculations are correct; if not, then the smaller allowable stress must be used. When welded stays are employed, 6,000 pounds per square inch is the allowable limit, regardless of their diameter or length between supports.

Although the use of weldless rods would thereby result in lighter material, the cost of manufacturing such rods is great, chiefly in the ordinary commercial shops, where they are not equipped with the necessary upsetting machinery and forging dies to perform such processes economically. It is cheaper for these shops to make the jaws separately by the hand-forged method and weld them to the body of the rods. They do not even upset the threaded end of the rod, but make the rod of such diameter that the required cross-sectional area is at the bottom of the threads.

Assuming the use of weldless rods, and substituting values for letters in formula (9), we have:

$$A = \frac{36,375}{8,500 \times 3}, \text{ or } 1.426 \text{ square inches.}$$

Referring to a table of the areas of circles (or by calculation), we find that this value corresponds to a circle having a diameter of 1⅜ inches.

Fig. 38 illustrates in detail the method of connecting these through-stays to the front head.

Notice that the threaded portion is somewhat larger in diameter than the main body of the rod, so that after

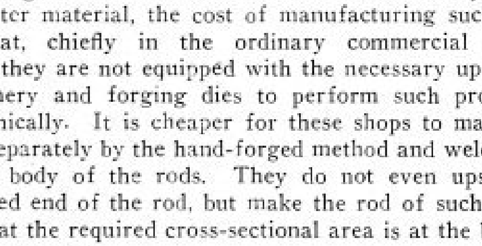


Fig. 38

threading the diameter at the root of the threads will be slightly greater than D. This increased diameter is accomplished in a special machine for that purpose, which upsets the rod. This process has a tendency to destroy somewhat the original physical structure of the steel, which renders it brittle, thus lowering its tensile strength. The code demands that the ends of such stay rods shall be thoroughly annealed to restore at least partially the original strength of the material. Table 11 gives the diameter of upset screw ends for round and square bars as printed in the 1903 edition of the Carnegie Steel Company's Handbook. The remarks accompanying the table should be observed, since they will prove particularly instructive.

TABLE 11

UPSET SCREW ENDS FOR ROUND AND SQUARE BARS

Diameter of Round or Side of Square Bar, Inches	Round Bars: Diameter of Upset Screw End, Inches	Round Bars: Diameter of Screw at Root of Thread Inches	Round Bars: Threads per Inch, Number	Round Bars: Excess of Effective Area of Screw End Over Bar, Per Cent.	Square Bars: Diameter of Upset Screw End, Inches	Square Bars: Diameter of Screw at Root of Thread Inches	Square Bars: Threads per Inch, Number	Square Bars: Excess of Effective Area of Screw End Over Bar, Per Cent
½	¾	0.620	10	54	¾	0.620	10	21
9/16	¾	0.620	10	21	⅞	0.731	9	33
⅝	⅞	0.731	9	37	1	0.837	8	41
11/16	1	0.837	8	48	1	0.837	8	17
¾	1	0.837	8	25	1⅛	0.940	7	23
13/16	1⅛	0.940	7	34	1¼	1.065	7	35
⅞	1¼	1.065	7	48	1⅜	1.160	6	38
15/16	1¼	1.065	7	29	1⅜	1.160	6	20
1	1⅜	1.160	6	35	1½	1.284	6	29
1 1/16	1⅜	1.160	6	19	1⅝	1.389	5½	34
1⅛	1½	1.284	6	30	1⅝	1.389	5½	20
1 3/16	1½	1.284	6	17	1¾	1.490	5	24
1¼	1⅝	1.389	5½	23	1⅞	1.615	5	1
1 5/16	1¾	1.490	5	29	1⅞	1.615	5	19
1⅜	1¾	1.490	5	18	2	1.712	4½	22
1 7/16	1⅞	1.615	5	26	2⅛	1.837	4½	28
1½	2	1.712	4½	30	2⅛	1.837	4½	18
1 9/16	2	1.712	4½	20	2¼	1.962	4½	24
1⅝	2⅛	1.837	4½	28	2⅜	2.087	4½	30
1 11/16	2⅛	1.837	4½	18	2⅜	2.087	4½	20
1¾	2¼	1.962	4½	26	2½	2.175	4	21
1 13/16	2¼	1.962	4½	17	2⅝	2.300	4	26
1⅞	2⅜	2.087	4½	24	2⅝	2.300	4	18
1 15/16	2½	2.175	4	26	2¾	2.425	4	23
2	2½	2.175	4	18	2⅞	2.550	4	28
2 1/16	2⅝	2.300	4	24	2⅞	2.550	4	20
2⅛	2⅝	2.300	4	17	3	2.629	3½	20
2 3/16	2¾	2.425	4	23	3⅛	2.754	3½	24
2¼	2⅞	2.550	4	28	3⅛	2.754	3½	18
2 5/16	2⅞	2.550	4	22	3¼	2.879	3½	22
2⅜	3	2.629	3½	23	3⅜	3.004	3½	26
2 7/16	3⅛	2.754	3½	28	3⅜	3.004	3½	19
2½	3⅛	2.754	3½	21	3½	3.100	3¼	21
2 9/16	3¼	2.879	3½	26	3⅝	3.225	3¼	24
2⅝	3¼	2.879	3½	20	3⅝	3.225	3¼	19
2 11/16	3⅜	3.004	3½	25	3¾	3.317	3	20
2¾	3⅜	3.004	3½	19	3⅞	3.442	3	23
2 13/16	3½	3.100	3¼	22	3⅞	3.442	3	18
2⅞	3⅝	3.225	3¼	26	4	3.567	3	21
2 15/16	3⅝	3.225	3¼	21	4⅛	3.692	3	24
3	3¾	3.317	3	22	4⅛	3.692	3	19
3⅛	3⅞	3.442	3	21	4⅜	3.923	2⅞	24
3¼	4	3.567	3	20	4½	4.028	2¾	21
3⅜	4⅛	3.692	3	20	4⅝	4.153	2¾	19
3½	4¼	3.798	2⅞	18	....	....	....	....
3⅝	4½	4.028	2¾	23	....	....	....	....
3¾	4⅝	4.153	2¾	23	....	....	....	....
3⅞	4¾	4.255	2⅝	21	....	....	....	....

REMARKS—As upsetting reduces the strength, bars having the same diameter at root of thread as that of the bar, invariably break in the screw end when tested to destruction without developing the full strength of the bar. It is therefore necessary to make up for this loss in strength by an excess of metal in the upset screw ends over that in the bar.

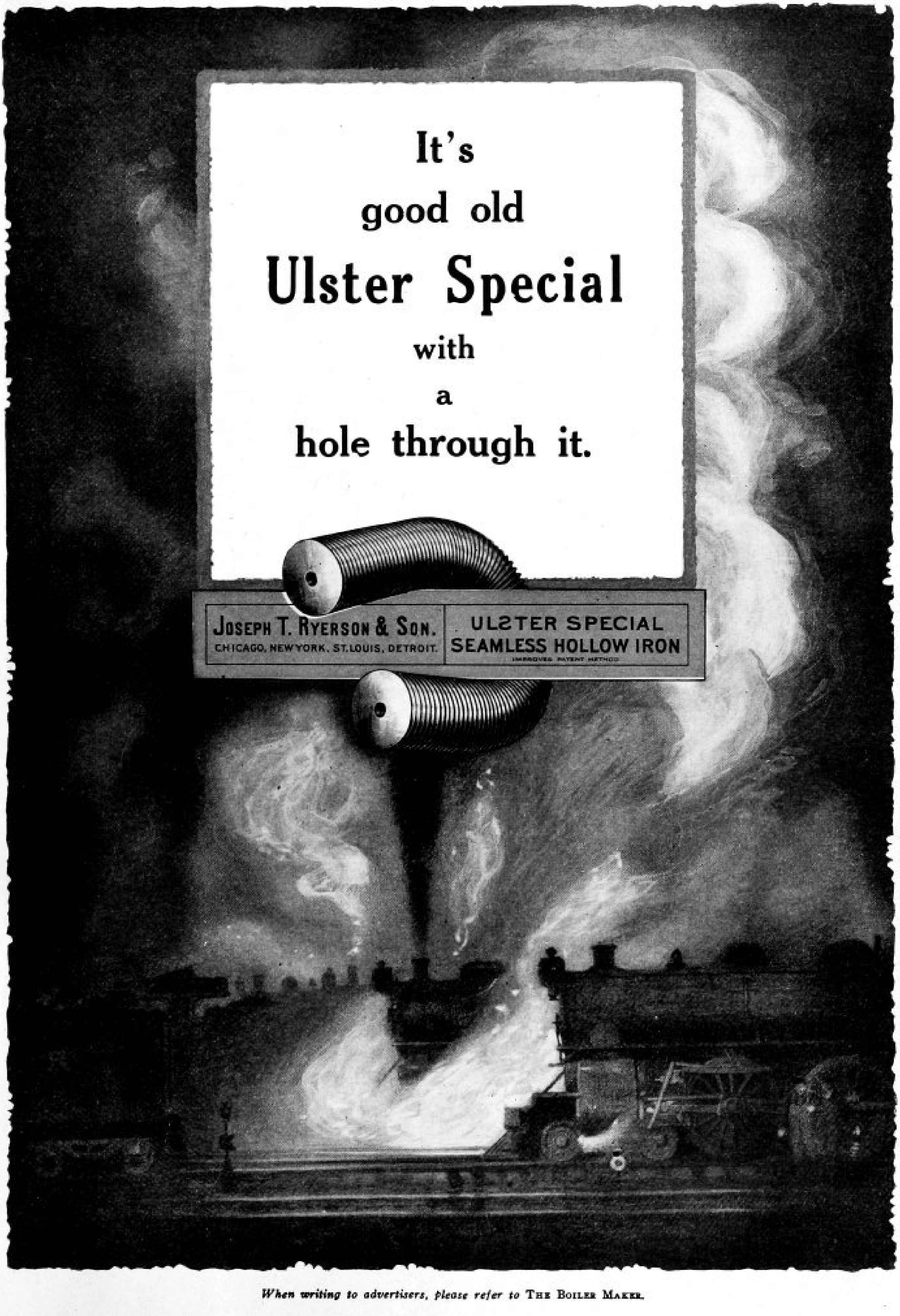
The above table is the result of numerous tests on finished bars made by Carnegie Steel Company, and gives proportions that will cause the bar to break in the body in preference to the upset end.

The screw threads in above table are the Franklin Institute Standard or U.S. Standard.

To make one upset end for 5-inch length of thread, allow 6-inch length of rod additional.

Referring now to the table, we find that for a diameter of 1⅜ inches the diameter of the upset required is 1¾ inches, that 5 threads per inch are cut, and that the diameter at the root of the threads is 1.49 inches. This gives an excess in cross-sectional area at the root of the threads of 20 percent over that in the body of the rod. It should be understood that the diameter of the upset is based on the calculated rod diameter, i. e., even though the diameter of the body of the rod were to be made 1½ inches, the upset required for a 1⅜-inch diameter would be retained, since there is evidently no necessity for making the upset end any larger than absolutely necessary.

The rear end of the rod is made in two different forms.


It's
good old
Ulster Special
with
a
hole through it.
Joseph T. Ryerson & Son.
Chicago, New York, St. Louis, Detroit.
Ulster Special
Seamless Hollow Iron
Improved Patent Method

depending on the type of crowfoot employed. One is the jaw construction and the other is forged to the shape of an eye. Fig. 39, (a) and (b), illustrates the two types in detail.

Before a discussion of the comparative advantages of either form over the other is possible, the various types

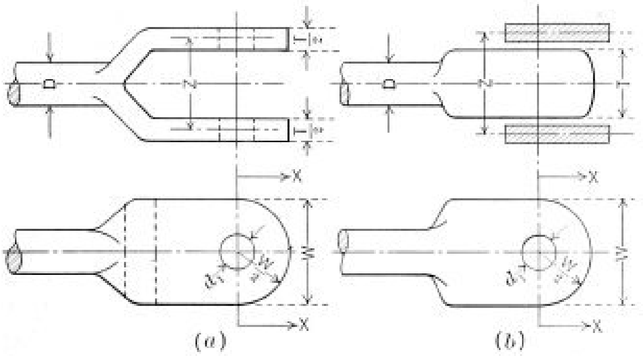


Fig. 39

of crowfeet utilized for anchoring through rods to the rear heads shall be described.

In Fig. 40 are illustrated the more common designs of pressed steel crowfeet and the dot-and-dash lines clearly indicate the *types of through rod ends applicable to each.*

Having decided on using the eye form of construction, it will devolve upon us which of the crowfeet to choose. Two of the designs are practically the same, the *double* crowfoot being employed for the larger rods when it is

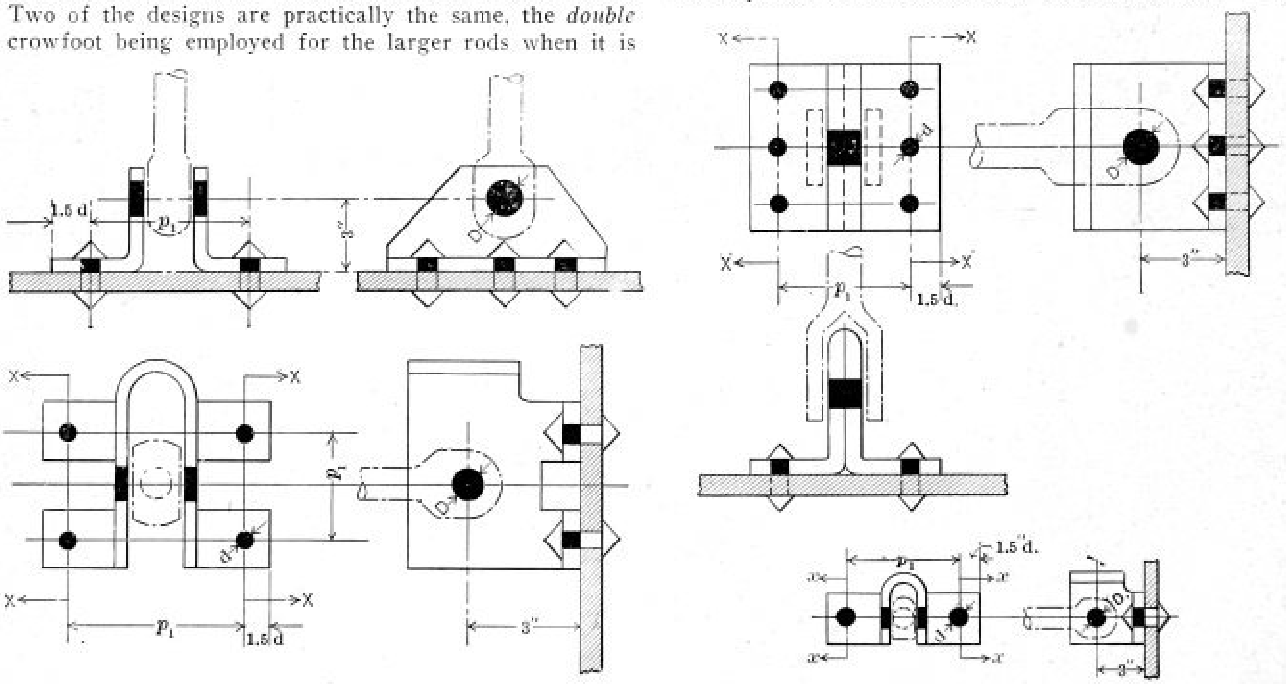


Fig. 40

desired to get more rivet strength. This form may be extended so as to provide six toes, if that many rivets should be necessary. The *ell* crowfoot is also an efficient form, although not quite as rigid as the others. It is very cheaply made, however, and is the choice of many boiler makers. The *tee* crowfoot is also very strong and economical of manufacture. It may be extended in size to accommodate any number of rivets, and its form may be altered to suit any irregular area upon which it is placed, so as to clear the edges of the tube holes, etc. This form is, however, a veritable mud-catcher and offers too much corrosive surface to impurities in the water.

It should be particularly appreciated from the design of the single and double crowfeet that an unrestricted circulation of water is maintained through and under the loop which receives the eye.

Whenever boiler heads are required to be over 5/8 inch thick, the crowfeet (any form) should be *spooled* away from the plate, as shown in Fig. 41.

This construction permits of a circulation of water be-

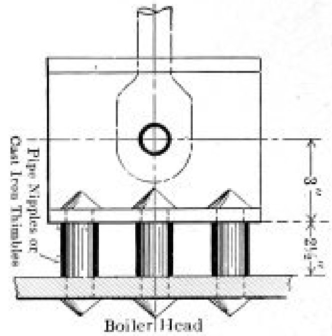


Fig. 41

tween the crowfoot and the boiler head, thus eliminating the danger of overheating the plate and rivets.

All of these crowfeet are designed and proportioned the same as the ends of the diagonal braces above the tubes. For instance, the net plate sections through *x-x* must be two-thirds of the net cross-sectional area of the stay rod, and the combined rivet areas must be at least 25 percent greater. The maximum rivet pitches, *p*, are determined from formula (5), and this, of course, also applies to the distance between the outermost rivets of adjacent crowfeet. Hence, by laying out the area below the tubes to a generous scale and locating the centers of the crowfeet, the designer is in a position to determine whether single or double crowfeet will be required. He should then check up for the rivet values and complete the design in the usual manner. These crowfeet are usually made of 3/8-inch, 1/2-inch and 7/16-inch flange quality boiler plate steel. Fig. 42 is a tentative arrangement of the crowfeet in the rear head of our boiler. The student should notice that it is not always possible to locate the centerline of the crowfeet exactly in line with the end of the rod where same passes through the front head. The additional stress in the rods, due to their being placed slightly in a diagonal position, is negligible, however, and need not be considered.

Fig. 42 (a) and (b) illustrate two other alternative schemes for bracing this segment. At (a) we have elim-

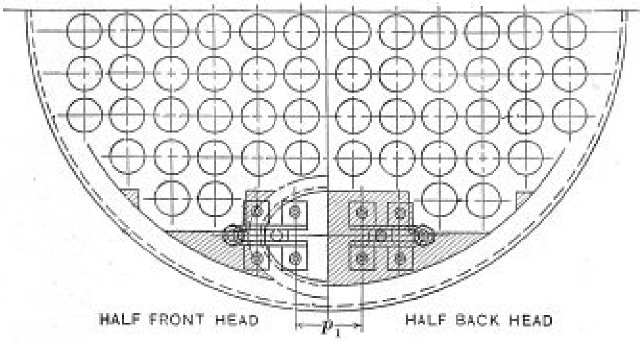


Fig. 42*a*

inated the stay rod above the manholes by interposing two additional tubes, thus giving the boiler a greatly increased heating surface.

Should the specifications call for exactly 70 tubes, we would be compelled to use an arrangement as shown at

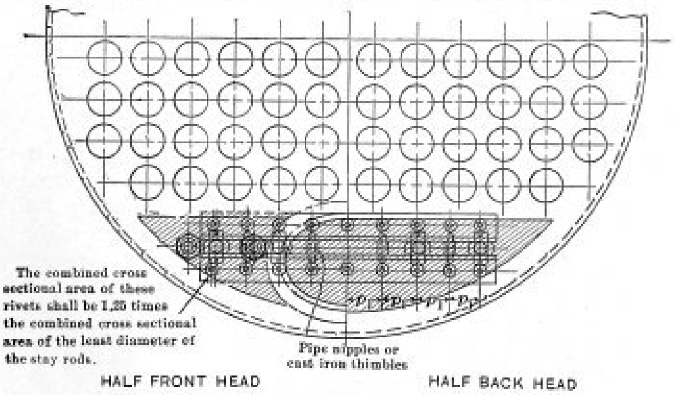


Fig. 42*b*

Fig. 42 (b), in which the four lower tubes are eliminated, thus greatly increasing the area of the segment to be braced. Nevertheless, the latter arrangement is to be preferred, since it gives a large volume of space at the

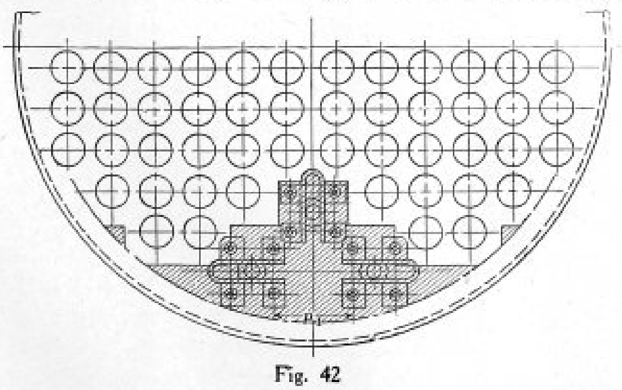


Fig. 42

bottom of the shell, which is conducive to an unrestricted circulation. With this design four rods should be employed, and an excellent method of anchoring them to the rear head is by means of two angles made of heavy boiler plate. The A. S. M. E. Code further states that the horizontal distance between through rods shall be 9 inches, to permit access into the full length of boiler.

In the various boiler shops some one of these four types of crowfeet is usually adopted as the standard construction. A variety of sizes of both the angle and double form are then developed, the calculations being based on a number of different commercial rod diameters. Flanging dies are next designed, so that the work may be turned out on a rapid production basis. A stock of the standard sizes may thus always be kept on hand, and in "working up" a boiler design the draftsman need only calculate the net size of through rods required and select the corresponding size of crowfoot.

The dimensions of the eye end of the rod, Fig. 39, may now be determined. Anchorage to the crowfoot is made by means of a cold-rolled steel pin secured in place with a split cotter pin. The table is self-explanatory and will enable the designer to order the pins complete.

COTTER PINS
AMERICAN BRIDGE COMPANY STANDARD
All Dimensions in Inches

Horizontal or Vertical Pin Finished					Horizontal Pin Rough or Finished			
Pin	Head	g	Cotter		Pin	g_1	Cottr	
p	h		c	d	p_1		c	d
1¼	1½		2	¼	1¼		2	¼
1½	1¾		2½	¼	1½		2½	¼
1¾	2	Net	2¾	¼	1¾	Net	2¾	¼
2	2⅜	Grip	3	⅜	2	Grip	3	⅜
2¼	2⅝	+	3¼	⅜	2¼	+	3¼	⅜
2½	2⅞	½	3¾	⅜	2½	¾	3¾	⅜
2¾	3⅛	Inch	4	⅜	2¾	Inch	4	⅜
3	3½		5	½	3		5	½
3¼	3¾		5	½	3¼		5	½
3½	4		6	½	3½		6	½
3¾	4¼		6	½	3¾		6	½

(To be continued.)

The Surplus Property Division of the Quartermaster General of the Army is offering for sale under sealed proposals 120 partly fabricated boilers, 3 vertical tubular boilers, completely constructed, and a quantity of boiler accessories and rubber belting, all located at Norfolk, Va., bids for which will be opened by the Surplus Property Officer, Zone Supply Office, Newport News, on September 30, 1919.

The partly fabricated boilers are knocked down, crated, and ready for shipment. They consist of boiler material ready for erection which conforms to the requirements of the American Society of Mechanical Engineers. There are 44 boilers of 10 horsepower capacity, 48 rated at 25 horsepower, and 28 rated at 125 horsepower. The three vertical tubular boilers are rated at 12 horsepower and were manufactured by the A. B. Farquhar Company, York, Pa. They were built to accord with the requirements of the Hartford Steam Boiler Inspection and Insurance Company for 100 pounds working pressure.

The boiler accessories consist of one Ryerson-Baird flue rattler, manufactured by Joseph T. Ryerson & Son, Chicago, Ill., with capacity sufficient to handle standard and superheater tubes up to 20 feet in length and arranged for motor drive; one Lagonda cleaner, manufactured by the Casey-Hedges Company, Chattanooga, Tenn., and thirteen vertical air receivers, manufactured by the Leader Iron Works, Decatur, Ill.

The rubber belting consists of 6,240 feet of various lengths, widths and weights.

Particulars, specifications and special bid forms may be obtained from the Surplus Property Officer, Zone Supply Office, in any of the following cities: Boston, New York, Baltimore, Philadelphia, Newport News, Atlanta, New Orleans, St. Louis, Jeffersonville, Ind., Chicago, San Antonio, El Paso, Omaha and San Francisco.

Riveted Joints

Concerning the discussion of riveted joints in the March and August issues of THE BOILER MAKER, with regard to the possibility of failure between the diagonal sections of plate, the author, in his treatise "How to Design and Lay Out a Boiler," has endeavored chiefly to bring out the fact that the stress in any member of a structure not resisting the load in a direct line with that member is greater than the direct load. The magnitude of the resulting stress depends on the angularity of the diagonal with the horizontal. This was proved by means of the parallelogram of forces demonstrated in the August issue.

Although providing a wide margin of safety, the assumption that the stress in the diagonal sections of plate between the rivet holes acts in accordance with the law established by the parallelogram, this assumption is not wholly correct, because the joint is a solid structure and the diagonal lines do not exist as separate members of the structure, but are considered imaginary.

It may, in fact, be stated that the actual determination of these stresses was until quite recently a much-mooted question. As was previously stated, when failure occurs in this manner it is due partly to a combined shearing and tensile stress, and all arguments to the contrary notwithstanding, it is true that a certain diagonal stress does exist at these points.

For the purpose of satisfying a recent inquiry, the following additional matter relating to the subject is presented to our readers. In this connection the author wishes to particularly thank George L. Christy, of Pittsburgh, Pa., for personally bringing up this point, which he thought might be of interest to the readers.

For practical purposes we might safely assume that the diagonal sections of plate are in full shear and base their required net sectional areas on the shearing strength of steel plates, which for boiler plate may be taken at about 35,000 pounds per square inch (ultimate). This would mean that the combined length of the diagonals, p_1, are in all cases to be made not less than 1.65 times the horizontal

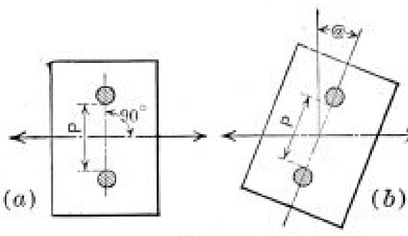


Fig. 21

sections, P. Although this method of reasoning represents the extreme in safety, it would also prove to be an altogether undesirable condition for a normal boiler seam, resulting in extremely wide joints.

It is evident, however, that the angularity which the diagonals make with the horizontal is an important factor, since it may be seen from the previous illustrations that as angle @ is increased the diagonals approach the vertical position and are therefore subjected to a more complete shearing stress. Also, as the angularity is decreased the diagonals more nearly approach the true tensile effect, in which the material is far stronger than when subjected to shear.

For the purpose of settling this question concerning the amount of metal necessary in the diagonal sections of plate in riveted joints, extensive tests were conducted at the Watertown Arsenal in 1915 by J. W. F. MacDonald. Plate specimens similar to those illustrated in Fig. 21, (a) and (b), were employed for the purpose.

Tests were first applied to the specimens as at (a), with the load placed at right angles to the line of rivet holes as shown. The area of a net section at a load necessary to break the plate was taken at 100 percent; then other specimens of the same thickness and dimensions were tested, but with the line of rivet holes placed at various angles to the line of application of the load and the excess of metal necessary between the rivet holes, to give the specimen the same breaking strength as in the former case, was noted for each different position. The results of these tests gave the following average results:

When angle @ of Fig. 21 (b) was 10 degrees, an excess of 7 percent of metal over that in Fig. 21 (a) was required; for a 20-degree inclination, 13 percent excess; for 30 degrees, 20 percent excess, and for a 40-degree inclination the required excess was 30 percent.

By comparing the above figures it should be noticed that the excess of metal necessary increased in a direct ratio with the angularity, i. e., that when the angularity was doubled, the excess metal required also doubled. For practical purposes we may satisfactorily assume that for each degree inclination of the diagonals with the horizontal, an excess of metal of 0.75 percent over that in the horizontal section is required.

The final solution to the problem, therefore, resolves itself to getting an excess of metal in the diagonal sections of a riveted joint equal to or greater than established by the aforementioned tests.

WILLIAM C. STROTT.

Dished Tank Heads

The following table includes data on tank heads from 12 inches to 132 inches in diameter. It is customary for boiler makers to assume the radius of curvature to be equal to the diameter of the cylinder. This, however, is not the case, as the table will indicate.

It should prove of convenience in computing the strength and capacity of heads, as well as in determining the length of the shell for a given capacity.

CAPACITIES OF DISHED TANK HEADS

Outside Diameter of Head, Inches	Maximum Depth Dish, Inches	Radius of Curvature, Inches	U. S. Gallons in One Head
12	1⅝	11 57/64	.19
15	2	14 1/16	.72
18	2⅜	18 15/64	1.55
24	3¼	23 25/32	3.26
30	4	30⅛	6.26
36	4¾	36 31/64	10.71
42	5⅝	42 1/64	17.25
48	6⅜	48 3/16	26.55
54	7¼	53 29/32	36.40
60	8	60¼	50.64
66	9	65	68.48
72	9⅝	72 9/64	86.72
78	11½	71⅞	121.82
84	12½	76 13/16	154.36
90	13	84 25/64	184.93
96	14	89 9/32	227.15
102	15	94 13/32	273.87
108	16	99⅛	326.10
114	17	104 1/16	386.50
120	18	109	453.86
126	19	114	528.60
132	20	118 29/32	594.77

Fort Wayne, Ind. G. A. SCHUST.

The Boiler Maker

Published Monthly by

ALDRICH PUBLISHING COMPANY, INC.

Member of The Associated Business Papers, Inc.

6 East 39th Street, - - - - New York

8 Bouverie St., London, E. C.

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor.

Branch Office
Boston, Mass., 294 Washington street, S. I. CARPENTER.

Advance in the prices of structural and boiler rivets, bolts, nuts and cold-rolled bars are threatened in the near future by the manufacturers of small steel products. They hold that the prices are too low to meet the high and increasing cost of production. With their output well covered for the next sixty days, future orders on the present price basis are being consistently refused.

Of course, with the increased cost of production and threatened labor troubles, the manufacturers of any product are justified in trying to solve their problems in any way possible.

This method, however, seems to aggravate the economic situation rather than to help it. The permanent remedy to the trouble remains to be given us, but whatever it is it must be satisfactory to the worker, the manufacturer and the consumer.

A possible solution to the grave economic situation facing the country is the proper training of men to better understand and appreciate the work they are doing. Industrial training aims at the accomplishment of this by making easier the performance of certain operations in the various trades and increasing the individual efficiencies of the men. We are told that the average output of unskilled labor exerting a maximum effort is about thirty-five percent of the possible human capacity.

The matter is especially important now because of the necessity of utilizing the services of returned soldiers to the best advantage. In the vast majority of cases these men have come back with greater ambitions and broader viewpoints. They have a very keen desire to do something better and to increase their earning power. During the training for war, however, they have not been instructed in the trades of peace, so in order to give them the skill in workmanship necessary to advancement, they must be intensively trained immediately. While learning they must also be earning a living wage.

The value of training the civilian population in the same way was very clearly demonstrated at the outbreak of the war, when the United States Training Service under the Department of Labor was organized to promote training classes in industrial plants and offered its free advice to manufacturers in starting such classes. In a very short time unskilled men were transformed into skilled workers.

Because Congress failed to provide the appropriations necessary to carry on this work, the national effort has become inactive and 20,000 industrial corporations that could utilize the principles advantageously are doing nothing to raise the efficiency of their men.

Manufacturers who are working on a campaign of trade education find that it is a paying investment, which tends to increase a liking for the work, which produces leaders to take charge of operations and which increases production in general.

The workers are satisfied with their increased earning capacity, as well as the greater confidence and pride in workmanship which comes with better education.

The third group to be satisfied in all production is the public, and certainly anything tending to reduce the living expenses of the present period will certainly aid in bringing about the desired result.

The first of the extra conventions of the American Boiler Manufacturers' Association voted for at the Buffalo convention in June will be held at the Astor Hotel, New York City, Wednesday, September 24, 1919.

William H. Barr will open the meeting by an address on certain topics that are holding the attention of the industrial world at present. The greatest interest will be aroused by the general discussion on "Boiler Costs," which was so unsatisfactorily treated at the last convention, because of the lack of a uniform system of estimating.

A complete report of the convention, discussions and papers read will be given in the October issue of THE BOILER MAKER.

The Massachusetts Board of Boiler Rules prescribes that: "A horizontal-return-tubular boiler, vertical tubular, or a locomotive-type boiler shall not have a continuous longitudinal joint over 12 feet in length."

What makes a joint over 12 feet in length dangerous? Boiler insurance companies have long stated that it is a source of weakness and the cause of many explosions. The readers of THE BOILER MAKER will no doubt be able to indicate the dangers of lengthening the joint and whether making it of the butt-and-double-strap construction, according to the A. S. M. E. Code, will counterbalance any of the defects.

Both the Massachusetts Rules and the A. S. M. E. Code cannot be correct in their requirements. However, the difference may be settled by a simple engineering discussion of the problem. Then if one view is proven to be more correct by a theoretical solution of the stresses in a boiler under working conditions, by statistics of explosions or by other means, it should be adopted by both Codes.

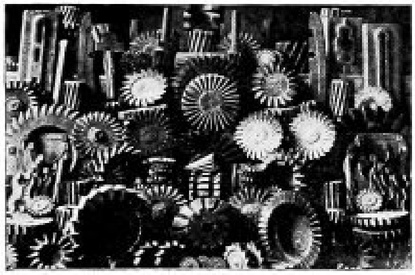
Engineering Specialties for Boiler Making

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

Chrobaltic Alloy for Cast High-Speed Steel Cutters

The mechanical and metallurgical arts and sciences, stimulated by war necessities, accomplished remarkable things in the past three years. Among others chrobaltic steel alloy was found to be a suitable substitute for tungsten in producing high-speel steel. In the production and use of multiple cutting edge tools, it is claimed that the use of this alloy has accomplished a saving in material and high-priced labor. It has been successfully used in making tools of intricate shapes, for blanking, drawing and forming dies, hot and cold trimmers, while in the manufacture of cast milling cutters its results seem to be satisfactory. In the cast state, tools are supplied either finished, ready for use, or annealed, so they may be machined to special dimensions by the user.

These high-speed steel castings have the appearance of smooth forgings, and are practically non-rusting and acid-resisting. The alloy will resist high temperature without flaking, so that it is adapted to cutters having thin edges. The tools may be hardened in air or oil and annealed and rehardened without the steel losing any of its properties. No change of shape is apparent under heat treatment, so the labor of finishing is greatly reduced. Cutters are cast to nearly the required size, only about one-sixteenth of an inch being allowed for machining before heat treatment. This allowance is reduced, however, so that only a small amount of grinding is necessary for hardening.



Variety of High-Speed Steel Cutters Made from Chrobaltic Alloy

The hardening process is carried out in a furnace of the muffle type, where the tools are heated to between 1,830 and 1,870 degrees F., maintained at this temperature a few minutes, then allowed to drop to 1,815 degrees, when the steel is withdrawn and quenched in oil. The annealing process consists in simply heating to 1,832 degrees and allowing the material to cool slowly in air. After annealing, the casting should show about 38 on the scleroscope and may be machined rapidly.

It would appear from results that the cast chrobaltic alloy cutters disprove the former theory that rolling, pressing or forging is necessary in the production of milling cutters, in order that they might have the required density and toughness.

From data available, the labor, cost and material saved in machining processes where these tools are compared with tungsten steel, as well as the labor and material conserved in their manufacture, are apparent. It is noted that in the case of the production of one completed article, when tungsten steel tools were used, ten pounds of material were required and eleven hours of labor, while with chrobaltic alloy it required but five pounds of material and three hours' labor, thus cutting the cost of production about half. The results of a test on shell billets indicate that about a pound more steel was necessary in making the tungsten cutter than the alloy, and that it required seven and three-quarter hours' less labor to complete the operations with the latter.

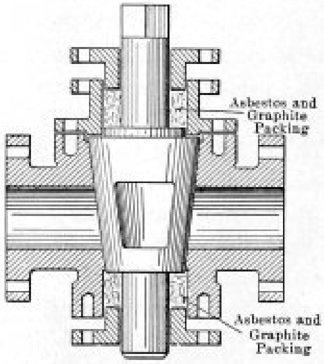
This new alloy is supplied by the Chrobaltic Tool Company, Railway Exchange, Chicago, Ill.

Double-Packed Stop Cock for High Pressures

A new blow-off valve, especially designed for high pressures, is being produced by the M. H. Treadwell Company, Inc., 140 Cedar street, New York City. It is essentially the taper plug type valve with certain refinements tending to keep it tight in the seat and to overcome sticking. The stop cock must be tight and free from pitting and grooving to prevent leakage. It is advisable to give a cock two or three turns instead of only a half or quarter turn, so that the plug will not wear excessively on one side.

In the case of the new plug, if it is too tight, it may be lifted out, but this should not be done unless absolutely necessary, for there is a chance of getting grit and gravel between the valve and seat. If this occurs the seat will be scored badly and leaking will result.

The stop cock is carefully packed on top with soft asbestos and sprinkled with dry graphite, both ends of the packing rings fitting close together. The top gland is then tightened so that the plug will barely turn, after which the bottom is packed in the same manner, the packing being drawn tight enough to release part of the pressure at the top. This equalizing of the pressure will enable the stop cock to turn quite freely.



Taper Plug Type Valve for High Pressure

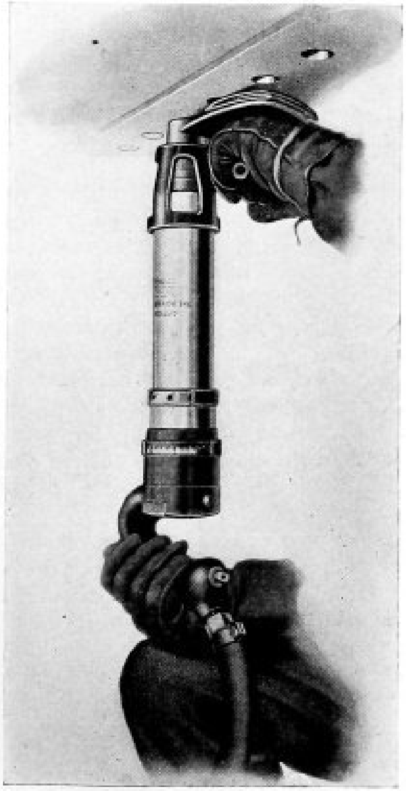
It is stated that, if handled with ordinary care, this stop cock will never give trouble, as both ends are packed and lubricated and move under the same conditions as a shaft in a lubricated bearing. If the valve sticks when not in operation, the gland at the bottom may be screwed up until the cock is released.

Device for Use on Pneumatic Riveting and Chipping Tools

A new attachment, known as the *Boyergrip*, for facilitating the handling of pneumatic riveting, chipping and calking tools, has been produced by the Chicago Pneumatic Tool Company.

The device fits over the muzzle of most makes and sizes of riveting hammers, to provide the riveter a firm, full hand control of the hammer without grasping the heated cylinder. It is designed with the intention of providing an unobstructed view of the work, as well as to eliminate the possibility of jammed or squeezed fingers. Because of this adjustability, left-handed and overhead work may be accomplished readily.

Device for Hand Control of Hammer Without Contact With Heated Cylinder



Device in Use on Close Work

On chipping and calking hammers it is claimed that the grip provides a comfortable hand-hold with perfect control at any working angle, as well as protection against the accidental shooting of the chisel and the danger of injury to the hand should the chisel slip from the work.

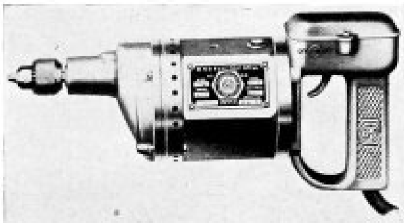
The New Duntley Lock for Air Hammers

Instead of the three parts usually found in locking devices for air hammers, the Duntley lock, recently brought out by the Duntley-Dayton Company, Chicago, Ill., consists of two parts only—a spring locking ring and a lock pin.

The new lock, the company claims, is more effective than the old as applied to both the riveting and chipping hammers. It can be easily manipulated when it is necessary to unlock and unscrew or adjust the handle, and is in line with the other improvements which are being made by the Duntley-Dayton Company to simplify the construction of air tools.

Portable Electric Trigger Switch Drills

The Black & Decker Manufacturing Company, 105 South Calvert street, Baltimore, Md., has recently placed two new one-hand drill models on the market. These drills, of 3/16-inch and ¼-inch sizes, are operated by the pistol grip and trigger switch method—a patented feature previously obtainable only in the larger size drills. Through this mechanism the current is controlled by the trigger without the necessity of changing the position of the hand which holds the drill. This arrangement has the additional advantage of preventing the breakage of drill bits, so often caused by sagging of the drill when the hand of the operator is withdrawn to turn the switch.



Black & Decker Portable Trigger Drill

These models are furnished with 1/6-horsepower motors with series compensated windings, and may be operated on any current from direct to 60-cycle alternating. Cooling is accomplished by the circulation of air through the housing by means of a vane impeller mounted on the armature shaft.

Oil Forge for Heating Rivets

An oil forge for heating rivets has been devised by J. T. Shepherd, plant plumber for the Pacific Coast Shipbuilding Company, San Francisco, Cal. It is claimed that backfiring is eliminated, and that a higher vaporization of the oil is secured by the use of this forge.

The main features are a valve in the air line and a needle valve in the oil supply pipe, with a mixing chamber formed of a 1¼-inch T, having a 1¼-inch nipple and a bell reducer.

A second mixing chamber above the first is formed of a 1-inch ell, supplied with oil from a 1½-inch T and a ⅜-inch nipple injector. Free oxygen is taken in with the vapor. A male hose connection obviates the necessity of using a leader.

In order to reduce the danger of damage to the forge, a stay plate protects the piping where the valves are controlled. The forge is also equipped with bleed valves, making it possible to clean out the tanks easily. Not only can the water be bled from the oil, but the bottom of the tank can be blown clean.

Questions and Answers for Boiler Makers

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

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *6 East 39th street, New York City.*

Layouts for 30-Degree Offset Pipes

Q.—Please publish the layouts for a 12-inch square pipe having a double angle offset, 30 degrees drop and 30 degrees horizontal. The outlet is horizontal and the inlet vertical. A curved elbow forms the inlet at the floor. The second layout is a round pipe 40 inches in diameter with a vertical inlet and a horizontal outlet at the top. The offset has a 30-degree drop and a 30-degree swing on the horizontal. The middle section is to be made of one piece and all sections must have the same diameter. N. H. S.

A.—These problems consist in finding the correct angles of the elbows. Probably the best method is to make me-

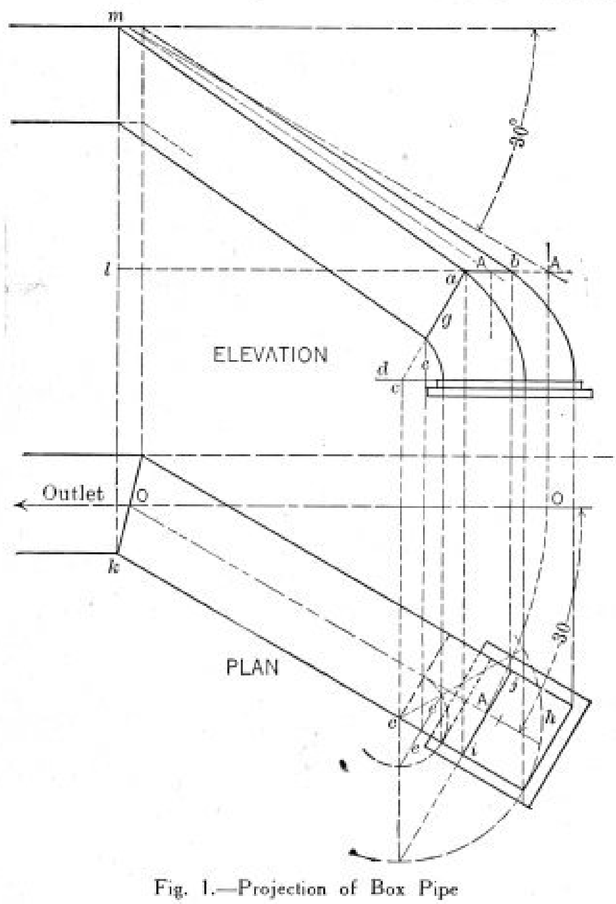


Fig. 1.—Projection of Box Pipe

chanical drawings of the installations, showing a correct side elevation and a plan for each. Fig. 1 shows such a drawing for the box pipe. Then from these drawings the patterns can be laid off directly and quickly on the sheets by triangulation without making any drawings of the patterns.

To make such a drawing, begin with the plan, which is very easily made by first locating the centerline *OA* with a 30-degree offset. On this centerline draw an outline of the pipe, making all of the three sections the same width. The intersections of the side lines of the connecting piece with those of the outlet will determine the line of the joint across the top of the pipe, and this line gives the true shape of the end of the horizontal top and bottom sheets. The front and back sheets of the outlet must be patterned from the elevation.

The correct elevation is not nearly so simple to make as the plan, and a special knowledge of projection is necessary in order to get it just right. In fact, the whole problem of these patterns is based on the making of the correct elevations in the mechanical drawing. First draw the horizontal centerline and the top and bottom lines of the outlet, making these full size, as in the plan. Then project the miter and the center point from the plan to the top line of the outlet. From these points the complete rectangular opening of the outlet as it would be shown in the projection is drawn.

From the top center draw a centerline with a drop of 30 degrees as according to the specifications. This will not be the true elevation of this line, however, as the line must be swung around 30 degrees horizontally. The distance that the projected centerline must drop from the 30-degree line is indicated by the horizontal construction line shown at *AA*. This distance is determined from the plan as follows:

Swing the point *A* on the centerline in the plan over into the outlet centerline at *O* and project the point on the elevation of the 30-degree line. Then move the intersecting point horizontally until it is over the point *A* started from the plan. (In the drawing the point *A* is the middle of the top joint line of the curved elbow. The location of this line of the plan is explained later.) The correct projected elevation of the centerline is then drawn. Projecting lines from each end of the elbow joint line in the plan will give the length *ab* in the elevation. The two upper edge lines are drawn joining the corners of the horizontal outlet of the upper corners of the elbows. Then the front and lower edge of the offset piece is drawn parallel to its upper edge.

It is necessary now to return to the plan view and do some construction work in order to get the elbow correctly projected in the elevation. First locate the center *c* of the curve of the elbow, which is 6 inches back of the outlet edge as per the specifications. Project this point to the elevation and then proceed to find the location of the horizontal line *d* that forms the foot of the elbow. From the center *c* describe an arc and draw a 60-degree tangent to it. (This construction has been laid off on top of the plan and below it, giving the layerout the choice of two methods.) From the point of tangency project a perpendicular. This construction gives the true projections and relations of the lines, where the inner curve of the elbow begins at the lower end of the bottom sheet. The perpendicular *d* is the height of the point of the elbow, and this may be laid off in the elevation over the point *e* in the plan, thus giving the corner and the base line *d* in the elevation. The line *g* finishes the outline of the connecting piece.

Also, from the center *c* lay off in the plan an arc *h* for the upper or outer edge of the elbow, and the perpendicular *ij* extended across the plan gives the location of the joint on the plan. The projection of this line in the elevation gives the top edge *ab* of the elbow. This line was also used to get the true projection of the 30-degree center-line as explained above. Finally, project the corners of the elbow from the plan to the base line *d* of the elevation for the edges of the elbow.

To get the true lengths of the edges of the offset for laying out the patterns, and the angle of the ends of the sheets, use the triangulation method. Thus, for the front edge of the top use the hypotenuse of a right angle triangle having a base *ik* and an altitude *lm*. In the same way use the respective horizontal and vertical projections to get the true lengths of the other edges. All the sheets have the same width. The curves of the sides of the elbows have radii of 6 inches and 18 inches respectively. The front and back sheets of the elbow are rectangles having a width of 12 inches and a length equal to one-sixth the circumference.

The drawing, Fig. 2, plan elevation and end view of the round pipe is made after the same method as described for the box pipe. The joints, however, are entirely different, and the connecting piece, if cut from one sheet, requires special attention. After making the three mechanical views, swing each joint around so as to get a correct view showing the true lengths of the lines. Then project the pattern lines from the miter line in the usual way.

Draw circles on each view and draw the division points, 1 to 12. Carry out this scheme in the correct views of the joints, noting that the division points must be advanced 30 degrees from the position shown in the mechanical views. After making the layout for the lower joint, make that for the upper joint immediately above it, shifting the division points 30 degrees ahead, as shown. The patterns for the upper and lower sections would be inverted duplicates of those for the ends of the connecting piece.

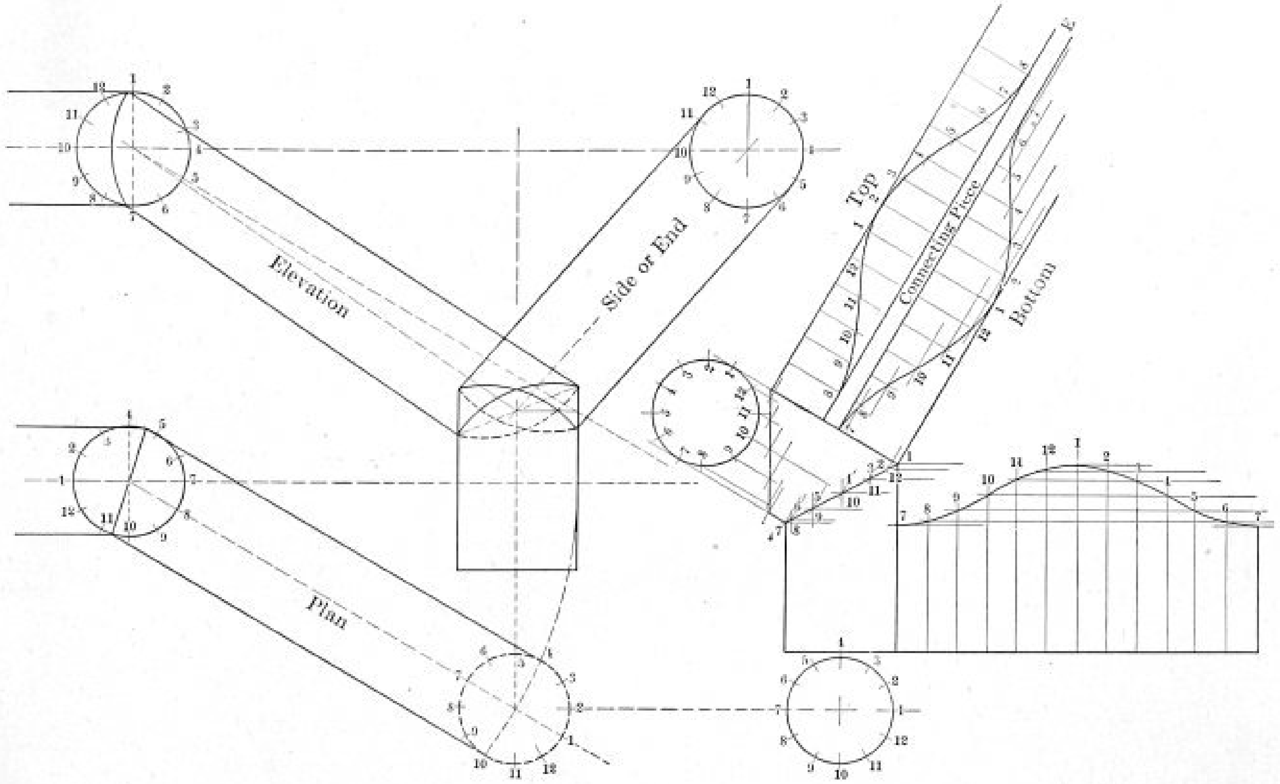


Fig. 2.—Projection and Pattern for Circular Pipe

Straightening Buckled Plates or Sheets

Q.—By what means and methods are buckled plates and light sheet iron flattened or straightened out? Very often this work is required, but I have never had it properly explained. O. M.

A.—Sheet or plate steel and iron will buckle as shown in Figs. 1 and 2. In Fig. 1 the buckle is at the middle of the sheet and the edges are straight; and in Fig. 2 the edges are bent and the center is straight. A third form may be a combination of the two.

For heavy plates, straightening rolls are used; but where such rolls are not installed, the ordinary bending rolls may be employed instead. It requires more time to straighten plates in ordinary rolls than in the straightening rolls designed for this purpose. The plan followed in the use of the bending rolls is to pass the plate through the rolls several times and reverse the sheet end for end at each operation. The rolls reduce the buckles to a smaller size, finally thinning them out flat. Observing the effect of the rolls in the flattening operations, pointers will be had for doing the work by hand.

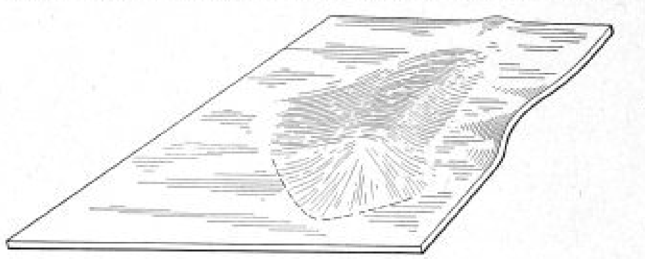


Fig. 1.—Sheet Buckled in the Middle

For flattening light sheet iron or plates, suitable sledges, mauls and a flatter must be employed. The following explains the way to take out the buckles in a sheet as shown in Fig. 1. The weight of the sledge and strength of the blows required depend on the thickness of metal. It is better to strike light blows until one fully understands the nature of the work. In the sketch Fig. 1 is shown a dotted line about the edge of one extremity of the buckle. The hammer blows should be heaviest along this line, gradually decreasing in weight to practically nothing at the top of the buckle. Working the buckle out in this

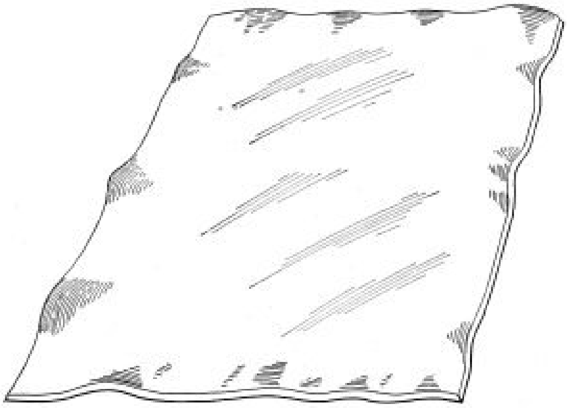


Fig. 2.—Edges of Plate Warped

manner, no other buckles will be made; whereas if the heaviest blows are struck at the top or center of the buckle, the result is that additional buckles are made, making the sheet worse than before.

For the sheet Fig. 2 the same process is employed, except that the work is carried on from the middle of the sheet to the edges. For very light sheet iron the blows should be struck on a flatter, as otherwise dents or cuts from the hammer or sledge will result.

Rivet and Tube Features

Q.—Would you kindly answer the following questions:
(A) Which of the two rivets shown is the most serviceable for general purposes, a snap rivet put in by hand, as shown at (a), Fig. 1, or a raised countersunk rivet driven into the hole by hand and a ring put around it with a snap, as shown at (b)?
(B) Which tube is the most serviceable, a tube in which the end is expanded and beaded as at (a), Fig. 2, or a tube in which the end is expanded and then thickened or staved up, as shown in Fig. 2 at (b)? These tubes are superheater flue tubes, 4 inches in diameter, and are in the firebox of a locomotive having a copper tube plate. W. T. M.

A.—The "cup" or hemispherical head Fig. 1 (a) is considered the best form for general boiler work. The head is stronger than the countersunk head and will stand a greater load when subjected to tension stresses. It is easier to drive, requires less time to form than the countersunk head, no calking is necessary when the head is properly driven, no countersinking is required, which weakens

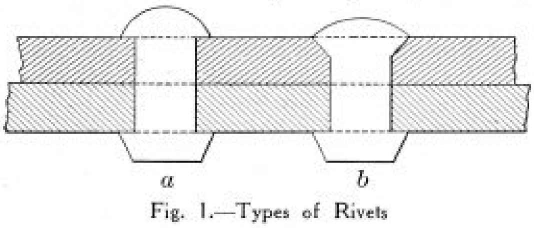


Fig. 1.—Types of Rivets

the plate. It is easy to calk, if necessary, as the head provides a good calking edge and can be removed readily if repairs are needed. The head must be formed or driven so that it is concentric with the shank, otherwise a weak rivet will result.

This type of rivet head cannot be employed where overlapping seams are very close together, and it is not as suitable as countersunk rivets for seams that come directly over the fire, for the head would soon burn off. For very large rivets driven by hand, the head is difficult to form, as the metal cools quickly.

The countersunk rivet (b), Fig. 1, is suitable for seams that adjoin each other where it is necessary to have them flush with the plate surface in order to allow clearance between the connecting parts. For seams directly in contact with the hottest flames and gases, as the head will not burn away like the cup head, larger rivets can be driven to better advantage.

Its drawbacks may be summed up as follows: It requires extra time and preparation to countersink the rivet holes in the plate and to drive them; they are difficult to

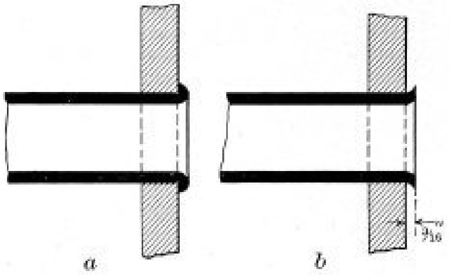


Fig. 2.—Proper and Improper Tube Expansion

remove in case repairs are needed and if a faulty rivet must be replaced; the head is not easily calked, as no calking edge is provided; it is not as strong as a cup head.

The common American practice in installing locomotive boiler tubes is to expand the tubes and bead them over in the firebox, as at (a), Fig. 2. The front end is either beaded or flared out as at (b), Fig. 2. The beaded tubes make a neater appearance, while the efficiency and holding power are increased as well. Tubes do not burn away as readily when beaded.

Riveted Joint

Q.—To what extent, if any, has the middle row of holes weakened the joint? The holes are punched but not used; the inner and outer row are riveted as in any other plain lap joint. C. J. V.

A.—If three rivets, Fig. 1, were used in one pitch, then the joint would be subject to the following method of failure:

1. Shearing of three rivets.
2. Breaking the net section of the plate between rivets.
3. Breaking of net section of plate between rivets in

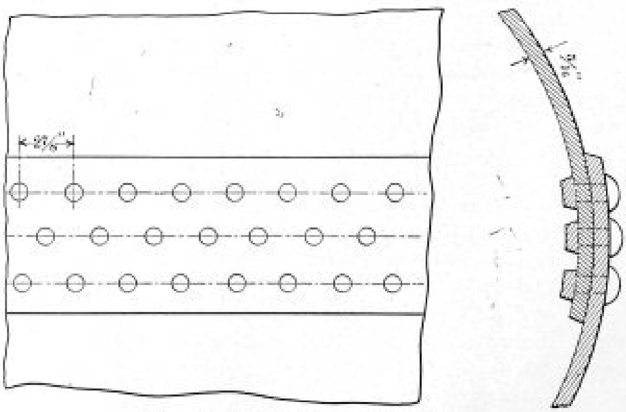


Fig. 1.—Triple Riveted Lap Joint

inner row and shearing of rivets in either of the outer rows.

4. Crushing or shearing of the plate in front of rivets in either of the outer rows.

When two rivets, Fig. 2, are used, as in your example, then the joint may fail from any of the following:

1. Breaking of section of plate between the blank rivet

holes in the center row or between rivets in the outer rows.

2. Shearing of two rivets.

3. Crushing or shearing of the plate in front of the rivets.

Calculating for the efficiency of the joint in Fig. 1, we find that for the rivet efficiency, assuming the following data:

Plate thickness	5/16 inch
Tensile strength, taken at	55,000 pounds
Rivets, size	11/16 inch
Hole, size	¾ inch
Pitch of rivets	2⅞ inches
Diameter of boiler	48-inch plain lap joint

$\frac{3}{4}^2 \times 0.7854 \times 38{,}000 \times 3 = 50{,}364$ pounds shearing strength of rivets.

$2\frac{7}{8} \times 5/16 \times 55{,}000 = 49{,}414$ pounds tensile strength of plate.

$50{,}364 \div 49{,}414 = 100.19$ percent rivet efficiency.

$$\text{Plate efficiency} = \frac{2.875 - \frac{3}{4}}{2.875} = 74 \text{ percent.}$$

The strength of plate in front of the rivets to resist a crushing stress is greater than for the strength of the other parts of the joint just considered.

In Fig. 1 the efficiency of the joint is based on the rivet

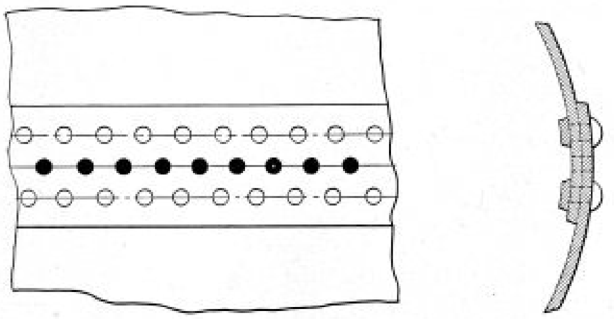


Fig. 2.—Same Joint With Center Row of Rivets Omitted

efficiency, which in this case is the weakest, as

$\frac{3}{4}^2 \times 0.7854 \times 38{,}000 \times 2 = 33{,}576.04$ pounds.

$33{,}576.04 \div 49{,}414 = 67.94$ percent.

These calculations show that by leaving the rivets out of the center row the joint efficiency is reduced 6.06 percent:

$$74 - 67.94 = 6.06 \text{ percent.}$$

From a practical standpoint the joint, Fig. 2, is not good design; the distance between the rows is too great, making it difficult to calk a tight seam. The rivets are laid out in a staggered design, while if the middle row is left out, they form a double-riveted lap, resulting in too great a pitch between rivets.

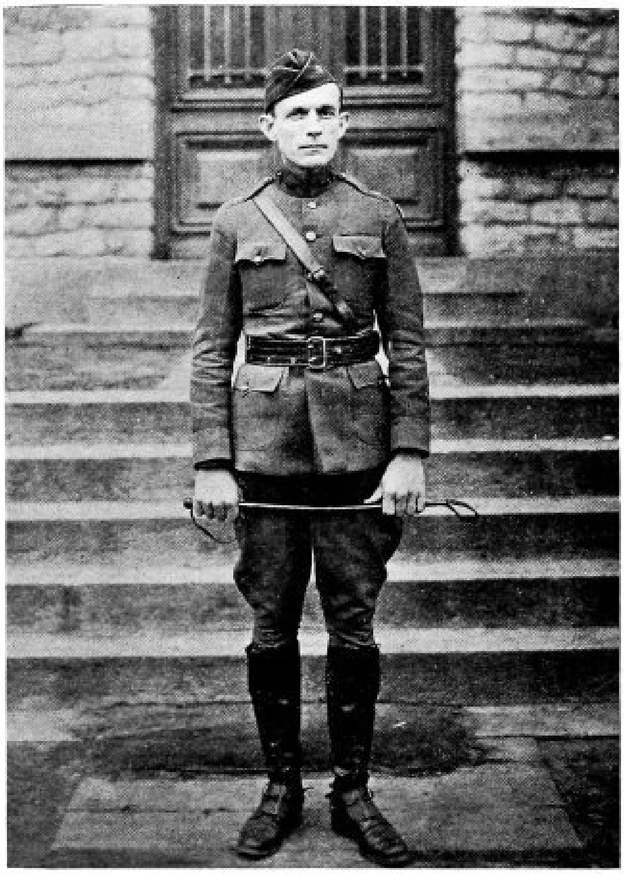
PERSONAL

Claude E. Lester enlisted August, 1916, in the machine gun company of the 13th Pennsylvania Infantry for an expected campaign of three or four months with the punitive expedition in Mexico with Pershing. On the opening of hostilities with Germany he was still retained in the service and but recently discharged after over three years of active service.

Shortly after enlistment he was made first sergeant of the company, and then jumping the grade of second lieutenant was made first lieutenant of infantry in October, 1916, while in service on the border, and assigned to the machine gun company of the 13th Pennsylvania Infantry in the service of the United States. On the break-up of the old 7th Division he was transferred to the 108th Machine Gun Battalion and later to the 109th Infantry.

In March, 1918, he was recommissioned to the grade of first lieutenant of engineers and assigned to the 50th Engineers, organizing that unit, taking it abroad and being its commanding officer during its entire life, passing from the rank of first lieutenant through that of captain to major in July, 1918.

The 50th Engineers was a regiment of maintenance of equipment men, specially inducted into the service or specially selected from the several camps by Major Lester



Major C. E. Lester, of the 50th Engineers, U. S. A.

and made up almost entirely of highly skilled mechanics in the many trades necessary to make up a shop organization.

In addition to duties as commanding officer of the engineer regiment, he was also general foreman of the Nevers Shops, probably the most attractive and up to date in Europe. He was made assistant superintendent of shops and later made general superintendent of the 19th Grand Division Transportation Corps and superintendent of the Nevers Locomotive & Car Shop, being relieved from this duty in July, 1919, by reason of the cessation of activities. He then returned to the United States and was assigned to the Motor Reconstruction Park at Camp Holabird, Baltimore, Md., and but recently discharged to return to civil pursuits.

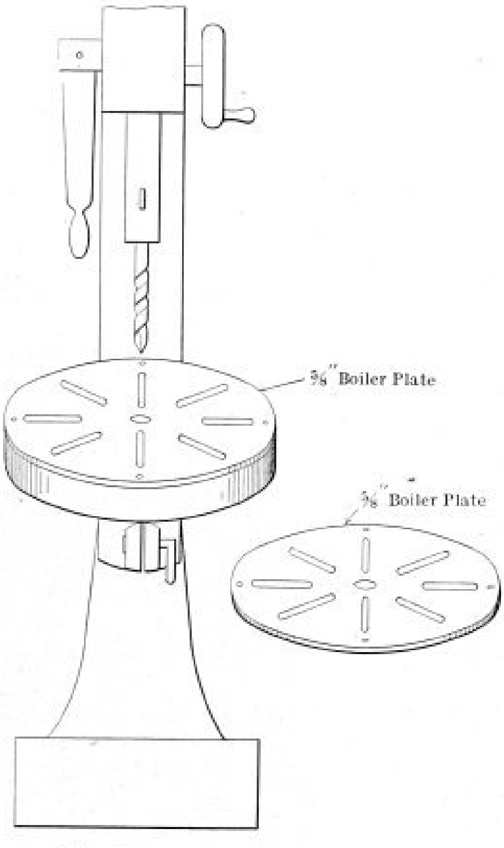
The Chicago Pneumatic Tool Company announces the removal of their Cincinnati office from the Mercantile building to the Walsh building, Pearl and Vine streets, Chicago, where a service station with a complete stock of pneumatic tools, electric tools, air compressors, oil engines, rock drills and repair parts will be maintained.

Letters from Practical Boiler Makers

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

Drill Press Table Pad

The shop foreman used his thinking cap the other day when a new drill press arrived, for he would not allow it to be operated until a special table pad or false top of 5/8-inch plate had been made and put on, as is shown in the



False Top to Protect Drill Press Table

sketch. The idea is one that can be made use of by other readers, so it is sent along for their mental note books.

When any really accurate work is to be drilled it is but a few minutes to take off the false top, and then there is the unscratched new top. One has only to note some of the abused drill press tables to realize the value of this idea.

Punching Telltale Holes in Staybolts

Having in mind the number of staybolts which can be punched per day, as compared with those produced by the drilling method, one naturally considers the punching method as by far the more economical. Such is not the case, however. All items considered, the costs of the two methods are very nearly the same. When the telltale hole is drilled the cost should include the labor, the cost of the power to run the machine, the value of drills, the cooling compound for the drill, the depreciation and interest on machine value and the proportionate cost of the shop space.

Against these items, for the punching method, we must include the labor cost of a forging machine operator, who is generally a high-priced mechanic, and his helper, the cost of fuel oil, the cost of power to operate the forging machine, the cost of a fan blast for the furnace, the upkeep for the furnace, the depreciation of machine and furnace value and the proportionate cost of shop space.

From this comparison it is noticeable that the punching method does not save to any marked extent the total average cost per bolt.

Another item which has not been considered, and which has an important bearing on the first cost, is the life of the bolt or the length of service the punched bolt renders as compared with the drilled bolt. A study of the advantages and disadvantages of punched bolts brings out some interesting points. What becomes of the metal when the hole is punched? The original diameter of the bolt does not increase. Neither is it elongated by the operation. Does heating affect the life of the metal? These and many other questions were put up to us to answer in defense of the punching method.

A service test was made on a staybolt installation by applying a row of hot punched bolts, a row of square sheared bolts which had been drilled, and a row of bolts cut off in the turret lathe and drilled before application. The bolts were all applied from the inside of the boiler and driven up by a gang who did not know that a test was being made. After driving up, the hot punched bolts had a far better appearance, while it also showed that the hot punched bolts lasted the longer. This, then, is the real value of the hot punched bolts that it will stand up in service.

The punch used should have at least one-sixteenth taper, in order that it can be withdrawn easily after the punching operation. The total number of bolts which can be punched with one punch should average between six and eight thousand. A number less than this can usually be traced to some mechanical defect in the machine itself or the improper heating of the bolt. The bolt should not be heated to a white heat. A cherry red indicates that the material is sufficiently hot for the punching operation and apparently has no bad effect on the life of the metal. A stream of water should run on the punch during its return stroke after each punching operation. Of course, the countersink and punch are made from the same piece. The punching operation includes, also, the countersinking of the bolt at the same stroke of the machine.

The hot punched bolt does not require any opening up after being driven if ordinary care is exercised during this operation; an exactly centered hole is assured.

Where the solid bolt is used, the points in favor of the hot punched bolt are longer service, elimination of trouble from broken drills being left in the hole, and accurately centered holes.

Rutherford, N. J. H. L. BURRHUS.

D. W. Phillips, who during the greater portion of the late war was employed by the United States Shipping Board Emergency Fleet Corporation, has recently been released by the Shipping Board to the Ruemmeli-Dawley Manufacturing Company, of St. Louis, to take up the duties of superintendent of the boiler department of their plant.

Inspection of Lancashire Boilers

The inspection of a Lancashire boiler is, on the whole, simpler than that of the locomotive type. Special points to be observed are: If the boiler has flanged ends, it is necessary that they be circular. A maximum eccentricity of 1 inch must not be exceeded and the flange should not have a small radius. The great stress that comes upon an eccentric dished end when the boiler is under pressure does not require comment. The eccentricity commonly arises through the flanging of the flue holes, known as "bunging" in English shops, after the flanging of the periphery. The latter is then drawn to the "bung" holes.

The flanges of the flues should not be less than 1 inch in radius and the snap should not on any account be allowed to cut in. This is a point that is too often disregarded.

The welding of the flues must be carefully examined for soundness.

The relative lengths of the flues and the barrel must be checked before riveting.

Drilling is usually done in position save for the tack rivets, but the alining of all holes should be checked before the riveting is commenced and the sizes of the rivets noted.

Deflection of the ends should be recorded and no permanent deflection permitted.

In a dished end it is vitally important that the radius of the dish be constant all around.

In a flat end boiler some of the rivets in the gusset plates are not infrequently found to be loose after the cold test. This is a point likely to be overlooked by an inspector who has not been advised of it. (Incidentally, it demonstrates the unsuitability of hot rivets to carry a shear stress.)

Finally, plate thicknesses should be checked with the press and no calking with a narrow tool be allowed.

Lincoln, England. A. W. Penim.

Covering Sections of the Boiler Exposed to Hot Gases from the Combustion Chamber

In the July issue of The Boiler Maker appears a letter by Glenn Lacey on "Some Ideas on Making a Tubular Boiler More Safe and More Efficient." Suggestions are made in this article for covering the shell where it is exposed to the fire in a manner similar to the protection used for the blow-out pipe in the boiler.

In my opinion such a wrapping would not be practicable, as there is considerable difference in the exposure a blow-off pipe undergoes and the shell above the fuel bed, where a heat of about 2,500 degrees is consistently maintained. If a crack should develop and the heat be concentrated at such an exposed point, more trouble might result in causing the boiler to bag than if the wrapper were not used.

If repair expenses are to be kept a minimum, I believe that a Dutch oven furnace or one of high section will both increase the operating efficiency and minimize the cost of upkeep while practically eliminating the danger of fire cracks in the girth seams. Anyone contemplating the purchase of new boilers would do well to consider the two-course type where the girth seam is sufficiently behind the bridge wall to practically do away with danger from cracks, which have always been a source of annoyance in tubular boilers having a low setting.

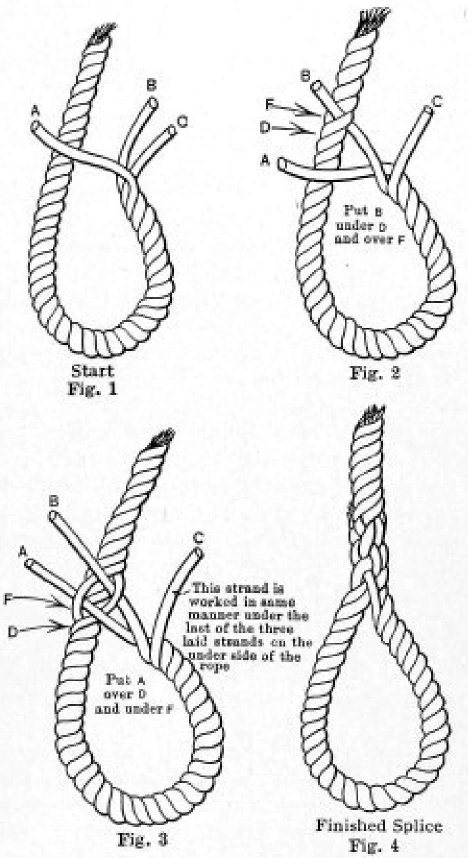
It has been my experience during many years of inspection that tubular boilers used at 120 pounds pressure will last twenty-five and thirty years, and even forty or more, at lower pressures. Pressures of 150 pounds need not necessarily cause trouble if the boilers are given adequate attention. Insurance companies and inspectors will no doubt bear out the statement that there are vastly more accidents to watertube boilers than to the tubular type, although they are theoretically less liable to serious explosions. In recent years the worst accidents in the case of watertube boilers have been caused by the failure of bumped heads.

Williamsport, Pa. P. J. Lyons.

Making an Eye-Splice

This is a trick that few men have got the hang of, yet it is simple and something that is very handy to know. Often it is desired to have an eye in the end of a line, and if one will carefully read these instructions and study the sketches and then practice on a piece of line the stunt can be easily learned.

Take the line or rope and start in Fig. 1 by untwisting the three strands. Bend the rope around to measure off



Various Stages in Rope Splicing

the size eye you wish, and at the place you want the splice lay over strand *A*, then lift strand *D* of the laid rope, as in Fig. 2, and tuck it under the end of strand *B*. For lifting the strands of the rope a pointed round stick is needed. After passing strand *B* through, take strand *A* and tuck it through the laid strand *F*, passing it over *D* as shown in Fig. 3. Follow the same method with the last strand *C*, lifting the last laid strand of the rope and tucking C under. Now pull the ends of the strands up snugly to the standing part of the rope, and then repeat the process of tucking the ends through again in the order described. This is done in all three times, and then the splice will be complete. The finished splice will look like the sketch, Fig. 4.

Defective Rivets

As an unequaled object lesson which should be seriously taken to heart by every practitioner in the art and trade of boiler making, the rivets illustrated on page 213 of the July (1918) issue will serve a more useful purpose than when placed.

The writer, who takes every available opportunity when cutting up operations are in progress, is not surprised at the photograph. But for the fact that housewives are prejudiced against the preservation of such curiosities and always take the first opportunity of clearing such curiosities out of existence, the writer would have by now a pretty considerable collection. Tools are bad enough, but they have some resemblance to articles of utility; odd lumps of iron are no ornament to any home. As a consequence, when looked for they are missing.

The standing marvel is that the pressure vessels made by past enterprise, still praised by the older generation of mechanics, and containing such convicted criminals as those illustrated, should have served the length of time which, in many instances, their scrap condition testifies. The risks run by those who operate and those in the near vicinity—to say nothing about the safety of the public at large—have been considerable, by reason of some individuals' want of conscience in boiler making. The evidence is in the illustration in the July issue. No ordinary factor of safety over the drawing board will be sufficient to cover such workmanship. The illustration is a more cogent argument than any other for position drilling *in situ* which the present writer can advance.

Will someone please controvert the statement that the holes were out of correspondence and blame hydraulic closure for these specimen results? The five sorry specimens point a moral and adorn a tale, for certainly their own tails are no adornment. As specimens of tortured material to show quality of rivet, they serve admirably and are an advertisement for the rivet maker.

Is it any wonder that statutory rules, trade restrictions and close supervision have been found desirable in the public interest to prevent such individual enterprise as that shown? Does it not seem desirable, seeing that so much hangs upon workmanship, that a boiler maker should be licensed as such, just as a certificate of competency is required by law of a marine engineer? The handicraft of boiler making should only be allowed in competent hands, just as the plumber in Great Britain has to be registered, since public health is to a large extent in his custody.

Any trained observer watching the process of dismemberment in a scrap iron yard finds rivets which drop out of the holes at a touch or defy the seven-pound sledge and drift set after the heads are removed. These are ancient boilers, remember, which do not get into the custody of the scrap iron dealer until they are at least a score of years old.

The ancient boiler has, however, still considerable utility; it makes, after suitable repair, excellent storage tanks for fluid; if even past this state, cut up and treated with the shears (justified up to the hilt in this connection) the resultant wrought iron scrap is one of the finest raw materials extant. Its normal price was by no means despicable—ten years ago $24 per ton was a usual figure. To-day the advertisement headings in Great Britain bear some striking posters issued by scrap iron dealers who appeal for discarded plant, to be used ultimately in some shape or other as munitions.

The price paid to the seller is tempting, the profit to the dealer considerable, the spirit of conservation above suspicion—so that the enterprising scrap dealer is doing a brisk trade. Thus there is at the moment an unequaled opportunity to view the anatomy, otherwise the workmanship, of former generations.

The rivets illustrated are fair specimens of numbers removed at the present time due to the above circumstances.

Heavy wrought iron scrap like boiler plate, rivets and crane chain receives its best subsequent utility when piled into blooms for forge treatment under the hammer. To use it otherwise than for forgings of special character is not good economics. The quantity of such material available grows steadily less, while its need grows greater. Marine shafting, locomotive forgings and horseshoes are unequaled when made from such material.

Rivet, pan head, maltreated and deformed, misshapen and abused when in its original location, which it never filled adequately, finds itself at last incorporated somewhere in a position of real responsibility to perform a fitting duty.

As a portion of a steamer's propeller shaft, the weigh shaft of a locomotive, on the hoof of a cavalry horse, not to mention more active military duty, the abortion made by some alleged boiler maker becomes an integral unit in the chain of circumstances leading to the filling of the present steel shortage.

London, England. A. L. Haas.

Use of the Graduating Wedge

When applying a patch to the outside or inside surface of the barrel of a boiler or tank, we usually have an odd part of the circle to consider in regard to making the necessary allowance for the "take-up," as it is commonly called by boiler makers. This deviation in the length of the straight sheet is due to the neutral line of the material not making direct contact with the surface to which the patch is to be applied. When there are holes in the boiler or tank, and we wish to punch these in the flat sheet, so that bolts can be put in and the patch drawn down tight, it is essential that the proper amount of length be added when the patch goes outside, or subtracted when it goes inside the boiler. This length is put on, or taken off, in

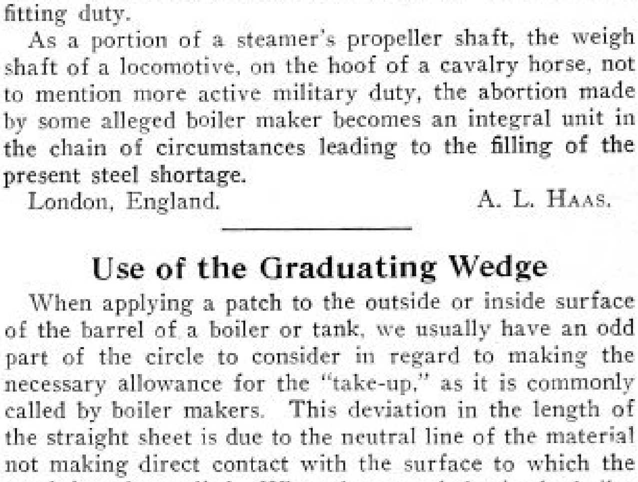


Fig. 1

proportion to the distance around the boiler, or the part of the circle that our patch has to cover.

When the entire circle is taken into consideration, we take for the allowance 3.1416 times the thickness of the patch. But the full circle is also 3.1416 times the diameter of the boiler, so we must conclude that the ratio of the full allowance to the full circle is the same as that of one thickness to one diameter, because $\frac{3.1416d}{3.1416t}$ is equal to $\frac{d}{t}$, in which d is the diameter of the boiler and t the thickness of the patch.

What if the patch does not reach exactly one diameter length around? In this case we take half a diameter and half a thickness, and still have the same fraction as above —and here is where the "graduating wedge" gets to work. For any other fractional part of the circle, no matter whether the holes are equally spaced or not, the wedge will give the correct location of each hole. The advantage is with the layer-out, when his tools do the figuring; but this is what the "graduating wedge" is made for, and it will do the work.

Fig. 1 shows the wedge tool with its sliding edge setting against the straight-edge. The sliding edge is made of ⅛-inch steel, shaped as shown to carry the wedge, which is made of 1/16-inch steed. The two pieces are riveted together with a 5/16-inch rivet, flattened on the under side of the wedge so the wedge will lay down flat on the plate. The sliding edge is offset upward for the same reason.

The wedge is 12 inches long, being 1½ inches wide at the end *B-C*. This makes it ⅛-inch wide for each 1 inch measured from the point *A*. These inch marks are numbered 1-2-3, etc., and show the width of the wedge in eighths of an inch.

The half-inch marks are marked also, but not numbered. These are short marks and give the width of the wedge in sixteenths of an inch. After using the tool a few times the rest will come easy. For thirty-seconds, we go between. In boilers we never work closer than this, our two-foot rule being graduated only to sixteenths.

To illustrate the use of this tool, let us start on a job such as putting a reinforcing plate inside the barrel of a boiler, over the holes for the tee iron. The neutral line,

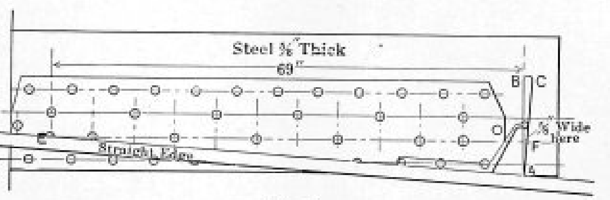


Fig. 2

commonly taken as the center of the material's edge, is near enough for nearly all boiler work, and in this job it is less than the surface to which the plate makes contact; so from the foregoing we must take off one thickness of the reinforcing plate for each diameter length around the boiler that the plate has to cover. Suppose the diameter of the boiler inside at the point to be reinforced was 69 inches and the thickness of the plate ⅝ inch. We now turn to Fig. 2, which is made as follows:

First see that the boiler is thoroughly scaled and swept out clean and all burrs hammered smooth or chipped off. Also see that any studs sticking into the boiler are chipped off, so the plate will bear on smooth surface.

Next get a sheet of paper large enough to cover all holes to be put in. We sometimes paste two or three pieces together when we get a very large job. Lay the paper in the boiler over the holes very carefully (it should lay down smooth); then cut out all the holes full size. Also spot any studs that have been chipped off, so they do not come near the rivet holes.

We must have a sketch showing how much extra surface to cover; and, having drawn the lines on the plate, spot the first hole as *E*, Fig. 2. Then lay on the paper over the lines for the tee-iron holes and mark all holes full size. Now to allow for the "take-up" on these holes, take from the first hole *E* 69 inches to the right to *F*. The holes do not reach that far, but this is done to set the tool. Lay a straight-edge so the upper edge comes over point *E*, while at the right end it inclines away so that when the wedge tool is placed against it the 5 mark will fall upon line *E-F* at a distance of 69 inches from *E*.

It can now be seen that when the tool slides up the incline to the left it diminishes the width of the wedge in proportion to the distance it is moved. Referring to Fig. 1, consider hole *G* perpendicular to *E-F*. The side *a-b* sets 90 degrees to *E-F*, the side *a-c* cuts the intersection, and the wedge locates *H* as the exact place for hole *G*. In a similar manner, any hole in Fig. 2 could be corrected to its "take-up." The line *I-J* shows that *H* must be moved parallel from *G*—that is, when setting holes "back" always keep parallel to line *E-F*.

There are many other uses for this tool after one gets familiar with its operation. When there is a washout flange taken into the reinforcement, we generally work each way from the center, taking half a diameter and half a thickness to set the tool; then the holes for the flange are so near the center that they don't have to be changed very much, and we get them by comparing with the holes that come perpendicular to each upon the tee-iron rows.

The other holes shown in Fig. 2 are marked from the blue-print or a sketch, but if there are any studs in the boiler which would interfere with the rivets, these being spotted in the paper pattern, would give a chance to move the rivet holes and avoid trouble.

The rivet in the tool makes it possible to set the side *A-B* at a right angle with the rivet lines. The 69-inch line, Fig. 2, must be drawn at right angles with the line *E-F* before setting the tool, as this gives a chance to swing the wedge. All lines drawn along side *A-B* will be perpendicular, while the side *A-C* at each setting makes contact with an intersection of a perpendicular line and line *E-F*. It takes but a short time to set the tool after one is accustomed to its use.

Columbus, Ohio. PHILIP NESSER.

Announcement of the International Machinery Exposition, to be held in the Grand Central Palace, New York city, has been made by the Merchants and Manufacturers Exchange of New York. This is to be one of the most advanced steps made in the machinery industry since the war ended, and will be a permanent affair. October 15, 1919, is scheduled as the opening date, at which time it is expected that hundreds of machines will be in actual operation on the floor. The exposition will occupy 50,000 square feet of floor space in the high structure, which is the largest exposition building in the world and will include a most comprehensive display of modern engines, lathes, milling machinery, planers, drills, screw cutters, presses, boring, wood-turning machines, etc.

Lloyd L. Warfield is manager of the machinery exposition and will be assisted by an able staff. Inquries should be addressed to the Grand Central Palace.

L. E. Strothman, who for several years has been manager of the steam turbine and pumping engine departments of the Allis-Chalmers Manufacturing Company, is leaving that firm to become vice-president and general manager of the Richardson-Phenix Company. He has been connected with the Allis-Chalmers Company since 1902, and prior to that with the Filer & Stowell Company and the Nordburg Manufacturing Company.

He is a member of the American Society of Mechanical Engineers, having held the chairmanship of the Milwaukee section during 1915 and 1916.

Selected Boiler Patents

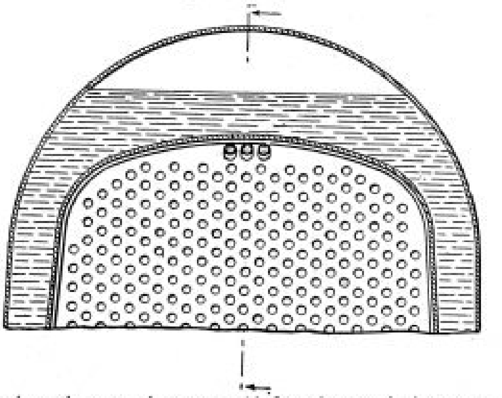
Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney, Washington Loan and Trust Building, Washington, D. C.

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

1,301,692. BOILER SAFETY TUBE. VICTOR HANSEN, OF WALLACE, IDAHO.

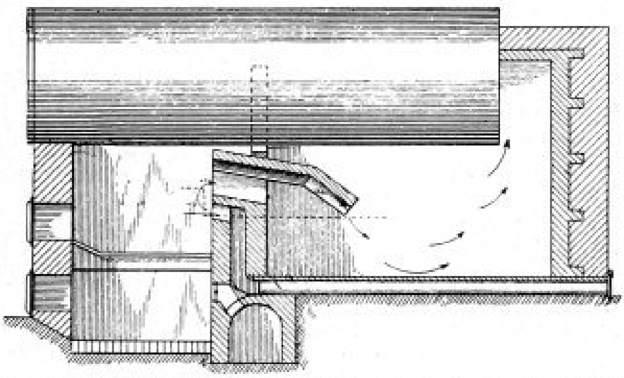
Claim 2.—In a steam boiler having a firebox, a safety tube disposed longitudinally in the firebox of the boiler adjacent to the crown sheet, and extending at its ends through the flue sheet and door sheet of the boiler to communicate at both its ends with the water space of the boiler, that end of said safety tube adjacent to the flue sheet being



offset to clear the seam between said flue sheet and the crown sheet, and the opposite and having a downward bend of greater extent than at the first-mentioned end and adapted to accommodate a protecting brick between said safety tube and the seam formed by the crown sheet and the door sheet. Three claims.

1,293,845. BOILER FURNACE. WILLIAM J. MANHIME, OF KANSAS CITY, MISSOURI, ASSIGNOR TO COMBUSTION SPECIALTY CO., OF KANSAS CITY, MISSOURI, A CORPORATION OF MISSOURI

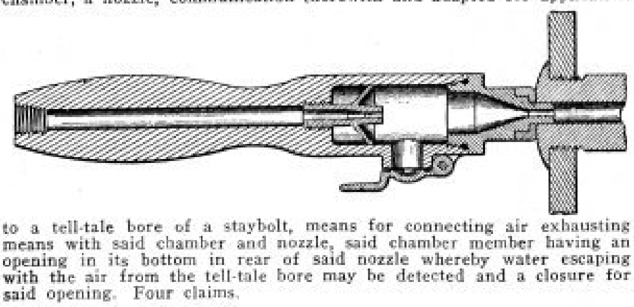
Claim 1.—A boiler furnace including a bridge wall, a grate, a fire box and an ash pit in front and a combustion chamber in the rear of the bridge wall, the bridge wall having an upper extension running



rearward into the combustion chamber, and a constricted passage spaced from the boiler and above the plane of the grate and establishing communication between the fire box and the combustion chamber below the said extension of the bridge wall; the furnace having an air duct for supplying heated air to the constricted passage and a controlled flue for supplying air to the ash pit for passage up through the grate. Two claims.

1,298,416. STAYBOLT TESTING DEVICE. BENJAMIN E. D. STAFFORD, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

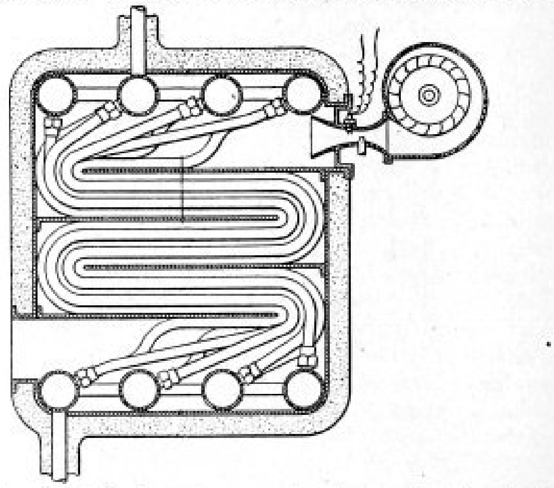
Claim 1.—A staybolt testing device, comprising a member having a chamber, a nozzle, communication therewith and adapted for application



to a tell-tale bore of a staybolt, means for connecting air exhausting means with said chamber and nozzle, said chamber member having an opening in its bottom in rear of said nozzle whereby water escaping with the air from the tell-tale bore may be detected and a closure for said opening. Four claims.

1,298,184. STEAM GENERATOR. WILLIAM A. DOBLE, WILLIAM A. DOBLE, JR., AND JOHN A. DOBLE, OF SAN FRANCISCO, CALIFORNIA, ASSIGNORS TO DOBLE LABORATORIES, OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF CALIFORNIA.

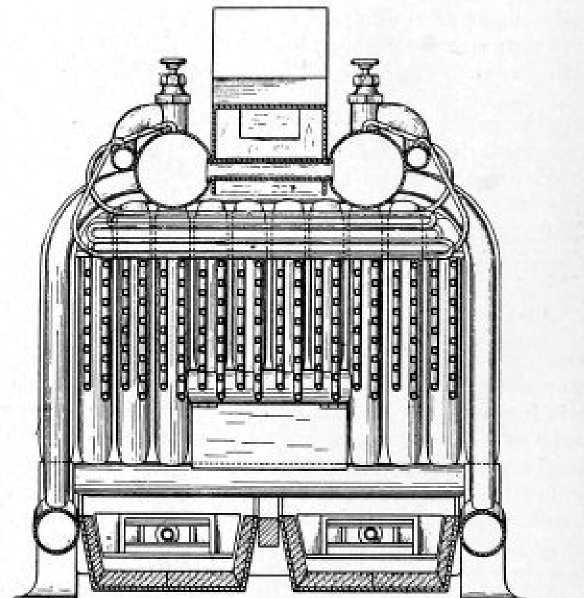
Claim.—In a steam generator, a casing, a steam header arranged within the casing at the top thereof, a water header arranged within the casing at the bottom thereof, tortuously bent tubes arranged to



pass back and forth in the casing connecting the steam header with the water header, the upper return convulsion of said tubes being spaced from the steam header a greater distance than the successive convolutions are spaced from each other, forming a combustion chamber, and a burner arranged to protect a flame into said chamber. One claim.

1,293,644. WATERTUBE BOILER. PATRICK J. HEALY, OF SAN FRANCISCO, CALIFORNIA.

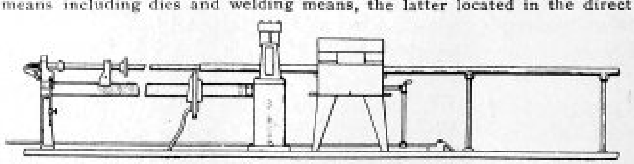
Claim 1.—In a watertube boiler a pair of side mud drums, a pair of superposed steam drums, the side mud drums being located considerably beyond the outer sides of the respective steam drums, a series of vertical side tubes connected at their lower ends to the mud drums



and having their upper ends curved inwardly and connected to the outer sides of the steam drums, intermediate tubes connected at their ends to the inner sides of the respective steam drums and arranged between the ends of the latter, horizontal end tubes connected at their ends to the respective steam drums, end mud drums connecting the side mud drums, and vertical head tubes connected to the horizontal end tubes, to the steam drums and to the bottoms of the curved upper ends of the endmost vertical side tubes. Four claims.

1,293,836. APPARATUS FOR RECLAIMING BOILER-TUBES. JOHN T. McGRATH, OF BLOOMINGTON, ILLINOIS.

Claim 1.—Means for welding tube sections together comprising heating means including dies and welding means, the latter located in the direct



line of the heating means, whereby two joined tube sections may be shifted directly from the heating means to the welding means, and an axially movable mandrel associated with the welding means, combined with a stop on the mandrel for locating the welding point between the hammer dies and the welding means. Seventeen claims.

THE BOILER MAKER

OCTOBER, 1919

Work in the Staten Island Shipbuilding Company's Boiler Shops

Several photographs of the boiler shops of the Staten Island Shipbuilding Company, which were not available when the article appeared in the August issue of THE BOILER MAKER, may prove of interest to our readers, for they show very well how the production is carried on in this plant.

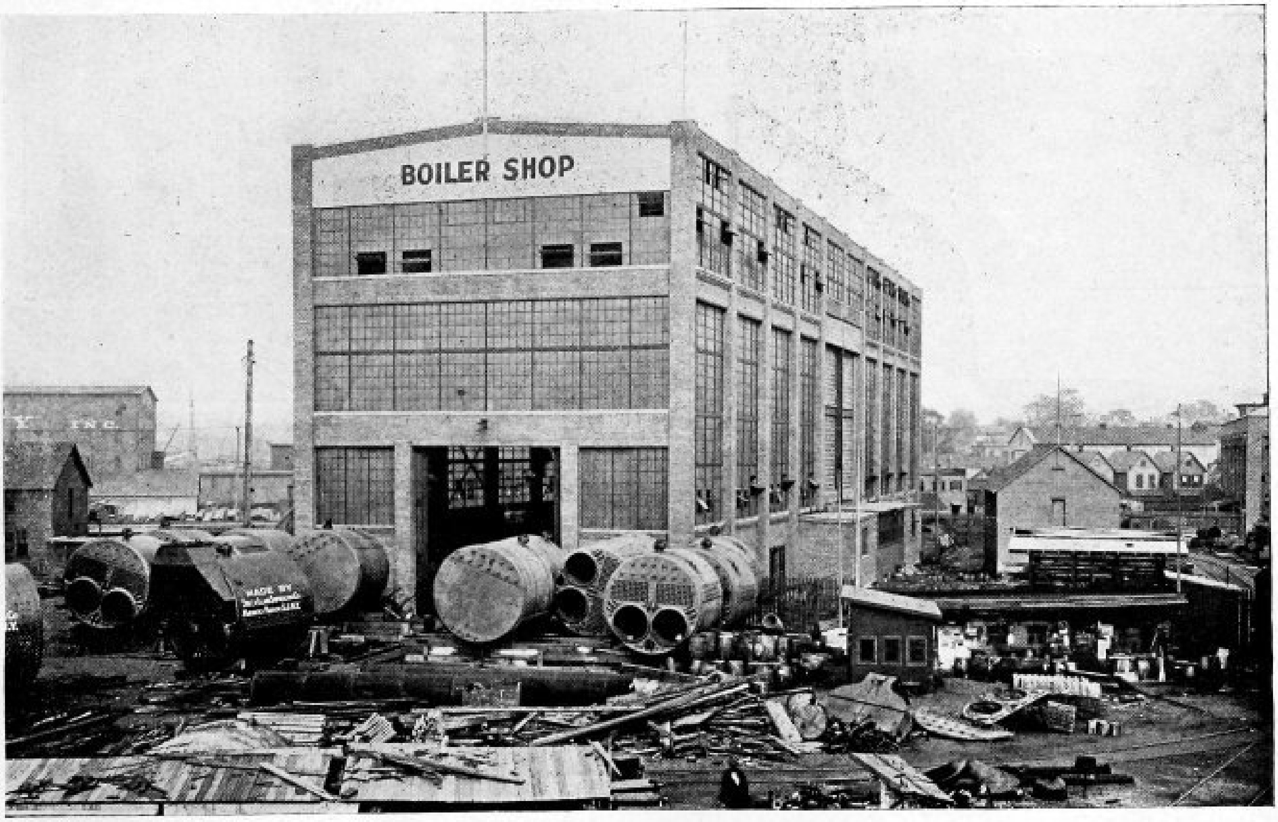


Fig. 1.—New Boiler Shop

As noted in the previous article, it was almost impossible to get all the equipment needed during the war period, and so work that might be done by multiple operation machines in many cases has to be done in laborious stages. Instead of having gang drills for drilling heads, and the like, pneumatic hand drills are utilized for the position drill during assembly.

In spite of this handicap, the main shop is rapidly approaching its maximum output of seventy-five boilers a year. The auxiliary shop, too, is supplying all the necessary stacks, tanks, uptakes and the like for its own shipyards, as well as material for outside plants.

Power is supplied to the yard by the Richmond Light & Railroad Company at 6,600 volts and is transformed by three 5,000-kilowatt transformers to 440 volts and 220 volts for generators, electrical equipment and light in the yard. About 4,000 horsepower is used. There are two generator sets, totaling 200 horsepower, consisting of an Allis-Chalmers direct-current 200-volt, 600-ampere generator, driven by a 225-kilowatt motor, and a Westinghouse 220-volt, 250-ampere installation. Four compressors are required to supply the air for pneumatic equipment in the shops, as well as the pipe lines to the ships. One Worthington compressor with a capacity of 4,200 cubic feet per second and two Worthington compressors each with a capacity of 1,600 cubic feet per second maintain a pressure of 100 pounds in all the lines through the yard, with the exception of the boiler shop, where a pressure of 120 pounds is maintained by a 9-inch by 8-inch high-speed compressor supplied by the Chicago Pneumatic Tool Company.

Marine Scotch boilers have been specialized upon, and all the work of the shop is devoted to this type. All repair work is carried on in the old plant at Port Richmond. About eighty men are employed in the two shops.

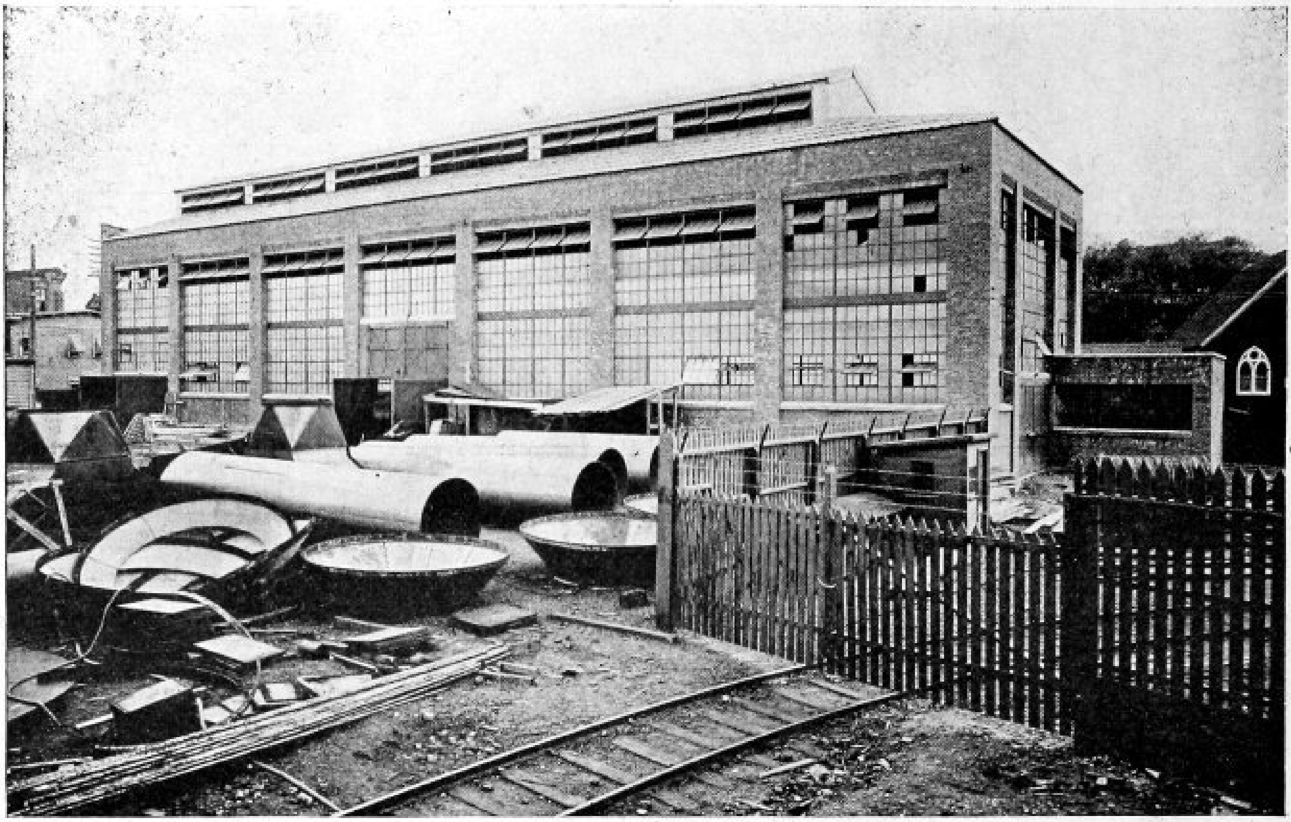


Fig. 2.—Auxiliary Boiler Shop

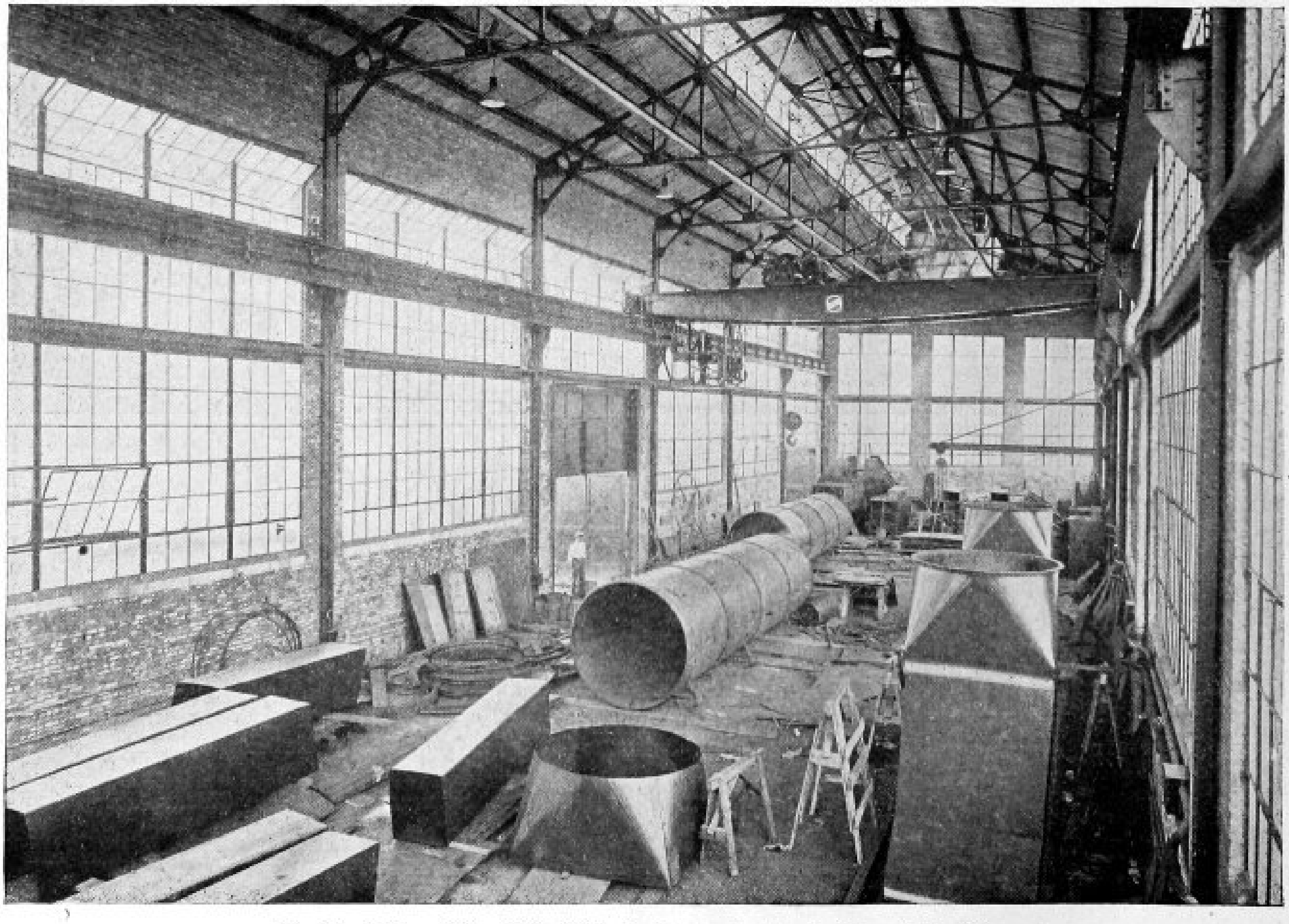


Fig. 3.—Tank and Stack Work Under Construction in Auxiliary Boiler Shop

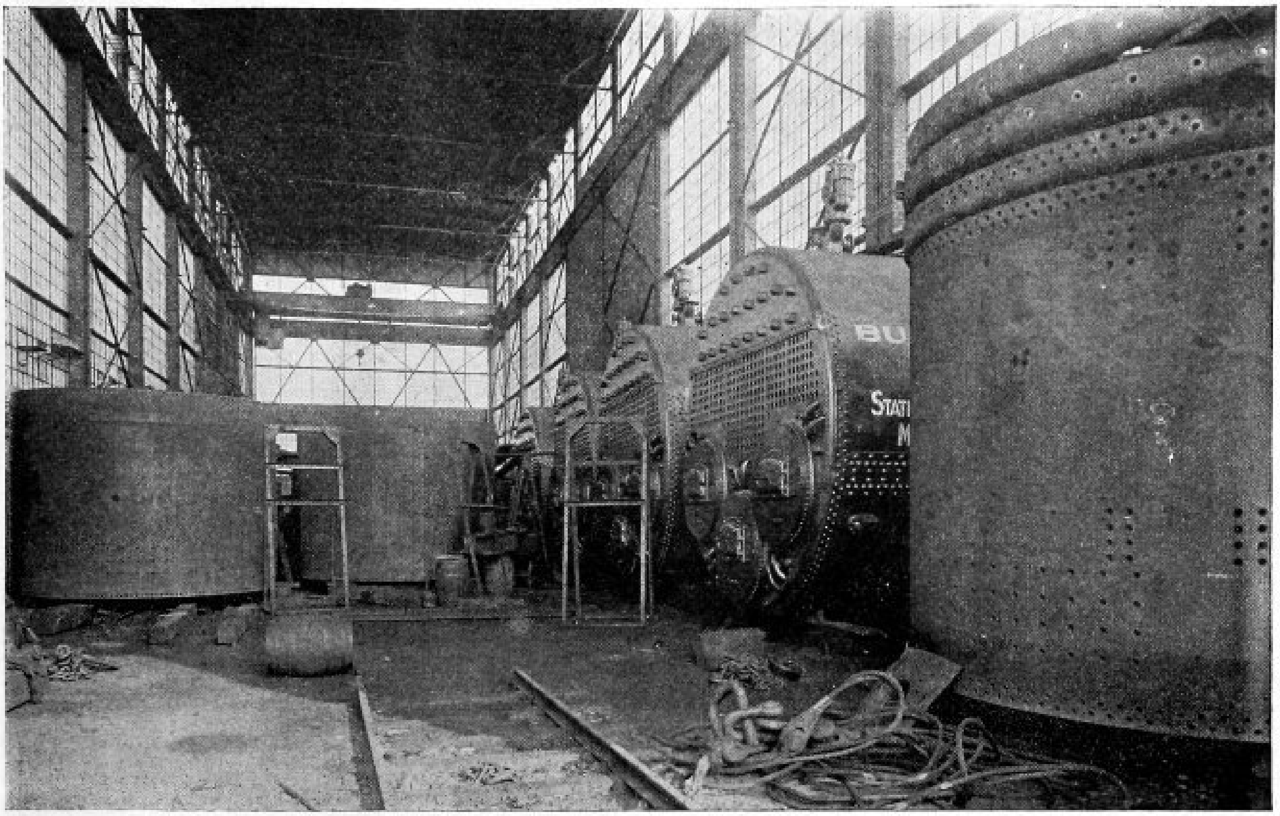


Fig. 4.—Testing Floor of Boiler Shop

Fig. 5.—Main Floor of Boiler Shop; Flanging Press in Extension at the Right

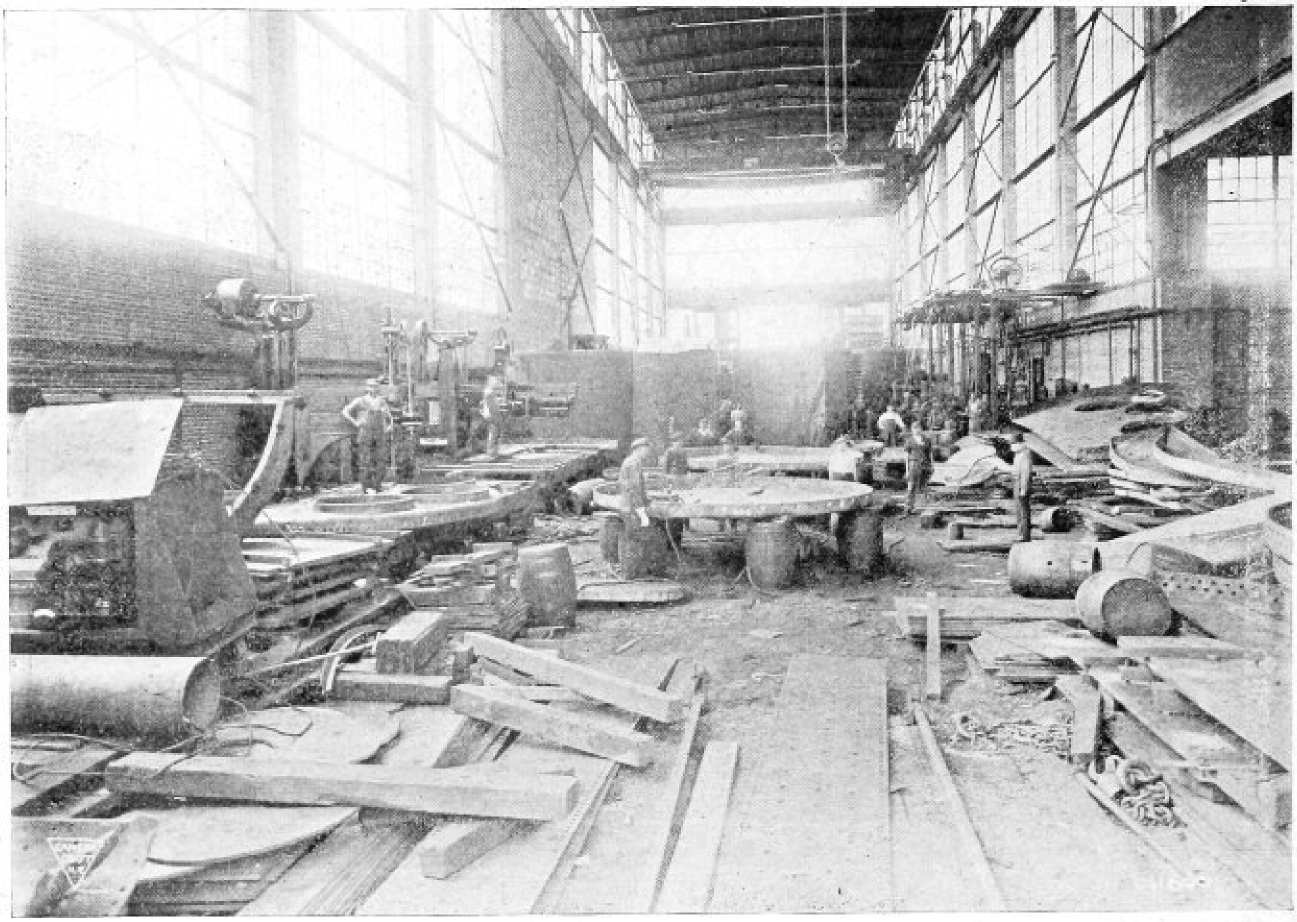


Fig. 6.—Interior of Boiler Shop

The Insulation of Locomotive Boilers

Use of 85 Percent Magnesia Lagging on Locomotive Boilers Causes Saving in Fuel Consumption

BY WILLIAM N. ALLMAN

It is an acknowledged fact, and now admitted by all engineers, that the insulation of heated surfaces is a matter of vital importance. The value of such insulation is dependent upon its efficiency and cost. There has been so much written during the past few years with reference to the importance of insulating heated surfaces that it is hardly necessary to make any extended discussion here.

Methods of Transmitting Heat

Heat may be transmitted from one body to another, or from one point to another by three avenues, namely: radiation, conduction and convection. Radiation of heat takes place between bodies at any distance apart and follows the laws governing the radiation of light. Radiation may also take place through the air without raising the temperature of the air. This may be readily observed by exposing yourself on a cold day to the sun, the heat from which is easily detected, while the surrounding air will still remain cold.

The rate at which a hot body radiates heat and a cold body absorbs it depends upon the condition of the surfaces as well as their respective temperatures. The darker and rougher the surface, the more rapid will be the radiation, so, in preventing it, the best results are obtained by using smooth, light-colored surfaces.

Conduction of heat is the transfer of heat between two bodies or parts of the same body. In other words, the transfer of heat from one particle of matter to another is carried on by contact of the molecules of which the body is composed. This process is the phenomenon that takes place in any insulating material. No material, or substance, is absolutely heatproof, the conductivity being less with lighter, spongy material containing small, minute air cells.

Convection of heat can only take place in liquids or gases; for example, water when heated in a vessel becomes hot at the point where the heat is applied and is transferred to the whole mass; a circulation is set up, thus carrying the heat to the entire body.

Air, being the best non-conductor of heat, forms one of the principle combinations in the insulation that intervenes between the heated surface and the surrounding atmosphere; therefore, the greater the number of dead air cells obtained in any insulation, the more efficient will that insulation become.

Types of Insulation

Twenty-five to thirty years ago wood was the standard lagging for locomotive boilers in this country, while at the present time practically all of the boilers are lagged with 85 percent magnesia, which combines the high non-conducting qualities of carbonate of magnesia and asbestos in a light, highly efficient insulation. This can be furnished in various thicknesses, curved, straight or tapered to fit the surface of the boiler, and is unequaled for the purpose of insulating locomotive boilers.

Eighty-five percent magnesia lagging is light, easily applied and durable. The most approved method of fastening to the boiler is by means of a special T-hook and wire fastened around the boiler. This method permits the removal, when necessary, of a single block without disturbing the others. For closing the joints after the application of all the blocks, it is a general practice to apply bands buckled on, thus binding the blocks securely together.

Value of Insulation

By the term "insulation" is meant the proper protection of the heated surfaces in order to reduce loss of heat to the minimum. The measure of such heat losses is in terms of British thermal units, and very often this important matter is neglected.

Table 1 shows the losses that may be expected in the uninsulated surfaces of the boiler:

TABLE 1

Steam Pressure (Gage)	Steam Temperature (Degrees F.)	Difference Between Temperature of Steam and Surrounding Air (Degrees F.)	Loss Per Square Foot Per Hour (British Thermal Units)	Waste of Coal in Pounds Per Square Foot Per Year Based on 300 Days (10 Hours Each) Per Year	Number of Square Feet of Surface that Wastes a Ton of Coal in One Year
0	212	142	334.0	77.0	26.00
10	240	170	425.0	98.0	20.40
25	267	197	522.5	120.6	16.58
50	298	228	644.0	149.0	13.42
75	320	250	737.5	170.2	11.75
100	338	268	820.0	189.2	10.57
150	366	296	930.0	221.6	9.02
200	388	318	1079.0	249.0	8.03
250	406	336	1184.0	273.2	7.32

(Temperature of surrounding air 70 degrees F.)

* Note—Above figures based on coal having an average heat value of 13,000 British thermal units.

The magnesia lagging used in boiler insulation can readily be applied in blocks ranging from approximately 24 inches to 40 inches long by 6 inches wide and in varying thicknesses. In order to obtain a uniform outline, it is the common practice to taper the blocks to provide for the thickness of the boiler sheets where they lap at the seams.

TABLE 2

Areas in Square Feet of Flat Blocks 6 Inches Wide

Length in Inches	Area in Square Feet	Length in Inches	Area in Square Feet
1/64	0.00065	7	0.29169
1/32	0.0013	8	0.33336
1/16	0.0026	9	0.37503
⅛	0.00521	10	0.41670
¼	0.01042	20	0.83334
½	0.02083	30	1.2501
¾	0.03125	40	1.6668
1	0.04167	50	2.0835
2	0.08333	60	2.5003
3	0.12410	70	2.9169
4	0.16667	80	3.3336
5	0.20835	90	3.7503

Table 2 shows the efficiencies of a well-known make of 85 percent magnesia lagging in thicknesses 1 to 3 inches inclusive. On account of the extreme high cost of fuel at the present time, it is quite important that boilers be properly lagged, and every square foot of exposed surface results in a considerable loss in heat which should be conserved and converted into useful work.

Consider a locomotive boiler carrying a pressure of 200 pounds, the temperature of which would be 388 degrees Fahrenheit; and, assuming an average temperature of 70 degrees Fahrenheit for the surrounding air, we obtain a difference of 318 degrees Fahrenheit. The loss from an uninsulated surface under these conditions would be ap-

TABLE 3

Thickness of Lagging	Concave Chord	Convex Chord in Inches
¾ to 1 5/16	6	6 3/16
1	6	6¼
1 1/16 to 1 7/16	6	6 5/16
1½ to 1 15/16	6	6⅜
2	6	6 7/16
Over 2	6	6½

proximately 1,079 British thermal units per hour, as shown in Table 1, and, based on coal having an average heat value of 13,000 British thermal units, would be

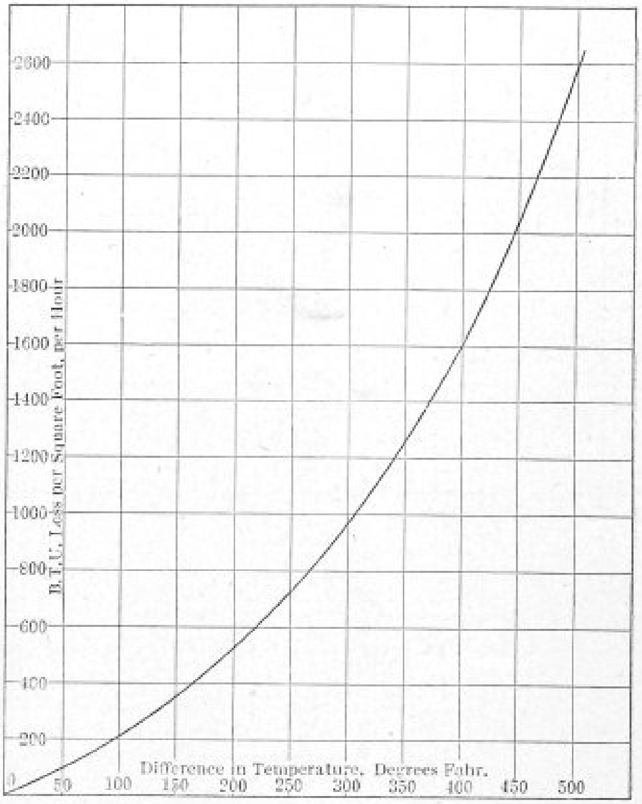


Fig. 1.—Heat Loss Through Ordinary Boiler Insulation

TABLE 4

Areas, in Square Feet, for Convex Blocks of Various Radii

Length in Inches	6 3/16 Inches Wide, Area, Square Feet	6¼ Inches Wide, Area, Square Feet	6 5/16 Inches Wide, Area, Square Feet	6⅜ Inches Wide, Area, Square Feet	6 7/16 Inches Wide, Area, Square Feet	6½ Inches Wide, Area, Square Feet
1/64	.00067	.00067	.00068	.00069	.00698	.00070
1/32	.00134	.00135	.00136	.00138	.00139	.00141
1/16	.00269	.00271	.00273	.00276	.00279	.00282
⅛	.00537	.00542	.00547	.00553	.00558	.00564
¼	.01074	.01085	.01095	.01106	.01117	.01128
½	.02148	.02170	.02191	.02213	.02235	.02256
¾	.03223	.03255	.03287	.03320	.03352	.03385
1	.04297	.04340	.04383	.04427	.04470	.04513
2	.08593	.08680	.08767	.08541	.08940	.09027
3	.12890	.13020	.13151	.13281	.13411	.13541
4	.17187	.17361	.17534	.17708	.17881	.18055
5	.21484	.21701	.21918	.22135	.22352	.22569
6	.25781	.26041	.26302	.26562	.26822	.27083
7	.30078	.30381	.30685	.30989	.31293	.31597
8	.34375	.34722	.35069	.35416	.35763	.36111
9	.38671	.39062	.39453	.39843	.40234	.40625
10	.42968	.43402	.43836	.44270	.44704	.45138
20	.85937	.86805	.87673	.88541	.89409	.90277
30	1.28906	1.30208	1.31510	1.32812	1.34114	1.35416
40	1.71875	1.73611	1.75347	1.77083	1.78819	1.80555
50	2.14843	2.17013	2.19184	2.21354	2.23524	2.25694
60	2.57812	2.60416	2.63020	2.65625	2.68289	2.70833
70	3.00781	3.03819	3.06857	3.09895	3.12934	3.15972
80	3.43750	3.47222	3.50694	3.54166	3.57638	3.61111
90	3.86718	3.90624	3.94531	3.98437	4.02343	4.06250

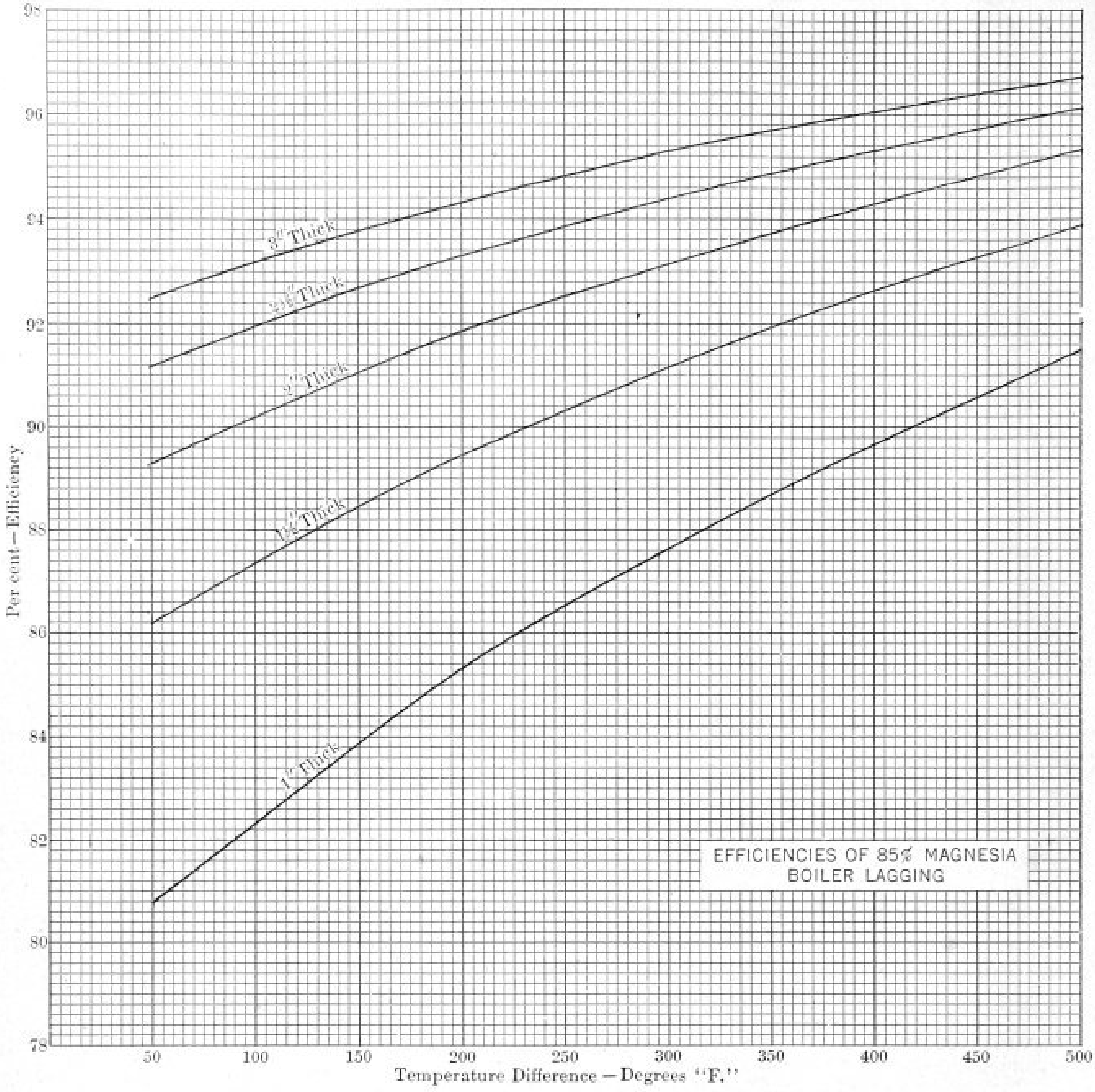


Fig. 2.—Efficiency of Magnesia Boiler Lagging as an Insulating Material

equivalent to a waste in coal of 249 pounds per year per square foot of surface, assuming the boiler to be in service 300 days of 10 hours each. By the application of 85 percent magnesia lagging with high insulating value, the major part of the above loss may be saved, and from Table 2 the following efficiencies are obtained:

1½-inch thick lagging..........	91.43 percent
2-inch thick lagging............	93.33 percent
2½-inch thick lagging..........	94.57 percent

This would would be equivalent to saving the following amount of fuel per square foot of surface per year:

1½-inch thick lagging..........	227.6 pounds
2-inch thick lagging............	232.4 pounds
2½-inch thick lagging..........	235.5 pounds

Cement lagging is still used by a few roads. This form of lagging had its greatest use about twenty-five years ago, when it began to replace the old method of wood lagging; but after the advent of 85 percent magnesia blocks, which has a much higher efficiency and considerably less weight, cement lagging was gradually displaced. At the present time magnesia has been adopted as standard lagging by most of the roads throughout the United States and Canada.

Computing the Area of Lagging

For the purpose of determining the area in square feet for the lagging of boilers, Tables 2, 3 and 4 will be found most convenient. It is the general practice for the various lagging manufacturers to furnish boiler lagging in 6-inch widths, and the tables have been prepared on this basis and can be readily applied to any length desired. Table 2 shows the area in square feet for perfectly flat blocks of various lengths, which, of course, is the same for any thickness of material. When dealing with curved blocks for application to the barrel or cylindrical surfaces, Tables 3 and 4 are used; for example, a thickness of 1⅞-inch lagging would appear under 6⅜-inch "convex chord," and then, referring to the column in Table 4, for a 40-inch length of block, the area would be 1.77083 square feet.

Among Indianapolis Boiler Shops

Back From The Front—Simple Calking Outfit—Emergency Heaters—Electric Tool Starter—Side-Stepping Accidents—Whitewashing The Shop

BY JAMES FRANCIS

A lot of "the boys," and some of the managers too, have just got back from "over there" and are mighty busy—at least the managers are—trying to find out "where they are at" and what the business is and has been doing. The writer walked into a shop beside the Belt Railroad on the 22d of January and swapped hearty handshakes with the young manager, who, khaki-clad, was busy with his nose buried deep in the office book, "How's business, Mr. Kennedy?"

"That," was the quick reply, " is just what I am trying to find out myself! You see, I haven't been back but two days yet and I surely have my hands full in getting a line on what has been done while I was with the colors!"

But the shop was noisy with repair work and I watched for a few minutes the work of a man who was finishing the longitudinal seam of a high pressure tank about six feet in diameter, sixteen feet long and made of at least three-quarter-inch steel. Timbers had been laid down upon the earth floor of the shop so the shells—there were two of them—could be rolled over and over upon the timbers so as to bring always the work side of the shells toward the light.

Why the Dark Shop?

This shop was one of the windowless affairs into which men used to delight in placing boiler shop apparatus so the men could always work in the dark or by lamp, gas or electric light. Wonder why shop owners ever tolerated the dark shop? It is not conducive to the best work or to the best profits, either. In this shop, about all the working light came from the north side, and windows were all too scarce there, hence the trouble the men had been put to in order to place rolling skids in such positions that what little light there was in the shop could be utilized to the best advantage.

Some new rivets had been driven in a portion of the longitudinal seam in each shell and the workman was surely making a clean, neat and good job of calking and finishing the seams along the new rivets. He used an outfit of the most simple character. The "air-gun" and four short "bits" therefor, with an empty nail keg, completed the outfit. The man did not even have a hammer with him. Three of the bits were lying on the head of the inverted empty nail keg, which was used merely as a support for the bits not in use, also as a seat by the workman when the position of the calking edge permitted him to sit down while at work.

A Simple Calking Outfit

The tools used were a flat chisel, two calking tools and one plain set, smooth and flat on its end, for smoothing down plate edges back of the space where calking had been done. By means of the very simple outfit noted above, not only was a good and quick job of calking turned out, but the laps of the plate were each and all finished as smooth and as clean as though they had been ground and scraped smooth.

The round-nose calking tool was mostly used, but a bit with a sharp edge was there and the workman admitted that, while he did not use this tool very often, there were places where it was very necessary, particularly on a repair job. "Sometimes," he said, "the round-nose tool failed to stop the weeping of water during test, while a few taps from the sharp cornered tool put the "Q T" on that little leak instanter!"

This shop, like most of the boiler shops, suffered a good deal of loss from the excessively cold winter of 1917-18, when it was utterly impossible to work in the shop, where temperatures ranged on a few mornings between 10 and 18 degrees below zero, something rarely experienced in Indianapolis. But the winter in question made it necessary to provide means whereby some rush work could be hustled out independent of weather conditions, and to that end, a heater for burning soft coal, coke, wood or whatever fuel could be obtained—and fuel was hard to get then, too—had been constructed. One of these heaters was "fired up" and placed adjacent to each group of men in the shop.

At the time of the writer's visit six of these heaters were standing outside of the shop, waiting the call for more heat, which happily has not been sent out during the past winter. Each of the heaters was made of tank steel, the shell being about 1/8 inch thick, the bottoms about 1/4 inch. Fig. 1 shows about how these heaters were set up and the making of the six evidently took very little time.

Shop Heaters

The shell *A* was about 18 inches in diameter and of the same height. Three legs each about 3/8 by 2 inches, were riveted on as shown at *BBB* and a bail *C* was supplied, made of plain round 3/4-inch black steel, placed through two holes in the top of the shell and the ends of the bail hammered over sufficiently to prevent their coming out of the shell. By the looks of the bail, it was evidently formed with the center loop, then the ends were heated, slipped through the holes in the shell while the bail-ends were hot, and "belted" up until they could not slip out of their holes.

The lower portion of the shell was punched about every 2 inches with 3/4-inch holes to permit air to get to the coal inside of the heater. These holes were a little closer at the lower edge of the shell, the distance being increased both between rows and between holes in the rows, farther from the lower edge of the shell.

The manner of inserting the bottom of the heater was very simple. This piece, shown at *H*, Fig. 2, was made from steel a little thicker than the side and was punched full of holes—about as full as possible and leave plate enough to sustain the bottom and its load of coal. The leg *F* and the bottom were fastened together by the same rivets. Pieces of 1 inch by 1/4 inch flat black steel were formed and punched as shown at *G*, the long or vertical end having two holes punched to fit those in the leg *F* and the shell *E*.

A single hole was punched in each of the three pieces *G*, and holes to match were punched in bottom *H*, thus leaving a quarter of an inch of space all around bottom *H*, inside of shell *E*. The bottom was thus well supported at three equidistant points and the quarter inch space around the bottom permitted a lot of air to reach the ignited coal. The bail *C* was found very handy when a heater was to be moved in the shop from one place to another; for a couple of men would thrust a piece of steel through *C*, which was so located as to be just above the sides of the heater. With the rod in place, the heater could be carried around at will. When one man, using a heater alone, wished to move it he simply signaled the crane man, slipped the crane hook into loop *C*, and away went the heater, fire and all, to the new place where its presence was desired.

Electric Tool Starter Needed

The writer has been looking for some time to see if some enterprising manufacturer of machine tools and boiler shop appliances will not bring out a much needed attachment for punches, shears and similar tools, which

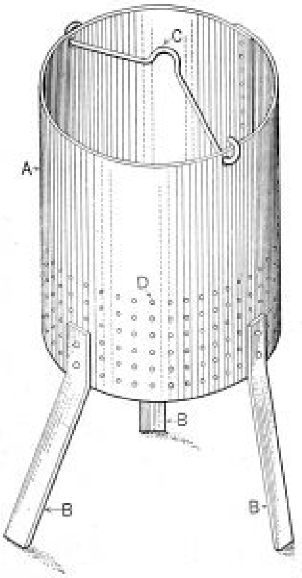


Fig. 1.—Boiler Shop Heater

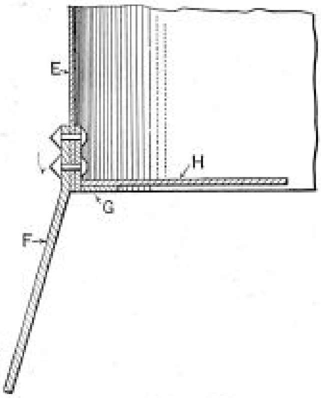


Fig. 2.—Detail of Leg Connections

have to be started for each stroke by pressing or moving a lever. The device which is required is an electric arrangement for throwing the starting lever or pedal, the starting current being sent through the mechanism by pushing a button or by closing a circuit through a squeeze switch, which may be held between the fingers or between the teeth, thereby permitting the use of both hands on the part of the operator.

With a device of this kind work with a punch or a shear would be very very much accelerated, besides permitting the operator of the machine to work with much greater exactness. This arrangement would do away with the present necessity for placing the work properly and then withdrawing attention therefrom while hand or foot sought for and moved a heavy and perhaps cumbersome lever, or sought for and pressed a floor treadle. The little contact which controls the electrical starter could be held at all times between the fingers or teeth, its long flexible connection permitting free movement of the operator, and the arrangement would permit of instant starting of the machine when the punch or shear was fair with the mark, thus greatly reducing the possibility of the work slipping away from the mark while the operator is starting the machine. The writer has never seen or heard of starting mechanism of above-described character in operation, but it surely is wanted badly in the boiler shop.

Side-Stepping Accidents

The dodging of accidents is a big part of the work in some shops and in one—not the shop noted in the preceding paragraphs—they try to discount accidents as far as possible by avoiding things which might lead to trouble. In this shop, the foreman is continually on the lookout for acts or things which might lead to possible accident and keeps at his men until they are beginning to look out for things on their own account which might cause accident.

Printed notices are posted conspicuously around the shop, and to keep interest in the notices alive and thriving the notices are changed very often, new and clean cards being put up as soon as the ones posted become dusty and old looking. As the shop manager observed, "A man never will read an old notice. Might as well post them wrong side out as to let 'em get old and dust-stained."

One notice which is frequently posted is as follows:

> WARNING!
> Warn a man when danger is near, even if he knows it; no harm is done.
> You may save him the injury.

There is a good deal in the above suggestion and the more it is kept before a bunch of men, the sooner it will become a sort of second nature to them and the more will men be cautioned and warned. But it is one thing to warn a man and quite another thing to make him follow the safety advice which is thus given him. In this shop, the management warn their men in season and out, but when they find a man or a bunch of men who will not heed the persistent warning, nothing is said or done save that the reckless parties quietly drop from the payroll and other men take their places in the hope that the newcomers will prove receptive in the "Safety First" matters.

If not, the changing and the evolution go quietly on until all the reckless men are weeded out and the shop in question has reached a stage where accident is almost entirely unknown, either to men or to the work. "But," the manager of the shop stated, "That is done only by everlastingly sticking to it."

Whitewashing the Shop

The manager of one shop watched a man for a quarter of an hour one day as the workman was hunting around in a dark corner selecting a lot of small pieces of plate for a job in which the pieces could be used. The man had an incandescent lamp on the end of a long flexible cord, with the bulb well protected by a wire cage. But the shop was dark, as too many boiler shops are, and the man made hard work trying to hold the lamp and at the same time use both hands in shuffling plates. Half the time he held the lamp cord in his teeth so he could use both hands and see at the same time.

The manager walked back into his office, did the thinking act for about fifteen minutes, then sent away and ordered a whitewashing machine with two lines of hose and spray nozzles. While the machine was being obtained, the manager sent two men aloft, armed with brushes and lines of air hose with thin wide flat nozzles, something like vaccum sweeper nozzles, only not as wide. With this equipment each and every timber and board in the shop was swept and blown clear of its accumulated "dust of ages."

Life surely was not worth living in that shop during the two days that the men were "sweeping and dusting," and but very little work was done in the shop, most of the men being sent to outside jobs and doubled up there, to keep them out of the shop. As soon as the dirt and dust had been removed, the whitewashing machines were turned loose and in two days more the shop was so transformed that the manager hardly felt sure that he was in his own place.

A Transformation

After the transformation, the light was found to be so good that a man needed no electric lamp at all to shuffle scrap sheets in any corner of the shop and the layout man allowed that he was nearer to being in heaven than ever before, that he could see to do work without squinting his eyes out. So well did the whitewashing take and suit, that thereafter, each spring and fall, the entire interior of the shop was given the "twice over," once with air and then with whitewash.

The manager liked the air and whitwash so well that he had an airline of pipe run aloft in the upper part of the shop, and he also had walks or scaffolds built up into the roof of the building, good substantial runs, four feet wide, with stair-stringers and treads leading permanently to these runs, from which the workmen could easily and quickly reach dust and whiten the roof of the shop. While it required two days to go over the building from ladders, the two men of the whitewash brigade could now do all the work in one day, the permanent walks or scaffolds and the "cellar stairs" making the task much easier and quicker.

The "funny" man of the shop cracked a joke at the expense of the manager, whom, the wag said, was "sitting up nights trying to devise a way whereby he could have whitewashed, the shop floor and the steel sheets in stock"! And "the wag" might also suggest that the manager has found such a good thing in a clean, light shop that he should pass the stunt along to other boiler shops and perhaps even add "boiler shop whitewashing" to the regular business of the shop, in which case the shop might add a line to its advertising to the effect that there was

"GOING OUT WHITEWASHING DONE HERE"

By Lime-Kiln Club Artists in True "Brudder Thompson" Style!"

How to Design and Lay Out a Boiler—XII

Use of Cold-Rolled Pins—Computing the Size of Cold-Rolled Pins to Use in Crowfeet—Bracing Below the Tubes

BY WILLIAM C. STROTT*

Instead of special cold-rolled pins some boiler manufacturers employ ordinary rivets for this purpose. Although there is no objection to this practice, the rivet shanks are usually not perfectly straight, their diameters are not exact, and somewhat out of round; hence they do not transmit the load properly and are apt to be subject to unusual bending stresses.

As a basis, the code demands that the cross-sectional area of the pin be at least 0.75 times the least cross-sectional area of the rod, which, for our case, is 0.75×1.43, or 1.07 square inches. This area corresponds to a pin having a diameter of approximately 1⅜ inches. The strength of the pin with regard to flexure (bending) is found by means of the following formula, which is that employed by the Carnegie Steel Company and is given in that company's "Pocket Companion":

(10) $$M = f \times 3.1416 \times d^3 \div 32.$$

For convenience, the author has resolved it into the following simplified form:

(10_a) $$M = f \times .098175 \times d^3,$$

in which

M = maximum bending moment of the pin in inch pounds.
f = safe working fiber stress in the pin in pounds per square inch.
d = diameter of the pin in inches.

In the above formula the safe working strength of the material, f, may be taken at 20,000 pounds per square inch.

The maximum bending moment occurs at the center of the pin and is found from the formula, which is that for a beam supported (not fixed) at the ends and a concentrated load at the center:

(11) $$M = \frac{W \times l}{4},$$

in which

M = maximum bending moment, as before.
W = load on the center of pin.
l = distance between the centers of the supports of the pin, as indicated in Fig. 39, (a) and (b).

We will have to assume l unless we already have a detail of the crowfoot. It may safely be assumed as 2½ inches, since it will rarely, if ever, exceed this length. W is evidently the load on one stay rod, or the total pressure on the segment divided by the number of rods; it is:

$$\frac{242.5 \times 150}{3}, \text{ or } 12{,}125 \text{ pounds.}$$

Substituting in formula (11) and solving, we get:

$$M = \frac{12{,}125 \times 2\tfrac{1}{2} \text{ inches}}{4}, \text{ or } 7{,}578 \text{ inch pounds.}$$

Substituting in formula (10_a), we may now write:

$$7{,}578 = 20{,}000 \times 0.098175 \times d^3.$$

Whence

$$d = \sqrt[3]{\frac{7{,}578}{1{,}964}}, \text{ or } 1.56 \text{ inches, say } 1\ 9/16 \text{ inches diameter.}$$

The cross-sectional area of a 1 9/16-inch diameter is 1.92 square inches, which, in double shear, makes the pin good for (with a factor of safety of 5)

$$1.92 \times \frac{88{,}000}{5}, \text{ or } 33{,}792 \text{ pounds.}$$

This proves that the strength of the pin with regard to bending is usually the governing point in its design.

The thickness, T, of the "eye," Fig. 39 (b), is determined from the bearing pressure on the pin, which should not exceed 7,500 pounds per square inch.

Following is the formula to be applied:

(12) $$T = \frac{P}{C \times d},$$

in which

T = thickness of the "eye" in inches.
P = load on each stay rod.

*Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

(*Continued on page 316*)

Suggestions for Electric Arc Welding

BY H. L. UNLAND*

The advantages of the electric arc welding process for joining or filling wrought iron and steel are well known, but the simple precautions necessary in operating the apparatus, particularly the auxiliaries, are too often ignored. Many dangerous and painful accidents occur to operators who have never been properly instructed in the use of the equipment.

The eyes should be thoroughly protected by a mask from the light of the arc, or serious burns to the interior of the eye will certainly result. No chinks or holes in the mask should be permitted, since only a brief exposure of the eyes is required to bring on painful results. The inside of the mask should be kept painted dull black to prevent reflection of the light from behind.

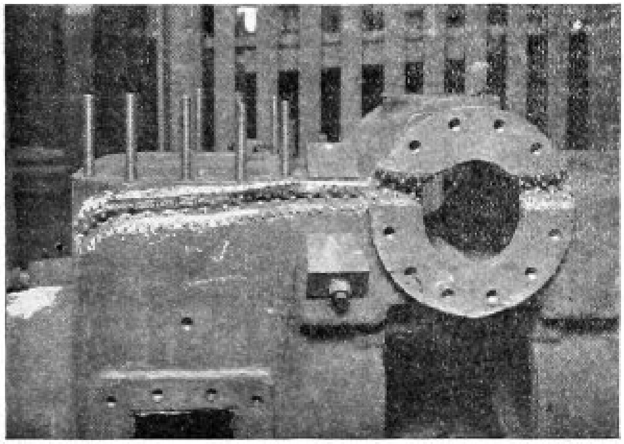


Fig. 1.—Broken Feed-Water Pump Prepared for Electric Arc Welding

The mask consists of a thin sheet of aluminum formed to the proper shape and provided with an adjustable band for supporting it from the operator's head. An opening in the front of the mask is provided for a window of glass, which may be either a number of individual sheets of different colors or a single compound sheet of glass.

The colored protective glass should be sufficiently dense to reduce the light intensity to a value not objectionable to the eye and at the same time the area immediately around the arc should be sufficiently clear to enable the operator to properly follow the work. Different color combinations are used, but the most general seems to be a combination of red and green glass.

The glass is held in a recess in the front of the mask by means of a clamping frame so that the light from the arc cannot pass through joints or cracks around the edge of the glass, as a small amount of light coming through one of these openings would in a short time affect the eyes of the operator.

It is advisable to keep a piece of clear glass on the outside, since, in welding, this outside surface will be struck by particles of molten metal and will become roughened to such an extent that it becomes useless and must be replaced.

A hand shield is principally used in doing metallic electrode welding. It consists of a light wooden frame with provision for a protective glass window similar to that used in the mask. The shield is also used by inspectors and others who require the protection only for short periods and at infrequent intervals. A light box frame surrounding the window is fitted to the operator's face, preventing light from the side or rear reaching the operator's eyes, thus eliminating any interference of a number of operators due to the light from the arcs. The protective glass of the hand shield is supported in guides on the front of the shield and is clamped in place by a wooden wedge driven through openings in the guides.

ELECTRODE HOLDERS

The fuction of the electrode holder is to electrically connect the electrode to the cable connected to the welding quipment. The requirements of this service are: It must securely grip the electrode so that the welder can operate it without play in the mechanism or without the electrode becoming loose in the holder while in use; the clamping arrangement should be such as to facilitate changing electrodes; it should be so constructed that the minimum heat reaches the operators' hand; the weight should be as low as possible and the balance such as to facilitate manipulation by the operator; the construction should be such that the operating parts are protected from accidental contact to avoid injury by burning or by being struck, and the general construction should be substantial to avoid bending or jamming.

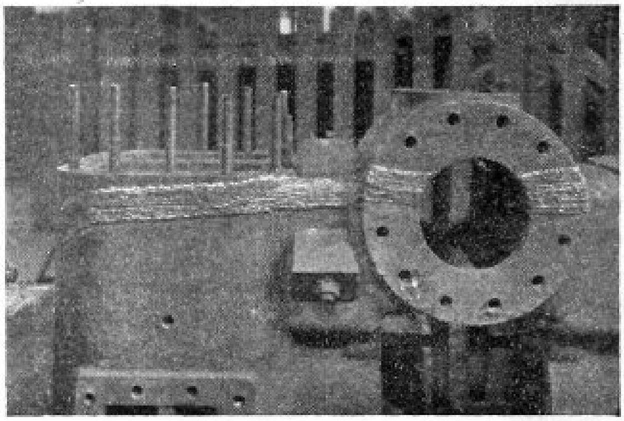


Fig. 2.—Appearance of the Weld After Welding With Bare Arc

ELECTRODES

Carbon electrodes should be rods of hard, homogeneous uncored and uncoated carbon. The diameter used will vary with the current to be used, and this information is given elsewhere. The length depends on the particular class of work to be done. Long carbons reduce the percentage of short ends thrown away, but are more liable to breakage. The average lengths range from 9 to 12 inches.

For welding iron and steel the metallic electrode should be a high grade of low-carbon steel wire. A large number of tests were made by the Emergency Fleet Corporation to determine the best chemical analysis of wire for this purpose, and the wire now made by a number of manufacturers meets these requirements. This material can be purchased either direct from the makers or through jobbers and can be obtained either in rolls or in short lengths cut and straightened. In ordering, "electric welding wire" should be specified, since wire for acetylene welding is often treated in such a way as to render it unsuitable for electric welding.

The electrode wire should be cut into pieces convenient for the operation. A length of 18 inches is satisfactory, since it is about the greatest length an operator can handle, and at the same time it reduces to a minimum the number of times the electrode is changed, and consequently the wastage.

* Power and mining engineering department, General Electric Company, Schenectady, N. Y.

CABLES

On account of the intermittent nature of the work it is possible to use smaller cable for the welding circuits than is standard for the current capacities. In this way there is also a gain in flexibility which permits better control of the welding arc, by facilitating the manipulation of the electrode holder.

In metallic electrode welding a length of at least 15 feet of extra flexible cable should be connected to the electrode holder to allow the operator to fully control the arc through manipulation of the holder. For the ground or return cable the standard extra flexible apparatus or dynamo cable insulated with varnished cambric for low-voltage circuit and covered with double weatherproof braid has been found suitable.

The carbon electrode welding arc is not as unstable as the metallic arc, and therefore the manipulation of the electrode is not so important. For this reason the standard extra flexible dynamo cable referred to above may be used for connection to the electrode holder, as well as for the return circuit.

It is difficult to give universally applicable figures covering amperes, speed, etc., for electric arc welding, due to the effect of conditions under which the work is done, the character of the work, and to a very large extent the skill of the operator.

The following figures are based on favorable working conditions and a skilled operator. However, they are approximations only and are given here merely as a general guide:

CURRENT REQUIRED FOR METALLIC ELECTRODE WELDING

Light work	25 to 125 amperes
Heavy work	up to 225 amperes

Electrode Diameter, Inches	Amperes	Plate Thickness, Inches
1/16	25-50	up to 3/16
3/32	50-90	up to 1/4
1/8	80-150	1/8 to 3/8
5/32	125-200	1/4 up
3/16	175-225	3/8 up

The same size electrode may be used with various thicknesses of plate, but the heavier plate will require the use of the heavier currents.

CARBON ELECTRIC WELDING

The carbon electrode can be used for welding and for building up metal in a large number of cases where the metal is not subjected to high strains or where it is under compression only. This process can also be used to a very large extent in rough cutting of plates and in cutting away parts of structures.

The average current ranges for different types of work are as follows:

Light welding	150 to 250 amperes
Medium welding	250 to 350 amperes
Heavy welding and medium cutting	400 to 600 amperes
Very heavy welding and heavy cutting	600 to 1,000 amperes

The maximum values of current permissible for the carbon electrodes are as follows:

Diameter of Electrode, Inches	Maximum Amperes
1/4	100
1/2	300
3/4	500
1	1,000

Graphite electrodes permit the use of somewhat higher current densities, but the higher cost of graphite electrodes is a serious handicap to their use. Lower currents than those given may be used, but higher values will result in undue burning of the electrode.

For depositing or building up metal by means of the carbon arc, or flat surfaces where the work is accessible and all conditions favorable, the following figures may be used:

Current, Amperes	Pounds per Hour	Cubic Inches per Hour
200	1½	5.4
300	3	10.8
400	4½	16.2
500	6	21.6

For continuous work the above figures may be used, but for short jobs of ten minutes or less the rate will be double the amounts given.

PREPARATION OF WELD

Metal that is clean is much more likely to make a good, strong weld. Scale, rust, grease, soot and foreign matter will contaminate the weld, and such inclusions necessarily weaken it or else make it hard. Impurities may also make the metal porous and spongy, due to a liberation of gas. Pieces of foreign matter may prevent the molten metal filling all parts of the weld and thus cause cavities.

Various methods for cleaning are in use; pickling for small parts, washing with gasoline (petrol) or lye, boiling with lye, sand blasting, chiseling, scratch brushing, etc., the method depending on the local conditions.

Preparatory to welding locomotive tubes to the sheets, it is sometimes advantageous to send the locomotive out on a run to burn off the grease and then clean off the oxide and soot by the sand blast. Another method is to heat the boiler to normal by steam pressure and then clean it by the sand blasting or scratch brushing process.

In welding heavy sections where it is necessary to deposit several layers of metal, the surface of the preceding layer should always be cleaned before starting the next.

When sections of 1/8 inch or less in thickness are to be joined, the edges need not be beveled, but they should be separated a small amount. Thicker sections should have the edges beveled to give a total angle of 60 degrees, as well as separated by 1/8 inch. In some special cases angles as low as 30 degrees may be necessary and as high as 90 degrees may be used, but an average safe value is 60 degrees. Still heavier sections may be beveled from both sides and the weld made from both sides. In the latter case a layer should be put on one side and then a layer on the other to prevent warping.

For long seams the edges should be 1/8 inch apart at the end where the weld is started, and at the far end the space should be 1/8 inch plus 1½ percent of the length. This takes care of the expansion of the metal in the sheet and also of the contraction of the metal in the weld as it cools.

Another method of reducing expansion is to put in short sections at intervals, welding in one layer at a time, starting at the center and working alternately toward either end. Then put one layer in the open sections and continue in the same way till the weld is completed. The welded section of any layer should not match those in the layer below or above, the joints being broken as in laying brick work.

The welding of complicated shapes, such as fly wheels and some castings, may require preheating at certain points to produce initial expansion, which will be overcome as the weld cools. In some cases the entire space must be preheated, and in some cases after welding the whole piece must be annealed. This is sometimes done by heating the piece uniformly and then covering it with sand asbestos, etc., and allowing it to cool slowly.

In welding cracks in plates, forgings or castings, the crack should be chiseled out to get a good bevel, entirely through the plate with 1/8 to 3/16-inch clear opening on the back or to the bottom of the crack in castings or forgings. In boiler work, ½-inch holes are sometimes drilled well beyond the ends of the crack and the crack chiseled, beveled and welded.

Use of Flux

It is the experience of a great majority of welders that flux of any kind is unnecessary in welding, and, further, that it is a source of danger, in that there is liability of contaminating the weld. If the work is kept clean by brushing at frequent intervals and ordinary care is taken in the operation of the arc, a good weld can be made without flux; and if these attentions are lacking, flux will not make a good weld.

Ingenious Crane Doorways

An effective arrangement for handling boilers in and out of the erection building of the Heine Boiler Company has been carried out by the engineering staff of that company.

A number of novel features in connection with the construction are of more than passing interest. For instance, the wide upper door, which contains seven windows, as shown in Fig. 1, weighs 9,000 pounds and is

Fig. 1.—Swinging Doors for Special Crane

lifted by compressed air. Half of the weight of this door is counterbalanced, making the net weight for the air to lift approximately 4,500 pounds. To permit the crane to pass through the doorway, this door, which is 64 feet wide, must be lifted 9 feet.

Two small swinging doors are visible in Fig. 1, beneath the left-hand girder, through which the cage for the crane man passes. These doors swing open simultaneously with the lifting of the wide door. During eight months of use these air-operated doors have given no trouble whatever.

Central Swinging Doors

The two central swinging doors, shown most clearly in Fig. 1, are each 27 feet high and 8 feet 6 inches wide, giving a total width of 17 feet—ample space for removing any boiler. These doors are operated from the inside by means of a hand crank. The crank is at the end of a shaft which passes through the brick wall at a convenient height for hand operation. On the outer end of this shaft is a pinion of 4 3/16-inch pitch diameter, which engages a bevel of 1 foot 6⅜-inch pitch diameter. The gear teeth have a 1-inch circumferential pitch. A vertical shaft about 9 feet long connects the bevel gear with a spur gear, Fig. 1, of 5 3/16-inch pitch diameter. This spur gear in turn engages a 90-degree segmental rack having a pitch radius of 3 feet 3 inches.

The dimensions and design are such that the doors swing open with very little exertion on the part of the

Fig. 2.—Handling Material Through the Doorways

operator, who opens them while the air is lifting the wide upper door. The swinging doors weigh about 2,000 pounds each, are made of steel throughout, and are operated separately. The frame work is steel, hence there is no danger of warping, shrinking or sticking. When installing these doors, a plumb line was made to pass through the hinge holes to insure perfect alinement. A smaller door for the use of workmen passing in and out of the building when the large doors are closed is fitted into one of the large doors so well that it is invisible in the photographs.

Crane Equipment

Two cranes are used on the craneway. The larger is of the 30-ton type having a span of 60 feet, while the smaller has a 5-ton capacity. It is also equipped with a motor generator, charging a magnet, which is used for handling small material. An auxiliary 10-ton hook is installed on the main crane.

As will be noted, the words "Safety First" are plainly painted in large letters along the full length of the large crane. The crane girders are painted white, to contrast as sharply as possible with the surroundings inside the

Fig. 3.—Crane Operating in Storage Yard

erection building. Although this building is amply provided with windows, the metals handled and the interior in general are dark in colors, hence the workmen have no difficulty in seeing the white crane as it approaches. The operation of the mechanism has proved satisfactory in every way.

Locomotive Boiler Feeding Arrangements on English Roads

BY CHARLES RUSSELL

It is only in recent years that much attention has been paid in England to the disposal of the feed water in locomotive boilers. As possibly the methods now employed may be of interest to American readers, I propose to describe the principal ones.

The system known as the "top feed" serves a twofold purpose. It localizes the deposition of the impurities in the feed water, facilitates their removal from the boiler, and introduces the feed at a chosen position in the course of the circulation. It is generally agreed now, as a result of many experiments, that the course of the circulation in a locomotive boiler is along the top of the barrel from the firebox to the front tube plate, then downward and along the bottom of the barrel to the firebox, down the sides thereof and up again to the top. It was found by experiment that the circulation could be altered by different methods of firing. It is safe to assume, however, that firing which will give a good steaming effect will produce a circulation of the kind described. This being so, it is advisable to introduce the feed either at the top or the bottom of the barrel. Of the two positions, the top is preferable because the incoming water may be passed through the steam space and take up a large amount of heat before meeting the main body in the boiler.

The system is arranged as follows: The delivery pipes enter the boiler in the safety-valve seating and deliver the feed into a conduit that leads into two trays placed in the front of the barrel and clipped to the longitudinal stays. These trays are comparatively shallow and are perforated on their sides by small holes, through which the water must flow to reach the main body, being broken up in so doing into fine streams, which pass through the steam space. The purpose of the trays is to concentrate the deposits of the soluble compounds of lime and magnesia, which, as is well known, are precipitated by heat. It is found that a large amount of the precipitation is made in the trays and can be removed from them by bringing them under the safety-valve seating for cleaning.

Another form is used in which the feed enters the dome and passes down along a helical trough onto two trays that are inclined across the axis of the boiler and deliver the water to the sides of the barrel, a practice that seems to require some justification in the light of the accepted beliefs concerning the circulation alluded to above.

The Great Northern Railway of Great Britain employs a system consisting of a special dome, into the top of which the feed pipe delivers the water. Inside the dome is a series of trays, four in number, the upper one being shaped like an inverted dish and the lower ones being flat and of increasing diameter, with the result that the water, as it overflows from one, will trickle onto the one below. The top plate is mounted on a steam pipe that is in communication with the boiler, and is perforated where it supports the plate by a number of small holes through which steam is intended to enter the feed. A plate at the bottom of this special dome prevents direct communication with the boiler. Through this plate two vertical pipes project for two or three inches; these convey the water out of the dome into the barrel, the surface of the bottom being designed to provide a settling tank.

It is doubtful whether the short time that the water remains in the dome when an engine is working is long enough to permit of any great amount of settling, but it is said that a considerable quantity of scale is found in the dome when the periodical cleaning takes place.

Many European readers of The Boiler Maker are ignorant of the developments in this direction in America. Perhaps some of the readers will enlighten us in the matter.

Does it Pay to Replace Air with Electric Drills?

In answering this question three factors must be considered: The source of power, its distribution and the performance of the equipment. Cost is a function of all three.

At the present time, power is available in most localities from a central or private service station and its cost is in most cases quite reasonable.

Where electric power is not available, the choice is between generating it or compressing air. To get anywhere now, we must make some assumptions. It requires about 22 brake horsepower to deliver 100 cubic feet of free air per minute at 90 pounds pressure. This same 22 brake horsepower will deliver 14 kilowatts, driving a generator with 85 percent efficiency. This power must now be distributed. The distribution of the electric power is flexible, permanent, efficient and cheaper. Ten percent is the maximum allowance that need be made for loss. We have, therefore, 12.6 kilowatts delivered at the tools.

An air line is costly to install, inflexible, subject to freeze-ups, leaks, and generally high cost of upkeep. It is impossible to prevent leakage, even with constant replacements of hose and repair of joints. The cost of this item may become tremendous.

To illustrate, the amount of leakage for very small holes in a 90-pound system will be:

1/16-inch hole....... 6.0 cubic feet leakage per minute
1/32-inch hole....... 1.5 cubic feet leakage per minute

The question now remains: Which will do the most work, the 90 cubic feet per minute of compressed air at 80 pounds or 12.6 kilowatts of electric energy? The efficiency of an electric motor is constant throughout its life, but the efficiency of an air motor falls continuously as the piston and valves wear. Assuming that we have a new air drill, let us compare results on the basis of the ½-inch tool. The manufacturers of two standard makes of pneumatic tools give the air consumption of the ½-inch drill as 15 cubic feet for the 4-cylinder piston type and 20 cubic feet for the rotary piston type. Our unit of air supply would therefore take care of five or six ½-inch pneumatic drills.

The efficiency of the tool in the hands of the operator is affected by weight, balance and vibration. The advantage of weight obtained in some sizes of air tools is more than offset by the better balance and lack of vibration in the electric tool.

The Chicago Pneumatic Tool Company will remove its Birmingham office from 801 Brown Marx building to 1925 Fifth avenue, North, where a service station with a complete stock of pneumatic tools, electric tools, air compressors, oil engines, rock drills and repair parts will be maintained.

This company also announces that Nelson B. Gatch has been appointed district manager of sales, with offices at 52 Vanderbilt avenue, New York City.

The Boiler Maker

Published Monthly by

ALDRICH PUBLISHING COMPANY, INC.

Member of The Associated Business Papers, Inc.

6 East 39th Street, - - - - New York

8 Bouverie St., London, E. C.

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor.

Branch Office
Boston, Mass., 294 Washington street, S. I. CARPENTER.

Because of the threatened printers' strike in New York City it has been necessary to print the October issue of THE BOILER MAKER before the proceedings of the special session of the American Boiler Manufacturers Association held at the Hotel Astor, New York, Wednesday, September 24, 1919, became available. A complete report, however, will appear in the November issue.

The meeting was very successful in that the discussion on uniform boiler costs brought out the fact that progress had been made in the desired direction. More important still, however, were indications of errors made in estimating on the standard boiler. Because of these discrepancies future estimates will be made with the elimination of the undesirable features in mind.

The errors occurred where material such as braces, brackets, manholes, saddles, castings and the like had been purchased from outside firms in some cases, while in others they were produced by the manufacturers themselves. In these cases the question of labor appeared to be the indeterminate factor, so that the productive hours varied greatly in the bids submitted.

Overhead charges, which gave so much trouble in the estimates last July, were very nearly on a uniform basis at this meeting.

In the interests of uniformity of production, the proposition of utilizing the same system of cost accounting in different plants was brought to the attention of the meeting. Such a system would incorporate modifications to meet special conditions, but in general it might be stated that it would include uniform bills of material, stores, records, inventory sheets, requisitions, labor summaries, cost sheets, etc. In each case particular attention would be given to the general accounting system and the organization of the accounting department so as to effect economical operation and dispense with unnecessary or duplication of clerical help and accounting records.

Among other matters brought before the session, expressions of opinion on the present and future prospects of boiler production were given by several of the members representing various sections in the country. The general sentiment seemed to be that a great demand exists at present for boiler products, and the prospects of still greater needs, both here and abroad, are promising. It is almost impossible, however, to get either experienced boiler makers or inexperienced helpers to do the work.

Because of the interest shown by the members at this meeting, it was decided to hold another in December, the exact date and place to be decided upon by the executive committee. Further estimates on boiler costs will be discussed at this time.

The Executive Committee of the Master Boiler Makers Association has decided to hold the next annual convention in Minneapolis, Minn., May, 1920, if adequate hotel accommodations can be made in that city.

The accompanying set of questions has been prepared by Edwin L. Seabrook, Secretary of the National Association of Sheet Metal Contractors, with the idea of enabling the boiler maker to get a line on where he stands in the matter of efficient management.

Granting that the contract merchant of 100 percent efficiency does not exist, it will be found quite profitable and interesting to grade yourself. Be honest with the answers, and a review of the questions may enable you to see where conditions could be improved in your business.

Each question is valued at so many points, as indicated at the left. Study the questions carefully and credit yourself with what you think is correct in the space at the right. The sum total of your credits will give you your standing.

Points		Credits
10	Do you know what parts of your business pay best, and which pay least?	________
6	Do you do any advertising, circularizing or publicity of any kind, setting aside a definite amount and planning its expenditure carefully?	________
3	Do you try to push any nationally advertised product the trade uses?	________
5	Do you discount your bills?	________
10	Do you pay your bills according to the terms allowed?	________
5	Do you make any display of your products to attract public attention?	________
7	Do you, your clerks and merchants study the merchandise or products you sell? Do you and they know the best talking points?	________
4	Do you make good use of advertising helps offered by manufacturers and supply houses?	________
4	Do you belong to your local or national trade organizations? (Allow two points for each.)	________
8	Do you attend your local meetings? (Allow eight points for regular attendance.) ..	________
6	Do you read at least two good trade journals?	________
7	Have you a good mailing list, and do you use it?	________
7	Do you attempt to give prompt and courteous service?	________
8	Do your mechanics, etc., like the boss?	________
10	Do you use an efficient bookkeeping system that gives you the facts of your business?	________
100		

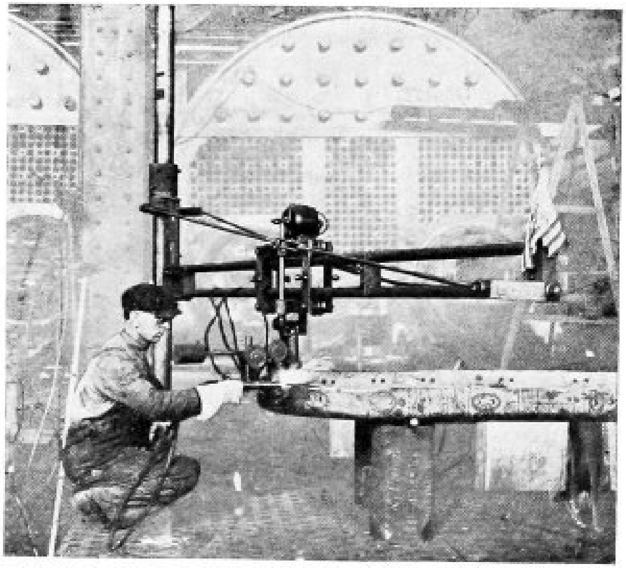
Engineering Specialties for Boiler Making

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

Cutting Machine for the Boiler Shop

A device known as the Pyrograph, for trimming and bevelng boiler sheets to correct the flange height and calking angle in one operation, by means of the oxy-acetylene torch, has been placed on the market by the Davis-Bournonville Company, Jersey City, N. J.

The Pyrograph comprises a motor-driven carriage supported on a radial arm of a length that provides for cutting the flange of a 9-foot diameter boiler head at one setting. While the largest diameter circle that can be cut at one setting is 9 feet, much larger work may be trimmed and beveled, inasmuch as the arm can be swung through a semi-circle of 20 feet or a full circle of 20 feet diameter, provided the shop conditions permit the arm to swing in a complete circle. Heads larger than 9-feet diameter are reset as many times as may be found necessary to reach the flange all around.



Pyrograph for Trimming and Beveling Boiler Plates

The radial arm construction is light but rigid, consisting of two cold-rolled parallel round steel bars firmly tied together by end connections and intermediate spacer blocks, and supported by a truss rod. The vertical cast iron pivot member of the radial arm is mounted on ball bearings at the top and bottom in order to insure the maximum ease of movement. The steel post around which the radial arm swings is adjustable vertically by means of a crank operating a rack and pinion gear; a dog and rachet hold the post at any height within the limits of adjustment required.

The column has a broad flanged base, which may be bolted to a cast iron floorplate or a concrete foundation if required to be self-supporting, or the top of the post may be shackled to a column of the shop building and the base supported on an ordinary floor without an individual foundation.

The carriage is supported on the radial arm by four grooved ball bearing rollers, which provide for the easy radial movement required to follow the feed action freely. The carriage and the arm derive their movements from the feeding mechanism, which operates directly on the part to be beveled, the flange part itself acting as the track and guide for the feeding mechanism.

The torch is adjustably mounted on the carriage beneath the radial arm, and the tip may be directed at any angle required to cut to the desired calking angle. The adjustment provides for setting the tip to all angles from the vertical to the horizontal.

Operation

The operation of the Pyrograph is substantially as follows: A flanged boiler head to be trimmed and beveled to the calking angle is placed beneath the radial arm at a convenient height and leveled on blocks or low horses. The flange is gripped between the outer and inner feed rollers, and the torch is set at the height required to produce the length of flange wanted and adjusted to the angle of the required calking bevel. The cut is started in the manner usual with the cutting torches, by heating the edge of the flange white hot with the preheating flame and then turning on the cutting oxygen, thus starting the feed motor. The feed rollers traverse the flange, carrying the torch and carriage along; the radial arm acts as a support only and swings freely with the torch as the feed rollers traverse the flange.

The Pyrograph, once set, trims a flanged sheet evenly, producing a flange of uniform height all around without torch adjustment, provided the sheet has been leveled up; but if this is not done it is necessary to mark off the height of the flange with a scribing block or height gage and chalk the line to be followed by the torch. The operator then guides the torch, making it follow the layout line by manipulating the slide rests as it advances. The latter practice is generally followed because the operator should constantly watch the torch operation, anyhow, and guiding the torch is an easy matter. Time is saved in setting up and the cutting is as quickly done.

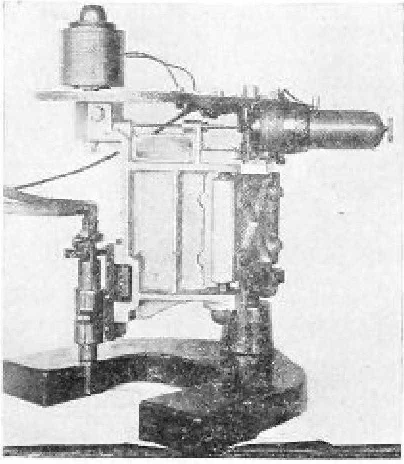
Adaptable to Other Uses

The vertical adjustment provided at the column is 18 inches, which is ample for all ordinary boiler flange work and many other uses. The machine may be adapted to straight line cutting and beveling the edges of flat plates by adjusting the torch for vertical cutting and providing means of engagement for the feed rollers. This need be nothing more elaborate than an ordinary angle iron clamped to the plate parallel with the cut to be made. The angle iron provides the flange for engaging the feed rollers and guiding them. The machine may be used also for cutting square, rectangular and other shaped holes in plates by simply providing the straight or curved angle iron guides of the required shape. There are many possibilities in beveling, cutting and perforating which will readily suggest themselves to the practical boiler maker.

The Lukens Steel Company, Coatesville, Pa., is operating a new 204-inch plate mill, which is the largest in the world. The rolls are of the 4-inch reversing type, each weighing 30 tons.

Machine for Cutting Handholes and Other Openings in Steel Plates

The device known as the Camograph No. 2 was specially designed by the Davis-Bournonville Company, Jersey City, N. J., to cut handholes in boiler plates, and similar openings in ship plates and other wrought iron and steel sections. An oxy-acetylene flame perforates the



Camograph No. 2 for Cutting Handholes

steel, and the path traversed is controlled by an internal cam at the top, the shape of which determines the shape of the opening made. The machine is suited for cutting all openings in steel plates that cannot be produced quickly and economically on a drilling machine. A handhole having a periphery of 12 to 13 inches can be smoothly cut in ½ to ⅝-inch steel plate.

The machine comprises a cast iron base with a U-shape opening, through which the torch flame strikes the work beneath. At the back of the base is a vertical post, to which a double-jointed radial arm is pivoted. The cutting torch is mounted on the outer end of the radial arm, which provides for movement in any direction over the entire area covered. The jointed arm is made of two aluminum castings of light but rigid construction; these are mounted on ball bearings, which offer a minimum of frictional resistance.

A feed roller on the outer or free end of the radial arm is surrounded by a yoke in which is placed the guiding internal cam or template required to control the movement of the torch. The feed roller is magnetized by a powerful electro magnet, and is thus attracted to the inner face of the cam, the parts in contact being made poles of the magnet, one of which rotates and thus acts as a traction driver.

The traverse movement or feed is provided by a small variable speed electric motor mounted on the swinging radial arm. The motor drives the feed roller through a double worm reducing gear, and the magnetic pull provides for the necessary traction. The electric current that operates the motor also serves to energize the electromagnet, by which the feed roller is held to the cam face. Direct current is required.

The shape of the opening cut in the plate being determined by the shape of the cam, it is necessary, therefore, to provide a cam plate for each shape required. The cam fits into a circular opening in the yoke or cam holder and is readily removed and replaced by another. The nominal diameter of the largest hole cut with the No. 2 Camograph is 7 inches, but openings other than circular having one dimension much larger may be provided for. All thicknesses of plates used on the largest marine boilers are readily cut. While intended for cutting commercial steel plates only, the power of the torch is ample for cutting much thicker metal, should it be required.

Red Devil Rivet Cutter

The Red Devil rivet cutter is a pneumatic tool designed solely to cut and back out rivets. The principle of construction is simple—a plunger driven in a long barrel by compressed air striking a chisel head. The efficiency of the tool lies in the tremendous power which it puts behind every blow. One and one-quarter-inch rivets can be cut cold in ten seconds. One-inch rivets can be cut in from three to five blows.

As manufactured by the Rice Manufacturing Company, Indianapolis, Ind., exclusively for the Duntley-Dayton Company, 1416 Michigan avenue, Chicago, the valve head and nose piece are attached to the valve by being forced on under 50,000 pounds pressure. This method of construction provides a solid joining without projections to interfere in close work. High-grade springs placed at each end of the barrel reduce shock and vibration and afford easy operation. All inlet and exhaust valves are curved at an angle which permits the air to enter and leave with the least possible obstruction. An air pressure of 90 pounds, the company reports, will give the best results, although the machine will work fairly well on pressures as low as 40 pounds.

Only three men are required for the operation of the tool. The operator controls the left handle with his left hand and rocks the valve handle with his right. An assistant holds the chisel on the rivet. At the opening of the air port, by the turning of the valve handle upward, the full force of air acts on the plunger, driving it down the barrel until it strikes the chisel head. On throwing the valve handle down to exhaust, the plunger returns to the head of the tool ready for the next operation. After the rivet is cut it takes but a moment to remove the chisel and insert the backing-out punch. Countersunk rivets are punched through with the latter attachment.

Development and Specialization of Rod and Wire Welding Fillers

Vast strides in automobile, railroad and ship construction within the past two years have brought the matter of welding to a position of great importance, for all of the steel industries are dependent on this art. Seven years ago welding, as carried on at present, was practically unknown, and the progress made since then has been largely due to the improvement in fillers.

Some time ago the Central Steel & Wire Company, of Chicago, caused tests to be made on various steel alloys in the metallurgical laboratories and forge, in order to determine whether the existing use of a single filler for all purposes might be improved. Preliminary investigations led to the adoption of the present convenient form of wire and rod fillers. This was an important change, but the subsequent discovery that wire must be treated differently for electric welding and acetylene welding was even more so.

Swedox was the first special welding material supplied accomplishing this differentiation. Then it was determined by experiment that a filler used successfully in welding nickel steel, for example, was very inefficient in the case of vanadium steel. Gradually fillers were treated so that they might be used to advantage with practically any steel alloy, until at present there are eight special welding materials available.

Questions and Answers for Boiler Makers

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

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *6 East 39th street, New York City.*

Square Tank Problem and Camber

Q.—Please explain and show how a square tank having a top manhole opening can be made without angle irons and without the bottom and top having four flanged sides. What is meant by camber? Show a simple method for finding it. R. T. S.

A.—A square or rectangular tank may be formed in the manner shown in Fig. 1 (a) and (b). In the case of a square tank, the pattern for all sides is alike, except for the top, where a manhole must be cut out. The plates

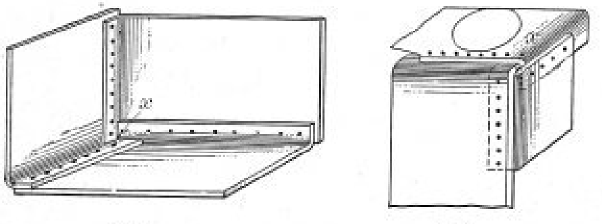


Fig. 1.—Method of Forming Square Tank

have two flanged ends and two straight sides, which are riveted respectively to the straight and flanged sides of adjoining sections, overlapping as shown in Fig. 1 (a). The corner connections have an opening which must be plugged. This may be done by drilling out the corner and driving a rivet to fill each gap. To insure watertight joints, the rivets must be placed close together, and it is well to place tar paper between the flanged and straight sheets to the depth of the flange.

Pattern Development.—The shape of the pattern is rectangular, as there must be metal allowed for the flanged part of each sheet. Therefore, from Fig. 2 the sectional view shows the length should equal the sum of the respective distances *a-b*, *b-c*, *c-c*, *c-b* and *b-a* as measured along the neutral axis of the sectional view shown by the dotted line. The straight length *a-b* and *c-c* may be measured directly from the drawing. Arc length *b-c* equals

$$\frac{1 \times 3.1416}{4} = .7854$$

inch, when radius to neutral layer equals ½ inch. For light plate less than ⅛ inch in thickness, the radius of head equals approximately ¼ inch. The width of the pattern is equal to the flat plate section *c-c*, which equals 40 — (½ + 1/16 + ½ + 1/16) = 38⅞ inches. Note that the 1/16 inch is the plate thickness from outside edge to neutral line of plate. Length of plate equals 1⅛ + .7854 + 38⅞ + .7854 + 1⅛ = 42.6958 inches. Space off rivet holes on rivet line to equal spaces. Rivet holes may be punched before turning flange on plates.

Camber is the curved or arched section of a plate or beam. In boiler work, for example, the expression refers

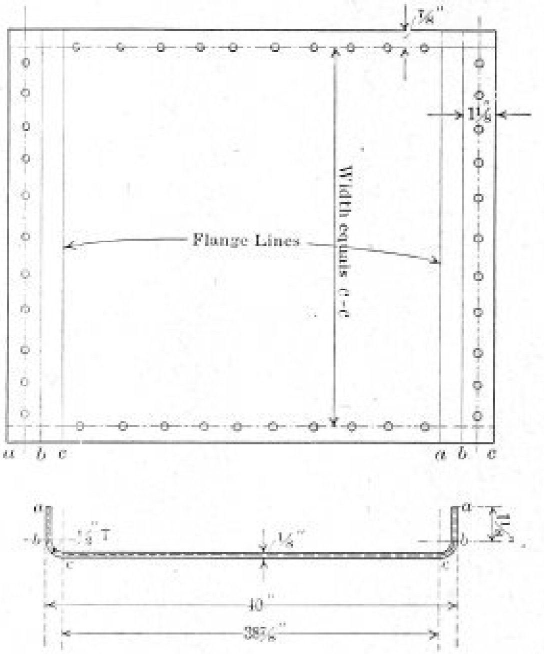


Fig. 2.—Development of Square Tank

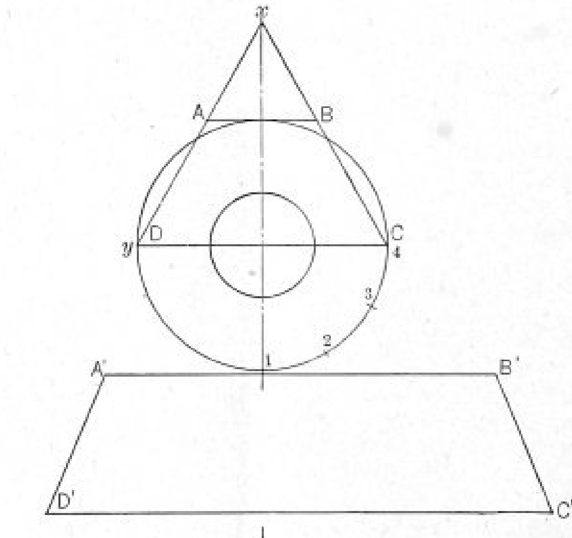


Fig. 3.—Development of Frustrum of Cone

to the curved lines that must be developed for tapering objects of regular or irregular form and taper.

In conical work as patterns for frustrums of cones, the patterns cannot have straight lines for the ends. For example, in Fig. 3 is shown a frustum of a cone, the pattern of which cannot be laid off as shown, as the ends *A'B'* and *C'D'* in the figure would not give the required shape after the pattern is rolled. To give the required form, the ends must be cambered—that is, curved. In conical work, where the taper is sufficient so that the side or element as *X-Y* can be used as a radius, the camber line can be readily laid off. In other cases where the taper is slight, making a large radius, then the approximate development or the triangulation method may be employed.

Pattern for Bumped Head

Q.—From the accompanying sketch, Fig. 1, please determine and advise me how to lay off the pattern for a dished head. Outside diameter of the head equals 15 feet; plate thickness equals ½ inch, and head is dished to a depth of 13½ inches. C. A. D.

A.—The required radius for any bumped head may be readily found by first laying off, as in Fig. 2, a sectional view of the head to scale, or to full-size dimensions; it is best, however, to lay off the view full size, if convenient. Draw the diagonal line *a-b*, which is the required radius

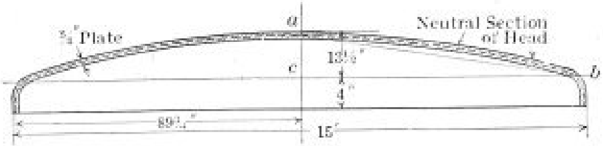
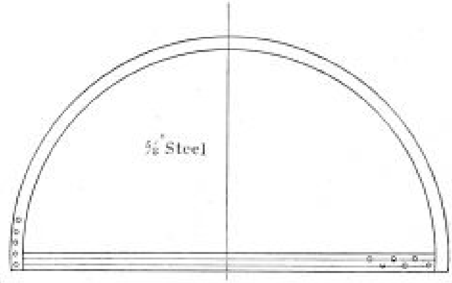


Fig. 2.—Sectional View of Head

$$ab = \sqrt{13\tfrac{1}{4}^2 + 89\tfrac{3}{4}^2} = 90.8 \text{ inches.}$$

The dimensions are taken to the neutral layer of the plate section.

All rivet holes may be laid off before bumping the head and turning the flange. Your drawing shows the head to be made of two sections, but the seam or joint does not indicate whether the joint is a lap or butt. If a lap seam



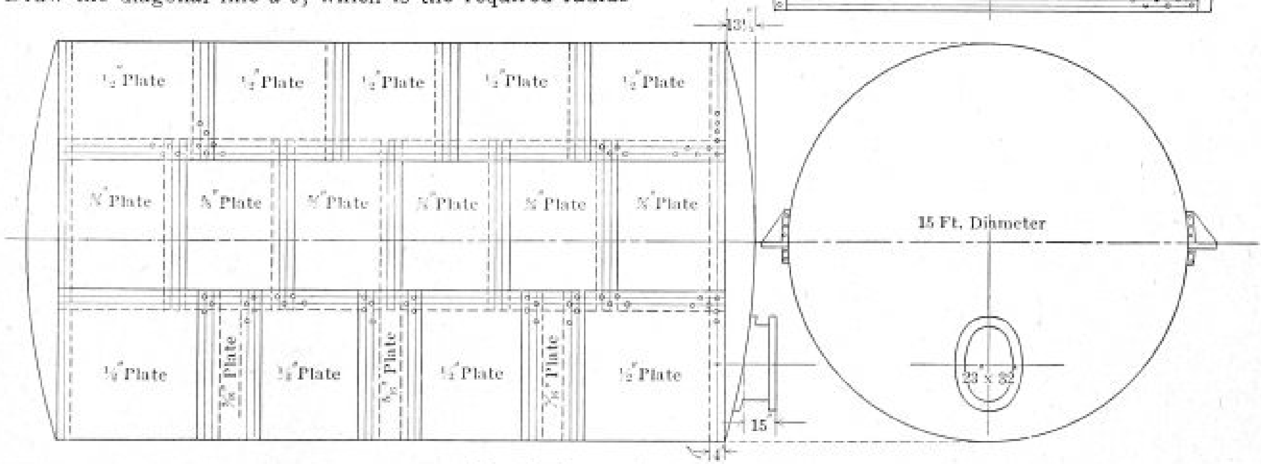


Fig. 1.—Pattern for Bumped Head

for the part of the head to be bumped. This length may be calculated. The length *a-b* is the hypotenuse of the right angle triangle *a-c-b*.

The length of $ab = \sqrt{ac^2 + cb^2}$; using the values in the example in the formula, we have:

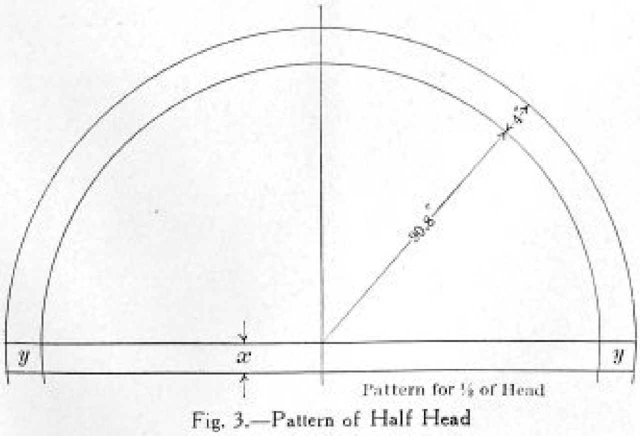


Fig. 3.—Pattern of Half Head

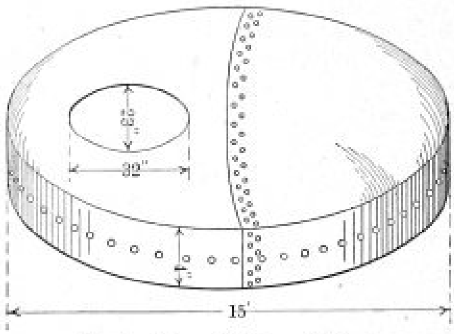


Fig. 4.—General View of Head

is to be made, then an allowance as at *X* must be made to one section of the pattern. At the corners the plate must be scarfed—that is, thinned down by hammering the plate when red hot. This is done in order to make a snug fit between the flanged sections of the head. The metal for the flange must also be allowed, which in this case is four inches.

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 Few Rivet Thoughts

Every reader of THE BOILER MAKER has driven rivets or seen them driven, but very few have ever really thought just what a rivet is and how it acts. To most, a rivet is a piece of round metal heated red hot, put through two holes and a head pounded up on each end.

Now let us just consider a rivet when it holds two plates together.

Take two pieces of cardboard, say 2 inches wide and 6 inches long, lap the two pieces an inch and punch a lead pencil through the two. Now pull on the ends of the two strips and the pencil will be tipped up, and if you keep on pulling the strips one will slip off the pencil. If a friend holds the cardboard together lightly and you then pull, the strips will tear; that shows that the pencil is stronger than the cardboard. If this were not so the pencil would be broken, or sheared, as it is called.

Suppose now that the pencil is put through two holes in pieces of wood each an inch thick and you pull the blocks; the pencil will not tip, and if you pull hard enough the pencil will shear, showing that it is not as strong as the blocks. This shows that the thickness of the plates has something to do with the holding of a rivet.

Go further with the experiment with the cardboard and pencil. Suppose that the pencil has a large head on it. When it is pushed through the cardboards this head comes up against the paper on one side, and if you slip a wooden washer as large as the head over the pencil and secure it against the paper, the head and the washer then take the place of the fingers of your friend who held the papers together. If you now pull on the ends of the cardboard the head and washer prevent the pencil from tilting, so the papers can be torn apart. This shows that the head of the rivet has something to do with the holding quality of the rivet.

If the two blocks of wood are placed on a table and a pull exerted on either end, the tendency of the two forces is to tip this pencil inserted through the holes. This tendency is partially overcome by the inch thickness of wood through which it passes. If the pencil had a head and washer the tipping action would be eliminated.

In the case of the wooden pieces, the strains would be as follows:

One side of the pencil bears against the right-hand edge of the hole, while the left-hand side of the pencil would have no pressure or strain on it whatever. On the left-hand block the strains would be reversed. The left-hand side of the pencil would receive pressure, while there would be none on the right-hand side. Where the two blocks meet, the right-hand block would have the left-hand side of the hole under pressure, while the left-hand block would have the right-hand side of the hole under pressure. These two forces would therefore tend to shear the rivet just as the blades of a shears would cut a piece of metal.

The heads of the rivet would first hold the plates together and the rivet itself in place. In the case cited they would receive the same strains as the blocks and pencil.

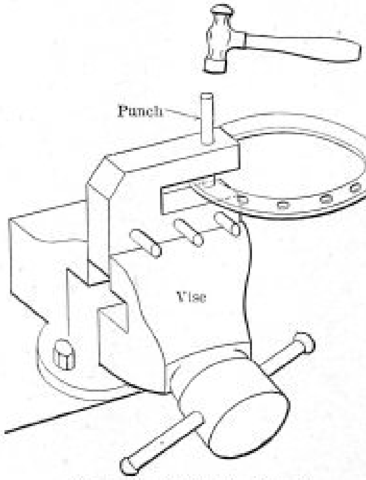
What has been said applies to rivets where two plates lap each other and the rivets are in single shear. When the plates butt and two straps are used, with the rivets passing through the straps and plates, then we have, as Kipling puts it, "another story."

New London, Conn. W. D. FORBES.

Bench Vise Punch

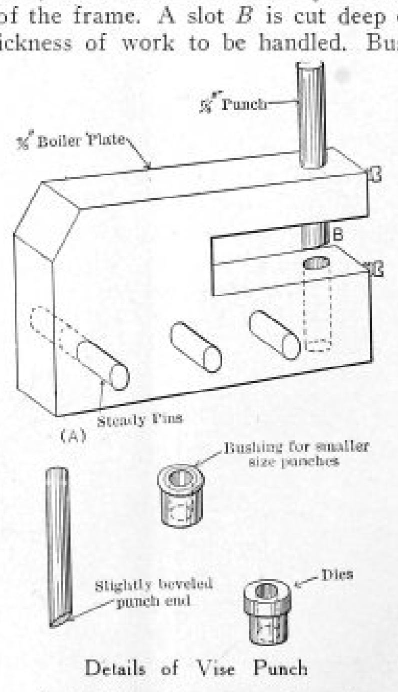
Where anyone has need for such a tool it will be hard to beat this type of home-made punch for small size holes. The sketch herewith shows both the details and a view of the punch in use.

A piece of seven-eighths-inch boiler plate is used to make the frame. Steady pins are put into the frame as



Improvised Bench Punch

indicated at *A*; these rest on the vise jaws and prevent movement of the frame. A slot *B* is cut deep enough to suit the thickness of work to be handled. Bushing and



Details of Vise Punch

dies can be made, if desired, so that other sizes of punches can be used.

I have found it more convenient to make separate punches and frame for each size punch, since these are very easy to turn out. For punching thin sheet metal and all gasket work these punches stand up very well, and since they can be made from scrap stock in spare time they are very cheap.

Flanging the Locomotive Throat Sheet in One Heat

An interesting development in the methods of throat sheet flanging for locomotives has recently been made by William Nees, of Drexel Hill, Pa. The device accomplishing this consists of special dies for use in a four-column flanging press with an overhead plunger. Two sections of the die are fastened to the upper and lower platens of the press, while the ram, or plunger, operates the middle section in flanging the circular belt.

The metal is laid out to size and cuts made for the inner flange. The sheet is then inserted between the upper and lower sections of the die, as indicated by the dotted line, Fig. 1, where it is held firmly until the plunger completes the interior flange. After this the platens are separated and the finished work taken from the press.

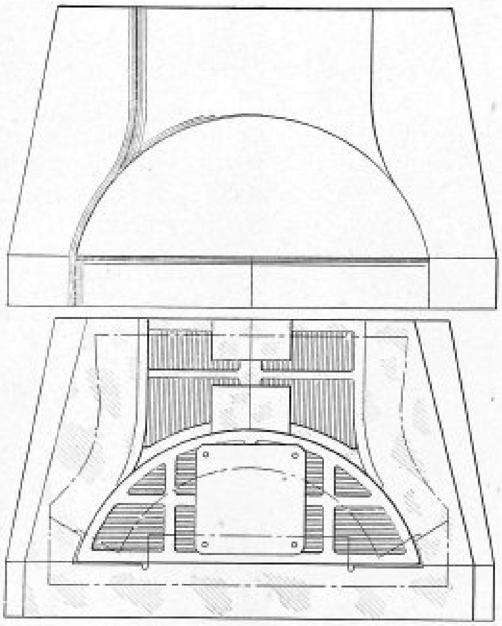


Fig. 1.—Top and Bottom Sections Assembled

So far as it is known, this particular die is the only one that will successfully flange a Belpaire type throat sheet in a single heat.

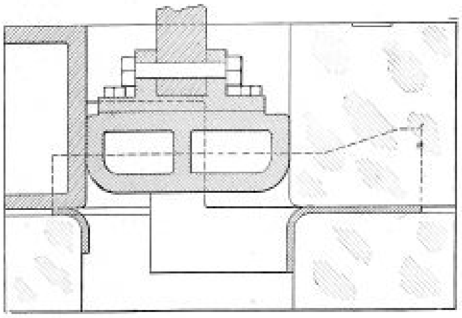


Fig. 3.—Section of Flanging Die

Special dies of various shapes may be utilized in this manner to facilitate the flanging of difficult sheets that would ordinarily require several heats to accomplish satisfactory results.

Notes from a Memorandum Book

The width of the water space at the centerline of a boiler should be made 1½ inches greater than the ring at the sides and back whenever it is possible and consistent with other details of a particular design.

The sizes preferred in constructing the wide fireboxes are:

Length, inside the ring, measured horizontally, 85 inches, 91 inches, 97 inches, 103 inches, 109 inches, 115 inches and 121 inches.

Width, inside the ring between firebox frames, 32 inches, 33 inches and 34 inches.

Width, inside the ring above the firebox frame, 40 inches, 41 inches, 42 inches and 43 inches.

Width, inside the ring for wide fireboxes, 61 inches, 66 inches, 71 inches, 76 inches, 80 inches, 97 inches, 103 inches and 109 inches.

Material to be used in firebox rings: Narrow rings may be made of cast steel in one piece, while wide rings should have cast steel ends front and back, welded to steel or wrought iron sides.

For pressures exceeding 175 pounds, the rings over the firebox should be double-riveted and not less than 3½ inches thick. Single-riveted rings may be 2½ inches thick except for very small boilers, when 2¼-inch material with ¾-inch rivets having 2-inch pitch and 1¼-inch lap from the center to the bottom of the ring may be utilized.

Firebox Width, Inches	—Width of Water Space, Inches— Front	Sides	Back
30½ to 43	4	3½	3½
Over 43	5	4½	4½
Over 43, bad water	5½	5	5

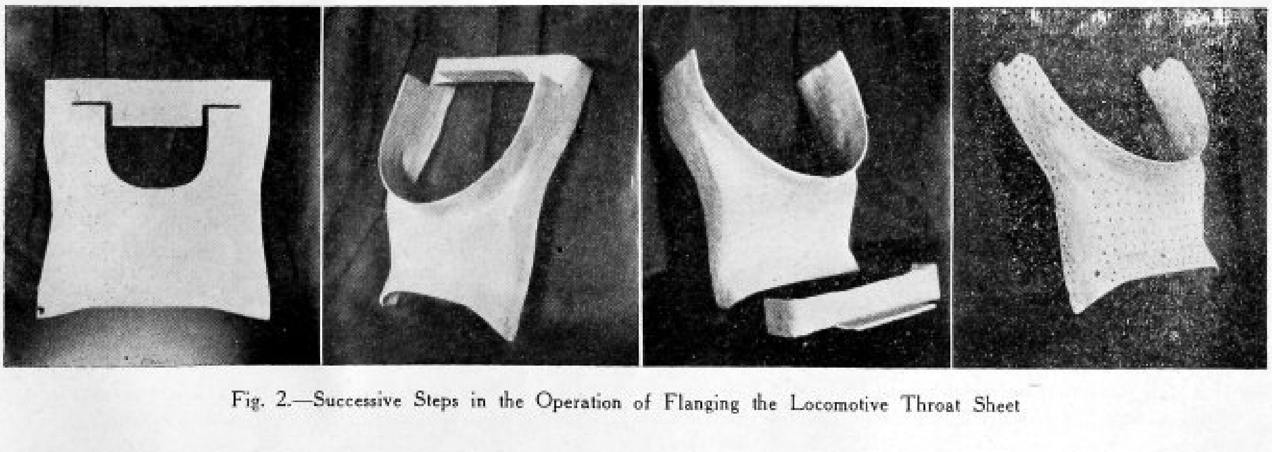


Fig. 2.—Successive Steps in the Operation of Flanging the Locomotive Throat Sheet

FIREBOX RINGS

Thickness, Inches	Front, Inches	Sides and Back, Inches
2½	3½	3
	4	3
	4	3½
3½	4	3½
	4½	4
	5	4
	5	4½
	5½	4½
4	4½	4
	5	4
	5	4½
	5½	4½
	5½	5
	6	5

Ash pans should be constructed so as not to interfere with the free admission of air. The total unobstructed air opening in ash pans should not be less than the total internal tube and flue area. The following openings are arranged in order:

1. For wide fireboxes provide openings in the sides directly under the ring. These spaces will admit air and facilitate the removal of ashes from the slope.
2. For deep ash pans provide side openings. These should be protected by perforated steel or netting inclined plates.
3. Arrange openings at the front and back ends of the pan.
4. For the hoe-out type of ash pan the openings of one or two of the dampers may be considered as air passages.

NOMINAL INTERNAL AREA OF ONE TUBE OR FLUE, IN SQUARE INCHES, FOR DIFFERENT DIAMETERS AND GAGES

(Swaging of Back End Not Taken Into Consideration)

Outside Diameter of Tube or Flue, Ins.	B. W. G. No. 9	No. 10	No. 11	No. 12	No. 13
1½	.....	1.19	1.25	1.29	1.35
1¾	.....	1.72	1.77	1.84	1.91
2	.....	2.36	2.44	2.49	2.57
2¼	.....	3.08	3.17	3.26	3.33
2½	.....	3.91	4.00	4.09	4.19
3	.....	5.86	5.98	6.08	6.20
5⅜	10.81	....	....	....	....
5½	11.82	....	....	....	....

Pittsburgh, Pa. George L. Price.

(*Continued from page* 303)

C = allowable bearing pressure on the projected area of the pin in pounds per square inch.

d = diameter of the pin in inches.

Substituting and solving, we get:

$$T = \frac{12{,}125}{7{,}500 \times 1.56}, \text{ or } 1.04 \text{ inches, say } 1\tfrac{1}{8} \text{ inches.}$$

This figure, being less than the diameter, D, of the rod, it might be said that if T is always made at least equal to

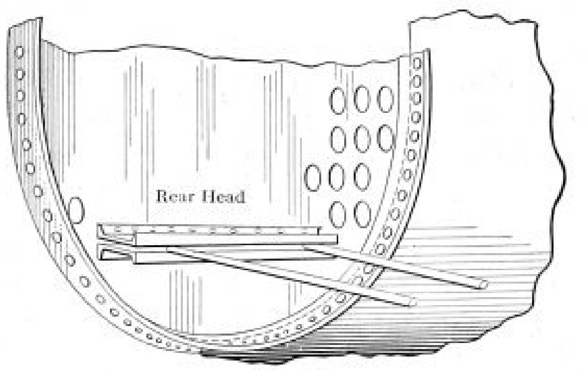


Fig. 43

D, the design will usually meet with all the requirements.

The net section through X-X is in direct tension, and we may safely allow 12,000 pounds per square inch as the working strength of the metal. The code requirement for this net section is at least 1.25 times the net cross-sectional area of the rod, which, for our case, will be 1.25 × 1.43, or 1.79 square inches. This would seem to give the "eye" a working strength greater than the body of the rod; but it is done for the same reason that the threaded end of the rod is made heavier than the body, due to the weakening effect of the forging process. Based on the A. S. M. E. requirement, the author has devised the following formula:

$$W = \frac{A + (T \times d_1)}{T}, \qquad (13)$$

in which

W = width of "eye" in inches.

A = least net sectional area, through $x - x$, required by the Code (see Fig. 39 (b)).

T = thickness of "eye."

d_1 = diameter of pinhole in "eye" (which is drilled 1/32-inch larger than the diameter of the pin).

Substituting and solving gives:

$$W = \frac{1.79 + (1.04 \times 1.78125)}{1.04}, \text{ or } 3.5, \text{ say } 3\tfrac{1}{8} \text{ inches.}$$

Fig. 43 is an isometric view clearly illustrating another method of bracing the segment below the tubes of the

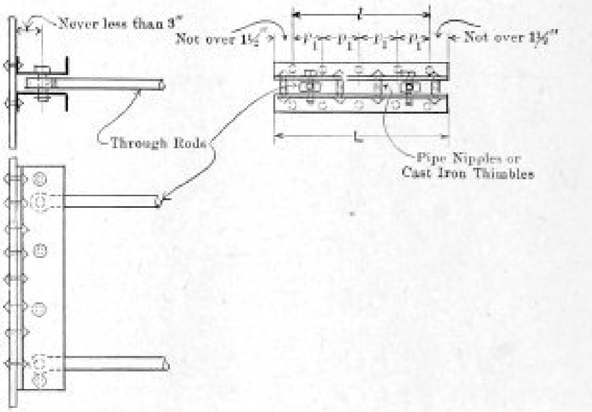


Fig. 44

rear head. The three orthographic projections shown in Fig. 44, together with the notations thereon, should be observed. The maximum pitch of the rivets attaching the girders to the head should not exceed that found by formula (5), and the length, L, sufficient to overlap an arc inscribed 3 inches from the outside of the head. Although the figures illustrate two channel beams back to back, steel angles may also be used, providing that sufficient strength is obtained.

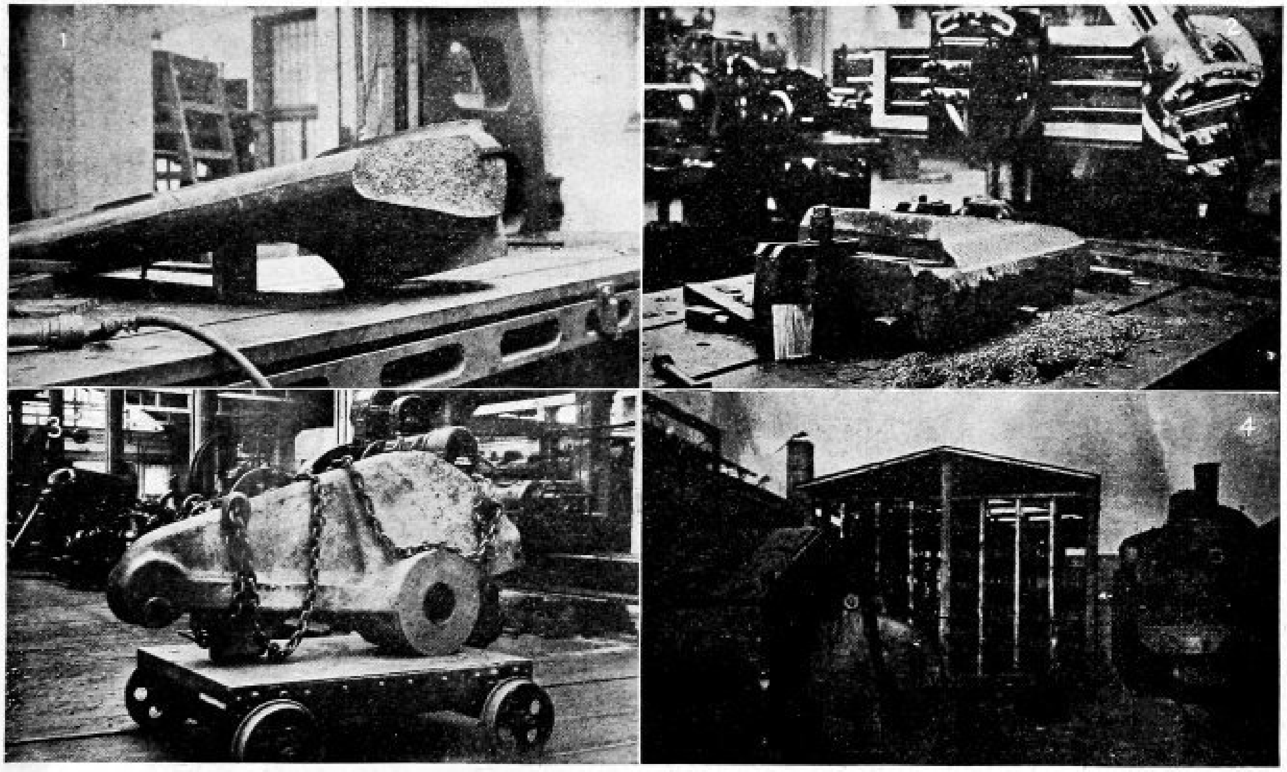
(*To be continued*)

The uses that can be made of the oxy-acetylene torch are without limit, and new ones are discovered every day. The possibility of quickly restoring a broken part to use, often means saving many times the cost of the part. It is not the cost of the thing that counts so much as the want of it. If a machine or department is held up, and work is waiting for a new part to come from the factory, the loss may run into hundreds or thousands of dollars. What, then, is the value of a repair apparatus which, in the hands of a skilled operator, will make the broken part as good as new in an hour or so? It is simply incalculable.—*Autogenous Welding*.

Remember that a soaking heat is required when preheating a large casting.—*Autogenous Welding*.

THE BOILER MAKER

NOVEMBER, 1919



Figs. 1 and 2.—Alligator Shear Blade Prepared for Welding
Figs. 3 and 4.—Weld Complete and Casting in Place

Oxy-Acetylene Welding in the A. E. F.

Some of the Work Done by American Boys with the Transportation Corps in the Nevers Shops in France

BY MAJOR C. E. LESTER*

"Before entering the military service in 1916, the writer followed, rather closely, the progress of the oxy-acetylene industry in this country, but lost contact after entering service until the organization of a 'maintenance of equipment' regiment of railroad mechanics during the early spring of 1918, for service with the A. E. F. The tables of organization called for several oxy-acetylene welders, and these men were selected after a personal investigation of their previous experience. Among those selected was a chunky, little fellow from Cleveland, Ohio, by the name of Julius Matousik, who later, by reason of his unswerving fidelity, strict attention to duty and skill in welding, gave the work in our new shops at Nevers, France, the needed impetus, and was the one to whom most of the credit is due for our success in welding. Of the ninety-five locomotive cylinders repaired and the hundreds of other jobs of all kinds attempted, we never lost a weld.

"Our organization contained some excellent supervisors and workmen, but Private Matousik was in a class by himself. Private Matousik (later master engineer, senior grade, for the reasons just mentioned) did not do all the work himself, but showed us what could be done and we carried on. To show that his work as appreciated, the following article that appeared in the *Stars and Stripes* (the official A. E. F. organ) under the date of May 30, 1919, is quoted."—MAJOR C. E. LESTER.

"When America put her strong hand to the task of war, nowhere did her effort tell with greater effect than in the great loco and car shops, where the men who had linked two oceans and laced a continent with steel pulled denim overalls over their O. D.'s for the fight behind the lines.

* Late General Superintendent, 19th Grand Division, Transportation Corps, A. E. F.

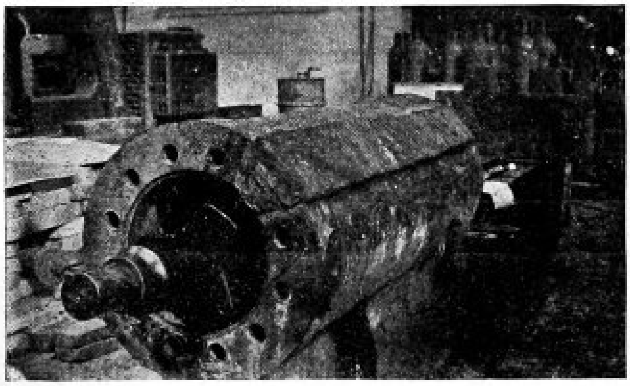


Fig. 5.—Repair on Pressure Cylinder of a Spring Stripper

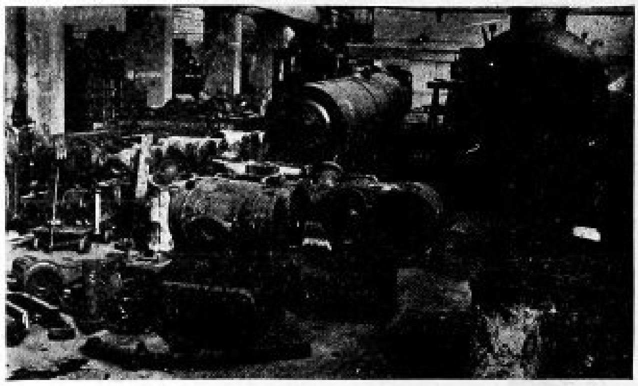
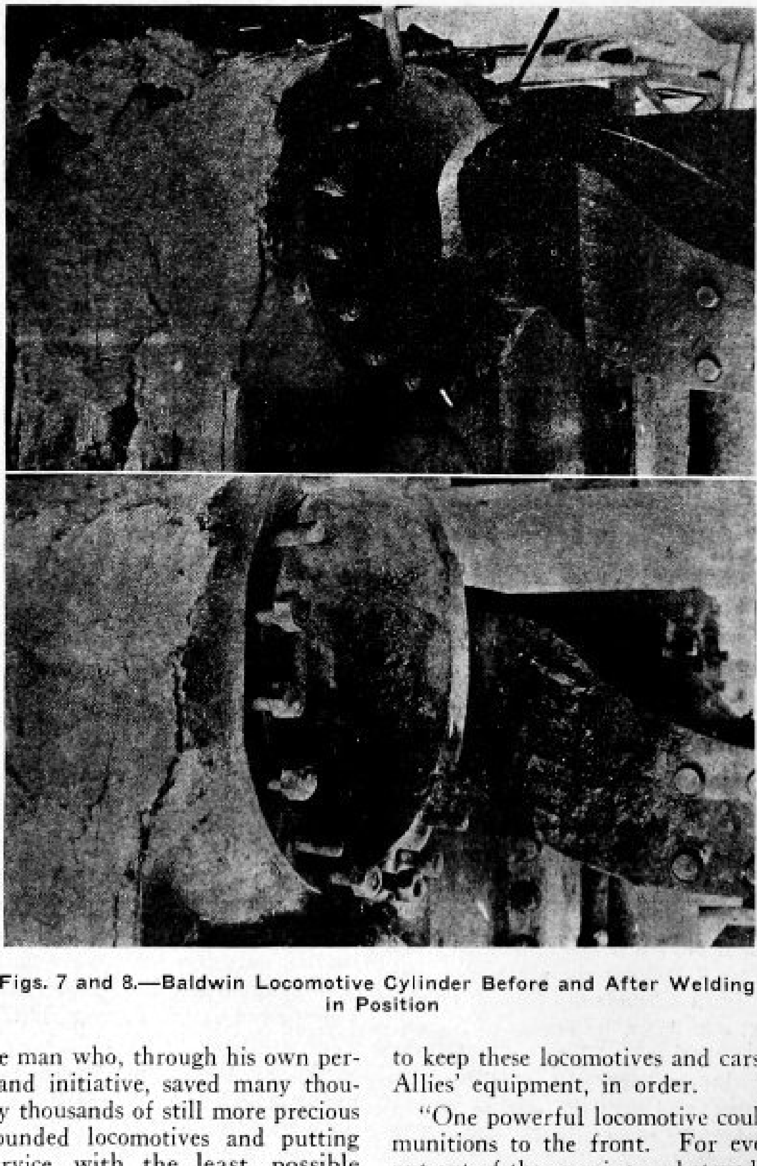


Fig. 6.—Corner of Erecting Bay in Nevers Shops

"One of these men, Buck Private Matousik, now master engineer, wears the Distinguished Service Medal, and wears it with the satisfaction of knowing that the work accomplished through his efforts amid the roaring machines of the great shops at Nevers was worth as much to his country as many a deed of glory on the battle front itself. Matousik was the man who, through his own personal skill as a welder and initiative, saved many thousands of dollars and many thousands of still more precious moments by healing wounded locomotives and putting them back into active service with the least possible loss of time.

"The war could not have been won without locomotives and without men expert in the operation and repair of locomotives. What American railroaders and American mechanics accomplished in France astounded the French mechanical experts. It was one thing to bring to France an enormous number of locomotives and cars, together with ample equipment, but it was quite another matter to keep these locomotives and cars, as well as much of the Allies' equipment, in order.



Figs. 7 and 8.—Baldwin Locomotive Cylinder Before and After Welding in Position

"One powerful locomotive could haul dozens of cars of munitions to the front. For every locomotive that was put out of the running and stayed out of it, dozens of cars of food, equipment and shells needed at the front had to stand still on a side track.

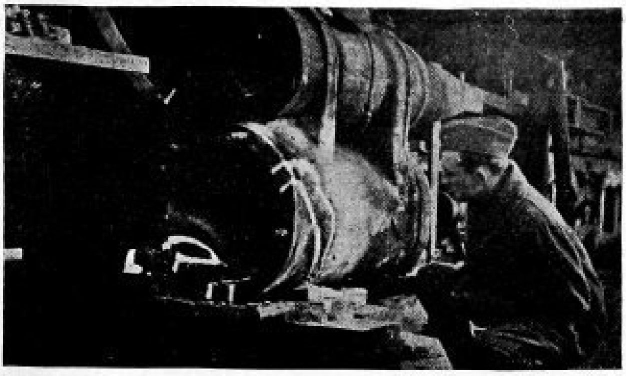


Fig. 9.—Examining the Results of the Broken Cylinder Weld

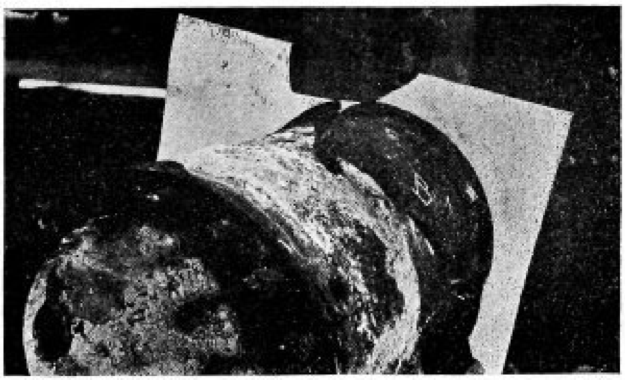


Fig. 12.—Typical Cylinder Crack That Came in for Repair

"Under the terrific strain of war the blown-out cylinder was a frequent occurrence. To wait for parts meant interminable delay. Here Mastousik stepped in and, in spite of the doubt and skepticism of some of his superiors, undertook the repair of the breaks himself. He succeeded, and with such results that his work soon took on an importance that resulted in his award.

"Instead of lying idle for weeks, locomotives that needed new cylinders were ready for action in a few hours. Kneeling on the concrete floor directing the white flame of his torch with the artistry of the expert, Matousik kept the wheels moving that carried the supplies and munitions to the men in the front lines.

"Here at the great A. E. F. railroad shops at Nevers, America's effort is still visible. The buildings (not yet completed) that were to be the repair headquarters for all the locomotives of the A. E. F. were turned over to the Americans early in 1918 to be equipped. This they did with the finest machinery in the world from the shops of the country that leads the world in railroading. Now, with American efficiency, the plants are being used as a school of instruction.

"From all parts of the A. E. F. hundreds of soldier students have come to Nevers. These men are receiving instructions from such men as Matousik. The students act as apprentices and helpers. They are taking courses in welding, machine shop practice, tool making, heavy blacksmithing and forging, foundry practice, boiler making, electrical work and other lines. Instead of delaying production, they are actually increasing it."

DIFFICULTIES OVERCOME

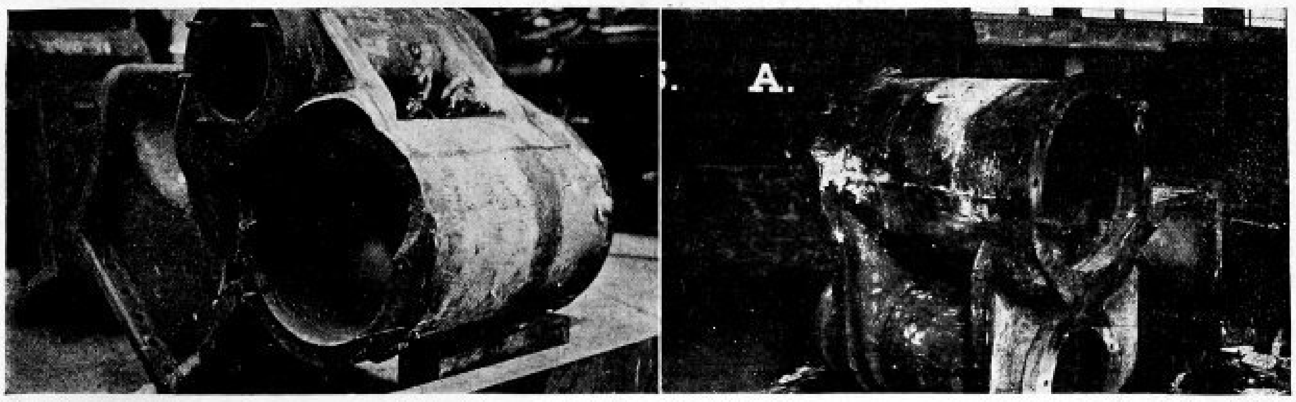
In view of the fact that the writer has not been in touch with the progress of the oxy-acetylene industry in this country for over three years, he may be a trifle proud of the results obtained abroad. However, when it is realized that the work was done under abnormal conditions—by an untried and new organization of soldier mechanics, it is believed that these same mechanics of the A. E. F. were not far behind those who stayed behind, either in skill or general progress.

The oxy-acetylene process was one of inestimable value in many ways, even though we had to use the boiler shop rolls to crush large carbide so that it could be used in ¼-inch generators. In addition, we had to use low-pressure torches with high-pressure generators. There were many other things that the purchasing agent never thought of (he apparently never considered spare parts as a necessity), and the fact that we were 3,500 miles from our base of supplies was a little thing in a big war—not worthy of consideration. However, the well-known ingenuity of the Americans stood us in good stead and the difficulties were quickly overcome.

All machinery that we were to install was of American manufacture. On unpacking it many of the smaller and fragile cast iron parts were found broken, but our welders quickly put them in working condition. The replacement of these parts from the States would have taken months, especially at this time, for there was an embargo on everything except food, men and munitions.

All the flues in French and Belgian locomotives were of brass, and we were required to safe-end them with the torch. Pipe bends, couplings, elbows, 45's, etc., were for some time a minus quantity; miles of pipe were put in without a fitting; all joints and bends were made with the torch. An auxiliary compressed air plant of ten 4-cylinder cross-compound air pumps was installed without a fitting, except where the pipes connected to the pump.

While France was the birthplace of the oxy-acetylene torch, the industry has never progressed as it has in the



Figs. 10 and 11.—Another Locomotive Cylinder Successfully Repaired

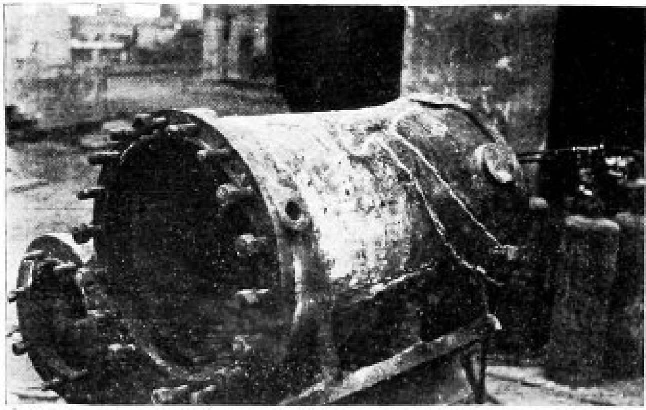


Fig. 13.—Cylinder Again Ready for Use

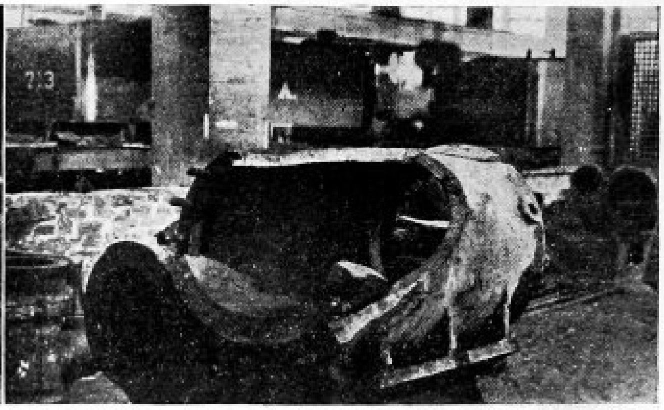


Fig. 14.—One of the Last Welding Jobs Attempted in the A. E. F.

United States. No developments have been made for years, and their experts were coming daily to inspect our plant for ideas to adapt to their own work.

Typical Repair Work

The accompanying photographs, Nos. 1, 2, 3 and 4, of a broken alligator shear blade, indicate an example of plain, heavy, hard welding. Although extraordinary skill was not required in making this repair, it did necessitate a great amount of hard work, patience and exposure to intense heat. This large casting (the break was about 32 inches and 6 inches) was broken by a careless boy trying to cut a heavy bar of steel without the guard guide in position.

Figs. 1 and 2 show the broken parts being prepared for welding, and Figs. 3 and 4 show the weld completed and the casting back in position as the upper shear blade.

Fig. 5 is the pressure cylinder for a spring stripper operated by a hydraulic accumulator. This casting was found cracked its full length and depth one cold morning. It was promptly removed from the body of the machine and placed on a planer, where the crack was V'd out to the proper dimensions, then put in a make-shift furnace for preheating and heated with a kerosene (paraffin) burner and welded in about nine hours by relays of welders.

Fig. 6 shows a corner in one of the erecting shop bays, where the larger defective or broken castings were assembled for welding, and where all stock cylinders were bored after welding. A Baldwin locomotive is shown in Figs. 7, 8, and 9, with a broken cylinder welded in position. This job was welded and bored, the piston and cylinder head reapplied and the locomotive pulled out of the shop in eight hours from the time it entered the shop out of commission. It may be well to state that, if any parts of the broken cylinders were missing and required the making of patterns and the welding of patches, that cylinder was promptly removed and one from stock applied. When the defective cylinder was welded it was bored, greased and headed to prevent rusting and placed in stock. Of the 100 cylinders welded, it was never found necessary to apply bushings. Furthermore, none of the welds ever failed.

Pieces of ashpan steel were used in the repair of Figs. 10 and 11 to prevent the flowing metal from entering the steam ports.

Figs. 12 and 13 indicate a type of break and weld that we handled with a full measure of success. This work was for a long time given to none but our very best welders, but in the great rush of work during the winter of 1918-19 it was found that there were many welders who had not the slightest difficulty in handling them after a little coaching.

It is regrettable that a picture of the cylinder shown in Fig. 14 is not available after it was repaired. This cylinder and another one like it were the two last welding jobs attempted in the A. E. F. These were welded at the Nevers shops about the middle of June, this year, for the purpose of turning them over to the French Government as good stock cylinders. It will be noted that the patch lying within the cylinder is extremely heavy. The original piece had been lost, and the operations of the shop having ceased, the pattern for this patch was made from a packing box by a German prisoner of war. The patch was cast and chipped in the same makeshift way and the cylinder welded and bored and placed in stock only a week before the last of the soldier mechanics left for the States.

Some readers will doubtless regard 99 broken locomotive cylinders in less than one year as a large number—as indeed it is—but in this were included cylinders belonging to the P. L. M. Railroad, the Nord Railroad, the Est Railroad, as well as the Belgian State Railways. Some of these cylinders had been broken and patched and running for years (nothing is ever scraped over there).

Causes of Defective Cylinders

Of the remainder there were 2 ALCos and about 75 Baldwins put in shape. The small number of ALCos can, in a measure, be explained by the fact that there were but 160 ALCo locomotives as against 1,000 Baldwins in the A. E. F. In addition, the ALCos had relief valves in the cylinder heads, which protected them greatly against careless handling. There were several factors causing the great number of broken cylinders. The greater number of the locomotive engineers of the A. E. F. were mere boys, many of whom had little experience in handling locomotives.

Flooded cylinders were given steam by careless or incompetent engineers or hostlers. Careless inspection in the works (manufactory) allowed the hanging of guides as much as 3/16 inch out of position. War-time patterns made by pattern makers of questionable skill from prints drawn by war-time draftsmen of doubtful ability in figuring the stresses in castings caused more trouble. Poor castings full of blow holes and slag, imperfectly designed, in that there were no weakening grooves either in the cylinder heads or cylinder head studs, contributed to our list of repairs. There may have been other things, and some of the things mentioned may not have entered into the problem at all, yet from a year's close observation of this work the writer feels that all of these things bore a measure of responsibility.

How to Design and Lay Out a Boiler—XIII

Designing Girder Braces—Through Rods Used to Stay Segment of Heads Above Tubes

BY WILLIAM C. STROTT*

This method of bracing is similar to that described in connection with Fig. 35, except that the members are separated a sufficient distance to accommodate the through rods.

Since this method of staying involves the use of another beam formula, we shall, in order to acquaint the student with its use, undertake the design of a system of girder-bracing for our boiler. Although there is considerable inherent strength in the boiler head itself, we are compelled by the code to disregard this fact entirely. Hence we assume that the total pressure on the segment is sustained by the girders and, of course, they are considered as beams uniformly loaded. The formula for the stress in any beam is:

$$f = \frac{M}{Z}, \qquad (14)$$

in which

f = Maximum fiber stress in the beam, which, in accordance with the Code, should not exceed 12,500 pounds per square inch.
M = Maximum bending moment in the member, in inch pounds.
Z = Sectional modulus of the beam section.

The maximum bending moment, M, for a beam supported at its ends, and uniformly loaded, is given by the following formula:

$$M = \frac{W \times l}{8}, \qquad (15)$$

in which

M = Maximum bending moment in inch pounds.
W = Load on each beam in pounds (one-half total pressure on the segment).
l = Length between supports in inches, which may be taken as the distance between the extreme rivets, as per Fig. 43. In actual practice this dimension is very closely approximated from the tube layout, but for this example we shall assume 30 inches.

Substituting in formula (15), we have:

$$M = \frac{18{,}188 \times 30}{8}, \text{ or } 68{,}205 \text{ inch pounds}$$

Formula (14) may now be applied:

$$12{,}500 = \frac{68{,}205}{Z};$$

whence

$$Z = \frac{68{,}205}{12{,}500}, \text{ or } 5.45 \text{ inches}^3.$$

Reference must now be made to one of the steel handbooks, either Carnegie or Cambria, for the properties of the various structural sections.

On account of the large pinhole necessary in this case, the use of angles is impracticable; hence we shall employ channel sections.

It will be found from the Carnegie "Pocket Companion" (page 168 of the 1915 edition) that a 6-inch channel section 13.00 pounds per foot has a section modulus about axis 1-1 of 5.8, being exactly what we require; but it should be observed that this section has a web thickness of only 0.44 inch. The bearing pressure of the pin against so thin a plate would be excessive. In short, the combined web thickness of the two channels must be equal to T of Fig. 39 (b). The minimum dimensions for this we previously found to be 1.04 inches. Therefore, we must employ beams having webs at least .52 inch thick. This thickness is readily obtained in a 6-inch channel 15.50 pounds per foot. (Note.—In determining which section modulus to use, i. e., for axis 1-1 or 2-2, first see which way the beam is loaded. If loaded perpendicular to axis 1-1, then use, the value of S in the column headed "axis 1-1." If the load is perpendicular to axis 2-2, then use the value of S in the column headed "axis 2-2." The student should satisfy himself on this point by comparing these axes with the application of the channels as illustrated in Fig. 44 or 45.) Attention is particularly called to the method of riveting both channels together with a separation between them. This rigidity ties both members together, forming a single girder of great strength. The pitch, p, of the rivet attaching the beams to the boiler head shall not exceed that found by applying formula (5), and the number and size of these rivets shall be such that their combined cross-sectional area shall be at least 1.25 times that of the combined cross-sectional area of the stay rods.

The distance back to back of the channels should be ⅛-inch more than the thickness, T, of the "eye" end of the rod.

The use of through-rods may also be employed to stay the segment of the heads above the tube, as illustrated in Fig. 45.

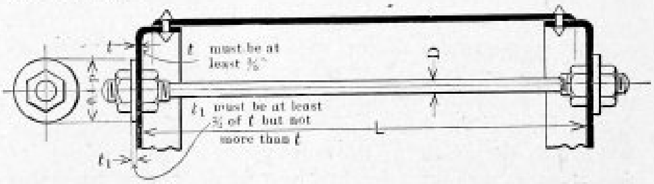


Fig. 45

When applied to a boiler, where the ends of the rods are not exposed to the products of combustion, crowfoot connections are not required. The rods may pass through both heads and may be secured with double nuts identically as detailed in Fig. 33, with the exception of the "doubling" washer on the outside.

The maximum pitch, p, from center to center of any two adjacent rods (be that distance horizontal, vertical or inclined) is found by the following formula:

$$p = \sqrt{\frac{175 \times t^2}{P}} \qquad (15)$$

p = Maximum pitch in inches.
t = Thickness of the head in *sixteenths* of an inch. The thickness of the doubling washer must also be at least equal to t.
P = Allowable working pressure in pounds per square inch.

Applying this formula to our problem we have:

$$p = \sqrt{\frac{175 \times 9 \times 9}{150}}, \text{ or } 9.45 \text{ inches, say } 9\tfrac{1}{2} \text{ inches.}$$

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

The diameter of the washer would have to be 0.4 × 9.5 inches, or 3.80, say 4 inches, and its thickness equal to that of the tube sheet, or $\frac{9}{16}$ inch.

The net cross-sectional area of the rods is found by the same formula we employed for the size of the rods below the tubes, which was formula (9).

With regard to formula (9), the allowable unit stress of 8,500 pounds per square inch applies to rods where the length between supports (i. e., the length, *L*, between the tube sheets, Fig. 43) does not exceed 120 times the diameter, *D*, of the rod. In the case of short boilers, where the dimension, *L*, is less than 120 times *D*, the value, 9,500 pounds, may be substituted in the formula, which would evidently permit the use of lighter through-rods. The reason for this allowance is that the rods, being shorter, are not subjected to an initial bending stress, due to their tendency to "sag" in the middle. Hence, through-rods are very rarely used in boilers over 15 feet in length on account of the higher cost of such construction. In marine Scotch boilers, however, through-rod bracing is exclusively employed. Such boilers have diameters as great as 16 feet with a length of only 15 or 16 feet. It is obvious that ordinary diagonal braces would be impracticable on account of the large segment to be stayed. In order to get a reasonable angle between the brace and the shell, the lengths of diagonal braces would have to be such that those on the front and rear heads would cross.

Instead of reinforcing washers illustrated in Fig. 43, the construction illustrated in Fig. 46 may be employed.

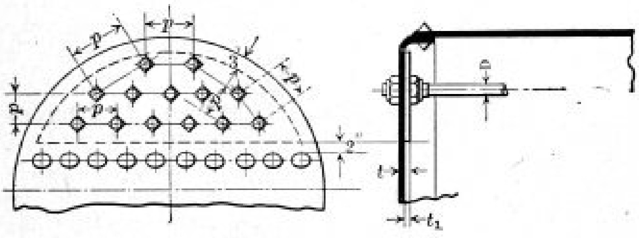


Fig. 46

The arrangement of the rods in this figure is mythical and merely serves to show the student how the maximum pitch, *p*, as found by formula (16), is measured. The dotted lines in the front view represent a reinforcing plate riveted to the inside of the tube sheet. The thickness of this reinforcing plate, denoted by *t* in the figure, must not be less than two-thirds of the tube plate thickness, *t*, nor is it permitted to be thicker than *t*.

The maximum pitch, *p*, of the rods shall not exceed that found by the following formula:

$$(16) \qquad p = \sqrt{\frac{200 \times 0.75 \times (t + t_1)^2}{P}},$$

in which the notations are the same as in formula (15), except that we include another letter, t_1, same being the thickness of the tube plate, also in *sixteenths* of an inch. Applying this formula to our problem, t_1 substituting in the formula, we have:

$$p = \sqrt{\frac{200 \times 0.75 \times (9 + 6)^2}{150}}, \text{ or 13 inches}$$

It should be noted that a higher value for *p* is obtained by increasing the thickness t_1 of the reinforcing plate. This form of construction does not affect the size of the rods as obtained by formula (9), except that we use the value of either 8,500 pounds or 9,500 pounds as the allowable unit stress, depending, as was previously explained, on whether *L* of Fig. 43 is less or greater than 120 times the least diameter of the rod, *D*. In any case, if the rods used are welded, then only 6,000 pounds' unit stress is permitted. This value holds good regardless of the distance between the tube sheets.

A further consideration that must not be overlooked when designing through bracing as per Fig. 44 is the arrangement of the rivets attaching this reinforcing plate to the head. These should be spaced evenly around the edges of the plate and uniformly distributed over its entire surface. The maximum pitch from center to center of these rivets should not exceed the value of *p*, as found by applying formula (5). The thickness of the reinforcing plate is substituted for the letter *t* in this case, whereas in all of the previous examples the thickness of the head was used.

There is still another method of bracing boiler heads, illustrated in Fig. 47.

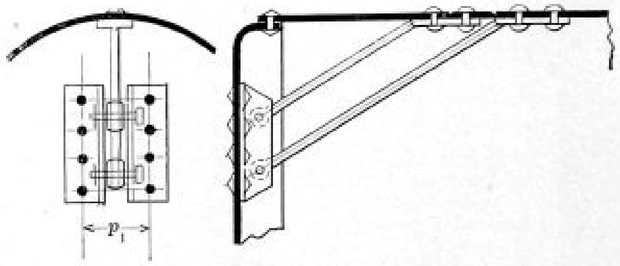


Fig. 47

This method obviously represents another form of the diagonal brace. The chief feature is in its connection to the boiler head, which is through a pin inserted in a pair of steel angles. This form is known as the "sling" stay. Due to its hinged connection, it is quite flexible and readily adjusts itself to the expansion and contraction of the boiler and to any other distortions caused by sudden vibrations, etc. For this reason the sling stay has been widely adopted in railroad boiler practice, and also in traction boilers, such as for road rollers, farm tractors, portable saw mills, etc. Nothing further need be said concerning the design of this form of brace, as all that has been explained before in connection with other types applies to it also.

This completes the subject of boiler head bracing*, or staying, in its entirety, and the next subject will deal with the design of domes and steam drums.

* Bracing the upper segments of boiler heads by the method illustrated in Figs. 46 and 47 will be covered in detail in future installments on the design of Scotch marine type boilers.

In the article "The Insulation of Locomotive Boilers" appearing in the October issue of THE BOILER MAKER, Fig. 1 shows the losses in B. T. U.'s for temperature differences from 0 to 500 degrees Fahrenheit, per square foot per hour for non-insulated surfaces instead of "Heat Losses Through Ordinary Insulation," which was given as the caption of Fig. 1.

J. H. Deppler of the Metal-Thermit Corporation has been elected a vice-president of the American Welding Society, and P. F. Willis, president of the Henderson-Willis Welding & Cutting Company, has been elected director of the Society.

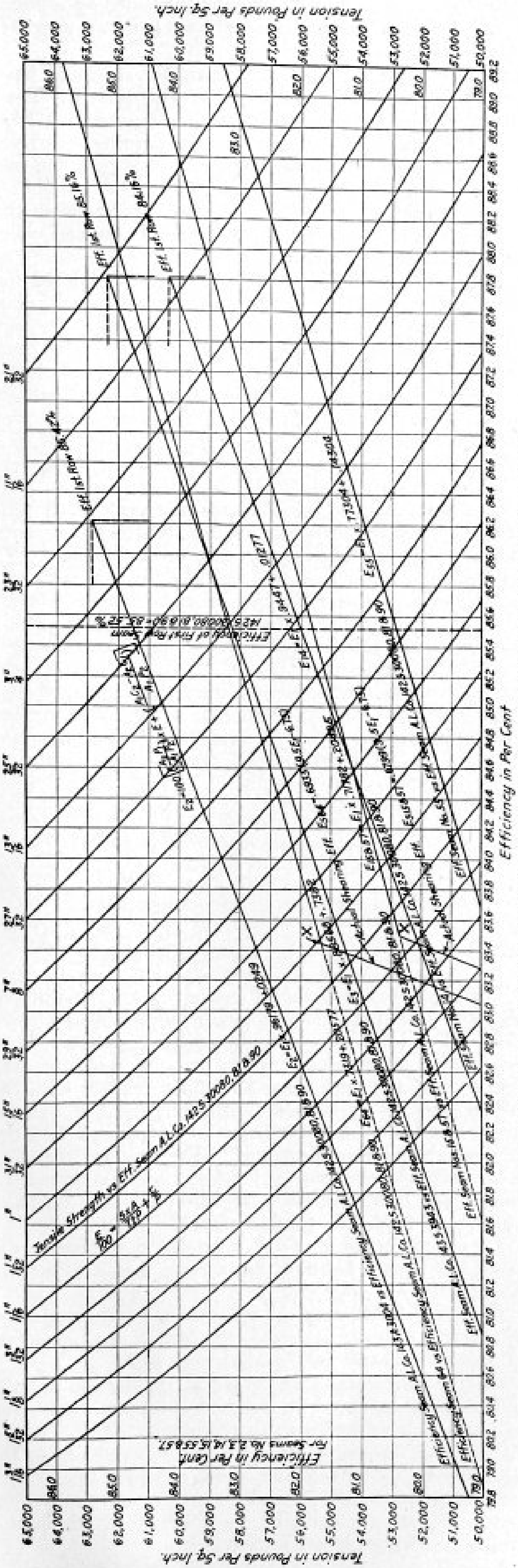


Fig. 1.—Seam Efficiency for Varying Tensile Strength and Plate Thickness

Calculation of Boiler Stresses *

BY G. E. PARKS

In boiler design and the calculation of boiler stresses, systems of curves like those illustrated below have proved of material value in Michigan Central Railroad practice. They are not only a great labor saver and aid in checking boiler specification cards, but they will often show at a glance the best possible arrangement of detail or size of part. Their accuracy will depend upon the scale employed.

Fig. 1 shows the relation between the efficiency of the boiler seam and the tensile strength of the plate for various thicknesses of plate and as two systems of curves are represented on a single co-ordinate field, care should be exercised in using the respective scales. The curved lines on the co-ordinate field represent the efficiency of the American Locomotive Company's seam, (known as seam No. 1), for different tensile strengths of plates. The dimensions of this seam are given in Fig. 2 and the curves are plotted from the equation.

$$T = \frac{SA}{t\left(p\frac{E}{100} - c\right)}$$

where:

T = Tensile strength of plate in pounds per square inch.
S = Shearing strength of rivets in pounds per square inch, taken as 44,000 pounds.
A = Area of rivet hole in square inches.
t = Thickness of sheet in inches.
p = Pitch of outside row of rivets in inches.
E = Efficiency of seam in percent.
c = The pitch, minus twice the diameter of rivet hole (p-2d), or the length of metal between alternate rivets in the second row.

The straight lines on the co-ordinate field represent the relation between the efficiency of seam No. 1 and the efficiency of the various other seams as plotted. If we assume that the tensile strengths and thickness of plate are the same in each case, the equation for the straight lines becomes.

$$E_2 = 100\left\{\frac{A_2 p_1}{A_1 p_2} E_1 + \frac{A_1 C_2 - A_2 C_1}{A_1 p_2}\right\}$$

In this equation the letters represent the values as given above, the subscript figure "1" representing values in seam No. 1 and the subscript figure "2" representing values in the seam under investigation.

The points marked "X" at the lower end of the straight lines representing seams 15 and 57, also seam 64, indicate the position of the curve at which the efficiency of the seam for shearing all of the rivets and the efficiency of the seam when tearing through the second row of rivets and shearing the rivets in the outside row are equal. Therefore, if the thickness and tensile strength of plate in seams 15, 57 and 64 are such that the point of intersection between the curved line representing the thickness of plate, and the horizontal line representing the tensile strength of plate falls at the left of the point "X," the seam will fail by the shearing of all of the rivets. The efficiency is determined as follows:

From the point of intersection between the curved line representing the thickness of the sheet and the horizontal line representing the tensile strength of the sheet, project a line in a vertical direction until it comes in contact with the straight line, marked "Actual Shearing Efficiency." Opposite this point of intersection, read on the vertical scale the shearing efficiency of the seam. The co-ordinate field as plotted does not show the points where the shear

*From *Railway Mechanical Engineer*

of all of the rivets is equal to the efficiency of the seam through the second row of rivets, for seams Nos. 2, 3, 14 and 55, therefore, these seams would not fail due to shear of all of the rivets for any thickness of the plate or tensile strength of the plate, which is given on the drawing.

The equation of the straight line marked "Actual Shearing Efficiency," is:

$$E_{S_2} = \frac{A_2 N_2}{A_1 P_2} (P_1 E_1 - C_1)$$

where:

E_{S_2} = Efficiency due to shear of all the rivets in seam under investigation represented by the straight line.

A_2 = Area of rivet hole in seam under investigation.

A_1 = Area of rivet hole in seam No. 1, represented by the curved lines.

N_2 = Number of rivet shearing planes of seam under investigation. In all seams plotted on this sheet, N_2 equals 9.

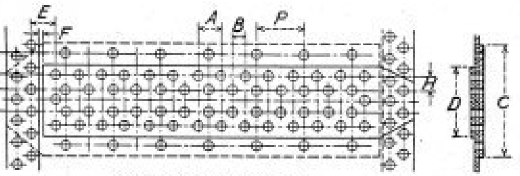
P_2 = Pitch of rivets in outside row of seam under investigation.

P_1 = Pitch of rivets in outside row of seam, No. 1.

E_1 = Efficiency of seam, No. 1.

C_1 = Pitch minus twice diameter of rivet hole in the seam, No. 1.

At a point representing 85.52 percent efficiency for seam No. 1 is a vertical dotted line which is the efficiency of the seam through the first row of rivets. If the thickness and tensile strength of plate are such that the efficiency for seam No. 1 is higher than 85.52 percent and is shown on the right of the dotted line, the higher efficiency should not be considered as the seam would fail through the first row of rivets which has an efficiency of 85.52 percent. At the right end of the straight lines representing seams Nos. 2, 3 and 14 are the points where failure will occur in the first row of rivets and these points represent the maximum efficiency of the seams. The co-ordinate field is not large enough to show similar points for seams Nos. 15, 57 and 64.



Longitudinal Seam

DIMENSIONS OF SEAMS

Seam	Dia. Riv.	Dia. Riv. Hle.	P	A	B	C	D	E	F	G	H	I
142530080,81,90 Seam No. 1	1 3/8"	1 3/8"	9 1/2"	4 3/4"	2 3/8"	19 3/4	12 1/4	4 3/4"	3/4"	3 3/4"	2 3/8"	3 3/4"
143A 3004 Seam No. 2	1 1/4	1 5/16	9	4 1/2	2 1/4	18 1/2	11 1/2	4 1/2	3/4	3 1/2	2 1/4	3 1/2
143S 3943 Seam No. 3	1 1/8	1 3/16	8	4	2	17	10 1/2	4	3/4	3 1/4	2	3 1/4
14	1 1/8	1 3/16	7 1/2	3 3/4	1 7/8	16 1/4	10	3 3/4	3/4	2 3/4	2	3 1/8
15 & 57	15/16	1	7	3 1/2	1 3/4	14 1/4	8 3/4	3 1/2	3/4	2 1/2	1 3/4	2 3/4
55	15/16	1	6 1/2	3 1/4	1 5/8	14 1/4	8 3/4	3 1/4	3/4	2 1/2	1 3/4	2 3/4
64	1	1 1/16	7 3/4	3 7/8	1 15/16	16 3/4	10 5/8	3 7/8	3/4	3 1/2	2 1/4	3 1/2

Fig. 2.—Dimensions of Standard Boiler Seams

Problem 1.—To find the efficiency of boiler seam No. 1 having 1 1/8-inch plate, the tensile strength of which is 58,000 pounds.

From the point of intersection of the 58,000-pound line on the horizontal scale and the curve representing a 1 1/8-inch plate, project a line vertically either to the top or bottom axis and read off the efficiency, which is 81.6 percent.

Problem 2.—To find the efficiency of boiler seam No. 2 having 1 1/8-inch plate, the tensile strength of which is 58,000 pounds.

First find the efficiency that seam No. 1 would have under the same conditions, which is 81.6 percent. Then from the point where the vertical line representing 81.6 percent intersects the straight line representing seam No. 2 find the efficiency corresponding to this point on the vertical scale, which is 81 percent.

This system of curves may be used to determine the value of any of the factors in the general equation when the other factors are known.

Problem 3.—To find the tentile strength required for 15/16-inch plate to give an efficiency of 80.5 percent, using seam No. 14 as an example.

On the vertical scale of efficiency find 80.5 percent, and project a line in a horizontal direction until it intersects the line representing seam 14. From this point project vertically to the 15/16-inch line, and this intersection projected to the vertical axis gives a tensile strength of 57,000 pounds per square inch.

Problem 4.—If seam No. 14 has an efficiency of 80.0 percent what will be the efficiency of seam No. 2, providing that the thickness of plate, tensile strength of plate and shearing stress of rivets are alike for both seams.

From the point where the 80.0 percent line from the vertical scale intersects the line of seam No. 14, project a line vertically to the line of seam No. 2 and from this point project a line horizontally and find the efficiency, which is 82.7 percent.

Fig. 3 shows the stress on several sizes of staybolts, under conditions varying from supporting 13 square inches to 22 square inches of area with boiler pressures varying from 110 pounds to 230 pounds gage, advancing by five pounds each.

The general equation is

$$S = \frac{BP \times a}{A}$$

where:

S = Stress on staybolt in pounds per square inch.

BP = Boiler pressure in pounds per square inch as shown by gage.

a = Area in square inches supported by staybolt.

A = Area of staybolt in square inches.

There are two systems of curves on the co-ordinate field, and care should be exercised in using the respective scales. The lines marked with the boiler pressure show the relation between the boiler pressure and the area supported by the staybolts and the lines marked with the various sizes of staybolts show the relation between the product of boiler pressure times area supported and the stress on staybolts as illustrated. The area for the staybolts is taken at the root of the thread for a V thread, 12 threads per inch, and there are also lines for staybolts which have 3/16-inch telltale holes.

To use the curve it is first necessary to determine the number of square inches of flat surface that is to be supported.

Problem 5.—What is the stress on a 1-inch solid staybolt with V thread, 12 threads per inch, when supporting 12 square inches at 200 pounds pressure?

On the horizontal axis, either at the top or bottom, find the area supported, in this case 16 square inches, and project a line vertically until it intersects the 200-pound line. From this point project a line horizontally to the right until it intersects the 1-inch staybolt line. This intersection projected vertically either to the top or bottom axis gives the stress on the staybolt, which in this case is 5,560 pounds per square inch.

Fig. 4 shows the shearing stress on rivets for such seams as outlined for boilers varying from 66 inches to

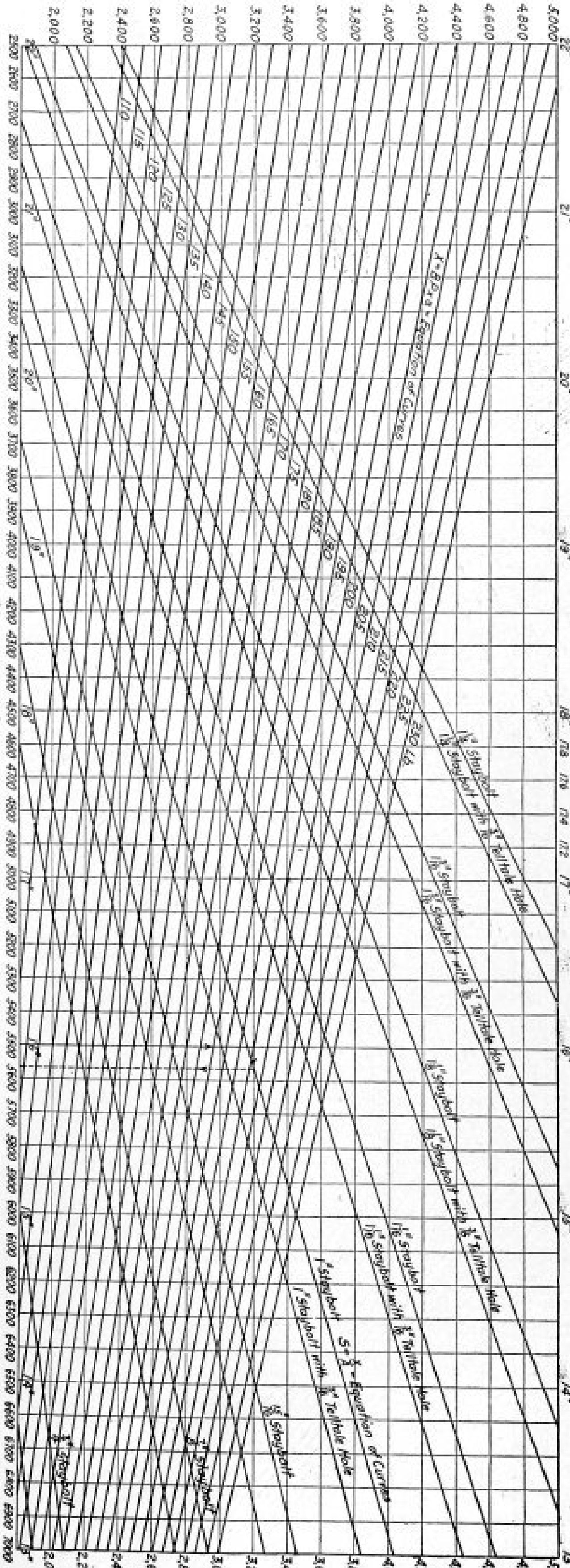


Fig. 3.—Staybolt Stress for Varying Boiler Pressure and Supported Area

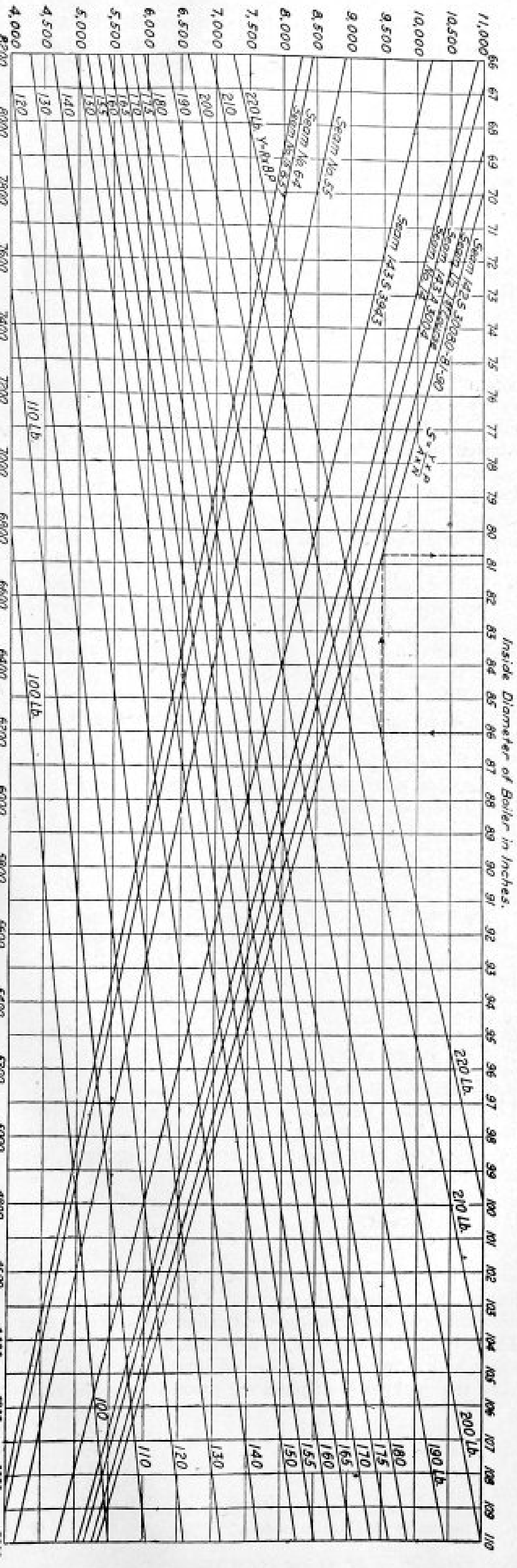


Fig. 4.—Shearing Stress on Rivets for Boilers of Varying Diameter and Steam Pressure

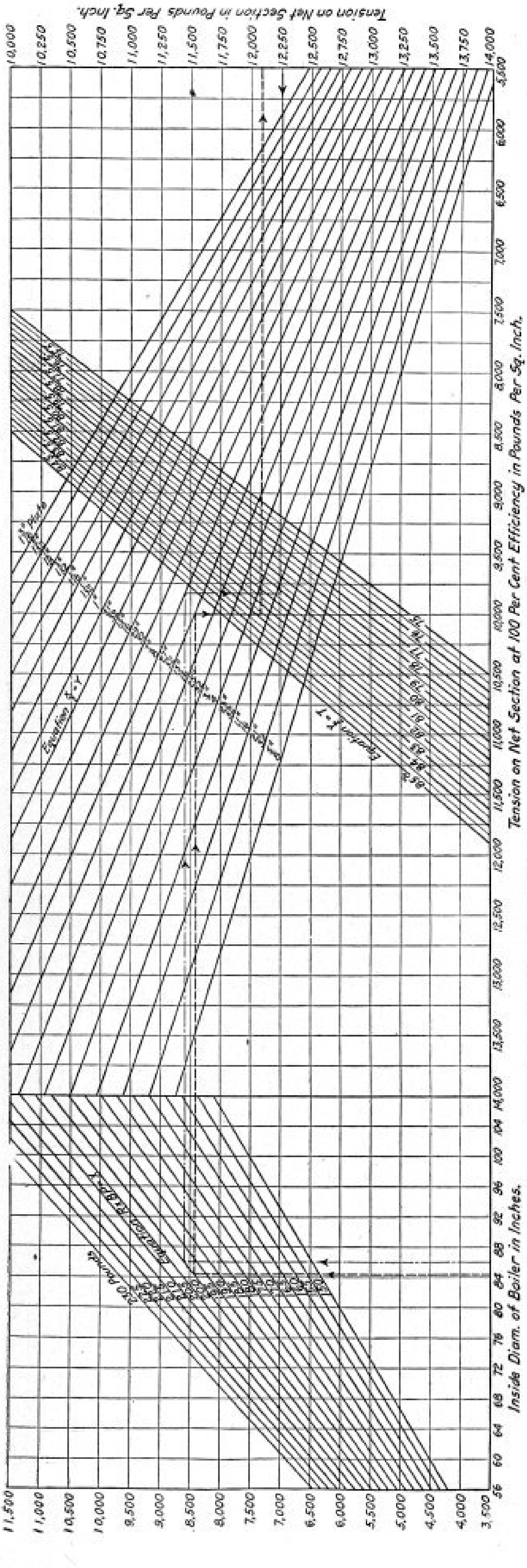


Fig. 5.—Tension on Net Section for Varying Boiler Pressure and Diameter, Thickness of Plate and Efficiency of Seam

110 inches in diameter, and for stress pressures between the limits of 100 pounds and 220 pounds gage pressure.

The general equation for shearing stress on rivets is

$$S = \frac{R \times P \times BP}{A \times N}$$

where:

S = Shearing stress on rivets in pounds per square inch.
R = Radius in inches of inside of boiler shell.
P = Pitch in inches of rivets in the outside row of seam.
BP = Boiler pressure in pounds per square inch as shown by gage.
A = Area in square inches of rivet hole.
N = Number of rivet shearing planes in pitch length taken.

The system of straight lines marked with the boiler pressure, represents the relation between the radius of the boiler and the boiler pressure. These lines are expressed by the equation $R \times BP = Y$, Y representing the figures given on the *Y-axis*. The second system of straight lines represents the relation of the characteristics of each individual seam, so far as shearing stress on the rivets is concerned, to the radius of inside of boiler and boiler pressure.

Problem 6.—What is the shearing stress on the rivets of seam No. 1 when used on a boiler 86 inches inside diameter and carrying 220 pounds' pressure?

On the top horizontal axis find the diameter of the inside of the boiler, in this case 86 inches, and project a line vertically until it intersects the line marked 220 pounds. From this point project a line in a horizontal direction until it intersects the line marked with the seam number, in this case seam 142-S-30, 080. This intersection projected vertically to the bottom horizontal axis gives the shearing stress on rivets which is 6,730 pounds per square inch.

Fig. 5 shows the tension on net section for various thicknesses of plate, boiler pressures, efficiency of seams and diameters of boilers.

The general equation is

$$T = \frac{\frac{D}{2} \times BP}{t \times E}$$

where:

T = Tension on net section in pounds per square inch.
$\frac{D}{2}$ = Radius in inches of inside of boiler.
BP = Boiler pressure in pounds per square inch as shown on the gage.
t = Thickness of plate in inches.
E = Efficiency of the boiler seam in percent.

There are two co-ordinate fields shown on the sheet, both of which are used in determining the tension on a net section. One field consists of a series of straight lines showing the relation between boiler pressure and the inside diameter of the boiler. The equation for these lines is

$$X = \frac{D}{2} \times BP$$

where X is equal to the product of boiler pressure and the radius of the inside of the boiler. This is transferred to the second field in obtaining the tension on a net section.

The second field consists of two series of straight lines crossing each other. The series of lines upon which are marked the thicknesses of plate are plotted from the equation

$$Y = \frac{X}{t}$$

where:

Y = Tension on net section at 100 percent efficiency.
t = Thickness of plate in inches.
X = Value of $\frac{D}{2}$ BP as explained above.

The other series of straight lines upon which are marked the different efficiencies show the relation between the tension on a net section at 100 percent efficiency and on a net section for the various other efficiencies of seams as noted.

These lines have been plotted from the following equation:

$$T = \frac{Y}{E}$$

where:

T = Tension on net section at the desired efficiency.
E = Efficiency in percent.
Y = Value of $\frac{X}{t}$ as explained above.

Problem 7.—To find the tension on a net section of a boiler of $84\frac{5}{16}$ inches diameter, 27/32-inch thickness of plate, 200-pound boiler pressure and 82.75 percent efficiency of seam.

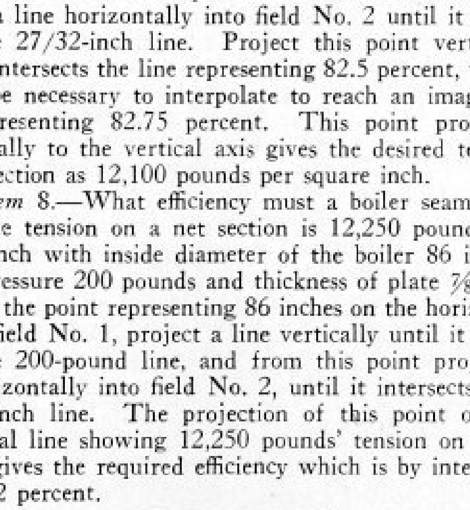
From the point representing $84\frac{5}{16}$ inches diameter on the horizontal axis of field No. 1, project a line vertically until it intersects the 200-pound line and from this point project a line horizontally into field No. 2 until it intersects the 27/32-inch line. Project this point vertically until it intersects the line representing 82.5 percent, where it will be necessary to interpolate to reach an imaginary line representing 82.75 percent. This point projected horizontally to the vertical axis gives the desired tension on net section as 12,100 pounds per square inch.

Problem 8.—What efficiency must a boiler seam have when the tension on a net section is 12,250 pounds per square inch with inside diameter of the boiler 86 inches, boiler pressure 200 pounds and thickness of plate ⅞-inch.

From the point representing 86 inches on the horizontal axis of field No. 1, project a line vertically until it intersects the 200-pound line, and from this point project a line horizontally into field No. 2, until it intersects with the ⅞-inch line. The projection of this point on the horizontal line showing 12,250 pounds' tension on a net section gives the required efficiency which is by interpolation 80.2 percent.

Cold Rolled Brace Pins

In the article "How to Design and Lay Out a Boiler" appearing in the September BOILER MAKER occurs a table giving the dimensions of cold rolled steel pins and cotters used in anchoring eye ends of brace rods to the crowfeet. The accompanying sketch in connection with this table will serve to render the data more useful, for the notations on the sketch are self explanatory.



COTTER PINS
AMERICAN BRIDGE COMPANY STANDARD
All Dimensions in Inches

Horizontal or Vertical Pin Finished					Horizontal Pin Rough or Finished			
Pin	Head	g	Cotter		Pin	g1	Cotter	
p	h		c	d	p1		c	d
1¼	1½		2	¼	1¼		2	¼
1½	1¾		2½	¼	1½		2½	¼
1¾	2	Net	2¾	¼	1¾	Net	2¾	¼
2	2⅜	Grip	3	⅜	2	Grip	3	⅜
2¼	2⅝	+	3¼	⅜	2¼	+	3¼	⅜
2½	2⅞	½	3¾	⅜	2½	¾	3¾	⅜
2¾	3⅛	Inch	4	⅜	2¾	Inch	4	⅜
3	3½		5	½	3		5	½
3¾	3¾		5	½	3¼		5	½
3½	4		6	½	3½		6	½
3¾	4¼		6	½	3¾		6	½

Rolling Boiler Tubes

The rolling of boiler tubes is always an interesting subject among boiler makers. For doing this work, the writer has made a flue pin with which a novice, after a few instructions, could go ahead and finish the job. This flue pin is made of 1½-inch stock of good material. By using 1½-inch stock an allowance is made for turning a collar on the flue pin, thus preventing the flue from being split or sprung. The novice would naturally stop the machine when he noticed that the collar on the flue pin was in such a position that the flue could not be rolled further.

TURNING THE COLLAR ON THE FLUE PIN

In order to determine the exact point at which the collar on a flue pin should be turned, take the regular pin, roll the flue until, in your judgment, it is tight. Then caliper the flue pin at the outside body of the rolls, at which point the collar should be turned on the new pin. Measure the distance from each end of the flue pin and make a note of this distance so as to instruct the machinist just where to turn the collar.

In old work this same plan could be used except that the flue pin should be made a little larger since the holes are larger on account of the flues having been rolled so often. This is especially true in the firebox end.

Put a taper on both ends of the flue pin. When the pin reaches the taper it will loosen and indicate to the operator that the flue is rolled. By this means a novice could not roll the flue any more than it should be as the pin will drop down from the body of the rolls. Reversing the motor will turn the flue pin out. This last idea has never to my knowledge been tried, but it seems feasible.

BOILER SHOPS OF THE OIL COUNTRY

I am of the opinion that it would be of help to the boiler makers in general if they could take a trip to some of these oil country boiler shops. It would certainly show them how the foremen in charge of these shops study out their problems, especially in rigging up punches, splitting shears or other machines which they could not very well get along without. I might state here, and I am proud of it, that I learned my trade in an oil country boiler shop. That was before air tools were used. Everything was hand work at that time.

There are good mechanics and excellent boiler makers in these oil country shops, who are not able to use their left hands in chipping or cutting off flues. In the old days a good bit of the work was left-handed and a man might as well quit if he could not work left-handed.

Most of the rivets were snapped. On many of the old-style boilers for drilling oil wells, the rivets were finished or hammered.

REPAIRING THE OLD-STYLE BOILERS

When these boilers needed repairing, it meant a trip to the boiler for it was not possible to bring them to the shop. The wages for the boiler makers in those days were $2.75 throughout the oil field and, believe me, every red cent of it was earned. In those days every boiler maker had to have a pair of high-topped gum boots, for use in crossing trout streams, which were numerous, as well as in walking through soft ground, where at times, the mud would come up to your knees. Remember all the hikes had to be made toting a good sized load of tools on your back.

Youngstown, Ohio. WILLIAM J. KELLY.

Boiler Manufacturers Hold Conference

Estimates on Standard Boilers Submitted—Question of Boiler Costs Discussed—Conditions of the Industry Reviewed

The first quarterly session of the American Boiler Manufacturers' Association was held at the Hotel Astor, New York, September 24. At the annual convention in June, it was decided that to further the interests of the industry it was advisable to hold frequent meetings. This special session was devoted to the matter of uniform estimating on standard boilers and information was brought out that will tend to eliminate most of the errors in future work of this nature.

The attendance greatly exceeded the expectations of the committee and indicated the interest of the manufacturers as well as their belief in organization.

WEDNESDAY MORNING SESSION

President Connelly: The first subject that we will take up at the meeting will be the matter of cost finding and the reports that have come in on the estimated cost of a boiler according to the given specifications. There have been 22 answers received, and the prices are all given on the cost sheets which have been distributed.

G. S. Barnum: If you will notice the hours of labor on construction you will see how they vary. There's No. 76 with 850 hours—now, that certainly must be a mistake. I think the variation of the labor might be accounted for, in some cases, in buying braces—some plants produce their own braces while others buy them. The same applies to the brackets, the manholes and saddles. I am wondering, if in figuring this rating so high, whether they have considered the flanging, which would amount to a good deal. We figured 440 hours labor, but we never figure for the work on the brackets, the manholes or braces. We do not buy them, but we figure them just the same as if we did buy them outside.

President Connelly: We will compare item with item, on the estimate sheets, beginning with the boiler shell, and see where the difference comes in.

A discussion on the items then followed, which the chairman requested be omitted from the record.

G. S. Barnum: The average price of the boiler complete is $3,819. Now, that means that some have gone above that price 28 percent, and some below the price 14 percent, or, in other words, a variation of 42 percent.

Secretary Covell: One man came within $400 of the average and another within $300 of the average.

G. S. Barnum: Now, while a good deal of this variation in price I think can easily be accounted for, especially in the price of castings, I do not think that all of us, including myself—are really careful enough in estimating the different items. I am wondering if we do not guess at some of them. Certainly the great variation in price would indicate that we do just that. I am going to take up this matter of plates when I get home and figure each strap and plate by itself and find out just where our company stands. I do not know any other way for us to progress in this matter, but to keep hammering away at these comparisons, so that we will be more careful in our future work.

S. F. Jeter: There are ten prices within 4 percent of the average—ten out of the twenty-two submitted.

President Connelly: The secretary brings to our notice one very important feature here, and that is, the matter of overhead or burden in percentage.

President Connelly: It runs from 81 percent as high as 200 percent. It averages between 175 percent and 180 percent.

G. S. Barnum: Our overhead is based on 180 percent.

President Connelly: Ours is 175 percent. What are some of the others?

F. J. Doyle: 150 percent.

E. C. Fisher: 180 percent.

C. V. Kellogg: We figure overhead 100 percent, but we figure our base of labor at 65 cents, which is included, to a certain extent, in our overhead of the other departments. In other words, we figure $1.30 net per hour.

C. M. Tudor: 180 percent.

W. L. Cameron: 185 percent.

F. C. Burton: 180 percent.

G. W. Bach: We departmentalize our overhead. It runs from 135 percent in the office to 180 percent in the main boiler shop. In further connection with this total price average as brought out, I have made rather an interesting comparison. After we had tabulated this bid, I compared it with the price in the so-called Gray Book, and much to my surprise, it came out within $3.00 of the price of the boiler that is listed under the A. S. M. E. Code specifications.

C. V. Kellogg: We had this same subject up at the last meeting of the horizontal return tubular boiler manufacturers in Cincinnati. The matter of hours and also the overhead on a 72-inch boiler was thoroughly discussed. The hours varied just as they vary here today. I analyzed a great many of the different propositions in overhead and the different ways of figuring them, based on 48 cents to 50 cents per hour overhead, and the result was an overhead of 167 percent to 177 percent. Here is an estimate figured upon a different basis. The actual labor is computed, then the material, with 15 percent for overhead of factory, and 15 percent for administrative overhead. This last is figured upon the selling price. To arrive at this, the total cost of material and labor has been divided by 85 percent in each case. This figures out exactly 180 percent. Now, the price list of July 1st in the Gray Book is based throughout on 180 percent overhead.

O. A. Rochlitz: Here is a letter written by myself on this subject to the secretary. We divide our overhead a good deal along the lines of the last speaker. Perhaps, if I read the letter, it will illustrate what I mean:

> We are enclosing herewith estimate sheet for a 78-inch by 18-foot horizontal return tubular boiler, according to A. S. M. E. code, and wish to call your attention to certain differences between our method of estimating and that recommended.
>
> We buy boiler fronts, grates and in fact all castings from a foundry, so we have none in connection with our works; therefore, the price indicated would be the price net to us, including all labor.
>
> We do not manufacture the upper boiler braces, or brackets. These are bought from the trade and naturally the price includes material and labor.
>
> We therefore wish to call your attention to the fact that the labor which we have indicated in hours on the boiler is the labor of fabricating and assembling different parts that we buy from the trade.

We also wish to state that our overhead expense is divided into two parts:

1st—Shop Burden; which as you will note is 65 percent of the productive labor.

2nd—Selling and administrative expense, which is 16 percent of the sum of the cost of material, productive labor and burden.

That is, we get our gross cost, then we add 16 percent for selling and administrative charge and our usual 20 percent profit on top of that.

You will note that in using these two percentages we can obtain a better estimate of cost on those articles which are bought from the trade than if a collective overhead figured directly on productive labor is used.

There are no doubt boiler shops which have their own foundry and possibly do not figure a selling and administrative overhead on the castings from their foundry. The same is true in the purchase of boiler trimmings. Selling and administrative expense as well as profit should be added; otherwise you are not obtaining a correct profit.

For instance, we all buy trimmings. Now, do you figure an overhead on them, or selling or administrative expense, or do you just simply base your profit on the transaction? Some of us feel that we are entitled to some of the cost of handling the matter beside the profit. We feel the selling and administrative expense as well as profit should be added, otherwise we are not getting the percentage of profit that we should.

We wish you would take up at the meeting in September, the question of charging an administrative and selling expense to those parts of the boiler on which no productive labor is done by the boiler manufacturer.

We would like to know what the general procedure is on this point.

President Connelly: The question is whether such parts of a boiler outfit as we buy should not carry a certain amount of burden and profit.

O. A. Rochlitz: The percentage of burden that we put in the estimate is 81 percent. I am absolutely certain that is wrong. I did not make the figure, but I did in another case compare our total overhead, taking the 65 percent burden and the 16 percent selling and administrative expense charged on the gross cost, and I found in this particular case that our total overhead was 180 percent, and not 81 percent.

Edward Mohr: We figure the actual cost of the labor and the material, that is, the actual cost of labor that we pay out, and then we figure the material at actual cost and we add our overhead to that. Our overhead last year was 92 percent.

President Connelly: It was 92 percent on the cost of the labor and purchases?

Edward Mohr: Ninety-two percent of the pay roll and the expense of running the business. We add that to the labor and that gives our actual cost. The labor and material and actual cost and overhead cost amounts to 92 percent.

C. V. Kellogg: The price list used in July was made up with the average rate of 48 cents per hour. If you will add 180 percent to that you will find it figures $1.344 per hour. I notice that some people figure 50 cents. Now, the average price per hour has advanced since this list was made—not on the entire plant, but especially on the direct labor portion—and I think at the present time it will average about 53 cents to 54 cents per hour instead of 48 cents. You will find that a close direct way of figuring would be 180 percent. Now, the Kewanee Company has figured on the basis of 100 percent overhead, but when you analyze the figures and figure on the basis of this price list that is made up, it figures exactly 159 percent.

A. C. Weigel: Does the overhead include the interest on investment?

President Connelly: It has not been the procedure with most of the boiler people here up to the present time. We had that up, if you remember, at the June convention, and there did not seem to be anybody but myself in the audience that wanted to include it, or, at least, was including it.

President Connelly: The question of whether or not 6 percent on money invested in business ought to be added into our overhead is one that there seems to be a good deal of variance on. Mr. Figsby, the partner of Ernst & Ernst, is here today and I am going to ask him if he will tell us whether or not he finds that custom in use in most of the places he visits.

F. H. Figsby: The adding of interest on investment is probably treated as an expense by one concern in fifty. The inclusion of interest on investment as an expense in the cost of production is more of a fad, than anything else, of certain accountants, and you will find certain accountants always including interest on investments, but those accountants are few in percentage to the total number of accountants practising. It has always been our policy to eliminate it because at the end of the year you have got to give yourself credit for it. It is not an actual expense—it costs you nothing—it is simply an exchange of money, as it were, from one pocket to another, and when you get down to figuring the cost, and where you are figuring pretty close, where the competition is pretty keen, you are liable to think, "Now, I can cut the price a little bit because I've got interest on investment in there and interest on investment costs me nothing." Therefore, you are inclined to cut the price, and when you do so you are cutting into profit—and there is the danger.

C. V. Kellogg: I disagree with Mr. Figsby on the question of figuring interest on investment. If you are renting a plant you would have to pay rent for it and you would include your rent as an item of expense, and I have been to meetings where a great many of the concerns were co-partners and they would say they did not draw any salary, and they didn't figure their salary as an item of expense, and I have asked them, "If you were going to work for somebody else you would expect a salary, wouldn't you?" They said they would. Why shouldn't they charge up their salary as an item of expense? If you had your money out of your plant you could loan it out very easily at 6 percent, and isn't it then an item of cost? Now another thing, this question of not figuring interest on investment—not ascertaining your selling price—is dangerous, for the reason that a majority of the manufacturers today are not figuring over 10 percent for a profit, and then they are shading that. There are a good many plants where the volume of business does not exceed the total capital invested. If that is true, your capital invested costs you at least 6 percent and if you are only figuring 10 percent, you have only 4 percent to go on. When it comes to paying commissions and agents' salaries, and so on, that 4 percent is soon gone and then you are eating into the 6 percent. In most of the lines outside of the boiler business, people do figure interest on their capital invested and they are getting to figure it more now than they have ever before, because it is getting down to a close question of profit. The margins are close, and if you do not figure your 6 percent on your investment you are going to be out at the end of the year.

E. C. Fisher: I think it would be a very nice thing if we could all agree to include it. I have always considered, as the speaker from Ernst & Ernst has said, the question of the account it could be charged to on the books. It would become kind of a primary profit, unless you find some other way to enter it. You certainly cannot charge it to material, you certainly cannot charge it to labor, and you cannot charge it to expenses. What would you charge it to in your books?

C. V. Kellogg: Accrued interest.

E. C. Fisher: Then the question comes right away whether it did not constitute a primary profit. I should think it would.

F. H. Figsby: Many arguments have come up on that subject, and we usually use this—if we could not get out of our boiler business or out of our real estate or whatever it happens to be more than 6 percent on our money, we wouldn't be in that business. We would be in the money loaning business. Now, the government has never allowed any manufacturer to include in the cost to them, for ordnance or for airplanes, any interest on investment, and you can't deduct interest on investment in your tax return. I wish we could but it has never been done.

President Connelly: Has there ever been any fight made to have it granted in government cases?

F. H. Figsby: Yes.

President Connelly: They have always been turned down?

F. H. Figsby: Yes.

E. R. Fish: It looks to me that, if you tried to figure interest on your investment, you would be getting a profit both coming and going. If you did not have your investment you would not be making any money out of your business. You are simply making money on the money you invested, and you are making in that way, or trying to make, two profits.

President Connelly: Well, the two profits are based on Mr. Kellogg's statement of only 10 percent, as a great many of the boiler people are figuring, does not admit of any large profit. Mr. Figsby has audited enough boiler shops to know what profit is made.

F. H. Figsby: It's on account of the poor turnover in the boiler business.

President Connelly: The subject of turn-over in the boiler business is the thing that Mr. Figsby has given some thought to—that is, how few times in a year the boiler plant turns capital.

E. R. Fish: I would suggest not to include interest on your investment, but to figure more profit on your product.

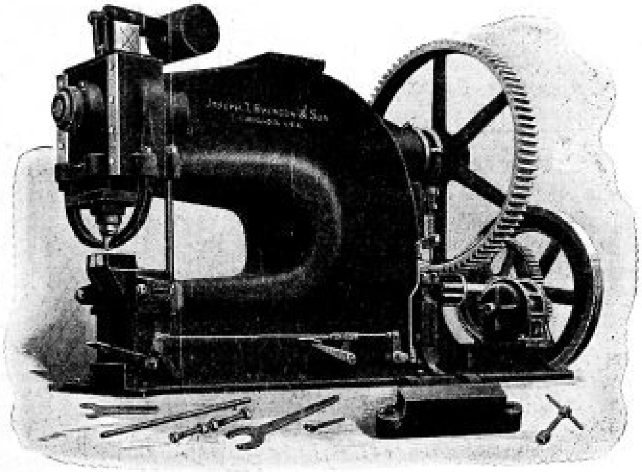
L. B. Pratt: My idea of the thing is simply this—you put your money into the boiler business rather than into bonds because you think you can get more money out of your business than you can out of the interest on bonds. Instead of putting your money into a plant you can rent a plant and you can put that same money into bonds, but the interest that you earn or that is paid to you on those bonds is income just as much as the profits that you get out of your boiler business, and you have to report it as such in your federal tax return. As Mr. Fish suggests, the answer is not to charge 10 percent but to charge 16 percent or 20 percent, or whatever the tariff will bear and yet enable you to sell boilers at fair prices. I think the trouble in the boiler business has been that too many of us have been willing to sell at too low a profit. It is not a question of getting your 6 percent included in your costs in some way. It is a primary profit and there is no way in which you can set that up as a cost. I am quite sure that the thing to do would be to raise the percentage rather than to try to figure two different kinds of profit, because the Government is going to look at them as coming under the same category and taxable in the same manner.

President Connelly: That's your solution to it, isn't it, Mr. Figsby?

F. H. Figsby: I think the boiler manufacturers have got to do something that they have not undertaken—something that may have been forced on them during 1917 and 1918. They followed the lead of other manufacturers. In other words, those were the days of high profits, but those days were preceded by many years of very, very low profits, and I think the boiler manufacturer has to do more work and has to have a greater capital invested—at least, that has been my experience for the ten or fifteen years that I have been connected with the business in the capacity of an accountant—than any other line of industry. You take the average boiler manufacturer and he turns his capital once a year. Some turn it one and one-half times, but very rarely will you find a boiler manufacturer who turns it twice. Now then, when we consider their net profits—3 percent, 4 percent, 5 percent and 6 percent—it is a whole lot less than the ordinary lines of retail merchandising. Why the ordinary department store makes a poor showing when they don't make over 6 percent net after paying all expenses, and after paying themselves fair salaries—and that's another thing, the boiler manufacturers, prior to 1917 and 1918, never paid themselves fair salaries. They figured, after all expenses were paid, on a division of profits for the partners or individuals or stockholders. We are inclined to sell too close, and the reason why we didn't make as much profit as we should have made is due to to these estimates that were made this morning—that is where this evil, this low profit, is going to be corrected. We have got to know—we cannot sell goods on guesswork—and there's no question but that—as we listened to these estimates that were made this morning—there is a lot of guesswork entering into it. The estimate form that is being sent out should make certain suggestions that a man can follow as to details, and we should in making our estimates include labor, material and overhead. Some of these estimates submitted contained only labor, others labor and material, others labor, material and overhead combined, and I recommend as an accountant—it is naturally my business to do so—that we standardise, that we make all these things uniform—our estimate blanks and our cost accounting systems. It makes no difference what kind of a system you use as long as you are using the same plan and it incorporates everything. Do not incorporate anything that is not there, but if you are paying yourself a normal salary, put it in, because you are paying it and that is a real expense. Interest on borrowed money is considered as an item of administrative expense in some cases and in other cases it is eliminated altogether. In the case of the America's Face Brick Manufacturers' Association we recommended interest on investment. There is one case where we did that, and we may seem inconsistent in doing so but we did it for this reason—most of the manufacturers of face brick started off as farmers who had some clay on their land and they were approached by the brick machinery people with the proposition that they would equip them to produce bricks. Most of this equipment was purchased with borrowed money. We put them all on the same basis and let them all charge interest on investment, but then we had them charge against their reserve for investment actual interest paid, and then they wiped off the difference.

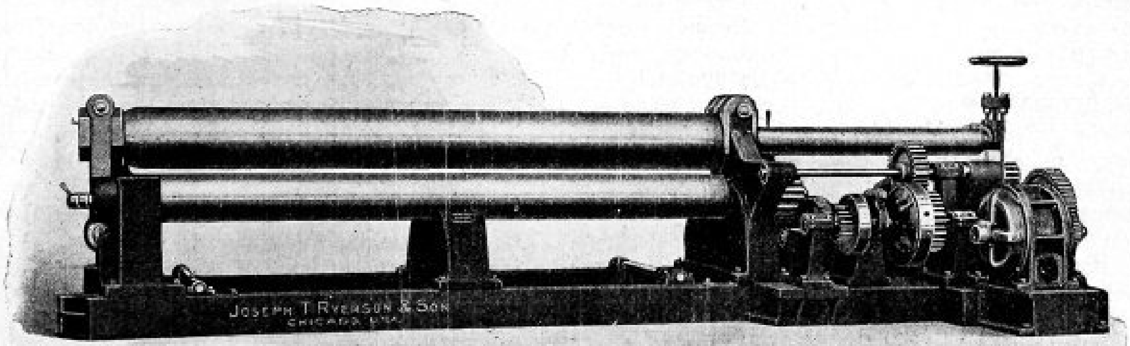
Boiler Shop Machinery

Ryerson-Kling Vertical and Horizontal Punches, Sheet and Plate Bending Rolls, Angle Bending Machines, and Bar Bending Machines.



Ryerson - Kling Single End Cored Frame Geared Punch

The Ryerson-Kling line of vertical punches can be furnished in any depth of throat or capacity desired. The construction of our vertical punches and shears is such that the attachments are interchangeable.



Ryerson - Kling Horizontal Plate Bending Rolls

The Ryerson-Kling Plate Bending Rolls can be furnished in any length and in any capacity. All rolls 10′ between housings or longer are supplied with center roller support, and the rollers are of steel forgings.

Let us figure on your requirements.

JOSEPH T. RYERSON & SON

MACHINERY

CHICAGO NEW YORK BUFFALO ST. LOUIS DETROIT

C. V. Kellogg: If we could adopt a substantially uniform estimate sheet, it would help out a great deal. Another thing I want to speak of is in reference to this price list of July 1. I notice this estimate is on 132 pounds, including pressure, of course, but I notice that there is a very great difference in weights. Now, the weight that is contained in this price list of July 1 was the average weight of several of the manufacturers in 1913, and the weights were not changed when this price list of July 1, 1919, was printed. Now I notice that the weights are off on some of the different items, and I would be very glad if the different manufacturers would take the time and check up these weights and send to me the average weight, for the reason that we are going to publish a new price list the first of the year and I would like to have it as near correct as possible, as it would aid us very much in figuring in the future.

President Connelly: What size units does that take in—does it start with 48-inch?

C. V. Kellogg: 48-inch to 78-inch—125 and 150-pound boilers. In addition to that, I can say that so far as the manufacturers in the west are concerned their actual quotations today check very close to this price list in actual practice.

G. W. Bach: The greatest difference that I found in the actual figure and the rate sheet figures is in the matter of trimmings. Our cost of these trimmings is $174, whereas in the Gray Book they are about $103.

T. F. Sellade: This sheet that Mr. Barnum has gotten up covers everything very thoroughly, but I agree with the accountant from Ernst & Ernst that the only way we will be able to get an absolute check for comparison is to take these sheets and take the labor and the material and the overhead on each item and show it on those sheets as a cost, instead of doing as some manufacturers do, just showing the material and leaving the labor off and the overhead. In other words, there is such a great difference—for instance, the Ames Iron Works in some cases shows just material, while another manufacturer takes the overhead and labor on it. Now, if we could get some basis by which we would all be figuring the same way, I think the troubles of boiler manufacturers would be eliminated considerably.

President Connelly: In this form that Mr. Barnum has worked out he includes overhead, labor and profit on each of these various parts of the boiler—the boiler proper, the fittings, the castings, and the stock.

Mr. Kellogg: Answering Mr. Rochlitz, in reference to his letter, as to whether there should be a profit charged on that portion of the material that is purchased—that would be a very difficult problem, for the reason that there are a few manufacturers who make nearly everything except trimmings. There are others who do not.

P. Bigelow: I do not see why that is not taken care of whether you manufacture the article or whether you buy it, if you put it in as your manufacturing cost or estimated cost price and then add your profit. When you figure up the estimate as a whole you have got to get a profit whether you figure it separately or not.

C. V. Kellogg: That is true and I agree with Mr. Bigelow, but I understand Mr. Rochlitz to say that there should be a separate profit added for the goods that you bought.

O. A. Rochlitz: The point I raise is this—as I explained before, we separate our burden. We charge 16 percent selling and administrative burden on the total cost, so that we charge it on castings—I am lumping that word, I mean all the foundry work on the boiler. We have paid the foundrymen a profit, of course, and we lump that all into our cost and we add our selling and administrative burden to that, and a profit, of course, to the whole thing. We add our profit after we have added our selling and administrative burden.

P. Bigelow: He buys that material and none of his shop overhead really applies on that, and should he apply it as a blanket overhead over both the material which he makes and the material which he buys, or should he apply it on just what he makes?

O. A. Rochlitz: Our burden, as we call it, our 65 percent, is charged on the labor. Naturally, it is not charged on the foundry labor because we do not do that, but we add 16 percent to the total cost to us on all these castings as an administrative expense. The foundrymen lump all that, but the boiler maker who has his own foundry has the advantage. The presumption is that he can make these castings for the same price that the outside foundrymen do, and he charges himself, let us say, the bare cost. He is content with the foundry profit on that, but we have to give the foundry profit to somebody else and then we want a profit on top of that.

C. V. Kellogg: These data which have been furnished are valuable as a matter of education. In the boiler business heretofore it has been the practice of nearly all the manufacturers to figure their selling price based upon their cost. There is such a wide variance as to cost—for instance, on castings it varies from 3½ cents a pound to 7 cents a pound, as demonstrated here today. It seems to me that the real question outside of the matter of education is for the manufacturers to arrive at some basis, that when they come to sell they are somewhere near alike. If a boiler is worth $2,000, everybody ought to figure at nearly $2,000. The only way that you can do this is to arrive at and establish a price list. Nearly every other manufacturing line in the country does it. At the present time, not particularly in the boiler business, perhaps, but in other lines, the question of standardization is being considered. There is no reason and no excuse why castings should cost 3½ cents in one locality and 7 cents in another.

A motion was made and carried that the tabulation of the boiler estimates be omitted from the proceedings, because of its confidential nature, which was intended for members of the Association alone.

WEDNESDAY AFTERNOON SESSION

The early part of the afternoon was spent discussing the revision of the by-laws of the Association.

President Connelly: Before leaving the subject of cost finding I wish to read a letter to the members of the Association from Ernst and Ernst on the matter of boiler costs.

New York, September 23, 1919.

American Boiler Manufacturers' Association,
New York City.

Gentlemen:

We have given consideration to the making of a proposition for preparing and installing accounting and cost systems for a group of ten to fifteen boiler manufacturers.

A uniform system can be applied up to a certain point where modifications are necessary on account of the size of the plant and the conditions peculiar to each plant.

Uniformity can prevail in such features of the system as the bills of material, stores records, such as inventory sheets and requisitions, also labor summaries, cost sheets, etc.

Particular attention would be given, in every case, to the general accounting system and the organization of the accounting department so that a close working combination of general accounting and cost accounting may be made so as to effect economical operation and dispense with unnecessary or duplication of clerical help and accounting records.

Our work contemplates making a survey of each plant by Mr. Conner, Mr. Baird, or the writer, for the purpose of making a study of the individual requirements and advising with the management with respect to such matters as storerooms, time recording devices, departmentization of plant, and the organization for carrying out the work.

We would follow up our survey by preparing the necessary forms covering the following features:

Purchasing,
Storekeeping,
Engineering,
Sales,
Timekeeping,
Cost Accounting,
General Accounting,
Statistical.

In each case we would prepare a written report containing instructions on each feature of the work, at which time we would present the forms at a conference held at the plant of the client.

The printing instructions and specifications would be prepared by ourselves and turned over to the purchasing department of the client for execution.

About ten days would be devoted by a member of our system staff in opening the new accounts and the instruction of the client's employees in the details of the systems. At the end of the first and second, and possibly the third month, a member of our staff would arrange to spend a few days at the offices of the client assisting with and supervising the preparation of the balance sheets and operating statements. This supervision, on our part, after the systems have been installed should be limited to fifteen days, any additional time required would increase the cost to the client, and it should only be necessary where the accounting organizations are not thoroughly competent.

Our charge for this service would be $1,500 for each plant, plus travelling and hotel expenses.

Where the operations of a plant include manufacturing that is strictly outside the field of boiler making, such as engine building, foundries, and structural steel work, we, of course, could not undertake the system work of such plants on the basis outlined in the foregoing.

The foregoing proposition is made with the understanding that the client has in his employ, or will employ competent accountants and clerks for the work.

Our organization is prepared to give this matter prompt attention and assign experienced system staff members to it until such a time as the installations are completed and in satisfactory working order.

Very truly yours,

F. H. Figsby.

J. A. McKeown (who did not attend the morning session): I am glad to hear that there has been an improvement in the matter of estimating. We are experiencing what all boiler manufacturers are experiencing today—lots of business to be had but very few men, so it is pretty hard to make boilers.

President Connelly: It might be well to hear of the business prospects in various parts of the country.

A. O. Schofield (Macon, Georgia): We are not running absolutely full down our way, and as compared with 1917 and 1918, of course, we are behind. Those were periods when we had quite a good bit of direct and indirect Government work. As to our return tubular business right now, it is not as active as it ought to be. We have considerable plate work—just regular plate construction tanks—and a little tower work and stuff of that sort, but as compared with last year and the year before, our return tubular work is not as active as it might be. We work on a 54 hour a week basis.

E. R. Fish (St. Louis, Mo.): Generally speaking, our plants are about normally full. Just how long that condition is going to keep up we don't know, but business looks as though it was going to be good for an indefinite period. The oil business has a good deal to do with the amount of work that comes to our boiler shop, and there is great activity in that respect, particularly in the middle west, just now. We work 53 hours a week.

G. S. Barnum: As to things in New England, we are running, perhaps, 75 or 80 percent of our capacity of last year. We are working 50 hours a week—9 hours for five days and 5 hours on Saturday. We feel that business is slow with us just now, but the time is coming shortly when we are going to be very busy, providing something unforeseen does not happen.

President Connelly: Have you been obliged to advance your help since this new railroad shop schedule went into effect?

G. S. Barnum: No, we have not. Ours is not a union shop, but as I said this morning, our average trade now is about 58 cents, while a couple of months ago it was only 56 cents. That would show a slight advance.

E. C. Fisher (Saginaw, Mich.): We have a satisfactory amount of business, and we are running as swiftly as we can under the circumstances. All through the valley we have had very bad machinists' strikes since June 25. The strikes have been declared off now but the men have scattered in all directions and it is impossible to get the full force back. Our boiler business is running along satisfactorily. We have made one advance since the June meeting, but we did it voluntarily because we were trying to keep the boiler makers together. We run nine hours a day and five on Saturday—50 hours a week.

President Connelly: How are things in Erie City?

F. C. Burton: Why, we are very busy. We are running ten hours a day and five on Saturday—55 hours a week. I think July was probably the largest month we ever had. Of course, we have had the same trouble as all the rest, and that is, lack of help.

E. G. Wein (Williamsport, Pa.): We are very busy. We find lots of business. July was the greatest month we have had outside of March, and August was a very good month. September is running ahead of those two months. We are sold out about five months ahead. Our week is on a 55 hour basis.

F. T. Doyle (Oswego, N. Y.): We had the most satisfactory business during July and August. This month, business has dropped off considerably. However, we are working full time, that is, 50 hours a week, and the prospects are that we will continue on that basis for some little time because we have quite a good many orders piled up in the shop. We have about 14 or 15 weeks' business ahead.

L. B. Pratt (New York City): Business is very much better than it was during the first five months of the year. The first five months averaged about 35 percent of what we considered normal, that is, not compared with the war period business, but normal. Since then we have averaged about 125 percent—so we feel much more comfortable, and it has kept up right along through the last four months much better than the normal rate. We are working 48 hours a week. We went on that basis about three years ago, due to the large amount of Government work we had and the difficulty of running two kinds of shifts, one for commercial work and the other for Government work.

W. L. Cameron (Galesburg, Ill.): We are doing a fair amount of business, and we have got quite a number of prospects in hand now. We are working 50 hours a week. We have been working 55 hours up until recently when we cut it down to 50. Orders are on hand for about 2 months' work. That in addition to Government work will keep us busy for about 4 months.

M. Fogarty (New York City): I asked my friend, Mr. Cunningham, who is sitting alongside of me, what you were talking about. He said you were talking about the hours of labor. I said, "What do they say?" He says, "They speak of ten hours a day five days in the week and five hours on Saturday." I could hardly believe my ears that anybody in America worked that many hours in a week. Why, I felt that surely it must have been somewhere in Russia. In New York we work, that is, we keep the shop open for the men to work, 44 hours a week, 8 hours a day and 4 hours on Saturday.

I would like to call to the horizontal tubular boiler men's attention something that ought to interest them. I am one of the committee that helped the industrial commission to make the boiler laws in New York, and I was a consistent kicker on a matter that is against the interest of the boiler manufacturer, and while there were others that agreed with me—insurance inspectors for instance, when it came to a vote everybody seemed willing to leave it to the other fellow.

At the very end of a miscellaneous lot of rules and regulations about the pressure allowed on boilers and the fittings allowed on boilers, somebody slipped in: "No pressure shall be allowed on a boiler on which a crack is discovered along the longitudinal riveted joint." Now, that question arose and we argued it out in Syracuse, we threshed it out in Albany, and we threshed it out down here in New York for several days, and everybody agreed that the rule was drastic, and the insurance company's inspectors—two high class men of two high class insurance companies—both admitted that they were every day in the week accepting insurance on patched boilers, and there was nothing to prevent it and they thought that this paragraph was very drastic. They said, "This is the Mechanical Engineers' Code, and they have put it in, and we will hold the Mechanical Engineers responsible for it." We went over the matter and I put it up this way—we build a boiler up to date—butt strap joint, and everything according to law—we have tested the plates at the mill and the tests showed everything right up to the requirements. Through some cause in the shop the boiler happens to crack between the rivet holes, but the crack did not show. Finally after continual working—as our engineers call it, breathing—a leak finally develops. Well, you send for a calker and he tests the calked edge. He puts a fuller on it and says it is all right, then he tries the rivets and finds them solid. An experienced man immediately figures that there is a crack somewhere and, of course, the inspector would be called in and he would say to take the butt strap off. This is done and under the butt straps he finds a crack. Now according to the law that boiler is immediately discontinued from service and thrown out. Now, I wanted to know why we couldn't cut out a foot of plate more or less, on each side of the defective seam and test it. There might have been a mistake in the testing in the mill. If the plate is found to be O. K., put the joint right back—that is the butt strap joint. It is then just the same as it was when it came out of the shop. The other two plates are all right anyway.

I have never seen in all my experience—and I have been in this business for over fifty years—I have never seen a cracked seam in a boiler, unless it was because of dirt piled up on it which caused it to pull when scale formed. Such cases were in the time of the old iron boiler. I never saw a steel boiler in my life cracked between the rivet holes, that is from one rivet hole to another. Things like oil in the boilers are dismissed without a second thought. We know that many boiler makers have had their reputations ruined simply because some faulty system was installed and carried the cylinder oil into the boiler. I want to try to get this matter into the law so that a boiler found in such a condition will be immediately closed down and an apparatus put in to keep oil out of the boiler. You all ought to consider this matter carefully and I know you will.

Further business was transacted, and it was voted to hold another meeting in December, the exact date and place to be decided upon at a meeting of the executive committee.

The Convention then adjourned.

Registration at the Special Meeting of the American Boiler Manufacturers' Association

Bach, George W., Union Iron Works, Erie, Pa.
Barnum, G. S., The Bigelow Company, New Haven, Conn.
Bigelow, P., The Bigelow Company, New Haven, Conn.
Blodgett, L. S., The Boiler Maker, New York.
Burton, F. C., Erie City Iron Works, Erie, Pa.
Cameron, W. L., Frost Manufacturing Company, Galesburg, Ill.
Campbell, J. B., The McVeel Boiler Company, Akron, Ohio.
Champion, David J., Champion Rivet Company, Cleveland, Ohio.
Chapman, A. H., The Walsh & Weidner Company, Chattanooga, Tenn.
Chapman, Fred W., International Engineering Works, Inc., Framingham, Mass.
Connelly, W. C., D. Connelly Boiler Company, Cleveland, Ohio.
Covell, H. W., Lidgerwood Manufacturing Company, Brooklyn, N. Y.
Cox, Frank G., Edge Moor Iron Company, Edge Moor, Del.
Cunningham, Christopher, The Christopher Cunningham Company, Brooklyn, N. Y.
Day, W. C., The Frost Manufacturing Company, Chicago, Ill.
Doyle, F. J., Ames Iron Works, Oswego, N. Y.
Figsby, F. H., Ernst & Ernst, New York.
Fish, E. R., Heine Safety Boiler Company, St. Louis, Mo.
Fisher, E. C., The Wickes Boiler Co., Saginaw, Mich.
Fogarty, Michael, Michael Fogarty, Inc., New York.
Glenn, John F., Edge Moor Iron Company, Edge Moor, Del.
Goodwin, J. T., National Tube Company, Pittsburgh, Pa.
Hartley, H. J., Wm. Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa.
Jeter, S. F., Hartford Steam Boiler Inspection & Insurance Company, Hartford, Conn.
Johnston, J. F., Johnston Brothers, Ferrysburg, Mich.
Keenan Chas. E., Midvale Steel & Ordinance, New York.
Kellogg, C. V., Keewanee or Teller Mackay, Chicago, Ill.
Kirk, Thos. B. L., Standard Seamless Tube Company, Pittsburgh, Pa.
Low, F. R., Power, New York.
Llewellyn, Walsh & Weidner Boiler Company, Chattanooga, Tenn.
McCabe, Fred H., McCabe Manufacturing Company, Lawrence, Mass.
McKeown, James A., John O'Brien Boiler Works Company, St. Louis, Mo.
Memker, A. H., The Gem City Boiler Company, Dayton, Ohio.
Metcalf, Frank B., International Boiler Works Company, Stroudsburg, Pa.
Mikels, LeRoy, International Boiler Works Company, East Stroudsburg, Pa.
Mitchell, A. S., Champion Rivet Company, New York.
Mohr, Edward, John Mohr & Sons, Chicago, Ill.
Plank, L. F., C. H. Dutton Company, Kalamazoo, Mich.
Pratt, L. B., Babcock & Wilcox Company, New York.
Rees, T. M., James Rees and Sons Company, Pittsburgh, Pa.
Riley, George N., National Tube Company, Pittsburgh, Pa.
Rochlitz, O. A., Kroeschell Brothers Company, Chicago, Ill.
Schofield, A. D., J. S. Schofield Sons Company, Macon, Ga.
Sellade, T. F., Ames Iron Works, Oswego, N. Y.
Tudor, Cliff M., The Tudor Boiler Manufacturing Company, Cincinnati, Ohio.
Uhick, Chas. W., Ashton Valve Company, New York.
Walton, David A., C. J. Walton & Son, Louisville, Ky.
Weigel, A. C., The Walsh & Weidner Boiler Company, Chattanooga, Tenn.
Wein, E. G., E. Keeler Company, Williamsport, Pa.
Woolf, Douglas G., Textile World Journal, New York.

The Boiler Maker

Published Monthly by

ALDRICH PUBLISHING COMPANY, INC.

Member of the Associated Business Papers, Inc.

6 East 39th Street, - - - - New York

8 Bouverie St., London, E. C.

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Branch Office
Boston, Mass., 294 Washington Street, S.I.Carpenter

Although the printers' strike in New York City has been at a deadlock for seven weeks, the situation is now so well in hand that no further serious delays are anticipated in the publication of future issues of The Boiler Maker.

When the strike began on September 30, practically all magazine publishers whose printing was being done by union labor in New York City were forced either to suspend publication or have the printing done elsewhere. Many of the publications driven from New York in this way will not return. As a matter of fact, there is no intention on the part of the publishers to compromise with the radical element in the printing industry which is at the bottom of these labor disturbances.

Behind this outbreak can be found the same sinister influence that first in Russia, later in Germany, and now in America, is seeking to overthrow industry and establish mob rule. It is fostered by a class that violates contracts, repudiates agreements, refuses arbitration, defies its national labor organization and is a direct menace to the law and order of the land. In taking an unswerving stand against this element at whatever cost, the publishers are showing their loyalty to the United States and deserve the undivided support of their clients.

We are very glad to feel that the material published in The Boiler Maker meets with the approval of our readers, as evidenced by the many letters constantly received, indicating particular features that have been found helpful. After all, the only way in which a journal can attain its maximum usefulness, is to keep in close touch with its readers and from them learn the sort of information which is most needed. The following letter from one of our subscribers in Canada indicates one phase of the industry that we have not overlooked:

"The Boiler Maker in my opinion is both helpful and instructive to all branches of the trade, inasmuch as in introducing all the latest methods and appliances it still allows a little space for the old-time methods. There are and always will be times and places where these must be applied. I think every practical boiler maker will agree with me on this point. Your publication endorses this fact, and this is only one of its many good features.

"Many young boiler makers in modern shops would do well to know and acquire the old-time methods, as well as the present. To be practical boiler makers in the true sense of the word, this knowledge is essential, and I am glad to be in the possession of a publication which does not overlook this fact."

A great deal might be said of cooperation in business between the men who are producing and the management. In some cases organizations are too large to arrange matters so that there may be frequent personal conferences between the men and the boss.

The average boiler shop, however, is small enough for a direct exchange of ideas and suggestions and there should be no barrier, either real or imaginary, on the road to mutual respect and understanding.

When the men realize that suggestions are appreciated and they can deliver them directly and receive due credit, many new ways of reducing costs and increasing production will be discovered. There is little inducement to develop a good idea and never have the chance to present it.

Many conference plans have been adopted by various plants in the country to foster this "get-together" spirit. Certain of the men are chosen to represent the remainder of the force in weekly or semi-weekly sessions with the management. At these times all matters that have the welfare of the organization in view are discussed and such action taken as is necessary to incorporate suggestions or changes in the conduct of affairs to the mutual benefit of the men, the plant and, incidentally, the industry as a whole.

The economic well-being of the nation rests on certain well-known principles which sometimes, as at present, are forgotten but without the observance of which prosperity does not exist. Such propositions of State industrial control, as the recent much-discussed Plumb plan, may be seriously considered for a time as a solution to all difficulties, but, on investigation, reveal certain fallacies in their fundamentals.

The plan is important in that if adopted the overthrow of industry as it exists would follow, to be re-established on a State-control basis. Fortunately the past weeks have seen what in effect is a definite discard of the Plumb plan and for a time at least danger from its consideration is ended.

To keep it and similar measures forever buried every good American should understand the basis on which the welfare of the nation rests. Production is the answer—a production of every commodity in quantities sufficient to meet our own needs as well as to compete successfully in the world trade.

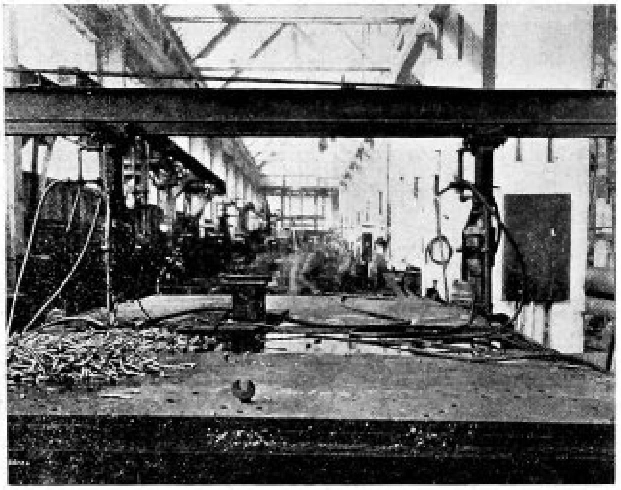
In our own field of boiler making there is no nation in the world better fitted to supply the demands of other nations. The increased demand in turn creates a need for more production and greater production is only brought about by the support of every man engaged in an industry.

Engineering Specialties for Boiler Making

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

Special Rigging Used in Conjunction With Portable Drills

A rigging devised for use in connection with portable electric drills for drilling boiler shell plate is being used by the Puget Sound Machinery Depot at Seattle. Compared with the cost of installing special power presses, there is a decided economy of investment, and from a production standpoint the performance has proved most satisfactory.



Drilling Three Thicknesses of 1 3/16 Inch Plate at the Same Time

The machines used are made by the Van Dorn Electric Tool Company, of Cleveland, six of which have been in operation now for some months, and at the present time two others are to be added to the equipment. All the work required for mounting these machines is an extra truss thrown over the top of the span, which will allow the operation of four machines at the same time on the same plate.

The feed is provided by a hydraulic cylinder controlled by a four-way valve, which spills underneath the plates. This is operated under city pressure of about 85 pounds.

Forged Cutter Tool Holders

J. H. Williams & Company, Brooklyn, N. Y., have recently produced the "Vulcan" forged cutter tool holder as an addition to their line of "Agrippa" tool holders.

New Vulcan Tool

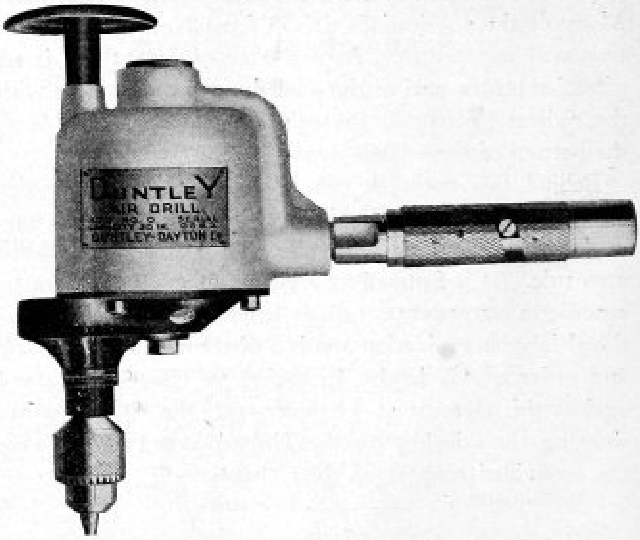
It is claimed that this holder makes possible the use of what is practically a solid tool without its expense.

Each holder by the insertion of a small, high-speed steel forged cutter is adapted to the heaviest service in any regular machining operation on the lathe, planer, cutter, etc. The holders are drop-forged from a fine grade of steel and heat-treated to develop maximum toughness and stiffness. They are simple in construction, being composed of three parts—the holder proper, a square-head cam, and a locking pin. "Agrippa" drop-forged high-speed steel cutters are available in a wide range of sizes and types—side tool, diamond point, roughing, hog nose, flat nose, threading, etc.

New Air Drill

In the new air drill just placed on the market by the Duntley-Dayton Company, 1416 Michigan avenue, Chicago, there is a radical departure from standard air drill construction which makes the drill unique. The motor or power unit is quickly detachable, making it possible by the removal of three screws and a nut to replace the motor should this become necessary.

The line thus far consists of two breast drill sizes, No. 00 capacity 1/4 inch, and No. 0 capacity 3/8 inch. Larger sizes are under construction. These are specially adapted for drilling telltale holes in staybolts and work of that character. As the motor is self-contained and well balanced, there is no vibration, a desirable feature in the performance of accurate work. The drill weighs 4 1/2 pounds.



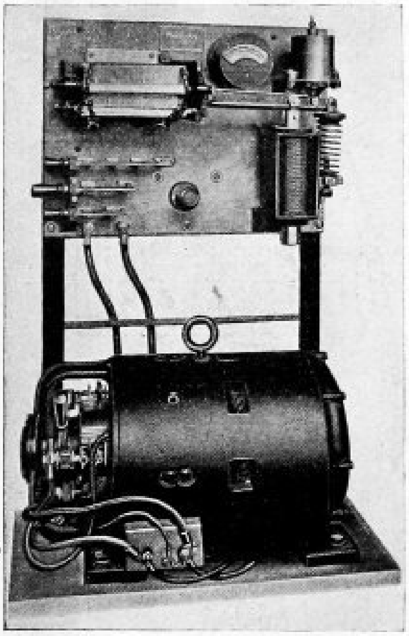
New Type of Duntley Air Drill

The self-contained motor consists of three pistons mounted in a frame, the entire engine rotating about a fixed crankshaft or spindle. The cylinders oscillate from a fixed base, and cams on the spindle operate the valves. All working parts run in a bath of oil.

Plastic Arc Welding Unit

A plastic arc welding unit has recently been supplied by the Wilson Welder & Metals Company, New York City.

The set is composed of a dynamotor having a flat compound-wound generator and a current-control panel. The Wilson principle of constant welding speed is utilized. To accomplish this, a small carbon pile, a compression spring and a solenoid working in opposition to the spring are mounted on the control panel. The solenoid is in series with the arc so that any variation in the current will cause the solenoid to vary the pressure on the carbon pile, thus keeping the current at its adjusted value. Con-



Wilson Plastic Arc Welding Unit

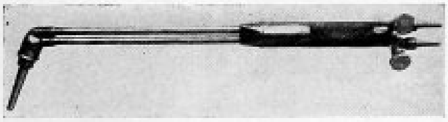
stant currents, ranging from 25 amperes to 175 amperes, are possible.

Various standard motor characteristics are available as a dynamotor unit: 110 volts, 220 volts, direct current; 440 volts, 60-cycle, two or three-phase, alternating current. It may also be obtained in a gasoline (petrol) belt-drive without the motor.

New Welding Torch

A welding torch, having various refinements of design, has recently been produced by the Air-Reduction Sales Company, New York City. It is claimed that this torch increases the efficiency of the welding flame with a decreased gas consumption.

The general design has been improved, particularly in the construction of the valve handles and hose connections. A gas pressure table has been rolled on the upper part



Efficient Welding Torch

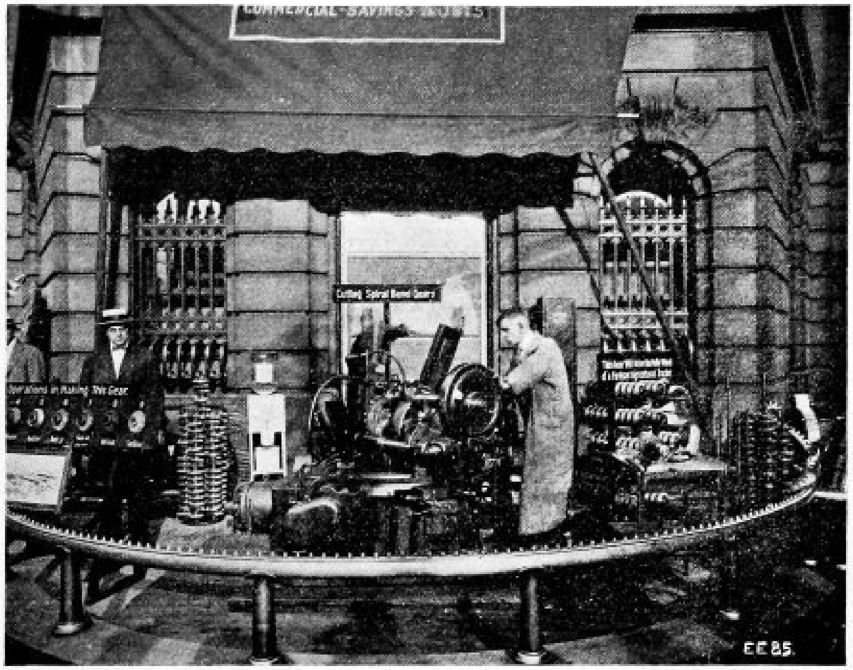
of the handle. The valve handles are octagonal and arranged on the left side of the torch, where they will not catch in the operator's clothes.

The tubes are of hard-drawn seamless brass, countersunk at both ends, while the valve body and the butt of the handle are combined in a single casting instead of being screwed together, as is the usual practice. Threads on the tip have been eliminated by the use of a tip nut to prevent gas leakage. Heads and tips of various types are available for use with the different sizes of torches and make the equipment adaptable to all classes of welding, from sheet metal to castings.

Gear Cutting Exhibit

A novel exhibit of gear cutting was held recently on one of the principal streets of Cleveland by the Van Dorn & Dutton Company of that city.

The object of this demonstration of the use of machine



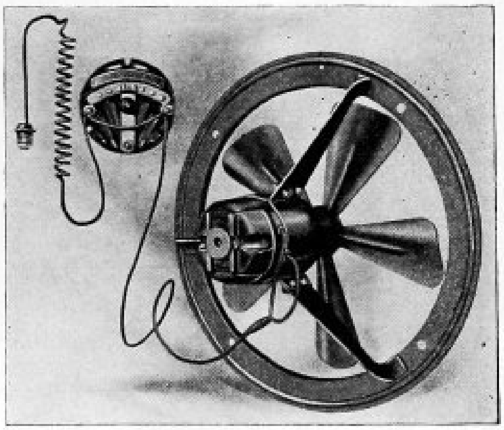
Exhibition of Gear Cutting in Cleveland

tools and gear cutting was to give the public an idea of modern production methods in this connection and of the extent and application of the gear cutting industry. Special types of gearing for electric cranes, hoists, mill machinery, bevel, spiral rack and pinion, sprocket and the like were shown.

Ventilating Outfit

A fan having six speeds is being placed on the market by the Buffalo Forge Company, Buffalo, N. Y.

It is claimed that the unit is economical in operation, with large capacity. The fan is 16 inches in diameter, driven by an inclosed motor, which will operate on a



Six-Speed Fan with Capacity of 1,000 Cubic Feet of Air per Second

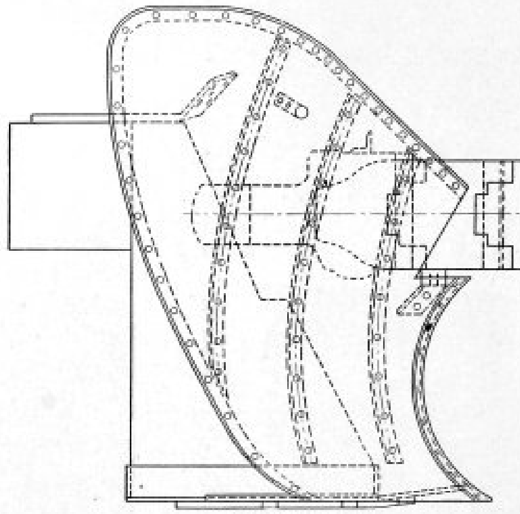
110 or 220-volt direct current or a single phase 25, 30, 40, 50 or 60-cycle alternating current circuit. The air capacity is 1,000 cubic feet per second, and the speed 500 to 1,000 revolutions per minute.

Questions and Answers for Boiler Makers

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

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *6 East 39th Street, New York City.*



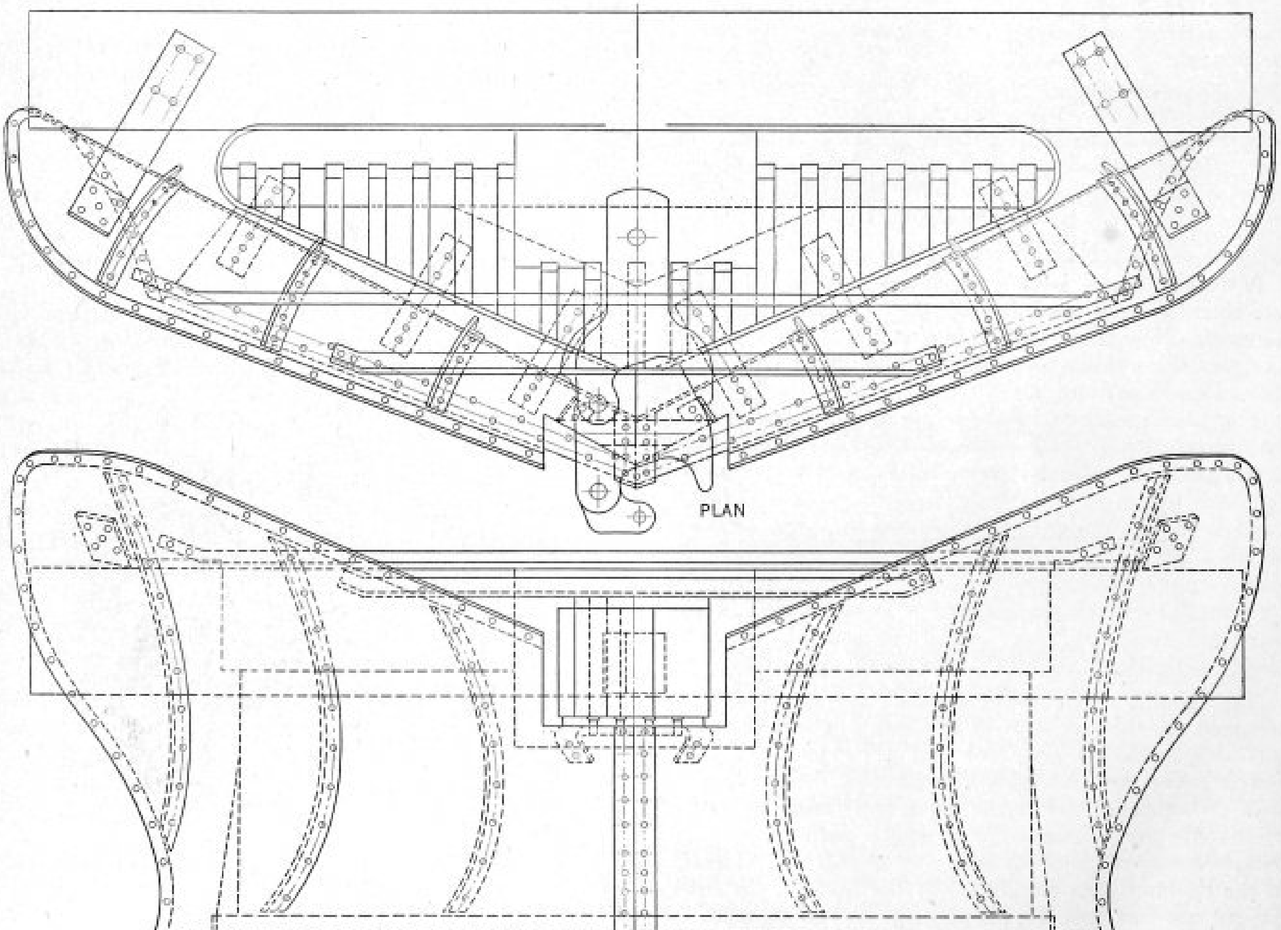
END ELEVATION

Pattern Layout for a Snow Plow

Q.—Please illustrate how the patterns should be laid off for a snow plow as shown in the accompanying drawing. Fig. 1 gives the plan, front and side elevation of the plow. E. W. O.

A.—Figs. 2 and 3 show the development of one section of the snow plow problem. This object is so irregular in shape, having an irregular taper and curvature, that it involves the method of triangulation development for laying out the pattern.

In Fig. 2, is a reproduction of the plan, front and side elevations. The two views, plan and side elevation, are divided into a number of triangular sections by dividing



SIDE ELEVATION

Fig .1.—General Plans of Snow Plow

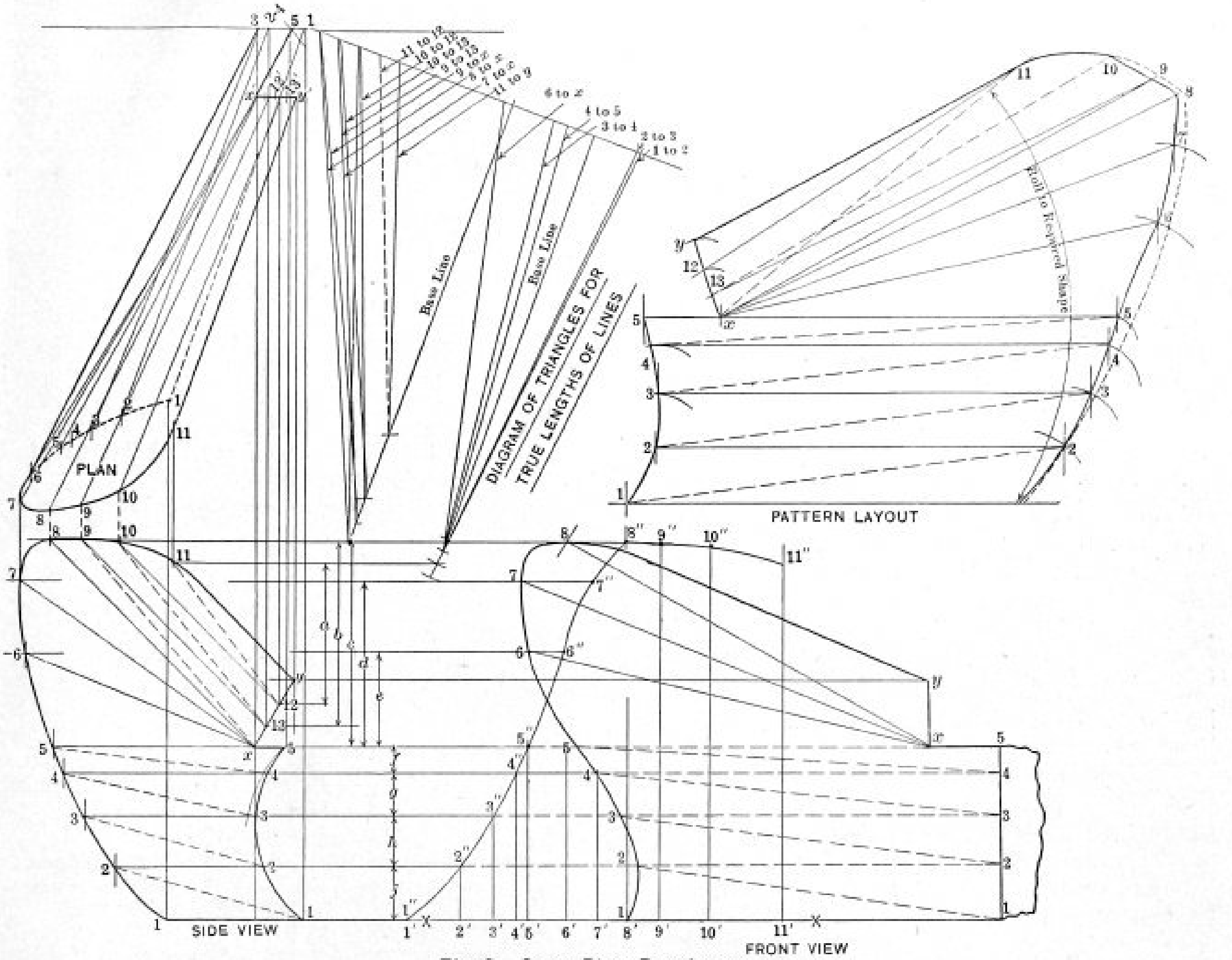


Fig. 2.—Snow Plow Development

the contour outline of the side view first into any number of parts as shown at 1-2-3-4, etc. The lines at the bottom section from 1 to 1, 2 to 2 to 5 to 5 inclusive, are parallel with the side vertical plane, hence their horizontal projections in the plan show them in their true length, but the dotted lines from 1 to 2, 2 to 3, and 3 to 4, etc., of this view are shown foreshortened in both the plan and side views. The points taken in the side view are projected vertically to the plan to intersect at the respective ends of the view as illustrated and numbered to correspond so that it is not difficult to locate their respective length of lines between them when constructing the diagram of triangles, which is done in order to find their true lengths.

At any convenient place, lay off the diagram of triangles as illustrated to the right of the plan. The base lines of these triangles are at right angles to each other. On the base lines lay off the bases for the triangles, taking them from the plan. Thus to find the true length of the line *8* to *x* we take as a base line length *8* to *x'* of the plan. The height of the vertical leg of this triangle is equal to the distance *c* of the side view. This distance shows how far point *8* is above point *x* when measured vertically and at right angles to the side vertical plane. The heights for the remaining triangles are determined in a like manner as indicated at *a-b-d-e,* etc., in the side view.

To obtain the true length of arc lengths from 1 to 2, 2 to 3, 3 to 4, etc., on the outer irregular curved section of the object, proceed in this manner: Lay off a base line as *x-x,* which is indicated in the front view, and on this line lay off the arc lengths from 1 to 2, 2 to 3, 3 to 4, 4 to 5, etc., of the plan, thus locating on line *x-x* the points 1'-2'-3'-4' etc., at right angles to line *x-x* and from these points draw vertical projectors. From the points 1-2-3-4 etc., on the outer curve of the side view draw horizontal projectors intersecting the vertical ones at 1"-2"-3"-4" etc. The arc lengths from 1" to 2", 2" to 3", 3" to 4" etc., are the ones required for developing the pattern.

All of this construction work is approximately correct, as owing to the curvature of the object the triangulation lines do not lie directly on the surface as they are straight lines. By dividing the views into a greater number of triangular sections, closer and more accurate results will be attained.

Pattern Layout.—This consists of transferring alternately the true length of the solid and dotted lines, using the true arc lengths previously determined for the large end and taking the ones for the small end directly from the curved and straight section of the small end of the front view. These lengths are true in size since they lie parallel to the side plane with the exception of *x'* to *5'*, which however is shown in its true length in the plan from *x'* to *5'* as this line is parallel to the horizontal.

In the pattern it will be noted that a dotted line is drawn around the developed outline of the pattern. This line is done to allow additional material as in the development of the pattern it may be made a trifle short.

Largest Scotch Marine Boiler

Q.—Will you kindly give me the data of the largest Scotch marine boiler you have in regard to the diameter, length, thickness of plate, diameter of rivets, steam pressure and when and where built? C. M.

A.—We have no definite information regarding the largest Scotch marine boiler ever built. The single ended boilers vary in size from 9 to 17 feet in diameter, and from 7 to 12 feet in length, plate thickness ranging up to and including $1\frac{7}{16}$ inches for the shell plate. These boilers have two, three or four furnaces. Double ended boilers range in the same diameters, but they are longer. The double ended type is practically two single ended boilers connected together, without the back heads. This is accomplished by joining the two shells together. This form of boiler is very heavy owing to the thickness of shell plate, structural details and the large amount of water contained. Due to its form, great pressures cannot be carried. Coincident with the increase of steam pressures, other forms of boilers for marine use, are extensively employed.

Boiler Repairs and Welding

Q.—1. If a bag on a return tubular boiler is down 5 inches, would it have to be cut out and patched or driven back? If a patch is put on, how much weaker does it make the boiler? How much of a patch could you put on a boiler without the insurance company's complaining? Suppose the shell is ½-inch thick, would you put on a ½-inch patch or less and would ⅝-inch rivets do or ¾-inch?

2. In the case of a shell crack 3 inches long. I ordered it to be repaired by welding. The company did not think it would be safe. It was patched, but fire cracks developed in it.

3. Would you get better results if you drove the rivets inside instead of outside, and what is the difference?

4. Would you countersink the hole one-third of the thickness of the plate or more?

5. Give me the length of the rivets which ought to be used from ½ inch to $1\frac{3}{16}$ inches; that is, through the shell; on countersunk and butt set also.

6. Will you kindly let me know if there is any book published about cracks, etc.? F. P.

A.—1. In general, it is the best practice to remove a large bagged section of the boiler and patch it. When a bag is of slight deformation the plate may be forced to its original position by first heating it and driving it, or by means of a hydraulic jack. The strength of a patch depends on the plate thickness, rivet pitch, diameter of the rivets, and the arrangement of the riveted seams. A circular patch or one having diagonal seams produces the strongest form of patch. A general rule is to make the plate thickness of the patch equal to the thickness of the boiler plate, and the diameter of the rivets equal to the diameter of the rivets in the circumferential seam of the boiler. The largest repair made on shell boilers as in the tubular type is the application of a shell plate called a "half sheet"; this term, however, is a misnomer as very often boiler shells are repaired over one half of the circumference of the boilers. The Fig. 1 shows the application of a "half sheet" ready for riveting.

2. Cracks 3 inches in length and longer may be satisfactorily welded and meet with the requirements of boiler insurance companies. Old reliable companies as Lloyds Bureau and the Hartford Insurance Company, etc., allow certain repairs to be made by the oxy-acetylene or electric methods providing the work is properly done.

3. Hydraulically driven rivets are usually headed inside the boiler shell from the outside by the pneumatic and hand processes. There is practically no difference, but in driving by hand or with the pneumatic gun, the driving must be done from the outside in order to get the best results in production and to secure tight and well formed rivets. It would be awkward and inconvenient for the riveters to drive from the inside.

4. The depth of a countersink is usually made 0.4 times the diameter of the rivet holes. Thus, if a rivet hole is $\frac{13}{16}$ inch, the decimal equivalent of which equals 0.8125, the depth of the countersink equals $0.8125 \times 0.4 = 0.325$ inch, say $\frac{5}{16}$ inch.

5. Lengths of rivets for different diameters and grips are given in structural handbooks as Cambria Steel Company's. Following are the general stock lengths required for forming cone head rivets. Total length of stock required is found by adding length of grip required to the lengths for forming rivet heads:

Rivet Diameter Inches	Length required for driven head Inches
½	$1\frac{1}{16}$
⅝	$1\frac{1}{8}$
¾	$1\frac{5}{16}$
⅞	$1\frac{3}{8}$
1	$1\frac{3}{8}$
$1\frac{1}{8}$	$1\frac{1}{2}$
$1\frac{3}{16}$	$1\frac{1}{2}$
$1\frac{1}{4}$	$1\frac{5}{8}$

From the total length of stock required for cone heads subtract the following amounts to find the lengths of rivets having countersunk heads.

For rivets a inches diameter subtract b inches from stock.

A Inches	B Inches
½	½
⅝	½
¾	⅝
⅞	¾
1	⅞
$1\frac{1}{8}$	⅞
$1\frac{3}{16}$	1
$1\frac{1}{4}$	1

6. THE BOILER MAKER's book on "Laying Out for Boiler Makers," *Third Edition,* contains the information on boiler repairs and welding.

Recracking of Welded Flue Sheet Bridges

Q.—What causes a flue sheet bridge to crack after it has been electrically welded and how to overcome it? N. F. M.

A.—Short firecracks as between staybolts and in flue sheet bridges are not difficult to weld, as in such cases it is not likely that great stresses will arise in the welded joint when it is cooling. In long cracks, however, heavy stresses arise in the metal, which if not avoided will cause the sheet to crack again.

One method of relieving the strains which arise first from the expansion of the metal surrounding the weld, and subsequently the contraction stresses when the metal cools, is to hammer the weld directly after it is made. This causes the weld to expand. Heavy blows should not be struck, and the hammering process should not be carried on after the metal has attained a "blue heat" as otherwise new cracks may develop.

Another method is to play compressed air or run water along the metal at about 5 inches from the weld on both sides during the welding operations. By confining the expansion of the metal in this manner into a narrow zone the contraction stresses are lessened.

Flanged Heads

Q.—As I am a steady reader of the BOILER MAKER I would like to ask a few questions about heads, etc.

How can I make a layout for a dished head 44 inches inside diameter, $\frac{5}{16}$ inch thick and 5-inch bump? Please give a rule if there is any and send me a sketch. Also state how to lay out a flat head with a 3-inch inside radius as shown in Sketch, Fig. 1. J. J. T.

A.—In flanging circular heads of heavy plate, the tendency, when there is a small clearance between the internal and external dies, is for the flange to increase in depth or length. With a small clearance there is very little room for the plate to gather at the knuckle or curvature of the flange, therefore, the metal is forced into the depth of the flange.

The required diameter of heads flanged in dies of this kind may be easily found by first finding the calculated diameter from the dimensions of the head and from the result subtract the plate thickness of the head.

For heads flanged between dies having a large clearance the metal gathers at the curved part, and allowances must be made for this. The best plan is to flange one head to the calculated dimensions of the disk and then note the effect on the depth of the flange. Allowances then necessary can be determined and made.

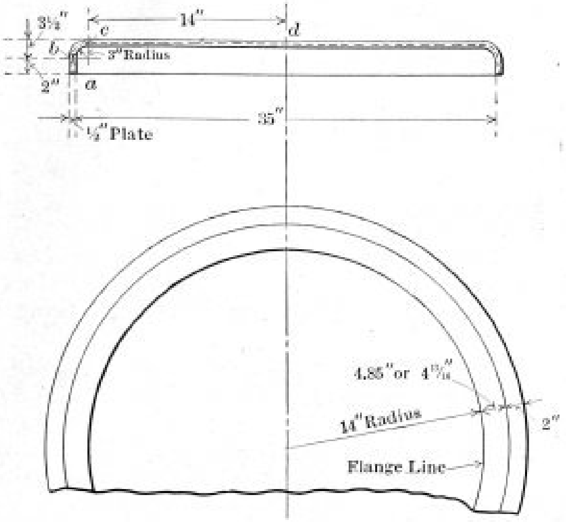


Fig. 1

In the example, Fig. 1, the head is turned, having a flange 5½ inches deep and turned to a 3-inch radius at the knuckle, which requires a greater depth of flange than heads turned to a shorter radius.

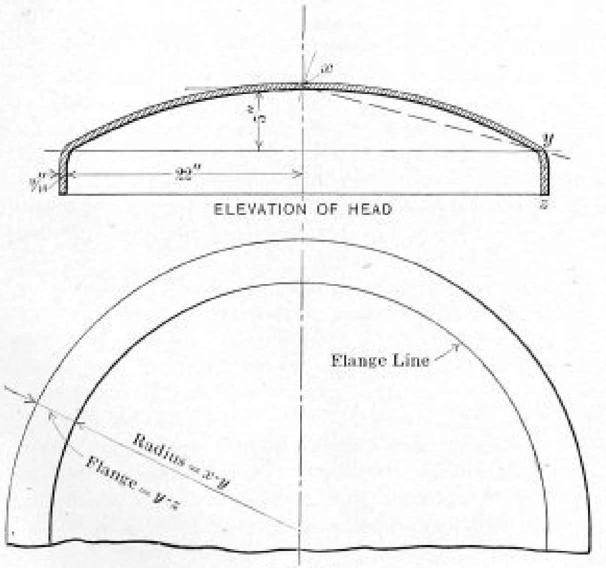


Fig. 2

Assuming that there is a small clearance between the dies, the problem is calculated as follows:

The calculations for the length of the arc *b-c* should be taken to the neutral layer of the plate, as in bending, flanging or rolling processes the length of the metal at this point does not change.

$$\text{The length of arc } b\text{-}c = \frac{6\frac{1}{2} \times 3.1416}{4} = 5.1 \text{ inches.}$$

The value of 6½ inches equals the diameter of a circle of which the arc *b-c* is one-fourth part.

Straight length of the head *c-d* equals

$$\frac{35 - (3.5 + 3.5)}{2} = 14 \text{ inches}$$

Radius of the flat disk for the head = 14 + 5.1 + 2 = 21.1 inches. From this radius subtract ½ of the plate thickness to take care of the increase in depth of flange. Then the required radius equals 21.1 — .25 = 20.85 or say $20\frac{13}{16}$ inches.

Dished Heads

Information has already been given in answers to questions bearing on dished head patterns. In examples of this kind the short method of determining the radius is as follows: Lay off a sectional view of the head as in Fig. 2 to the full size dimensions if convenient to do so. If not, draw the view to scale. The points *x* and *y* are then located in the center of the plate section, and line *x-y* is the radius of the flat plate required for the dished section *v-x-y*, which is dished to a depth of 5 inches from the plane of line *v-y*. The radius *x-y* is taken to the neutral layer of the plate which is the customary practice. The pattern can be readily laid off as shown in the figure using the dimensions of *x-y* and *y-z*.

Obituary

Richard Hammond, founder of the Lake Erie Boiler Works, Buffalo, N. Y., died at his home in Buffalo on October 9.

Mr. Hammond was born January 27, 1849 in Thurles, Tipperary County, Ireland, and received his early education there in the parochial schools, coming to this country when about thirteen years of age. He served his apprenticeship in the boiler making trade with Starbuck Brothers, Troy, N. Y., and became a journeyman boiler maker in charge of the outside work for this company, with which he was connected for several years.

In 1872, he transferred to the oil fields in Pennsylvania, and started business at Titusville, Pa. In 1875, he entered into partnership with John Cofield in Franklin, Pa., as manufacturers of oil-well boilers and engines, and a short while later purchased Mr. Cofield's interests, extending the business into tank building and refinery construction.

In 1880, he removed to Buffalo where he designed a plant for the manufacture of steam boilers. His methods and ideas were considerably in advance of the times and it was not long before his plant known as the Lake Erie Boiler Works had obtained an unusual reputation for the manufacture of heavy marine boilers. In 1890, he organized the Lake Erie Engineering Works, of which he became president. The shops were equipped with the most modern tools, especially designed and constructed by the Niles Tool Works. He continued at the head of both concerns to within about two years of his death, when he disposed of his interests and retired from active business life.

Mr. Hammond was an early member of the Engineer's Club of New York. He became a member of the American Society of Mechanical Engineers in 1890, and devoted a great deal of his time and practical boiler making experience to the Boiler Code Committee, of which he was a member. He was one of the charter members and a past president of the American Boiler Manufacturers' 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

The Board of Trade Rules

Reference has repeatedly been made in these pages to the restrictions and provisions of the British Board of Trade relative to boilers.

It is not too much to claim that these rules have had a profound influence on boiler legislation throughout the world, and every authority, insurance and otherwise, has reviewed them and found many valuable aids in producing codes of boiler rules. Virtually every first class specification dealing with steam generators is to some extent founded upon the formulae and principles propounded by the Board of Trade.

The rules thus occupy a peculiar position and there is possibly no other case where a single authority has had so great an influence upon an entire industry. In part, this is due to the fact that until the war Great Britain's mercantile marine formed the greater majority of the vessels under all flags, the total proportion in tonnage being more than half of the entire world's shipping. Moreover, it has always been a settled idiom of British legislation that monopoly has always been coupled with provisions for the public interest. At the same time, the safety of passengers in public conveyances has been always kept in view, hence railways and steamships are subject to stringent Board of Trade regulation. This to some extent explains that while boiler explosions are not unknown, the number of locomotive boilers, and those on passenger carrying vessels which give trouble are so rare as to be virtually non-existent.

The benefits of such a reputation are incalculable as proved by British experience. Further, every case of casualty due to boiler defects is closely examined by a competent and impartial tribunal. Every land boiler must be examined once every fourteen months under the factory acts. The inspector for convenience is usually the representative of an insurance corporation. Marine boilers in passenger carrying vessels are surveyed as is the entire ship once a year by a Board of Trade surveyor who is a State official appointed by competitive examination from applicants who have to be duly qualified and certified marine engineers.

Now the curious fact is noticed, that although numerous pocket-books of mechanical character give formulae and other provisions in a condensed form; very few engineers and practically no working boiler makers realize that the official publication can be purchased for the modest sum of 6d (12 cents). Its full title is "Instructions as to the Survey of Passenger Steamers." It is issued by the Board of Trade as an official publication and Messrs. T. Fisher Unwin are the agents in the U. S. A. for its sale. It contains 155 pages of printed matter of which over 50 pages concern directly or indirectly the craft of boiler making. Its price brings it within the reach of the youngest apprentice and seeing how constantly reference is made to its contents no boiler maker should be without a copy. In the case of dispute other than marine boiler work, its authority is unquestioned. Anything contained which applies to a given case may be quoted as conclusive evidence, and will in most cases be accepted as valid and final.

As I have recently quoted from its pages there is no need to recapitulate the extracts then given, but the following are worth notice:

Steel Boilers

"Local heating of plates should be avoided, as many plates have failed from having been so treated.

"All plates that have been flanged or locally heated, and all stays and stay tubes which have been locally heated, should be carefully annealed after being so treated."

The rules give certain explicit regulations as well as advice and recommendation; the duties of the surveyor are clearly laid down and warnings are given as to the particular importance of certain details on which evidence has accumulated from defects which have arisen. Open hearth steel only may be used for shell plates and all shell plates should be carefully annealed.

"Boiler makers should be requested to examine carefully all shell plates in the various stages of working, as they have the best opportunity of discovering defects, and occasionally cracks develop when working the plates in the boiler shop," is another passage.

After dealing with the necessity for very careful inspection of screwed stays to flat surfaces, the following remark will be found in Par. 97: "It is also desirable that the outer ends of all such stays should have a small hole drilled axially, of sufficient depth to extend into the body of the stay at least ½ inch beyond the plate into which the stay is screwed. If this is done the breaking of a stay in this manner (i. e., short up to inner plate surface) will result in leakage, and give warning to those in charge. Some makers reduce the diameter of the body of such stays somewhat below that of the ends where screwed into the plates; this practice is a commendable one, and should be encouraged by surveyors."

It must be remembered that the Board of Trade operates under Parliamentary authority in these matters of survey, (the Merchant Shipping Act of 1894) as a consequence in more than one direction they are hampered by the letter and more particularly by the spirit of the legislation which controls their activity. In effect they exercise considerable control over a very large series of related industries, so they do not hamper manufacture unduly by insistence upon general methods which would involve great capital expense in certain directions.

The fact remains that the Board of Trade encourages good workmanship and penalizes inferior results and their control has always operated to the advantage of the business. A marine consulting engineer can enforce methods by contract clauses which a statutory authority must leave alone. It is, however, interesting to compare successive editions of the rules, the tendency is to become more stringent as time passes. A comparison between the 1901 and 1913 editions, which has been made in the last few days by myself, shows numerous alterations all tending towards more stringent regulation and by inference shows how new innovation has been met by new ruling.

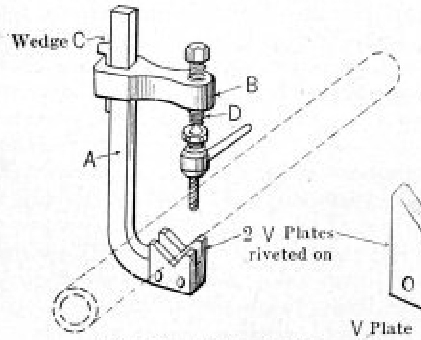
Perusal of the rules shows the considerable personal responsibility placed upon the individual surveyor, and to its credit the Board of Trade have a reputation for upholding their officers who are a picked and very highly qualified body of men respected wherever ships are common objects.

London, England. A. L. Haas.

Pipe Drill Post

I have recently made several sizes of the type of pipe drill post or old man shown in the sketch. I designed this simple affair to meet the need of a light yet durable tool.

The upright *A* is of ½ by 1-inch bar with two *V*-plates, such as shown in the detail sketch, riveted to the lower curved end. The jaws are serrated to prevent slipping.



"Old Man" For Drilling Pipe

The crosshead *B* is forged and the slot for the upright drilled and filed, one end being slightly tapered to take the wedge key *C*. The screw *D* is cup-pointed and case-hardened.

The rig is very easy and cheap to make. W.

Testing Watertube Boilers

The writer has recently had under his charge the testing of some eighty or ninety new watertube boilers, and the preparation of them for steaming conditions. As the method adopted has been very successful, and may also be applied to other classes of watertube boilers, these notes may be of interest.

First, a general idea of the boilers under consideration will be given, and then the three following items discussed:

1. Character of test required.
2. Preparing for and carrying out test.
3. Preparing for steam.

The boilers referred to above were of the Yarrow type: Steam drum, 50 inches diameter by 12 feet long; water drums, 30 inches by 12 feet long; number of tubes, about 3,500 of 1-inch diameter, except the three inner rows on each side, which are 1¼ inches in diameter; average length, about 8 feet.

The steam drum carries four safety valves bolted to pads and riveted on the shells. The front head carries the main stop valve, surface blow, two water gages, three try cocks and the auxiliary feed valve. The internal auxiliary feed pipe, scum pipe and steam-dryer pipe are fitted in the drum. The manhole is 16 inches by 12 inches.

The water drums (front heads) carry the main feed valves, and one drum is fitted with a salinometer cock. Each drum has an internal feed pipe arranged in a casing so as to cause a forced circulation. Blow-down valves are fitted to the shell of each drum. The manholes are 16 inches by 12 inches. Each boiler was capable of giving 7,000 horsepower, burning oil in a closed fire-room.

Character of Test Required

The character of the test required is as follows: Drums and tubes are to be tested to 400 pounds cold water pressure for one hour. The boiler, complete with all mountings, to be tested on board to 330 pounds cold water pressure for a period of six hours, a loss of eight pounds being the limit allowed in this time.

It will be readily admitted that such a test is severe and calls for careful preparation.

Preparing For and Carrying Out Test

As they come from the shop the boilers are usually in a very dirty condition; oil and grease from the tube expanders, chips of metal, scale, rivet heads, etc., are sure to be found in plenty. The oil need not trouble us at this stage, but all particles of metal, or anything liable to damage the valves, must be thoroughly blown out with an air hose; also each individual tube should be blown in order to ensure that it is clear. The boiler valves, though new, should all be taken apart, cleaned, and given a rub with finest emery to ensure a perfect seat. It is impossible to lay too much stress on the fact that this work must be faultless; a drop, however slight, is enough to spoil a perfect test.

After all the valves have been attended to, the safety valves may be gagged, the manhole doors carefully put on, air cock opened and the boiler filled slowly. For obtaining the best results all the air should be driven out, and this is sometimes a difficult matter. The air cock is usually fitted to the top of the drum, but a certain amount of air is trapped in the safety valves and in the main stop if this rises much above the level of the top of the drum. However, the amount trapped is small, and it is preferable to allow it to remain rather than to open the valve, as there is sure to be some little particle of grit in the water that may lodge on the seat and necessitate regrinding.

Having the boiler full, we may proceed to pump up by the hand pump to about 100 pounds. At this pressure it is well to make a thorough examination of the boiler, looking to all seams, rivets, mountings and tubes. Any leaky tubes can be easily detected by a long lighted taper passed between the rows. Assuming all is well, the pressure may be increased to 200 pounds, and later to 250 pounds, a good examination being made at each pressure. The manhole doors will probably require a little tightening up by this time.

If any fittings should be found porous they must be dealt with as experience dictates. A very small leak may be stopped by peening with a hammer or by a calking tool, care being taken to relieve the pressure first. If a casting is spongy it should be removed and a new one fitted in place. Valves not exposed to steam, as, for instance, the main feeds, may be tinned, if necessary.

Let us now assume that all is satisfactory and that the pressure on the boiler has been raised to 330 pounds without any leaks. We can relieve the pressure and prepare the boiler room for the final test.

All gages to be used should be calibrated and large gages should be used, so that a drop of even half a pound may be noted. Boiler room hatches should be closed or covered with canvas, and all openings in bulkheads plugged up, in order that the boiler may not be subjected to any draft. Stacks must also be covered, and all openings to the furnaces closed.

When this is done, and the necessary thermometers, etc., are in place, the inspector may be called, the boilers pumped up to the full pressure, and the hand pump locked or disconnected.

Readings should be taken every half hour. If it is desired to gage any part of the boiler while under test, suitable arrangements must be made beforehand.

The writer took some measurements of the boilers both before the pressure was applied, and while it was on, with the following results: After a 400-pound test on the shell and tubes (all openings for fittings being blanketed) the part faced for the main stop showed a permanent distortion of thirty-seven thousandths, and the faces for water gage fittings as much as twenty-five thousandths. All these faces had to be scraped up again before fitting the mountings. Before applying the 330-pound test with mountings in place, measurements were taken between the port and starboard water gage fittings (top) and found to be 24 inches. While the pressure was on, this showed 24¼ inches. The fittings were bolted to extensions on the head about 8 inches long. A tram was also made from the boiler shell to the top of the main stop spindle, and under this pressure showed a difference of ⅛ inch. The head was ¾-inch thick.

Preparing For Steam

After the test has been passed, we may proceed to clean the boiler, as follows: Having emptied them and removed the bottom manhole doors, we put into each bottom drum 25 pounds of soda, 6 pounds of lye and 5 gallons of coal oil. Replace the manholes and put in enough water to fill the bottom drums. Then connect a temporary steam pipe to the bottom blows and admit steam carefully at about 40 pounds pressure. The steam will condense, and, in time, bring the water to the boiling point.

When the pressure on the boiler is approaching that of the incoming steam, the surface blow may be slightly opened to maintain a pressure of 25 or 30 pounds. The condensation of steam will soon fill the boiler to the level of the scum pan, and all oil and grease will be removed in this manner.

Boiling is continued about 70 hours. At the end of this time, the boilers may be emptied and allowed to cool and then the manual part of the cleaning will commence. The tools required are few and simple: Wire hand brushes, tube brushes, wire cables fitted with sockets into which the tube brushes are screwed, scrapers, and a bale of rags, are all that we require.

First the internal pipes are removed and the top drum brushed down thoroughly with the wire brushes, care being taken to clean well around the tube ends. Sometimes there is a little mill scale found on the heads, especially around the flange, and this can be removed with scrapers. It is not well to try to chip it, as the head must be left as smooth as possible.

When this is finished, the tubes may be started. The wire brushes should be wrapped with rags, as this leaves the tubes in a fine polished condition, whereas a wire brush alone makes them look streaky. The brushes will only clean the parallel part of the tubes, and the bell-mouth must be "poked" by means of a stick wrapped with rags.

After this is done, the drum and tubes may be blown out with the air hose, and then the bottom ends of the tubes "poked" in a similar manner and the bottom drums wire-brushed, and, if necessary, washed with coal oil.

As soon as the bottom drums are finished and attention has been given to all the small outlets for water gage fittings, etc., which are easily choked up, the boiler may be inspected by the chief engineer of the ship, who should, in the case of straight-tube boilers, "sight" every tube from the top drum, while his assistant holds a light at the bottom. If the inspection is satisfactory, the internal pipes may be cleaned and replaced, and the boiler filled to the working level with distilled water.

Should the boilers not be required for any considerable time, it is better to fill them right up to the air cock with slightly alkaline water, or they may be left dry and a tray of burning charcoal introduced into each bottom drum and the boiler closed entirely.

San Francisco, Cal. A. BLUNDUN.

Fundamentals of Safety Engineering*

BY SIDNEY J. WILLIAMS†

The subject of safeguarding the industrial worker may be divided into two parts—what machinery shall be guarded; and how shall the safety devices be applied?

If you want your plant to be 100 percent safe, the answer to the first question is—guard every moving part, wherever located, on which a workman might be injured if he came in contact with it in any way whatsoever. If the moving part is in a place here nobody ever goes, remember that someone is likely to go there sooner or later, in connection with the repair, maintenance or alteration of the machinery itself or of the building, never before necessary.

You probably have heard the classic story—a perfectly true one—of the man whose heel was cut off by an unguarded gear 14 inches below the ceiling. The man was standing on a scaffold, working on a shaft nearby; to brace himself he placed his foot against the shaft on which the unguarded gear was located, his foot slipped, and was caught in the gear. Many similar examples could be quoted of accidents occurring in out-of-the-way places. Recognizing this fact, the Illinois Steel Company rulebook—to mention only one example—requires that all gears, wherever located, must be enclosed.

Overhead Shafts and Belts

You may be puzzled by attempting to apply this principle to the guarding of overhead shafting and belts. Many plants contain miles of overhead shafting which it is almost a physical impossibility to guard. On the other hand, oilers and repairmen are frequently injured, sometimes fatally, on unguarded overhead shafting or belts. The only solution is, if the shafting positively cannot be guarded, to prohibit any work on such overhead transmission while it is in motion. Repair work, shortening of belts, etc., can be done during the noon hour or at night; install automatic oilers or oilers which can be filled from the floor by using a special oil can with long spout.

Hidden Machinery

A gear, belt or other dangerous moving part which happens to be located below a table, or in some other concealed place, is not made safe because it is hidden. Someone must occasionally reach under the table to sweep or repair the floor or oil or repair the machine. He may slip or stumble so that his arm comes in contact with a gear or belt which would be safe for the workman standing in his normal position. The immigrant totally ignorant of machinery—and it is hard for us to realize the completeness of the ignorance on this subject, on the part of foreigners brought up in farming districts—may deliberately put his hand or his finger into an opening that looks interesting, just to see what it is. If he finds that "it" is an unguarded gear, it is needless to say that the accident is his own fault, but that does not relieve our obligation to pay his compensation nor does it restore him to his vacant place in the gang.

* Paper presented at the eighth annual Safety Congress, Cleveland, October 2, 1919.

† Secretary and chief engineer, National Safety Council, Chicago.

What I have said of gears and belts applies equally well to any moving part on which a man might be injured—counterweights, cranks, reciprocating parts such as a planer bed, and so on; also, of course, to all the operating parts of machines.

Safeguards

A safeguard should be so designed and constructed that it will prevent all accidents on the part guarded, not only accidents to the operator while at his regular work, but also to the operator or passer-by in case he should slip or fall or carelessly touch the machine.

The guard should not interfere with production. If it does, it is liable to be taken off. In designing a guard, it is generally wise to consult the man who will use it.

In general, the guard should be attached to the machine and not to the floor; if attached to the floor, use a connection which will interfere as little as possible with the movements of the operator.

The guarded part must be easily accessible for oiling, inspection, and repair. The door or removable section provided for this purpose should be hinged or otherwise attached to the remainder of the guard, or to the machine. If not, it is likely to be left off permanently.

The guard should not interfere with cleaning and sweeping around the machine. It should, therefore, be kept generally about six inches above the floor.

Guards should be strong enough to resist injury and keep in shape. A light, flimsy guard soon becomes bent and is discarded. A substantial guard is cheaper in the end.

Incombustible material is preferred. Wooden guards, soaked with oil, may become a serious fire hazard. Metal guards are neater and wear much better. "Metal guards look as if you wanted to; wooden guards look as if you had to." Guards may be made of cast iron, sheet metal, wire mesh, expanded or perforated metal, or slats. Where subjected to acid or fumes, wooden guards may be necessary.

It is desirable to interlock the guard with the operating mechanism, where possible, so that the machine cannot be operated unless the guard is in place.

A safeguard can often be so designed that it will also serve to prevent wear on the parts guarded—for example, a solid gear enclosure.

Application to Gear

Let us consider the application of these suggestions to the design of gear guards. Cast iron guards are preferred because they may be made to fit more snugly, present a better appearance, and protect the gears from dust and injury. In shops having similar gears on several machines, the cost of patterns and cast iron guards will be no greater than the cost of built-up guards. A cast guard of one machine may be used as a pattern for making guards for similar machines.

Guards for a variety of machines, and in many sizes, may be more cheaply made of sheet metal. In large guards, an angle iron is used to make the joint between the flat sides and the curved part of the guard. In smaller guards this joint may be made by cutting projections (like saw teeth) on each side piece and bending these over to form a smooth curve. The joint may then be made either by spot welding or by riveting. Short pieces of angle iron may also be used to form the joint—about 3/4 inch by 3/4 inch by 1/8 inch angles, 1 inch long, and 3 or 4 inches apart.

Gears should be completely encased; or where this is impracticable, should have a band guard with side flanges extending inward beyond the root of the teeth. If there is a spoke hazard, the gear should be completely enclosed, or filled in between the spokes.

Openwork Guards

Belts, flywheels, shafting, and large gears are often guarded by openwork rather than solid enclosures. Such guards should be so designed that no one can get his hand or his finger into the danger point even if he tries. If the guard comes within four inches of any danger point, the opening should not be greater than one-half inch square, which is small enough to exclude fingers. If more than four inches away—which is about the maximum length of a man's finger—the openings may be larger than one-half inch, but not larger than two inches square. This opening is small enough to keep out a man's hand. If a slatted construction is used, the slats should not be more than one inch apart.

The safety engineer's greatest difficulty is in guarding machines on which men are working. Let me repeat that it is very important not to attempt to guard machines in a way which will interfere with production. The great majority of both foremen and workmen will seriously object to such devices, will use them under protest, and when the opportunity offers will take them off for good.

Guarding a Punch Press

The punch press, using that common term to include all kinds of power presses, has the doubtful honor of causing more injuries, and especially more permanent injuries, than any other kind of machine. Where possible, the best guard is an enclosure around the plunger, which makes it impossible to get one's finger underneath. Often, however, this is impossible. In such a case, let me suggest that instead of buying a dozen or a hundred of some so-called safety devices, and putting them on every punch press in the shop, you start with one individual press and study the operation carefully in co-operation with the superintendent, foreman, master mechanic, and operator of the machine.

Ask yourself the question, why do accidents happen or why may they happen on this particular press? The answer will be that, for one reason or another, the operator finds it necessary or convenient to put his hand under the plunger, either regularly or occasionally. The way to make the operation safe, then, is to arrange it so that the operator need not and will not put his hand under the plunger. Some times this may be done by cutting away a portion of the dies so that the operator can keep hold of a part of the piece being formed and still not be injured. Often it may be accomplished by introducing an automatic or a foot-operated kick out. This almost always increases production as well as safety. Sometimes it is found practicable and advantageous to interchange the upper and lower dies. Sometimes the method of operation may be altered.

Aims of Safety Engineering

What I have said of the punch press is typical of many machines. Safety engineering does not consist in simply building wire mesh guards, nor in buying safety devices which look pretty in a catalogue, and putting them on the machine without regard to the wishes, the convenience, or the efficiency of the operator. The real safety engineer will, where necessary, study the operation of a machine until he understands it as well or better than the operator himself—as well as the foreman, the superintendent, the master mechanic; and then he will apply their brains and his own in working out either a guard, or a change in the machine, or a change in the operation, which will remove the underlying hazard and make the operation intrinsically safe.

Selected Boiler Patents

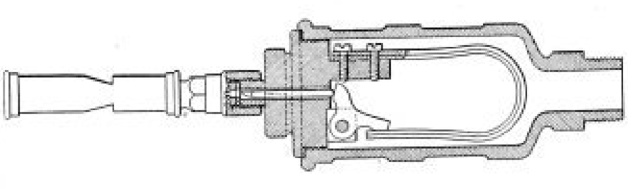
Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,312,175. LOW WATER ALARM APPARATUS FOR STEAM BOILERS. EIGIL AAGE HANSEN, OF FREDERIKSBERG, NEAR COPENHAGEN, DENMARK.

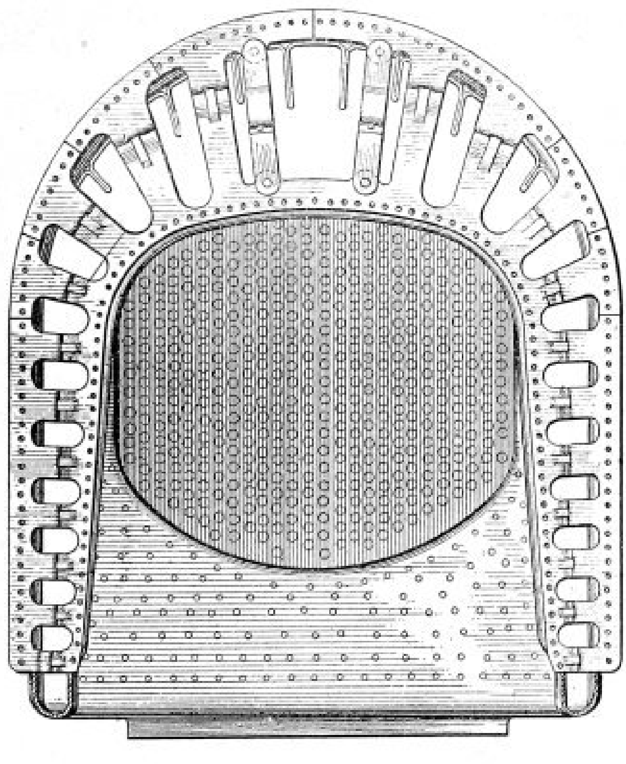
Claim 1.—An alarm device for indicating low water level in a boiler, comprising a casing adapted to communicate with the water space of a boiler, said casing having a passage therethrough, an alarm device



secured to said casing over the passage therein, a frangible diaphragm adapted to normally close communication between the casing and the alarm device, thermostatic means within the casing and means under control of said thermostatic means and adapted to be protected against and to disrupt said frangible diaphragm upon the presence of unduly high temperatures within the casing. Two claims.

1,299,344. BOILER STAY SHEET. ALLAN R. HODGES, OF MEMPHIS, TENNESSEE, ASSIGNOR OF ONE-HALF TO CYRUS A. McALLISTER, OF MEMPHIS, TENNESSEE.

Claim 1.—A stay sheet for locomotive boilers comprising an inner arch member for attachment to the firebox shell, an outer arch member



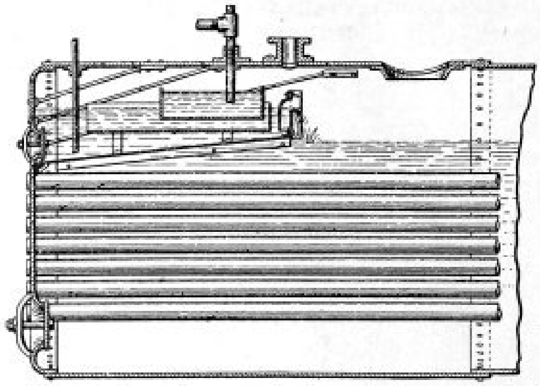
for attachment to the outer shell and a series of radially disposed flexible joints connecting said members at regular intervals and effective to permit outward movement of the inner member and inward movement of the outer member and to stay said members relatively to one another, the outer member against outward movement and the inner member against inward movement, each of said points comprising a pair of engaging companion members and having its said members formed as parts of the respective arch members. Four claims.

1,285,469. FURNACE ARCH. EDWIN F. TILLEY, JR., OF PLAINFIELD, N. J.

Claim 1.—A perforated furnace arch composed of fire brick having passages forming openings through the arch, the bricks at one side of the median line of the arch having interfitting ribs and grooves facing in one direction and the bricks at the opposite side of the median line having interfitting ribs and grooves facing in the opposite direction, and keying means at the center of the arch between said two series of interlocked bricks. Four claims.

1,294,826. STEAM BOILER. THOMAS T. PARKER, OF BROOKLYN, N. Y.

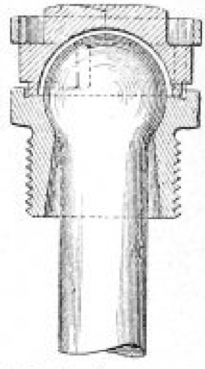
Claim 1.—In a horizontal steam-boiler, an open-top main receptacle within the same having at one end a feed-water outlet located above the normal boiler-water level, an auxiliary open-top elongated receptacle



supported within the main receptacle above the bottom of the latter, said auxiliary receptacle being closed at that end adjacent to the said outlet and open at the opposite end, a primary receptacle supported within said auxiliary receptacle and spaced from the walls of the latter, the sides of said primary receptacle extending above the said outlet, and means for supplying feed-water to said auxiliary receptacle. Five claims.

1,295,861. STAY BOLT STRUCTURE. ETHAN I. DODDS, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

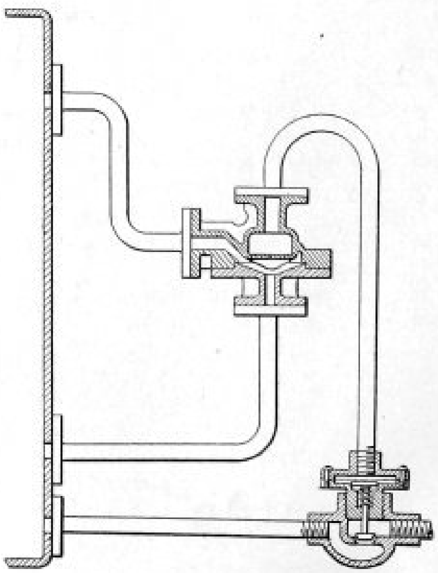
Claim 1.—In a staybolt structure, the combination with a bearing sleeve having cam slots, of a removable cap or closure adapted to be



seated in said sleeve and having lugs to enter said cam slots. Three claims.

1,312,583. FEED WATER REGULATOR FOR STEAM BOILERS. HENRY WILMOT SPENCER, OF LONDON, ENGLAND.

Claim 1.—A feed water regulator comprising a fitting, steam and water connections between said fitting and a steam boiler, and a chamber for



vaporizable liquids within said fitting, said chamber having its heat conducting surface provided with downwardly directed projecting parts arranged parallel to the plane containing the steam connection with the boiler. Two claims.

THE BOILER MAKER

DECEMBER, 1919

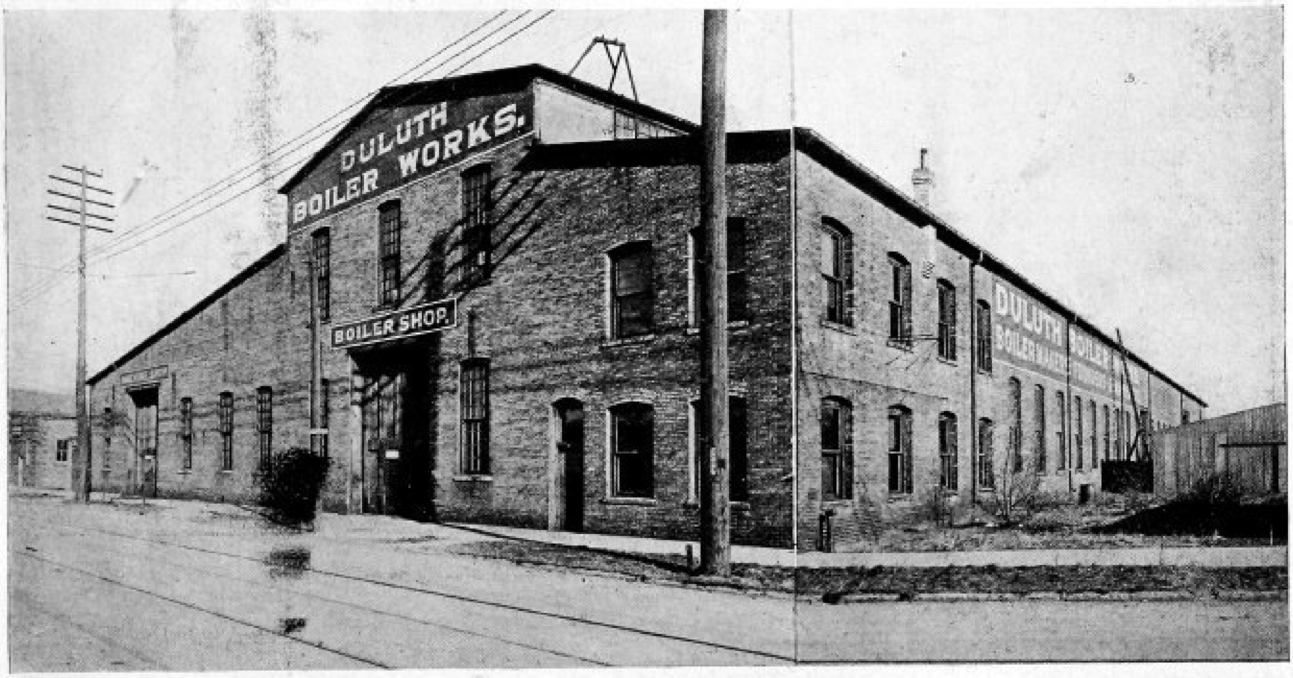


Fig. 1.—Exterior View of Duluth Boiler Works

Plant of the Duluth Boiler Works

Arrangements made by one of the Pioneer Shops of the Northwest to Build Boilers for Emergency Fleet Corporation

BY C. B. LINDSTROM

Most of the auxiliary boiler shops employed during the war by the Emergency Fleet Corporation of the United States Shipping Board met with many new problems in construction that they were not fully familiar with or equipped to handle. The exigency of the times required these shops to handle work entirely foreign to their usual pre-war contracts and activities. The notable result attained by these boiler contractors was their ability to adapt their shops to handle so satisfactorily the important problems that were presented to them.

One of the pioneer boiler shops of the northwest located on Lake Superior, the Duluth Boiler Works of Duluth, Minnesota, built during the year 1918 and part of 1919 sixty Scotch Marine boilers for the Emergency Fleet Corporation. These boilers were 14 feet 6 inches in diameter, 12 feet in length, of the three corrugated furnace, single ended type, having a plate thickness of 1 7/16 inches, and constructed to carry 190 pounds working pressure; the weight of boilers complete being 55 tons.

Plant and Equipment

A general view of the exterior of the main plant is shown in Fig. 1 with the tube shed and oil house adjoining it. The tube shed is arranged with a spur track to the main plant which facilitates the handling of the tubes. The interior of the main bay, Fig. 2, is 136½ feet in width and 290 feet in length, being served with a 25 ton electric crane, which travels the entire length of the shop. The loading track is directly back of the main bay, and is also served by this crane.

The buildings are of modern steel and brick construction, ventilated and heated with warm fresh air, which is carried by ducts and blown into the shops. With the overhead skylights and side lights in the upper part of the roof, good light is secured.

All machines are located to give a proper progress to the fabricated products. Each machine is served with an individual jib crane, and air hoist, and they are all driven direct by electric motors. On one side of the bay is a 10-ton crane which traverses the entire length of the shop.

The shop maintains a tool room for the making of new tools and the repair of air tools, motors, pneumatic hammers, etc., also a machine and blacksmith or forge shop.

A general view of the machine shop with complete equipment necessary for the production of boilers and plate

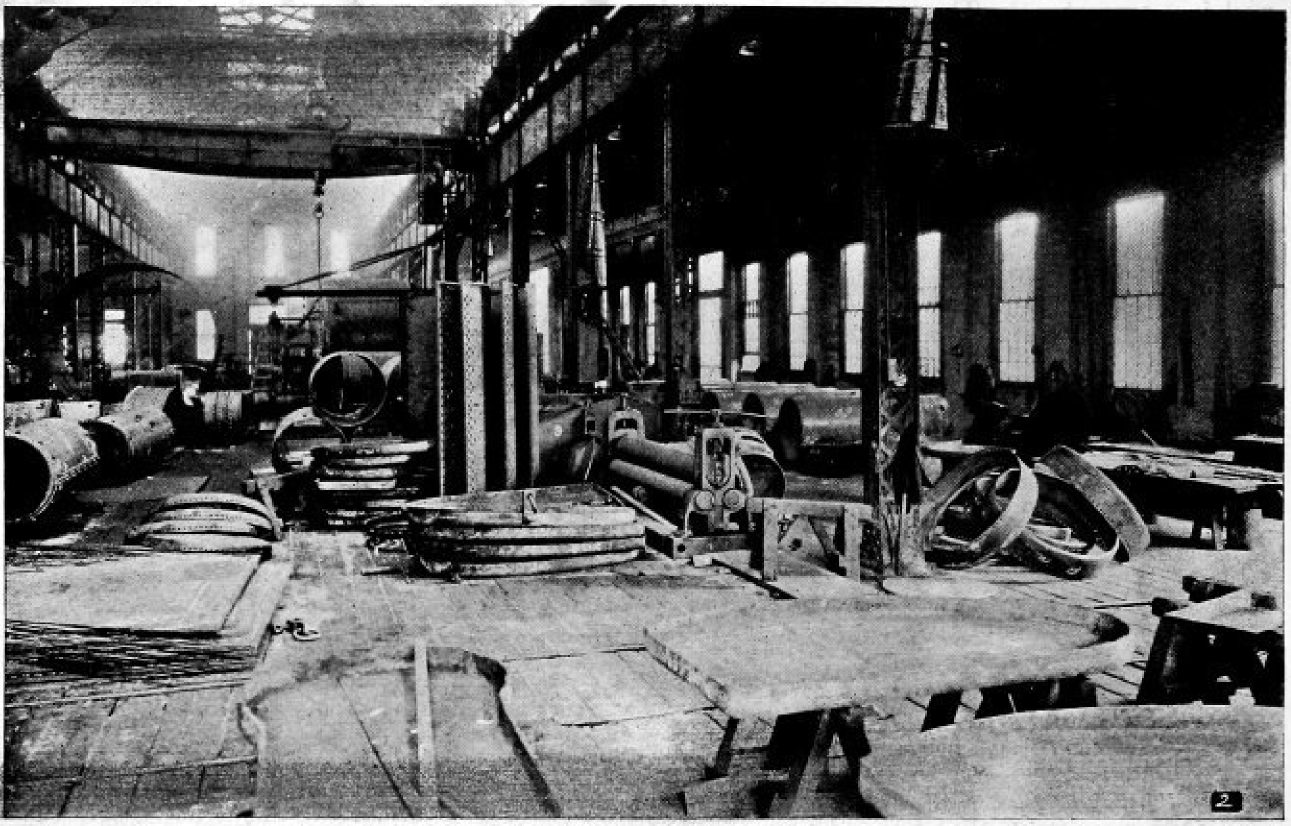


Fig. 2.—Interior View of Main Bay Which is Served by a 25-ton Crane

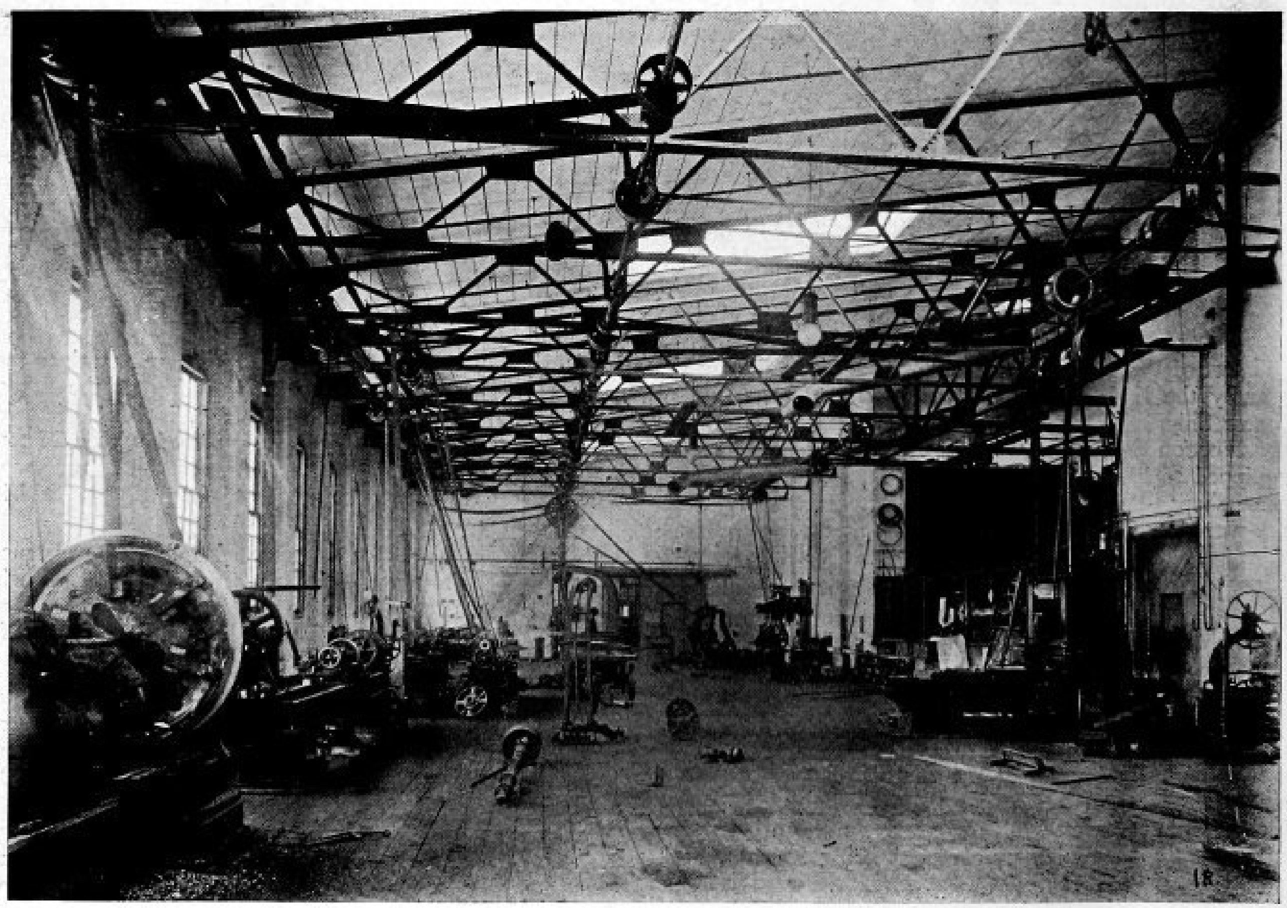


Fig. 3.—General View of Machine Shop in Operation

work is shown in Fig. 3. This part of the plant includes planers, radial drills, shapers and a turret lathe in addition to smaller tools for general shop work.

Equipment of Boiler Shop

The shop is equipped with three sets of punches and shears, one plate planer, two sets of rolls, three drill presses, four Dalley drills, one four spindle Foote-Burt drilling machine, oxyacetylene equipment, one Chambersburg hydraulic riveter, one Hanna air stake riveter with oil forges complete, set on riveting platforms for heating and supplying the rivets. The riveting equipment is centrally located near the erecting floor which is a great aid in handling the work.

In Fig. 4 is illustrated the four spindle Foote-Burt machine used for drilling the shell plates. The plates are placed by crane on a movable truck, which travels on a standard gage track. This machine is operated by one man.

Fig. 5 shows two Dalley drills so arranged as to drill the shell and butt straps, also the shell and the heads in position. The drills are movable horizontally on the large shaft shown in the picture and both drills can be raised or lowered vertically on the structural frame work.

Loading Boilers for Shipment

In Fig. 6 is represented the general assembly of the Scotch marine boilers; the two in the foreground being ready for the hydraulic test. One of the chief difficulties encountered in this work is the loading of the boilers on cars for shipment to the shipyards. This has been overcome by the use of a built-up turntable, consisting of a saddle which rests on a heavy plate on the car. The boilers are rolled onto the car with the use of the crane and a special inclined rigging of heavy timbers. After loading, the turntable is turned to the position shown in Fig. 7. A special heavy flat car of the type illustrated is employed for transportation. Alongside of the loaded car will be noticed a portable locomotive yard crane. This crane is a valuable adjunct in the loading and unloading of materials, requiring only two men to handle most of the yard work. The yard is large, being principally used

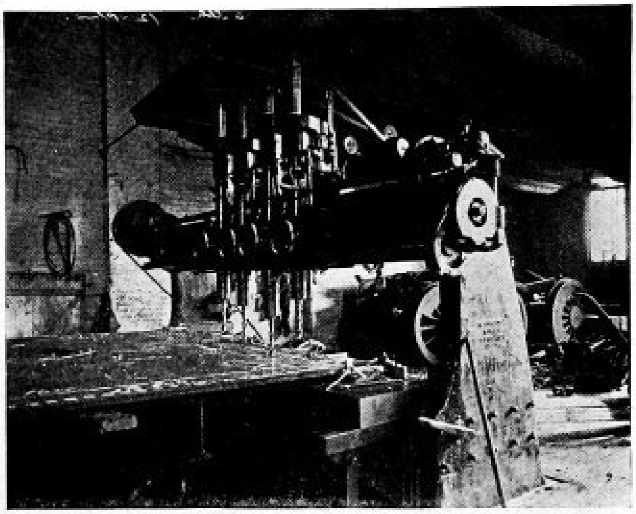


Fig. 4.—Foote-Burt Four Spindle Drilling Machine in Operation

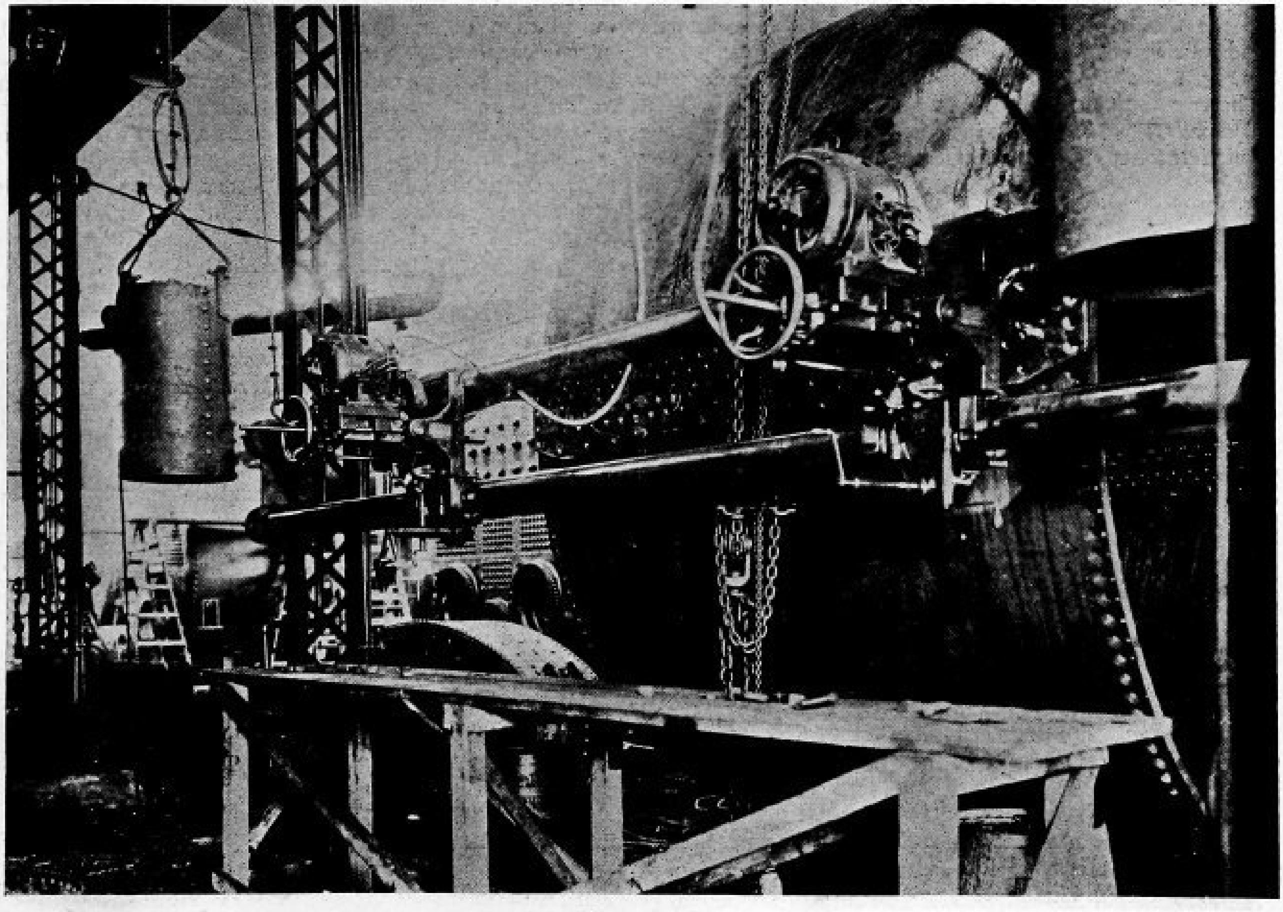


Fig. 5.—Dalley Drills Arranged to Drill Shell, Butt Straps and Heads in Position

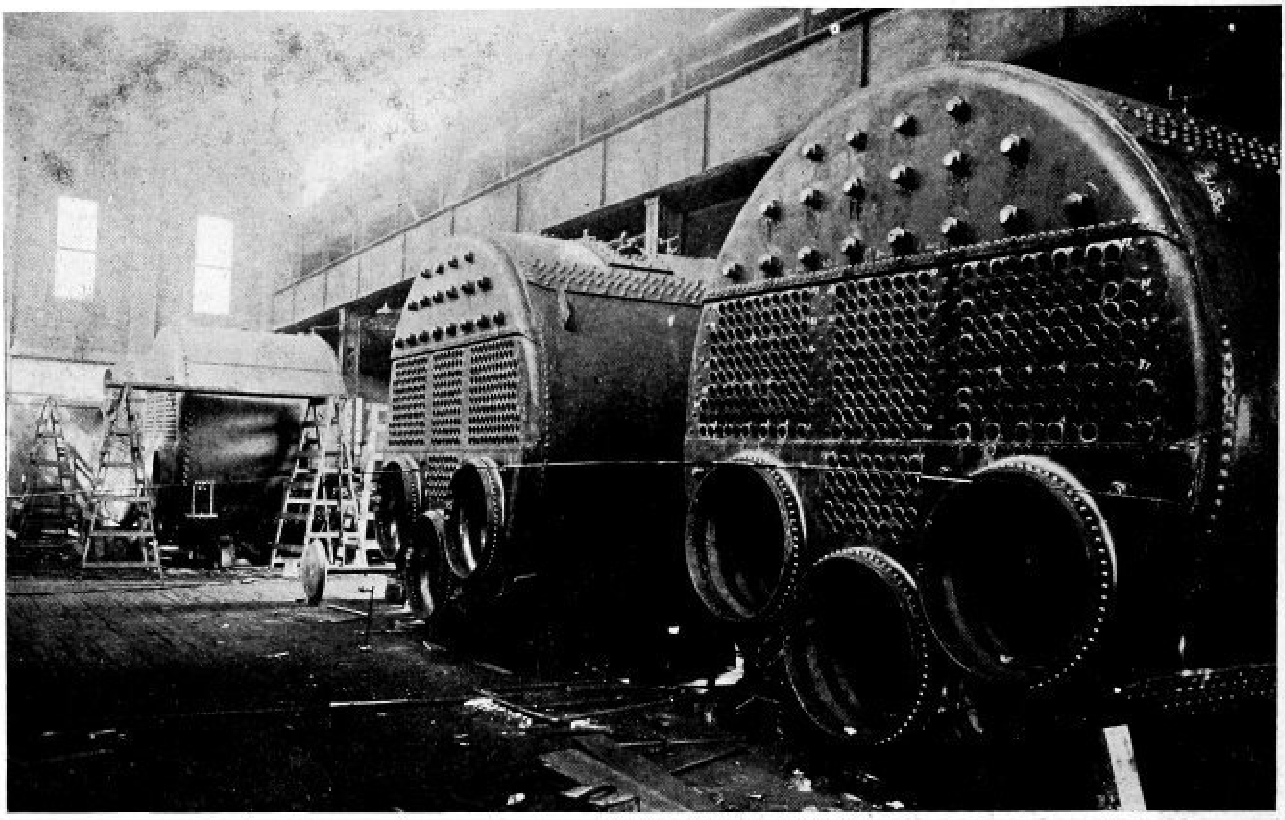


Fig. 6.—General Assembly of Scotch Boilers. Two in Foreground Ready for Hydraulic Test

for storage purposes. It is well tracked, and with the use of the traveling locomotive crane the switching of cars and moving of fabricated products is readily done.

Fig. 8 shows the compressor and hydraulic equipment. The two compressors are of the Chicago Pneumatic Tool Company type, having capacities of 1,146 and 622 cubic feet respectively. The air compressors are electrically

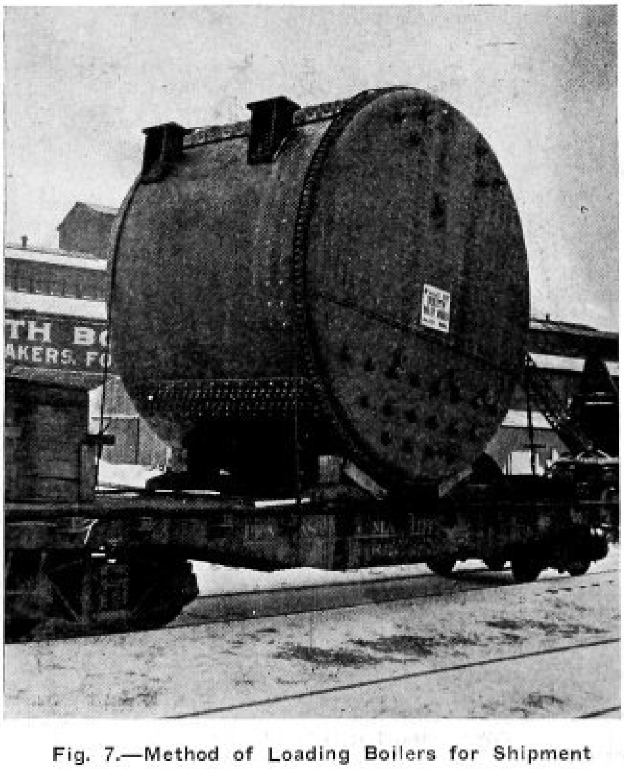


Fig. 7.—Method of Loading Boilers for Shipment

driven by direct motors. The picture also shows a double installation of hydraulic pumps for running hydraulic machinery, one being motor driven and the other belt.

This shop is so equipped that it can handle plate and boiler work of various descriptions. Recently a unique piece of work was completed, that of a penstock 1,800 feet in length, ranging in plate thickness from 3/8-inch to 1 inch. Some sections weighed 28 tons, and constructed to meet the requirements of the Pittsburgh Testing Laboratories.

Protect Your Tools From Rust

Nearly every man owns at least a few tools such as chisels, hammers, augers, saws, wrenches, files, etc.

These tools as a rule are infrequently used. They are often kept in places where they are exposed to moisture and consequently rust. Almost all tools with the possible exception of hammers are rendered less efficient by rust.

When it is so easily prevented, it seems strange that steps are not taken to do it. It is well worth while to save the tools as every one knows that has had occasion to buy new ones lately.

Probably the best tool protector and carrying case for a small kit may be made in the shape of a roll from a piece of pyroxylin coated fabric having a napped or fleecy back. This material is thoroughly waterproof and if care is taken in wrapping the tools in it after use, it will prevent moisture from reaching them and no damage from rust can occur.

The material is durable and will last a long time. It is obtainable at many department and general stores where it is sold under the general name of leather substitute. There are many leather substitutes on the market sold under various manufacturers' trade names. Practically any of them will answer very nicely for the use specified.

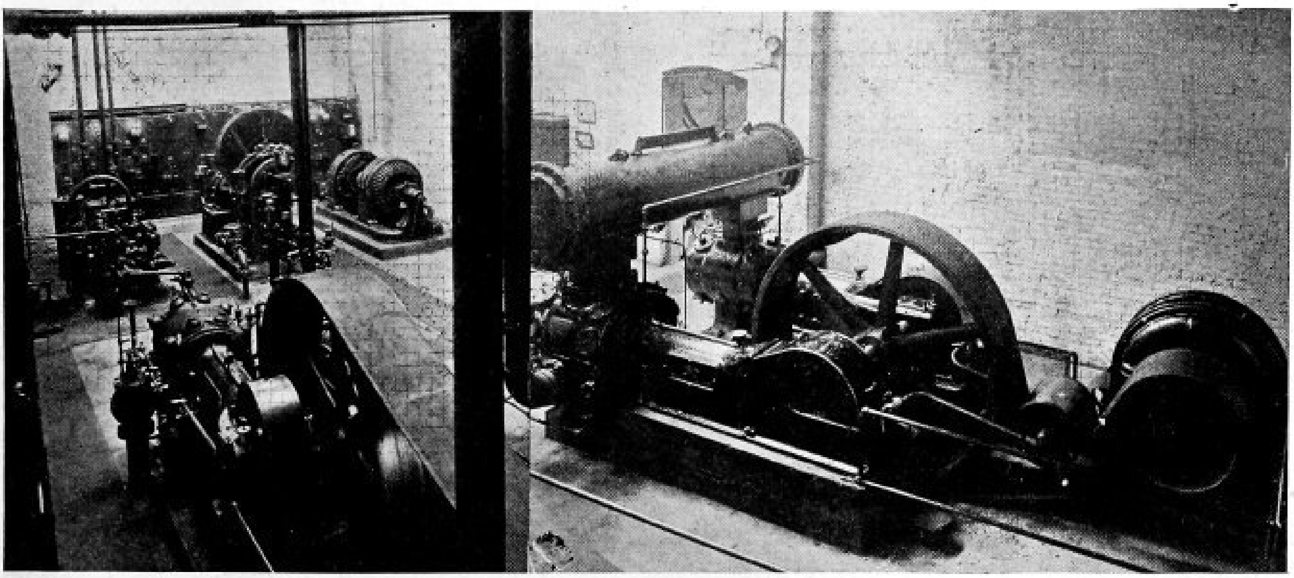


Fig. 8.—View in Compressor Plant Showing Hydraulic and Air Pump Equipment

Application of Standardization and Graphical Methods to the Design of Cylindrical Return Tubular Boilers*

BY HENRY C. E. MEYER

The advantages of stardardization of design in quantity production are so obvious that during the recent emergency the principle of stardard designs was applied with more or less success to all the many implements of war manufactured here or in the allied countries.

We have long been familiar with standard types of locomotives and automobiles, but the war was the direct cause of the development of standard ships, marine engines, liberty motors and many of the mechanical accessories of modern warfare.

In Great Britain a committee was appointed by the Institution of Naval Architects, North East Coast Institution of Engineers and Shipbuilders, Institution of Shipbuilders and Engineers in Scotland, Liverpool Engineering Society and Institution of Marine Engineers to investigate the extent to which the principle of standardization could be applied to the propelling machinery of vessels.

The most important feature of the work carried out by this committee was the development of a standard set of requirements, in so far as the structural strength of the boilers was concerned, which were recommended for adoption by the various authorities which have to do with the inspection and classification of marine boilers.

This parellels the work done in this country by the American Society of Mechanical Engineers for stationary boilers when they formulated their "Boiler Code," and is a decided step in the right direction since the existence of different rules for the same purpose evidently tends to annoyance and confusion and in many cases imposes a handicap on the builders.

Quoting from the report referred to: "The committee thinks, however, that at present it would serve no useful end to attempt a standardization of boiler design." From this it would appear that the British committee evidently was of the opinion that the advantages to be gained, by standardizing the designs of boilers, would not justify the trouble entailed.

When it is considered that at the present time the so-called Scotch boiler still holds first place for the generation of steam on purely merchant vessels, and that in Great Britain a great number of firms have been constructing such boilers for many years, and consequently each firm has a large range of designs at its disposal, it seems but natural that considerable difficulty would be experienced in harmonizing different opinions in order to obtain uniformity of design, but in this country we have to face a somewhat different condition, and it would appear that standard designs could be readily determined upon which would both decrease the cost of production and result in more uniform performance.

While in the application of sound principles to their work the experience of many of our builders is not exceeded elsewhere, and while in the investigations concerning the propulsion of vessels possibly more valuable data have been contributed by American naval architects and engineers than by any others, the fact remains that the growth of our shipbuilding industry has been very sudden of late; and while machinery, and good machinery, has been built at points far remote from the seacoast, there are today many firms building engines and boilers that have not at their disposal the results from many successful installations such as are possessed by the older shipbuilders.

It would therefore appear that an effort toward the standardization of boilers would be opportune at this time, and it is the object of this paper to indicate the general direction in which this matter might be approached.

* Paper read before the Society of Naval Architects and Marine Engineers, November, 1919.

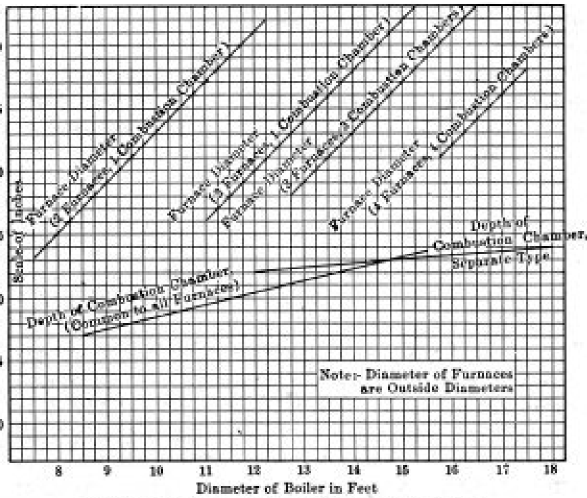


FIG. 1.— DIAGRAM FOR DIAMETER OF FURNACE AND DEPTH OF COMBUSTION CHAMBER

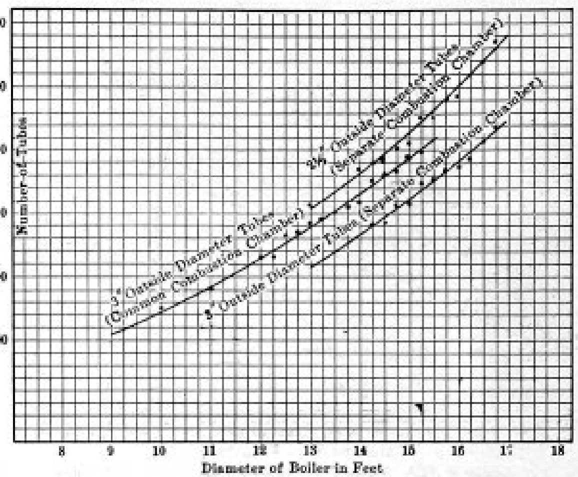


FIG. 2.— DIAGRAM FOR NUMBER OF TUBES

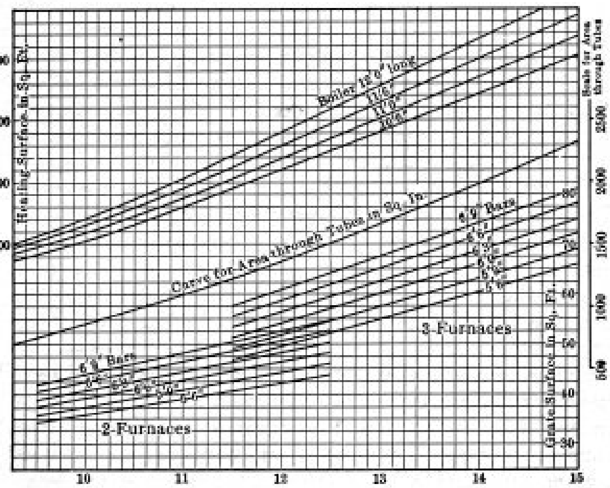


FIG. 3.— DIAGRAM FOR HEATING AND GRATE SURFACE AND AREA THROUGH TUBES FOR CYLINDRICAL RETURN TUBULAR BOILERS, COMMON COMBUSTION CHAMBER TYPE. 3" OUTSIDE DIAMETER TUBES

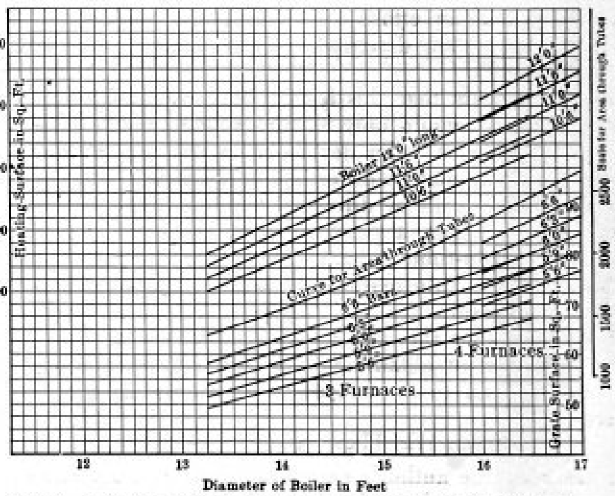


FIG. 4.— DIAGRAM FOR HEATING AND GRATE SURFACE AND AREA THROUGH TUBES FOR CYLINDRICAL RETURN TUBULAR BOILERS, SEPARATE COMBUSTION CHAMBER TYPE. 3" OUTSIDE DIAMETER TUBES

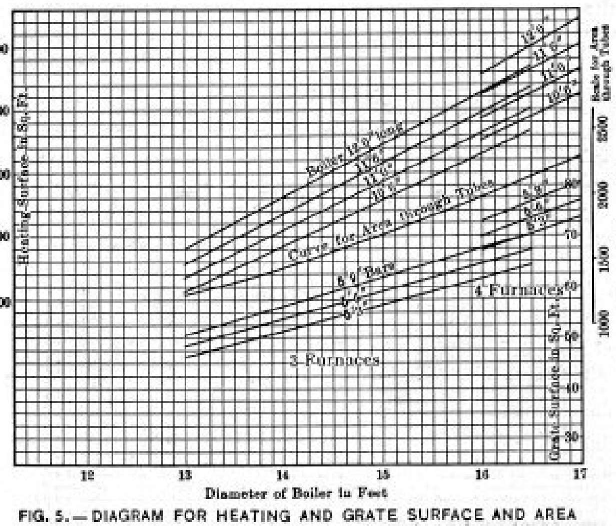


FIG. 5.— DIAGRAM FOR HEATING AND GRATE SURFACE AND AREA THROUGH TUBES FOR CYLINDRICAL RETURN TUBULAR BOILERS, SEPARATE COMBUSTION CHAMBER TYPE. 2½" OUTSIDE DIAMETER TUBES

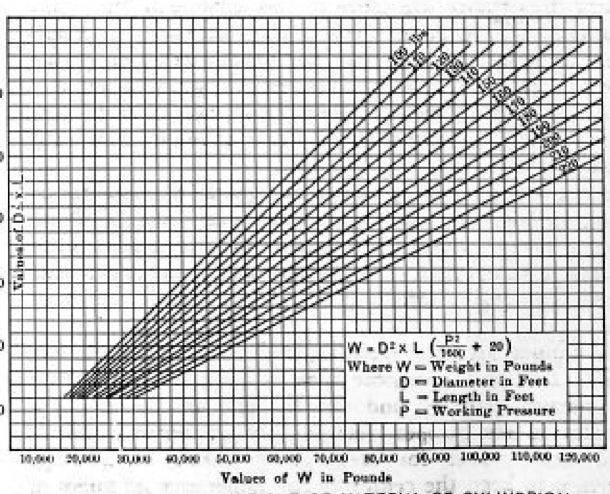


FIG. 6.— DIAGRAM FOR WEIGHT OF MATERIAL OF CYLINDRICAL RETURN TUBULAR MARINE BOILERS. COMMON COMBUSTION CHAMBER TYPE.

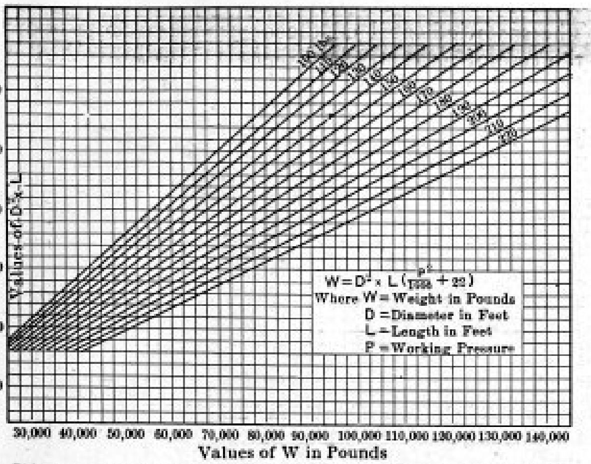


FIG. 7.—DIAGRAM FOR WEIGHT OF MATERIAL OF CYLINDRICAL RETURN TUBULAR MARINE BOILERS SEPARATE COMBUSTION CHAMBER TYPE

This paper is to be devoted entirely to boilers of the so-called Scotch type, which are subject to faulty design, due to the designer lacking sufficient previous data to build upon, and an effort will be made to supply data which will enable any designed to plan a boiler which will give good results.

Since it appears that this boiler was originated in the United States it would only be fitting were standard designs of this type of boiler developed in this country also.

There is today quite a difference between boilers of the same dimensions built by different manufacturers; and, as stated before, where a new designer wishes to plan a cylindrical return-tubular boiler there is not a great deal of really definite information available to enable him to be sure of his results.

It is hoped that the data given may at least be a step in the direction of obtaining more uniformity of design and possibly lead to the adoption or standard designs of boilers.

NEED FOR UNIFORM DESIGNS

It has been the author's experience that in many cases the specifications written for boilers were such that, had they been followed literally, the resulting boilers would have been failures, and boilers which have failed to perform satisfactorily are unfortunately not yet a thing of the past.

In order to obtain a successful boiler two factors of primary importance are more or less dependent one upon the other. These factors are heating surface and steam space. It would appear that the easiest steaming boiler is not always the one which contains the greatest amount of heating surface, and some very satisfactory boilers have contained only a comparatively small amount of heating surface for their size.

On the other hand, optimism as regards the amount of heating surface that can be crowded into a boiler is one of the primary causes resulting in designs wherein the principal characteristics are not properly balanced, and wherein conditions affecting accessibility, etc., are neglected.

We cannot sacrifice steam space indefinitely, nor can a boiler that is inaccessible have a long or satisfactory life. Steam space is undoubtedly one of the primary requisites to the proper performance of boilers, and it would appear that for ocean-going vessels an average practice is to keep the center of the upper row of tubes at one-sixth of the diameter of the boiler above the center line, whereas for coastwise or harbor vessels this distance is approximately one-fifth of the diameter, and these proportions have been rigidly adhered to in preparing the data for this paper.

Only two types of Scotch boilers have been considered, *i. e.*, those with separate combustion chambers and those with a common combustion chamber, and while there are other variations they are not by any means common.

TYPES CONSIDERED

The separate combustion chamber type is more particularly suitable for ocean-going service, whereas the common combustion chamber type is used principally for coastwise and tugboat service. When forced draft is used the separate combustion chamber becomes almost essential.

Perhaps one of the best reasons for adhering to the separate combustion chamber type of boiler for ocean-going vessel lies in the fact that the interior of this type of boiler is so readily accessible for cleaning purposes, and there can be no doubt that a boiler which is examined and thoroughly cleaned at regular intervals is going to give the best service and have the longest life.

It is not the intention to discuss in this paper the methods for arriving at the heating and grate surface required to develop a given power, but rather to determine upon the dimensions of a boiler to give a predetermined heating surface. While the determination of the heating and grate surface required ought to be based upon actual steam consumption it is to be regretted that there exists very little published data, determined by actual trial, as to the real consumption of steam by different types of marine propelling machinery, or as to the actual evaporation of water by boilers of the type under consideration.

The life of a boiler constantly forced to the limit is bound to be shorter than that of a boiler which readily keeps the machinery supplied with steam at a constant pressure, and it would also appear that, where fires are forced, the losses due to imperfect combustion would be greater.

Another very probable cause for the failure of boilers to steam properly lies in the fact that if the designer is limited to diameter of boiler he is apt to overestimate the amount of heating surface that can be placed in a boiler of a given size; and while there is no doubt that the heating surface which is contained in most boilers could be considerably increased by reducing the available steam space or by crowding the tubes, it is very much to be doubted whether the boilers would be improved thereby.

The writer has come across cases where the heating surface had been increased by keeping the tubes very close to the furnaces, and while the calculated heating surface was thereby increased it is quite probable that the elimination of all the tubes which were in close proximity to the

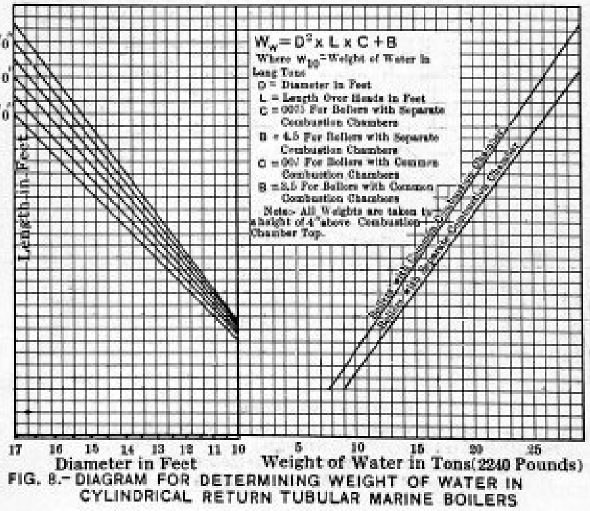


FIG. 8.—DIAGRAM FOR DETERMINING WEIGHT OF WATER IN CYLINDRICAL RETURN TUBULAR MARINE BOILERS

furnaces would not have had any appreciable effect on the steaming qualities of the boiler.

One of the causes of the great difference existing in designs lies in the fact that prior to the war, when the individual shipyards of this country were engaged on many different types of vessels at the same time, ranging from ferry-boats to big passenger liners, the conditions were not favorable to the development of standard designs.

A design for a 10-foot-diameter boiler might be followed by another for a 15-foot boiler, and this again by a design for a 13-foot boiler.

Each case being developed upon its own merits, it was to be expected that regular progression of the various proportions of different boilers would be given but scant consideration, with the result that in some cases boilers of varying diameters have had the same heating surface and diameter of furnace.

With this condition in mind the writer at one time made a series of designs progressing at the rate of 3 inches in diameter of boiler, which designs proved that a regular progression of dimensions could be maintained and that the resultant designs would have well-balanced proportions.

The designs referred to limited to boilers with separate combustion chambers for forced draft, and boilers with common combustion chambers for natural draft, all with three or four furnaces, but did not cover two-furnace boilers.

In the accompanying diagrams, boilers with separate combustion chambers for natural draft have also been included, and the diagrams for boilers with common combustion chambers have been extended to include two-furnace boilers.

Furnaces

The diameter of furnace that can be used conveniently in a boiler of a given size is a question that may be open to considerable discussion. It is, however, one of the first and most important features of design, since a furnace too large will result in either unduly crowding the tubes and reducing the steam space available or having an insufficient amount of heating surface and area through tubes, whereas a furnace too small in diameter will result in poor combustion and insufficient grate surface.

In determining upon a standard design, therefore, the diameter of the furnace should be a prime factor, and Fig. 1 gives furnace diameters which not only are in accord with average practice but which increase systematically in proportion to the diameter of the boiler.

Attention is again drawn to the fact that there seems to be considerable difference of opinion on this subject, some builders using smaller, others larger furnaces, but the dimensions given will ensure a well-balanced design when all the other features have been taken into account, such as the ratios between heating and grate surface and between area through tubes and grate surface.

It should be remembered that in Fig. 1 the diameters of furnaces given are the extreme outside diameters and not the effective diameters.

Tubes

While there are many different sizes of tubes used the most common practice seems to be to use 3-inch outside diameter tubes for natural and 2½-inch outside diameter tubes for forced draft.

It is evident that by the use of smaller tubes the heating surface in a boiler can be increased, but there seems to be no really sound reason why in a series of standard designs of boilers the above diameters could not be adhered to.

Fig. 2 gives the number of tubes for each size of boiler.

At this point it is well to note that the number of tubes which can be placed in boilers of a standard type and with standard characteristics will not give quite as regular a curve as plotted on the above diagrams.

The spots indicated on the diagrams give the number in the case of some standard designs actually worked out, and it will be noted that at various points a step occurs in the curve. This step is due to the fact that when the point is reached where due to the increase in size of the boiler, it becomes possible to add another horizontal row of tubes, the number of tubes is increased somewhat rapidly.

As regards the length of the tubes, this is of course dependent upon the length of the boiler, depth of combustion chamber, and depth of water space back of the combustion chamber.

It would appear that by definitely settling upon certain desired characteristics of boilers, *i. e.,* the ratio of heating to grate surface and the ratio of area through tubes to grate surface, the lengths of a complete series of boilers could be kept down to very few different dimensions, which would result in the possibility of keeping the tubes of certain standard lengths, possibly only three or four lengths being required, which would enable both the manufacturers and boiler-makers to keep stocks of tubes for ready use.

It would also have the further advantage that the lengths of furnace could be kept standard, and there is not reason why these should not be made to standard dimensions throughout, which again would make possible the standardization of furnace fittings.

Anyone familiar with repair-shop practice knows that unless each vessel is provided with patterns for the side bars for each furnace, whenever it becomes necessary to renew same, new patterns have to be made and fitted to each furnace, which in itself constitutes a serious economic waste.

Lastly, the boiler-maker would be benefited by the fact that all longitudinal stays could be made of standard dimensions.

Combustion Chambers

The depth of combustion chambers used in connection with these diagrams has been plotted in Fig. 1. The proportions given are quite sufficient for coal burning and generally should be sufficient when burning oil, although some designers prefer to use a greater depth in the latter case.

It should be kept in mind that the dimensions given are inside dimensions, and the actual depth used should be stated in even inches, which will somewhat simplify the calculations for allowable pressures on plates, stays and girders, etc.

Heating and Grate Surface

Based upon the dimensions for furnaces and combustion chambers given by Fig. 1 and upon the numbers of tubes given by Fig. 2, the diagrams for heating surface, grate surface and area through tubes have been constructed.

By reference to Figs. 3, 4 and 5 it is possible to quickly estimate how much heating surface may be expected from a boiler of certain dimensions or, knowing the heating surface required, what size boiler is needed. In this connection the writer would again point to the comparative scarcity of published data on the performance and efficiency of Scotch boilers.

The different authorities on the subject give figures for heating surface required that vary widely, and there is no doubt that the tendency to keep the boilers too small is somewhat of a temptation when costs have to be kept down.

After all, the most reliable data for designing boilers is not the result of builders' trials when all conditions are favorable, but rather the average result of actual long voyages of vessels which are no longer new but which have been in operation some time.

There is no doubt but that it might mean some expense to the shipowner to obtain these results, as in many vessels the apparatus for indicating the engines is taken down after the builders' trials and never used again. On the other hand, a careful investigation of the performance of a vessel not giving satisfactory service would probably result in the adverse conditions being eliminated, with consequent advantage to the owners.

In addition to the diagrams giving the characteristics of designs of a series of boilers, the writer has added diagrams for obtaining the weight of material entering into construction of a boiler and also the weight of water.

The weights of materials are gross weights and do not include fittings.

In examining the diagrams it is of course impossible for anyone not familiar with the designs whereon same are based to decide at a glance whether these diagrams will give proportions that are reasonable. For this purpose the writer has prepared Figs. 9, 10 and 11, which boilers were designed from data taken direct from the diagrams given. These designs do not present any unusual features, and in preparing them no difficulty was experienced in obtaining the proportions which the charts predicted.

The arrangement of tubes was kept as simple as possible tn order to avoid unnecessary complication of the smoke boxes since the few additional tubes that might have been added would only be of doubtful value anyway.

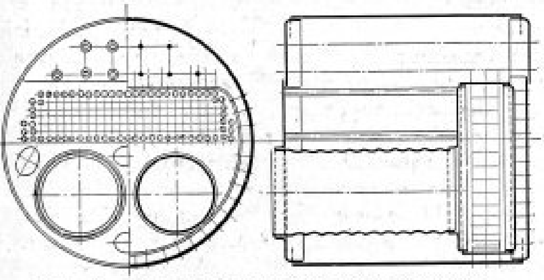


Fig. 9.—Boiler Designed by Aid of Charts
Details of Construction: Diameter, 11 feet; Length, 11 feet; Number Tubes, 179; Outer Diameter Tubes, 3 inches; Number Furnaces, 2; Grate Surface, 425 Square Feet. Total Heating Surface, 1357 Square Feet

The diagrams may be used very readily for making a table of standard boilers, and it is to be hoped that the data as given may prove of some benefit to the designer who has not at his disposal a number of designs which have proven to be successful.

For the designer who has already a great number of designs available it may follow that the methods outlined in this paper may be of benefit in co-ordinating his various dimensions of boilers.

The following example of the use of the diagrams may possibly demonstrate their value somewhat more clearly:

Let us suppose that it is desired to design a boiler having the following characteristics:

Type	Separate Combustion Chamber
Heating surface	2,200 square feet.
Grate surface $= \frac{H.S.}{34}$	66.3 square feet.
Area through tubes not less than...	1,800 square inches.
Grates not longer than	6 feet 3 inches.
Draft	Natural.

Since the length of grate bar is fixed, the grate area will be the determining feature as to the diameter of the boiler.

By reference to Fig. 4 it will be seen that bars 6 feet 3 inches long will give a grate surface of 67.5 square feet in the case of a boiler 15 feet diameter, *i. e.*, the diameter of furnaces appropriate to this diameter of boiler is such as to give this amount of grate surface.

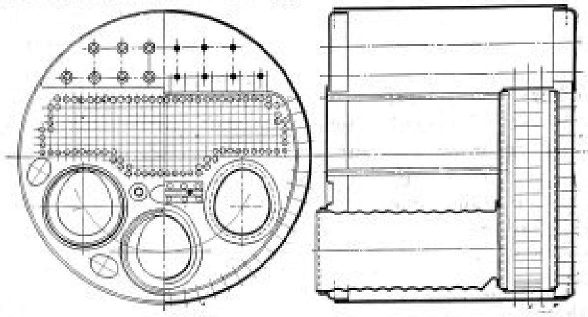


Fig. 10.—Typical 3 Furnace Chart Design
Details of Construction: Diameter, 13 Feet; Length, 11 Feet; Number Tubes, 284; Outside Diameter Tubes, 3 Inches; Number Furnaces, 3; Grate Surface, 60 Square Feet; Total Heating Surface, 2050 Square Feet

The same diagram also shows that if this boiler is made 11 feet long we will have 2,220 square feet of heating surface and an area through the tubes of 1,890 square inches.

The diameter of the furnace can next be obtained from Fig. 1 and is found to be 3 feet 11 inches outside, while the depth of combustion chamber would be 33 inches.

Fig. 2 gives the number of tubes as 320.

Allowing a water space of 9 inches at the back of the combustion chamber and 3 inches for the total thickness of heads, and combustion chamber back and tube sheets, the length of the tubes between sheets will be 7 feet 3 inches.

The weight of water obtained from Fig. 8 will be 20.6 tons.

The above results may now be compared with the results actually obtained in the design illustrated by Fig. 11, which results were calculated.

	Estimated	15 feet
Diameter	15 feet	11 feet
Length	11 feet	3 feet 11 inches
Diameter of furnace:	3 feet 11 inches	327
Number of tubes....	320	7 feet 3 inches
Eff. length of tubes..	7 feet 3 inches	2,288
Heating surface	2,220	67.5
Grate surface.......	67.5	1,962
Area through tubes..	1,890	
Depth of combustion chamber	2 feet 9 inches	2 feet 9 inches
Weight of boiler....	102,500 pounds	Actual
Weight of water....	23.2 tons	

It will be seen that the design in Fig. 11 closely approximates the desired characteristics and that specifications can be quickly prepared by this method.

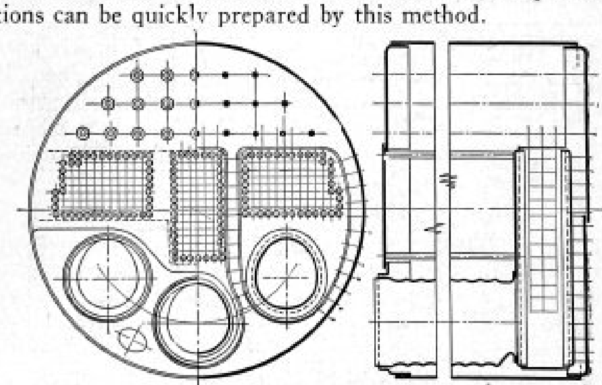


Fig. 11.—Chart Design.
Details of Construction: Diameter, 15 Feet; Length, 11 Feet; Number Tubes, 327; Outside Diameter Tubes, 3 Inches; Number Furnaces, 3; Grate Surface, 675 Square Feet; Total Heating Surface, 2288 Square Feet

Small Louisiana Boiler Shops

Method of Welding Tubes—Unique Aparatus for Stretching Tubes—Oxy-acetylene Welding on Pressure Vessels

BY JAMES F. HOBART

There are several very small railroad shops scattered about New Orleans which proved to be very interesting to the writer on a recent visit. It would be a bit incorrect perhaps to call these railroad boiler shops, for they do not do boiler work any more than they have to. However, they can do it and do it well, too. Therein lies the interest of this story.

When one of these little shops cuts out a locomotive firebox to install a new one, all hands turn to and do every bit of the work and send the locomotive out of the shop without leaking a drop or even weeping at the rivets or seams.

An old boiler maker in one of the shops, so tradition sayeth, was one day asked by his "M. M." why the new boilers which came in with some recently purchased locomotives had proved so "weepy and leaky?" "Just because," said the old boiler maker, "in the shops here they make this particular type of engine the boilers are built by the mile and pieces chopped off as they need them for locomotives."

Among other shops visited was the little plant of the Louisiana Southern Railroad of New Orleans. Here the writer was met by the genial master mechanic who passed out a seven by nine smile and a grip which nearly squeezed the corners off the writer's half of the smile.

Five locomotives are looked after in this little shop, mostly Baldwins. However, the company is being forced to put in heavier locomotives than the little fellows which have heretofore been sufficient for the work of the road, which is controlled by the Gulf Coast Lines and runs to the Gulf of Mexico along the Mississippi. Its main reason for existence is the transportation of produce from truck farms along the river to New Orleans.

At the time of the writer's visit, repairs on one of the locomotives were just being finished. A new front end, new tubes and a lot of new staybolts had been installed by hand. As a matter of fact, the only machine work necessary was that of rolling the new sheet for the front end, which was done elsewhere, as the shop was not equipped with bending rolls.

Tube Welding

Tube welding is managed by hand quite ingeniously with the aid of plug mandrels and swages. After welding the tubes they are heated in the forge fire for annealing and then upended in half barrels of hydrated lime to cool slowly.

The shop is electrically driven, although formerly operated by a 35 horsepower boiler and engine. When the shop boiler gave out, electric motors were installed and the engine stilled forever. A small 8 horsepower boiler drives the air compressor which is the only steam driven machine remaining in the shop.

Compressed air for driving the guns and drills in the shop is supplied by a Westinghouse, direct-acting, steam driven compressor similar to the type used on the locomotives. There are several spare compressors in the shop so that if one needs overhauling, an extra compressor is placed in use upon the engine. After the defective one is overhauled it is placed in shop service to supply air for the tools.

When convenient, the other extra compressor is overhauled and put into the store room. Then if a pump is needed upon any locomotive, the compressor in use in the shop is placed in service, and the overhauling repeated with the defective one. This method supplies the shop with air, tries out the overhauled compressors and maintains two separate machines for emergency use.

Stretching Boiler Tubes

After looking over the shop, the writer drew the master mechanic into a reminiscent mood and induced him to talk about the troubles he had got into and out of, and the stunts he had been forced to do under the various handicaps that a small shop is subjected to.

"I remember one piece of work," said my friend, "which I had to take a chance on but which came out all right. A set of tubes for one of the locomotives had been ordered and when they came they were found to be three-quarters of an inch too short. Here was trouble! I had no time in which to get another set of tubes, for that engine was needed badly and it simply had to go right out on the line without delay.

"When a man is up against it he is ready to try anything once. This time the scheme worked out all right. I had a good heavy vise which I fastened beside a large forge which we use for flanging and general forging.

"A tube was caught in the vise, with a plug of steel inside the tube to keep it from flattening. The vise *A*, Fig. 1, was located close to the forge *B*, and a good long fire was built as shown, so that a considerable length of the tube could be heated. Then I clamped a big pair of steam-hammer tongs to the other end of the tube as shown at *C*, attached a ⅞-inch rod to the clamp tongs and put turnbuckle *D* upon the rod and fastened the other end of the rod through post *E*.

"A long thread was then cut on the rod which went through the post, and an old brake wheel tapped out and screwed upon the rod, back of the post as shown at *F*. With this hand wheel, the slack in the rod could be quickly taken up whenever a new tube was put into the fire.

"A long heat was taken on the tube at *B*, the turnbuckle *D* was screwed up by the bar placed through it. Each of the tubes was stretched about an inch and then put into the boiler where they have never given the least trouble. Yes, that's the first time I ever heard of stretching boiler tubes, but it worked all right and I will try it again if I ever have to!

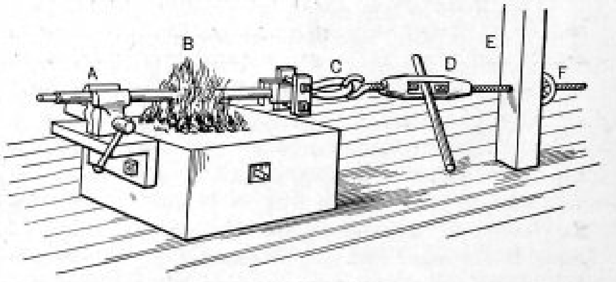


Fig. 1.—Stretching Boiler Tubes

"Mississippi river water is very good down here," continued my friend. "The one great trouble with it is the large amount of silt contained in the water. This substance is deposited upon the tubes and sheets like scale and requires a large coal consumption to drive heat through the coating thus formed.

Water and Scale Trouble

"The tubes in these boilers are so very close together that it is almost impossible to remove the dirt-scale by mechanical means. We use sal soda mixed with a little caustic soda, with good results. About once a year it pays to knock out about 30 or 40 tubes in a boiler. Then if the ends of the other tubes are rolled, a lot of the dirt-scale loosened in the process can be cleaned out by working in the open spaces, where the tubes have been knocked out. I find that such a yearly cleaning helps our coal consumption a whole lot.

External Corrosion

"External corrosion and wasting away of the plate troubles us a great deal. It is due no doubt to the excessive dampness here during certain portions of the year when the entire external surface of every piece of metal is dripping with moisture, which when mixed with the salt air from the Gulf, sure plays havoc with the outside of our boilers and engines.

Freezing, Even in New Orleans

"Yes, the cold weather last winter sure made us jump around quite lively. We have a water station here and draw water 1,200 feet from the Mississippi river. It takes about 26 inches of vacuum to do it too and we certainly had trouble with the pipe line some days when it

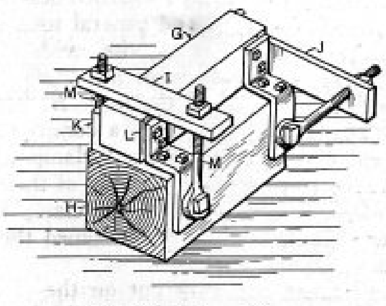


Fig. 2.—Floor Clamp

was cold. The pump man drained the pipe each cold night, but even with a ⅜-inch bleeder it froze a couple of times before we could empty it, and once I had to cut out three lengths which had burst. We never had such cold weather before that I can remember.

Ferruling a Tube

"Yes, there are a whole lot of things which we have had to do down here, that are pretty interesting to tell about, and then there are others—well, they wouldn't have been done, if there had been any other way out.

"There was one tube ferruling operation which proved rather strange to say the least. An engine came in one day with just one tube leaking and I determined to drive in a ferrule and stop the leak, if possible! After forging the ferrule, I started to drive it into the tube. Upon going to the other end of it, I found that the whole length had been driving along too! In fact, it was being driven ahead by the collar-tube which was inserted in the back end. Well, I just let it go and kept on driving until about a foot had been shoved in and the tube had moved forward inside the larger tube ahead of it.

"Well, sir, when I cut off the piece of collar pipe, I rolled it into the tube sheet, then I reached in and cut off the tube which had been driven forward, using the pipe cutter to do it. Then, I rolled the cut-off ends and the tube ran for several weeks without leaking a drop! It sure was a queer way of repairing a leaky tube, but then you know, it was one of those things which a man has to resort to when he can't do any better!"

Directly across the Mississippi river from the little railroad described above, with its 114 miles of track and five locomotives, is another 60 mile road with seven locomotives—the New Orleans and Lower Coast Railroad

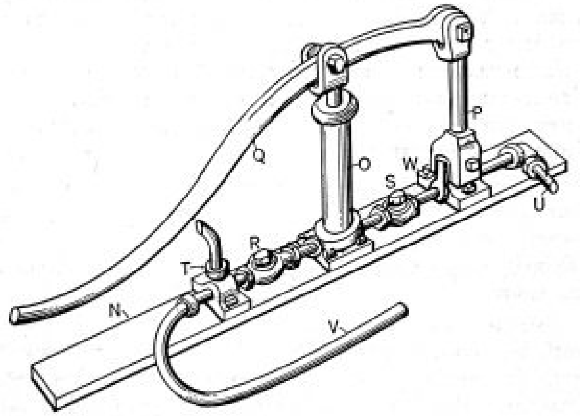


Fig 3.—Home-Made Test Pump

which runs through one of the most fertile truck farming districts in the world.

In addition to the seven locomotives, there is a full-fledged Republic motor truck fitted with regulation car wheel rims to run upon the track. This is used to gather up the green stuff along the road. It stops at every "gate and pair of bars" and deposits its loads at five mile intervals. At these points the produce is picked up by regular trains, thus relieving the way freight of collecting small shipments.

Oxy-Acetylene Welding

The shop is fitted with ample facilities for doing oxy-acetylene welding and the writer was advised that this method was used on pressure work as found necessary and that no bad welds or hard metal had as yet been found. Spring work was also done in this shop as required, the very handy clamp-block shown in Fig. 2, being conveniently located in the boiler shop, adjacent to the flanging forge.

This block, used for clamping small work parts preparatory to welding, was made up of two members. The cast iron shape *G*, which was about eight inches square and three feet long, was fastened to the wooden block *H*, by four heavy steel straps, two of which are shown at *K* and *L*. To the lower ends of these straps were attached clamp-bolts *M, M* by means of a one-inch bolt extending through block *H* and straps *K* and *L*.

The clamp bar *I* was drilled to receive the bolts *M, M* and a similar bar was placed at the other end of the clamp block as shown at *J*, together with a second set of straps, bolts, etc., as shown in the sketch. In addition to being very convenient for holding springs and small work for the torch this device was found to be worth far more than its cost for holding stake tools for forming thin sheet metal work. Heavy stakes could be used because there was a fine concrete base under the wooden block to which it was anchored by means of a couple of 1¼-inch bolts. These bolts were let into the block with the hexagonal nuts, flush with the top side and entirely covered by casting *G* and by straps *L*.

Home-Made Test Pump

Piled away in the boiler house, which by the way, was a stall in the round house, the writer noticed a stout looking pump for pressure testing, evidently home-made and well made at that. The whole affair was erected upon an eight-foot plank, *N*, Fig. 3, two inches thick and about 10 inches wide. The barrel *O* had evidently been made of a piece of hydraulic pipe, bored and reamed to fit the plunger which worked vertically without guides. The foreshortening of the lever *Q*, was taken care of by the stout link *P*, which was made with connections to stand up firmly under the side stress from the lever *Q*.

The castings *T* and *W* served to fix the pump pipe firmly upon plank *N*, also to carry the link *P*, and the lever-stop *X*. The stop was designed to prevent lever *Q* from going down too far, under the careless force of two or three workmen. The proper direction of water flow was secured by means of the two, stock, swing check valves *R* and *S*, which formed the working valves of the pump.

The suction pipe *U*, was arranged in such a way that it could be used at will, to take water through a hose, or to attach to a water supply pipe either from the male or the female end of the fitting. Delivery pipe *V* was arranged in a similar manner, with a piece of pressure hose coupled on as shown. With a hand pump jumping around under powerful strokes, the pipe connections, both suction and delivery, sure stood up a whole lot better through the hose than when rigidly connected by screwed or bolted unions.

How to Design and Lay Out a Boiler—XIV

Designing Steam Domes and Drums—Need of Installing Steam Headers—Computing Stresses in Dished and Flat Heads

BY WILLIAM C. STROTT*

Domes, or drums are ofttimes attached to the top of a boiler for the purpose of obtaining drier steam. This assumption is based on the theory that the driest steam always rises to the highest point in the boiler. This is probably correct, but experience has demonstrated that a device of this kind sometimes defeats the purpose for which it was intended.

Function of Steam Domes

The volume of steam contained in a dome of the usual proportions is comparatively small, and the truth is that, since this small volume is so far removed from the heat within the boiler, the dome literally functions as a condenser. In locomotives they are an absolute necessity; first because of the throttle valve within the boiler; and second, that, were this valve to be placed near the surface of the water, the steam pipe to the engine cylinders would receive charges of water due to the surging action while the engine is in motion.

Even in the portable locomotive-type boiler the steam and water space above the tubes is usually so restricted that the application of a steam dome is imperative. Nevertheless, to be at all effective, domes must be heavily covered with magnesia lagging, or some effective heat-insulating material. It so happens that in the ordinary isolated steam plant this is not done, at least not efficiently. The result is a condensation of the steam.

Fig. 48 illustrates the usual type of steam dome riveted to the shell of a boiler.

Probably the chief objection to the attachment of steam domes to boilers is from the standpoint of safety. It should be self-evident to the student that the rivets connecting the flange of the dome to the boiler shell are almost entirely in direct tension, and it should be recalled that objection was previously made to loading rivets in this manner. It is only necessary to say that domes have been known to "sky-rocket" clear from the boiler shell.

Size of Domes

The size of a steam dome is arbitrary, but the usual practice is to design it so that the least volume of steam contained will be equivalent to that generated by the boiler in one second.

The weight of a cubic foot of steam at a given pressure may be taken from a table of the "properties of saturated steam." Such a table is to be found in most any handbook on mechanical engineering, such as Kent, or Marks and Davis.

We find that the weight of one cubic foot of saturated steam at a pressure of 150 pounds per square inch gage is 0.363 pound. The weight of steam which any boiler will generate in one hour is found by multiplying the rated horsepower by 34.5 pounds. It is customary, however, to figure on about 50 percent overload capacity, hence the maximum evaporating capacity of our boiler will be $(150 + 0.50 \times 150) \times 34.5$ pounds or 7,762.5 pounds,—say 7,800 pounds per hour. This weight of steam would occupy $\frac{7{,}800}{0.363}$ or approximately 21,490 cubic feet. For one second's supply this would require a vessel having a volume of $\frac{21{,}490}{3{,}600}$ or 6 cubic feet. A dome having a diameter of 2 feet and a height of 2 feet has approximately this required volume.

A further examination of the steam table will show that the volume of steam per cubic foot increases as the pressure decreases; in other words, the lower the pressure the larger must be the dome in order to contain a given supply. This increase in volume is very rapid as the ordinary lower pressures are reached, and it must evidently follow that, for a given horsepower, the size of the dome would have to be abnormally large for boilers carrying low steam pressures.

The fact that the dome for our boiler (if one were specified) could not possibly be made much larger than 30 inches by 30 inches at the most, and that it could hold no more than 2 seconds' reserve supply of steam, should suffice to prove to any one the fallacy of the former theory concerning the advantage of a steam dome as a steam drying medium.

Steam Headers on Stationary Boilers

In power plants, however, when the steam consumption fluctuates, as in rolling mills, due to intermittent operation of the machinery, it is absolutely essential to hold a large supply of steam in reserve. This is accomplished by means of large steam headers, or receivers close to the engines, turbines, or other prime-movers. If a

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

device similar to this is not provided, then when the boilers are called upon suddenly to supply an enormous volume of steam, vibrations in the generating equipment and particularly in the pipe lines will occur. Such periodic demands on the boilers will invariably result in charges of water being carried into the steam piping. When a boiler generates very wet steam, it is called "priming."

The radius is usually made equal to the diameter of the head.

Example: What shall be the thickness of a dome, or drum-head, 24 inches diameter, formed to the segment of a sphere, the spherical radius of which to 24 inches, working pressure to be 150 pound per square inch?

Solution: Substituting in Formula (17) we have:

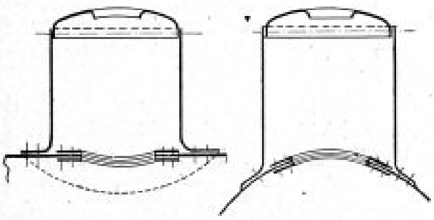


Fig. 48

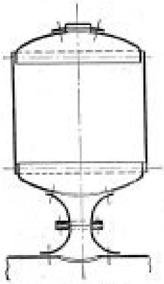


Fig. 49

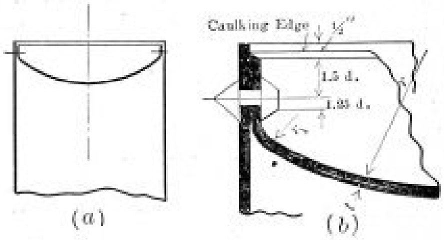


Fig. 50

$$t = \left[\frac{2.75 \times 150 \times 24}{55{,}000}\right] + \tfrac{1}{8} \text{ inch} = 0.305 \text{ inch, or say } \tfrac{5}{16}$$

inch.

An examination of the above formula will prove that for a given working pressure the less we make r, the thinner the plate will need to be. The minimum value for t would finally be reached when the head becomes a true hemisphere. There is no restriction to decreasing the radius to which the head is bumped. To eliminate any tendency, however, on the part of manufacturers to economize in plate thickness by taking full advantage of this fact, the Code states that when the radius to which the head is dished is less than 80 per cent of the diameter of the head, then the least value of r in formula (17) shall be taken at 80 per cent of the diameter. On the other hand, if such radius is greater than the diameter of the head, then the head must be considered as a flat surface. This is also true of dished heads, having thicknesses less than allowed by formula (17), regardless of the radius. In either case, the heads would have to be stayed, no allowance whatever being made in such staying for the holding power due to the spherical form.

Instead of the steam dome just described, removable domes, like Fig. 49, are occasionally specified. These, however, may evidently be placed under the classification of drums or receivers.

Computing Dome Stresses

Designing the shell of any device of this kind presents no further complications than were encountered in the design of the boiler shell proper. In fact, domes and receivers are pressure vessels and must be calculated as such.

Concerning steam domes of the type illustrated in Fig. 48, the A. S. M. E. Code establishes the following restrictions:

The longitudinal joint of a dome, when the latter is 24 inches or more in diameter, shall be of double buttstrap construction.

For domes smaller than this, lap riveted longitudinal seams are permissible. With regards to the style of riveting, where the dome flange connects to the boiler shell, the Code further states that this joint shall be double-riveted when the pressure exceeds 100 pounds per square inch. For pressures less than this, single riveting may be employed providing the maximum allowable working pressure on the dome, as found by Formula 1, be computed with a factor of safety of 8.

It is needless to go more fully into the design of a dome shell, but the heads present a problem which has heretofore not been encountered.

Dished Heads

Dished heads, as shown in Figs. 48 and 49, are much to be preferred over flat heads, and should be used whenever possible. Due to their spherical form, they are self-sustaining—hence require no bracing. The stresses in a dished plate are similar to those within any cylindrical vessel.

The A. S. M. E. Code present the following formula for the thickness of dished heads when the pressure acts on the concave side, Figs. 48 and 49, in which position they are termed convex heads.

$$(17) \quad t = \left[\frac{2.75 \times P \times r}{T_s} + \frac{1}{8}\right], \text{ in which,}$$

t = thickness of the head in inches.

P = maximum allowable working pressure in pounds per square inch.

r = radius to which the head is bumped, in inches.

T_s = ultimate tensile strength of the material, in pounds per square inch.

Concave Heads

In the case of vertical domes on boilers, where the head room is restricted, and where the steam and water drums of vertical watertube boilers are set end-to-end, it is frequently necessary to place the heads with the pressure acting on the convex side as in Fig. 50 (a). They are then known as *concave* heads.

The student should also realize that in cases similar to that illustrated in Fig. 49, if no manhole is provided in the dome, the upper head would have to be set as in Fig. 50, so that it could be riveted from the outside. Note from Fig. 50 (b) that the head must be beveled and calked. In order to provide a seat for the calking tool, the shell is extended about ½ inch is indicated.

Dished heads when set against the pressure in this manner are not quite as strong as in the former position, and must be calculated in accordance with the following formula:

$$(18) \quad t = \left[\frac{3.85 \times P \times r}{T_s}\right] + \tfrac{1}{8} \text{ inch, in which,}$$

the notations are the same as in the preceding formula.

The same restrictions concerning the values of r and t as laid down during the discussion of convex heads apply to these also.

(If the student has difficulty at first in distinguishing between dished heads when they are set concave or when convex, let him associate the word "concave" with something as being caved in. Then, whenever he is told that a head is to be concave, he may imagine that the head is caved in towards the shell.)

Very frequently dished heads are provided with flanged manhole openings similar to that in the front head of our boiler. The process of turning in the flange around the hole has a tendency to thin down (stretch) the plate. For this reason, the A. S. M. E. Code demands that when flanged manholes are provided in dished heads an extra 1/8 inch in thickness over that allowed by formula (17) or (18) (depending on the type of head used) is to be provided.

The final rule covering the design of dished heads is with regard to the corner radius r of the "bump," indicated in Fig. 50 (b). The Code states that this radius shall not be less than 1½ inches, nor more than 4 inches, in any case, but within these limits it shall be not less than 3 percent of the radius r, to which the head is formed. This is more clearly explained by a numerical example: For a head dished to a radius of 24 inches the inside radius of the flange would have to be not less than 1½ inches, because 3 percent of 24 inches = 0.72 inch, in which case the minimum of 1½ inches must prevail. There is no restriction, however, in increasing this figure. In fact, a generous radius at this point is desirable as it results in a safer head. On the other hand, it should not be made too great, because, in flanging, the excess metal will buckle. Suppose further, that we were designing a very large dished head—say with a spherical radius of 60 inches; then, 3 percent of 60 inches = approximately 1 13/16 inches. In this case the 3 percent limit prevails.

The above ruling was made to guard against the dangerous sharp corner radii so often produced in hand-flanged work.

FLAT HEADS

Instead of the dished head, the ordinary flat head may be used, but of course it must be braced with diagonal braces attached to the shell of the dome, or drum, exactly as described for the main boiler head. Of course, the same rules and formulas apply to their calculation. In figuring the area to be braced, the usual 3-inch annular ring is allowed for the reinforcing value given by the flange.

Stayed flat heads for pressure vessels need be no heavier than those required for dished heads of the same size and working pressure; for it should be understood that, in the case of all flat surfaces, no account is taken of the inherent strength of the material.

It is a fact, nevertheless, that an unbraced flat head may be made sufficiently heavy to resist rupture. The theoretical formula for the thickness of circular flat heads is as follows:

$$(19)\quad t = \sqrt{\frac{0.75 \times P \times R^2}{T_s}}, \text{ in which,}$$

t = thickness of head in inches.
P = pressure in pounds per square inch.
R = ½ the diameter of the head.
T_s = ultimate tensile strength of material.

Example: What is the theoretical thickness of a circular flat head 24 inches diameter to resist rupture at 150 pounds per square inch?

Solution: Substituting in formula (19) we have:

$$t = \sqrt{\frac{0.75 \times 150 \times 12 \times 12}{55{,}000}} \text{ or } 0.55 \text{ inch.}$$

By providing formula (19) with the usual factor of safety of 5, the value of t would jump to 3.8 inches. This proves how altogether impracticable it is to design pressure vessels with unbraced flat heads. Therefore, since such a boiler head cannot be made anywhere near the required thickness, it follows that it must either be dished to a spherical form, or else heavily stayed. The practical law to remember in this instance is that, a boiler is no stronger than its bracing.

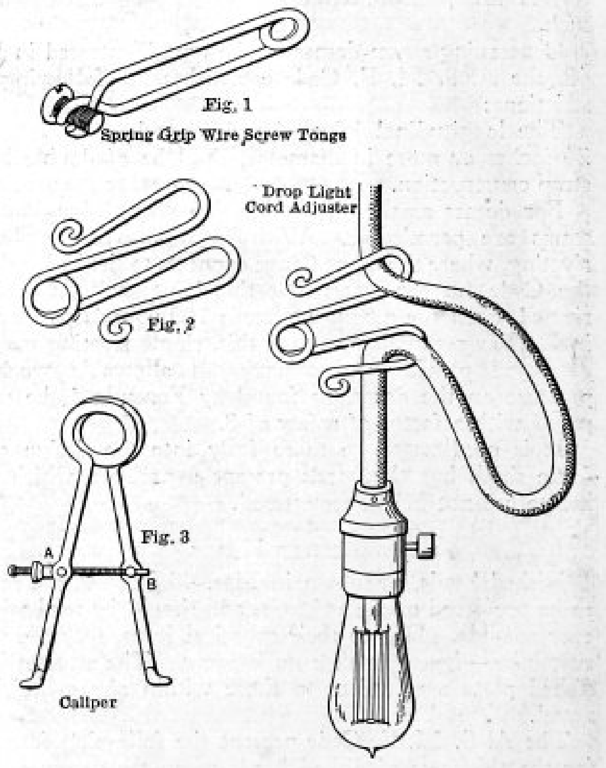
If in any particular problem the value of t, as found by formula (17) or (18), happens to be less than the thickness of the shell required, the head should be made the same thickness as the dome shell. Even so, it is good practice to make the heads a trifle heavier than the shell, especially when the shell thickness is in sixteenths, in which case increase the thickness of the heads to the nearest *eighth*. For instance, referring to the example previously given in connection with the application of formula (17), the thickness of the dished head required was found to be 5/16 inch. It is quite probable that the shell plate for a vessel this size and pressure would have to be at least 3/8-inch thick, in which case the head should also be made 3/8-inch thick.

(To be continued)

Handy Wire Kinks

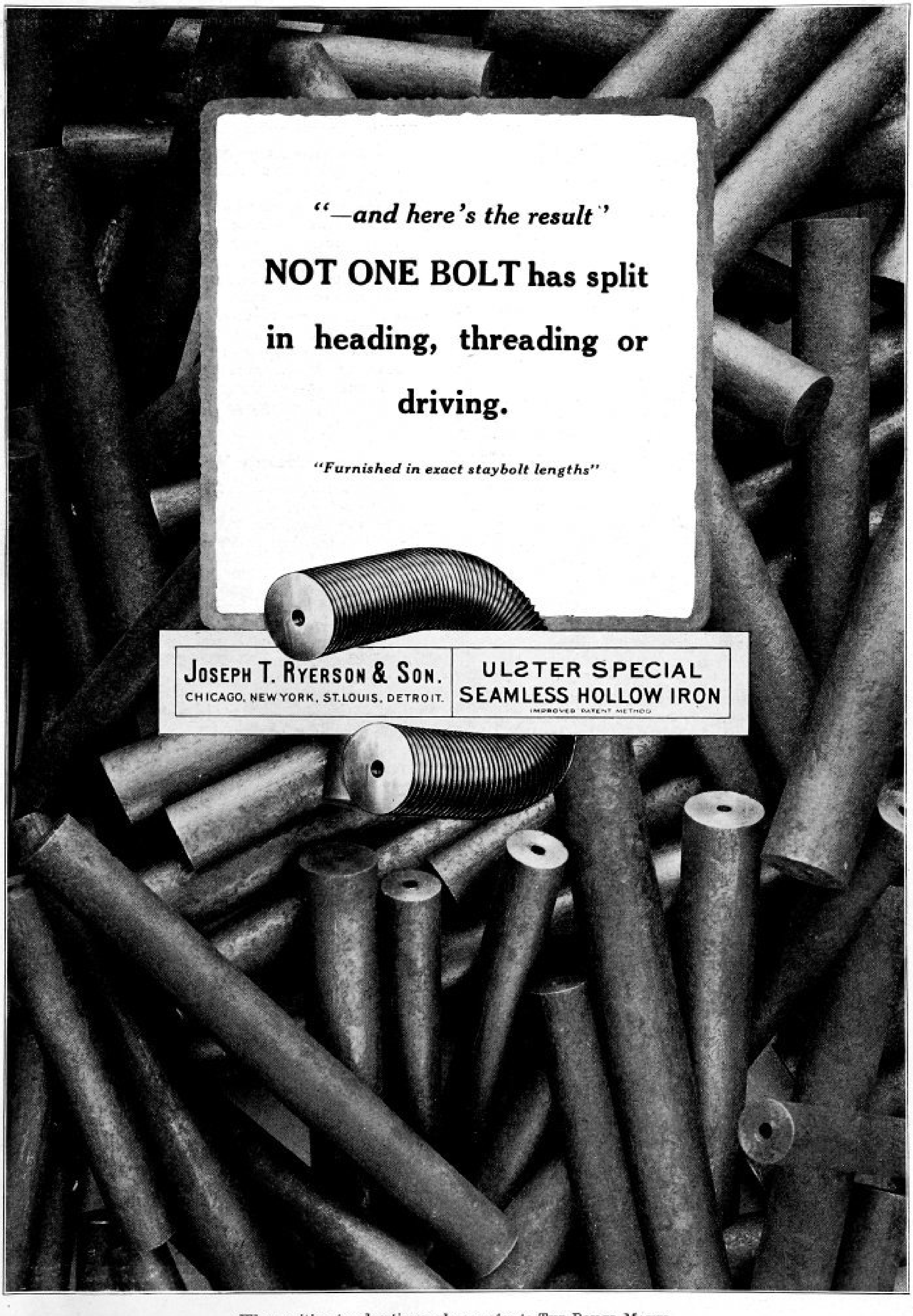
These sketches show some handy uses for short lengths of good steel wire, and the devices are very easily made.

The wire tongs, Fig. 1, are quite handy for many different uses, but best of all do they answer the need of



Convenient Device Made From Short Wire Lengths

light pinches for holding small screws while starting them in some unhandy place. The light cord adjuster shown in Fig. 2 needs no words to describe it. Fig. 3 shows a very novel and inexpensive way to make small calipers and dividers. The wire forms its own spring for opening the calipers, and, by flattening a section of the wire used for each leg at *A* and *B*, small rivets for holding the adjusting screw can be put on. C. H. WILLEY.


"—and here's the result"
NOT ONE BOLT has split in heading, threading or driving.
"Furnished in exact staybolt lengths"
JOSEPH T. RYERSON & SON.
CHICAGO, NEW YORK, ST. LOUIS, DETROIT.
ULSTER SPECIAL
SEAMLESS HOLLOW IRON
IMPROVED PATENT METHOD

Oxy-Acetylene Welding and Cutting*

Uniting Gases in the Torch—Heat Treatment of Cast Iron —Special Jigs for Tank Welding—Strength of Welds

BY HUGH H. DYAR†

About four years ago, when I was preparing a paper on this subject, I made inquiry to find out which phase of welding or cutting would be of special interest. The party of whom I made this inquiry said, "Tell them anything, they don't know the difference." This gentleman spoke with greater truth than he realized. At that time the process was little known and just beginning to come into wide commercial use. I find that even today the majority of engineers and mechanics who are using the process every day in their business really know very little about the basic principles. They have quickly accepted the use of the equipment on account of the self-evident advantages and have gone very little into its theory or study.

The process originated in France, and I believe the first torch used in this country, at that time a closely guarded secret, was brought over by Eugene Bournonville in 1904. In 1907, Mr. Bournonville became acquainted with Mr. Davis, who was already in the acetylene lighting business, and interested him in the welding process. As a result, they sent to France and purchased the American patent rights on what appeared to be the best torch in use at that time. Since then, the torch has been widely developed in this country, and it seems to be the consensus of opinion that our torches at the present time are superior to any obtainable abroad.

In the earlier development of the process other gases than acetylene were tried, the most important being hydrogen, which, when burned with oxygen, gives a temperature of about 4,000 degrees Fahrenheit. Acetylene gas, which is approximately 93 percent pure carbon, has very great possibilities for heat, and when burned with pure oxygen a temperature of about 6,300 degrees Fahrenheit is obtained. This heat can be applied to metal more quickly than it can get away by radiation.

If two separate pieces are placed adjacent to each other and the flame applied, the metal will flow and make one solid piece. This is called autogenous welding and differs from a blacksmith's weld, as it requires no hammering or pressure. Also, practically any metal can be welded by this process, which is not the case with the blacksmith's weld.

How Oxy-Acetylene is Made

As the name implies, two gases, acetylene and oxygen, are used. The acetylene is made from calcium carbide and water in a suitable generator which is automatic in operation and regulation. Oxygen can be obtained in a number of ways, by the electrolysis of water in which an electric current is passed through a water solution or by a chemical process in which manganese dioxide and chlorate of potash are heated. For ordinary commercial use, however, it is most easily procured in compressed cylinders.

The pressure in the oxygen cylinders when they are full is 1,800 pounds; this is reduced in the reducing valve to the pressure we use in the torch—the pressure varying according to the work we are doing. On some very small jobs we only use a few pounds pressure; on cutting heavy armor plate 18 or 20 inches thick, oxygen pressure will run about 125 to 150 pounds. The acetylene never exceeds 10 pounds; the average pressure is about 7 pounds. We have found that at those pressures if the holes are drilled properly we get a proper flame of correct velocity. I have seen a good many torches with the flame so fierce that if a light welding stick were used it would be blown away, and you could not get results. I have seen some torches where the velocity was so low it would not get down into your metal at all; it would simply burn. There is quite a lot to a torch; they look simple, but they are the result of a good deal of experimenting and research. We aim to get equal volumes of the two gases in the torch, and we have no difficulty in getting 1 to 1.14 under almost all conditions. I have seen those figures vary slightly in the laboratory, but if you try to cut the flame down too low it loses its effectiveness.

The plant for welding and cutting consists of an acetylene generator, the oxygen supply being in tanks, the regulating and reducing valves and the torch or burner that actually does the work, and which is connected to the regulators by pliable rubber hose. For portable work the acetylene may be compressed in tanks filled with a substance which is a good deal like mineral wool, and which holds acetone in suspension. Acetone is a chemical which has the property of holding in solution 25 times its own volume of acetylene for every atmosphere that the gas is compressed. If the acetylene were not dissolved in acetone it would be explosive at high pressure.

Uniting the Gases in the Torch

In this country there are two basic methods of uniting the gases in the torch. The one first used and still adhered to by some manufacturers is known as the low pressure system, in which the acetylene is supplied at a low pressure, three or four ounces, and drawn into the flame by the oxygen under high pressure a good deal on the principle of a steam boiler injector. The probable reason for the use of this method at first is that, when the art was new, acetylene was only procurable from low pressure generators such as are used on farms and in isolated places for lighting. The power used to draw the acetylene into the flame comes from the oxygen. As a general rule, a large excess of this gas is necessary. However, this torch gives good results in some cases.

The method has been largely superseded, however, by what is known as the high pressure system, in which both gases are introduced into the flame under an appreciable pressure, which produces a certain and constant mixture. The theoretically perfect flame is one that uses equal parts of acetylene and oxygen. One of the leading torches has succeeded in burning these gases in the proportion of 1 to 1.14.

A very great number of different sizes and styles of torches have been developed according to the different uses that have been found for the process, varying from a jeweler's torch that is used to weld the precious metals to very heavy torches for handling the largest casting. In addition to the hand-welding torch, we have developed a number of machine-welding torches, which have been adopted very widely for tube welding where the seam is passed continuously under the torch, the weld being made at the rate of from 2 to 4 per minute. Such torches, are water cooled, as the service conditions are very severe.

A brief description of the acetylene generators might be

* Abstract of paper and discussion delivered before the Cleveland Engineering Society.
† Representative Davis-Bournonville Company, Cleveland.

appropriate at this time. These machines really consist of a tank or container with water in the bottom and a carbide hopper in the top. A mechanical device run by a weight discharges the carbide into the water; acetylene is produced and maintained at a constant pressure by a diaphragm control, which stops and starts the feeding mechanism.

Actual Welding Process

In welding cast iron, the piece is first prepared by chipping out the crack in the form of a V, so that the weld can be made the entire thickness of the metal, thus producing a weld of full strength. As a point in question, take the preparation of the edges of the material to make a weld of half-inch boiler plate. We find that up to about $\frac{3}{16}$ inch, in some cases more, you can burn right through the metal and make a satisfactory weld without any previous preparation of the metal. For work heavier than that, and in cast iron repairing, we would chamfer it out, start making our weld at the bottom and gradually build it up, melting over the edges as they are built up. I would advise using a 45-degree angle on those chamfered edges. Some welders will chamfer their material out a great deal wider. In my opinion it is best to make the edges as narrow an angle as you can, because the more metal you have to weld in the more gas you use, and the more it costs.

In handling cast iron where the shape is somewhat irregular, as is usually the case, the proper heat treatment is fully as important as the actual making of the weld. For ordinary work the casting should be heated very slowly, usually in a charcoal fire, until it has become a dull red and any expansion strains taken care of; the weld should then be made while it is still at this temperature, and afterwards cooled down very slowly. Those of you who are foundrymen or have had experience in handling cast iron know that if this plan is not followed, strains are very apt to be developed that will crack the casting when it becomes cool.

One of the difficulties often spoken of in welding cast iron in which the welded spot is very hard, in fact too hard to be machined, can be prevented by proper heat treatment. There are, however, a number of other things that have a bearing on this. By the use of a high pressure torch some very remarkable and large welds have been made. Drop hammer frames, flywheels up to 20 feet in diameter, and any number of large engine beds and machine frames have been successfully welded by this process. The softer metals, such as brass and aluminum, which are usually in the form of castings, have to be heat-treated much the same as cast iron, but on account of their lower melting temperature they are, of course, not heated to such an extent. In welding steel, expansion and contraction are not of such great important as in cast iron. On account of its ductility and greater strength, the heating strains, while they are present to a certain extent, do not cause the trouble encountered with castings that are more brittle. In important work, such as repairing boilers, strains are taken care of by a special preparation of the sheet.

In regard to flux, I have found that in the bulk of steel welding a flux is not necessary. The purpose of any flux, of course, is to float the oxide that may accumulate, or to float other dirt that may be in the weld. We find that in steel the oxide or dirt comes to the surface, and it is very seldom that it is necessary to use flux. With cast iron the situation is different. We use a flux for that. We also use flux for brass and bronze, the basis of which is plain borax. There has been an extensive study of aluminum flux. Oxide of aluminum melts at a very much higher temperature than aluminum itself, so if you try to puddle your weld and get the oxide to float, you will melt through your casting and you cannot handle it. In welding cast aluminum, we find that it is often good practice in making the weld to take a steel stick and keep breaking it up. Keep puddling the weld with a steel stick, which mechanically breaks up the oxide. I should say a weld made in that way properly executed would give a strength of 80 percent.

In these aluminum welds we run onto a very difficult problem, because a very light tip with a torch will go through the pieces unless closely watched. Up until about a year ago practically all of the aluminum flux of the better grades used in this country came from Germany and France, and lately from Switzerland; but we are developing fluxes now that are very satisfactory.

One important branch of welding is met in the manufacture of steel containers, such as barrels, tanks and battery cans. In this work one of the principal difficulties is the arrangement of proper jigs and fixtures to hold the metal while the weld is being made. Steel is apt to buckle or become wavy when heat is applied along the edge, and unless the proper arrangements are made to hold it a poor job will result.

Special Jigs and Machine for Tank Welding

We have a number of special jigs, and also a special machine for welding tanks. It is quite important to clamp the edges of sheet metal tanks while they are being welded. We have gone quite extensively into the clamp proposition and now make some of them out of cast iron, with a water-cooled chamber in which the water is circulated continuously so that the clamps will not become too hot and get out of shape.

Automatic machines have been developed for welding barrels and tanks in which the torch is carried along the seam by a carriage similar to that on a lathe. This will do the work in less than half the time it can be done by hand, and produces a very thin and fine piece of work.

In welding cast iron, we sometimes experience difficulty in machining the welded portion, due to hardness of the weld. My theory is that if the welder is not quick with his work, or if he uses a torch that produces an excess of oxygen in the flame, he is liable to burn the free carbon out of the cast iron. As we all know, it is the free or graphitic carbon in the cast iron that makes it soft. If you burn that out, you approach to a greater or less degree the white iron, which has practically no free carbon in it. I have heard a number of other theories, but I believe the one I just gave is probably the most accurate. If the weld is watched so that the torch does not give an excess of oxygen, there will not be a great deal of trouble. If a cast iron weld is allowed to cool too rapidly it will be chilled, and I have seen some welds made in that manner that were harder than the devil's back. They could not be touched with anything.

In all welded work the question of strength of the joint naturally comes up. Joints properly made with the high pressure torch producing a neutral flame should give very nearly the full strength of the metal; and in actual work, wherever possible, the weld is made thicker than the balance of the metal, leaving a greater cross section in this spot, which produces a 100-percent weld.

The relative tensile strength of the weld compared to the original metal is a matter of interest. We find in practice that where the weld is of the same thickness as the plate, 75 or 80 percent strength may be counted upon for an average job. I have pulled a number of test pieces in the puddling machine that, when broken outside of the weld, showed over 100 percent, and I have seen some pulled that showed less than 50 percent. That is a thing that is hard to determine unless you know the welder. There is now being developed a machine on the X-ray principle which will enable you to look into the weld and see what is there. If there is a cold shut or dirt in there it will show up. I believe that machine will go a long way toward solving the riddle of what is in the weld.

It is practicable, wherever possible, to make the weld of greater cross-section than the sheet, in which case you can always count on over 100 percent joint. The increase in cross-section would be about 25 percent.

In this connection I might say that it has been my experience that electric welds are very seldom as strong as acetylene welds. It is the experience also of a good many of the boiler inspectors who have tested out both types, and I believe I am safe in quoting their statement. You do not get the tensile strength with the electric arc weld that you do with the acetylene. My theory is this: I believe that every particle that you drop is covered with a thin film of oxide. When it comes down, that film may be broken out more or less, but that is in the weld, and if it is subjected to punishment, as it is in the case, for example, of street car work, they do come off. You can take an acetylene torch, and, if necessary, puddle in a little area; the oxide will come to the top, as well as the dirt, and a strong weld will result.

As to whether it is possible to get material in a weld of, say, half-inch boiler plate in which the welded material is capable of elongation, here is the situation: When you are welding a steel plate, always remember this: The weld, wherever it is, is cast steel, and the balance is open-hearth or rolled steel, which, of course, signifies that the grain in the weld is coarser than the grain in the balance of the plate. For that reason we do not get the elongation nor the ductility in the weld that we do in the sheet. I have seen some fellows preparing test coupons, who anneal their weld, which can be done in practice very frequently—or they hammer it. By hammering it, they try to close the grain, make the grain finer, and thereby get a stronger job. You do get slightly finer results that way, but I find that the hammering only takes effect on the surface. On a half-inch test coupon, if you hammered the weld, I do not believe you would find the grain would be fine for a depth of about 10 or 15 one-thousandths. It does not sink into the metal. Where the welding is, you have practically cast steel, whereas the balance is rolled steel. That is why you do not get the elongation and conductivity. For the wire, we used to get a very fine grade of pure Norway iron that was exceptionally clean. That made a very ductile weld. We cannot get that now.

Getting Results

The cost of the work and the results depend almost entirely upon the operator. There is a good deal of difference in welders. I have seen some welders who would get the same results and use half as much gas as others. A number of the large companies that are interested in the oxy-acetylene process have opened schools for welders. We have such a school going in our factory at Jersey City now. Men come in lots of twenty-five and take a two-weeks' course. You would not take a farmer and put him in a foundry and expect to make him a molder in a few days. It cannot be done. It is the same way with welding. You cannot pick it up over night. That is why we have these schools.

Cutting by the Oxy-Acetylene Process

Of equal importance to welding is the cutting of steel by the oxy-acetylene process. It seems almost impossible that steel up to a thickness of about 20 inches can be cut by a tiny flame about as rapidly as weed can be sawed. The torch used for this work is similar to the welding torch, except that in addition to the regular oxy-acetylene flame, a jet of pure oxygen can be turned on, which actually does the cutting. The piece to be cut is heated on the edge with the regular flame, after which the oxygen is turned on. A hand torch is used for miscellaneous work, such as cutting out patches in boilers, cutting irregular shapes in plates which were formerly punched out, cutting steel "I" beams and in wrecking steel buildings. In a number of cases this work has been done at from one-fourth to one-sixth the cost of any other method. One important use is the cutting of risers on steel castings.

A machine built on the principle of the common drawing-board pantograph has found a wide commercial application in cutting out dies and stripping plates, cams of irregular shapes and the butt end of connecting rods. The motor will run on either direct or alternating current of 110 or 220 volts, and the pointer has a constant speed of travel through a train of gears. The pointer is guided over a drawn design and the same design is cut out of the metal.

Limitations of Machines for Cutting

A clean cut, of course, is rather a relative term. What I might call a clean cut you might not. But with the use of the machine we can get a cut that approximates a saw, except that it has slag on it. With the hand torch we cannot get so smooth a cut, due to the motion of the operator's hand. We make a good many holes with a torch for rivets in riveting work, and they work out satisfactorily. But it is not as smooth as a drilled hole. Our torch will pierce steel up to about 2 inches thick. When you get above that you cannot pierce through.

We have found that some of the alloys—the tungsten, manganese and some chromium alloys—are particularly hard to cut. You can only cut them by heating them—heating the entire piece—which very often in practice is not advisable. We can cut steel of practically any carbon, from the low, open-hearth steel, even wrought iron, up to 125 tool steel. In cutting, heating the piece facilitates the work very much. Less oxygen is used and the work is more quickly accomplished. We have not yet been able to regulate the depth. The cutting torch must be driven all the way through to eliminate the oxide. We may have some data on that line to report later.

C. W. Cross, has been appointed by the Chicago Pneumatic Tool Company as manager of western railroad sales with headquarters at Fisher Building, Chicago.

Announcement is made by the Pittsburgh Screw & Bolt Company, Pittsburgh, Pa., of the opening on November 1, last, of branch offices in New York City at 50 East 42nd street. J. Allen Dillon will be in charge as manager of sales.

Westinghouse, Church, Kerr & Company, Inc., 37 Wall Street, New York City, announce the appointment of Russell W. Stovel as a consulting engineer. Mr. Stovel will devote his entire time to the electrical and mechanicail features of the work of this organization.

Due to the difficulty the employes of the Westinghouse Electric & Manufacturing Company have experienced in getting homes near the East Pittsburgh Works, the company has resumed the Home Building programme that was postponed during the war and forty-eight houses are now under construction. The site for the new dwellings is on a plot of 109 acres owned by the company and located in Wilkins township along Ardmore Boulevard.

The Boiler Maker

Published Monthly by

ALDRICH PUBLISHING COMPANY, INC.

Member of the Associated Business Papers, Inc.

6 East 39th Street, - - - - - New York

8 Bouverie St., London, E. C.

H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

Branch Office
Boston, Mass., 294 Washington Street, S. I. CARPENTER

So little has ever been done in the matter of standardizing boiler design that the paper on the "Application of Standardization and Graphical Methods to the Design of Cylindrical Return Tubular Boilers," published in this issue of THE BOILER MAKER, may serve as a basis on which future developments in this direction can be made.

The question of uniform boiler costs, which is being given great prominence in the discussions held by the American Boiler Manufacturers' Association, is simply an indication of the tendency towards standardization. The same idea carried to shop production is the next and last step which should be made in order that the industry be placed on a competitive basis, both between its members and with other countries.

In taking up this matter of uniformity in boiler design, the first problem is to co-ordinate the vast amount of existing data. No previous attempt to put this information in usable form has, to our knowledge, ever been made, but with the present paper as a basis, future work should present no great difficulties.

No doubt the engineering departments of individual plants have collected information for their own use, but needless to say there is usually a very slight benefit to the rest of the industry from these sources. To all intents and purposes, boilers of a given type and size, no matter where built, should have approximately the same quantities of material going into their fabrication. To arrive at a uniform cost or an equable basis for determining the cost of similar boilers, they should be essentially the same in construction. Past proceedings of the American Boiler Manufacturers' Association have shown that this is not so.

We should like THE BOILER MAKER to be instrumental in keeping the industry informed of all advances made in the standardization of design, cost or production. To do this we need the co-operation of every individual in the trade who believes in the development of progressive methods.

The recent statement by the American Manufacturers' Export Association that "for the best interests of America's future foreign trade the export balance of more than $3,000,000,000 for the past year would have to be reduced" brings to our attention the ever increasing necessity of definite action being taken to establish satisfactory credit relations with Europe.

In part the association declares that "Since the United States produces more than it consumes, it cannot reach the full measure of prosperity except as part of a prosperous world; and since a prosperous world cannot be had until Europe is encouraged to increase its production so that its consumption will at least be equalized, the business man of this country realizes that he is faced with a situation where he should co-operate in restoring European industry and, in a sense, in building up his competitor's trade for the sake of the welfare of this country and for his own individual business future. We still have an export balance of over $3,000,000,000 to be paid. There are three ways only of paying, in goods, in gold, or by the extension of credit. The payment admittedly cannot be made in gold. The shelves of Europe are empty of goods and the facilities for immediate production are lacking. Credit must be extended, and for long enough terms to enable Europe to produce, and with goods decrease this astounding export balance. Organization and team work, between the bankers, the manufacturers, and the investing public are needed to extend credits amounting to billions of dollars."

There is no question as to what policy the boiler industry should follow in this matter for the need in Europe of replacement material for industrial and power plants as well as railroads is too well known to require comment.

The statement in the November issue of THE BOILER MAKER, that the twelfth annual convention of the Master Boiler Makers' Association will be held at Minneapolis, Minn., has been confirmed with the additional information that the meeting will take place at the Curtis Hotel.

The second quarterly meeting of the American Boiler Manufacturers' Association will be held at the Hotel Astor, New York, on January 8, at 10 A. M.

At the September meeting, also held in New York, a great deal of interest in the important matter of boiler cost finding was aroused. So many discrepancies occurred in the various estimates submitted that it was determined, in sifting the matter to the primary causes of errors, to thoroughly investigate the various factors entering into the determination of the overhead charges carried by the different members of the Association. The present session will be devoted to a discussion of the results of investigating the matter by means of questionnaires supplied to the members.

For the information to be inclusive and of real value, every member of the association should give the answering of the questionnaires very careful consideration.

Engineering Specialties for Boiler Making

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

Wooden Bridge Rope-Driven Crane Evolved Into Steel Electric Drive

A wooden bridge crane originally developed for use in stone quarries by the Lane Manufacturing Company, Montpelier, Vt., has been adapted to other uses by changing the structure to steel and introducing electric drive. N. B. Payne and Company, New York City, agents for this crane, have recently announced improvements in the design.

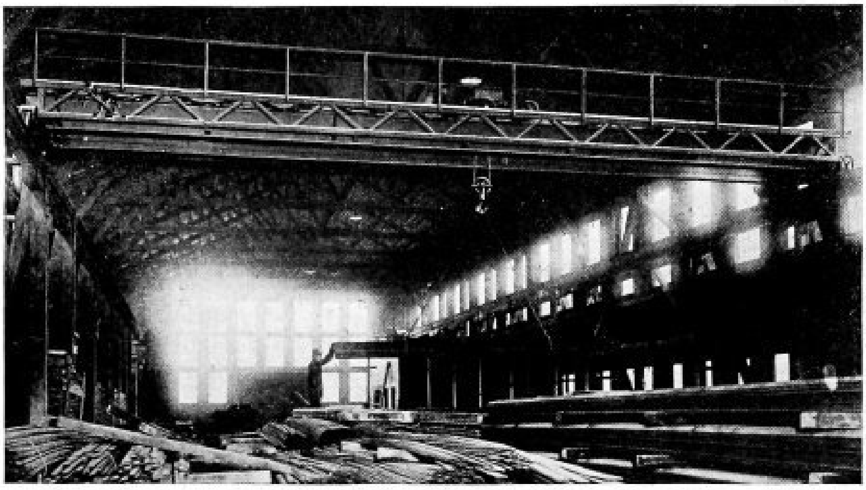


Fig. 1.—Lattice Box Section Girder Type Crane

Two motors are used for the three movements. Both motors are constant speed, non-reversing, in which the use of controllers and complex wiring has been eliminated. Control of all movements, including that of direction by means of a series of friction cones, is mechanical.

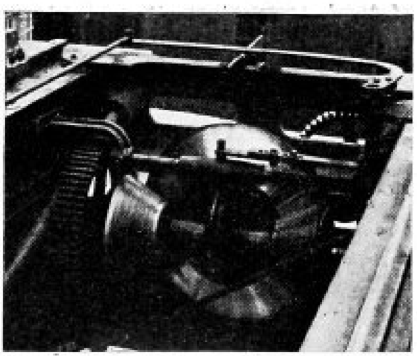


Fig .2.—Friction Cones and Gears on New Crane

Bridges are supplied in three styles:

For short spans, rolled steel I beams, reinforced with inverted channels riveted to the top flanges when necessary.

Steel girders of the lattice box section type for long spans, Fig. 1.

Heavy timbers of long leaf yellow pine reinforced bv large steel truss rods.

In all cases, these bridges are designed with a large factor of safety, at least 5, and with ample strength to sustain the load without undue deflection, horizontally or vertically.

The bridge girders are supported by cast iron end trucks, provided with cast iron, double flange, chilled wheels, which have steel axles running in renewable bearings. The trolley, made of cast iron, is designed for rigidity, compactness, accessibility of all parts, and is suitably reinforced with steel tension rods. The sides are joined together by several steel shafts. Power for hoist and trolley movements is transmitted by friction cones through steel worms, engaging bronze gears running in oil, Fig. 2.

The worm-gear drive is a load brake, controlled by a hand wheel. Two speeds of the hook are furnished with one part of rope. A luff block is provided with a hook and hinged, housed sheave, so that by running the line through this sheave and attaching the single rope hook to a girt on the underside of the trolley a two-part reaving of the rope is effected, thereby dividing the first two speeds by two, supplying four hoist speeds.

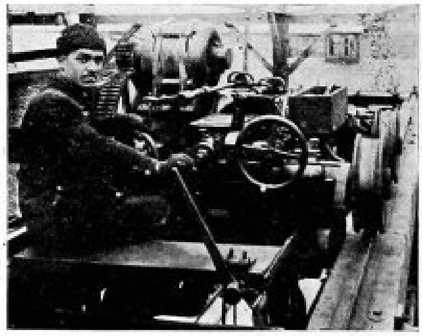


Fig. 3.—Hand Wheels for Controlling Operation of Crane

The following are approximately the speeds for a 10-ton standard crane:

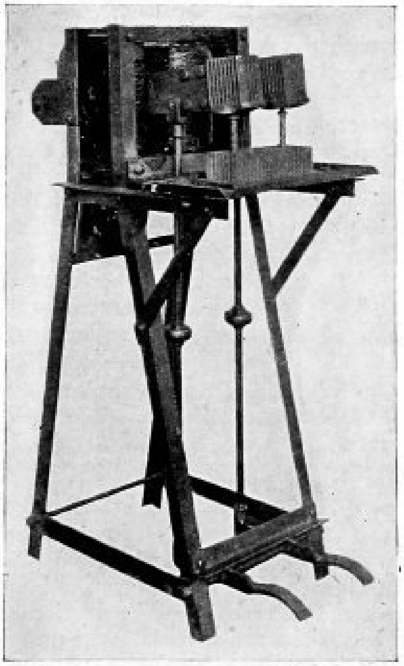
No load—40 feet per minute with one part of rope.
2½ tons—20 feet per minute with one part of rope.
5 tons—10 feet per minute with two parts of rope.
10 tons— 5 feet per minute with two parts of rope.

The hoist motor, through the same power cone, operates the trolley motion on the bridge at approximately 100 feet per minute. The reverse is obtained in the same manner as with the hoist movement. All movements are controlled by hand wheels, Fig. 3.

The bridge motor drives a friction disc by transmission through a pair of opposed cones, alternately contacting therewith. Control of the bridge travel movement in either direction is effected by shifting the cones by means of a lever connected to a rod running the full length of the bridge convenient to the operator's left hand.

Electric Rivet Heating Device

An electric rivet heater has been placed on the market by the General Electric Company, Schenectady, N. Y.



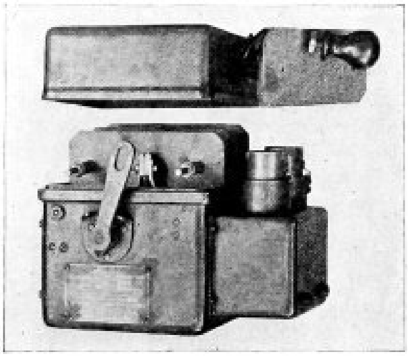
Electric Rivet Heater

The basis of the design is a transformer rated at 15 kilowatts mounted on angle iron legs, which may be fitted with wheels. At the front of the transformer, two copper bars are fitted with heavy, air cooled electrode blocks of cast copper, while under these is another copper block which acts as a support and as an electrical connection for two rivets in series. When the rivets are in place on the block, the electrodes are allowed to drop on the heads, thus completing the circuit and commencing the heating process. The two electrodes may be raised independently by two foot pedals, gravity being sufficient to lower the electrodes when the foot is removed. A primary tap switch mounted on the back legs of the machine gives all the variation needed for different lengths and diameters of rivets and rate of heating desired.

The sizes of heaters so far developed are a 5 kilowatt, two jaw for rivets up to ½ inch, and a 15 kilowatt, two jaw for rivets up to ⅞ inch.

Safety Starting Switch

Safety for the operator, safety for the motor and equipment and safety for itself are the three features embodied in a new type of starting switch for a small induction motor that is being put on the market by the Westinghouse Electric and Manufacturing Company. It is



"Fool-Proof" Starting Switch

claimed that the switch is accident proof and well nigh fool proof.

The action of the switch is automatic and consists of strong springs attached to the contact parts and controlled by a trigger. This trigger is released by overload, failure of power or by hand. When the switch passes the neutral point, the spring snaps it the rest of the way. The switch is shown in the accompanying illustration. Live parts are entirely enclosed in a dust-and-dirt-proof case.

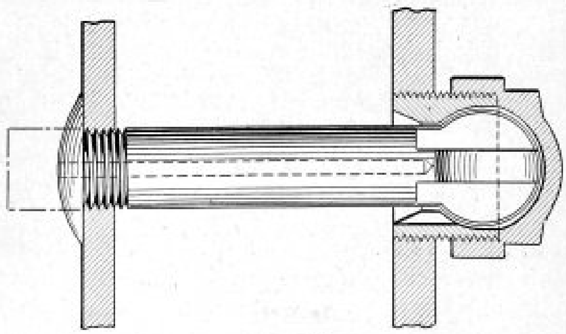
When power leaves the equipment, a low voltage, protective relay releases the trigger and throws the switch. Upon the return of power, it is necessary for the operator to move the handle first to the reset position and then to the running position, before the motor can again be started.

Any undue overload causes the overload relay to release a trigger, which opens the switch as if the voltage failed. An overload throws out the switch and it must be reset before the motor can again be started.

Two sizes are made, each for use on two and three phase motors, with voltages up to 600. Type No. 815 starts motors of 10 horsepower or less, while Type No. 816 starts motors up to and including 25 horsepower.

Flexible Staybolt

The new flexible staybolt invented by Harry A. Lacerda of Jersey City, N. J., and described in the July issue of THE BOILER MAKER, is designed with a ball and socket joint connection between the head of the bolt and the plug, or sleeve, screwing into the outer boiler sheet. Water is allowed to circulate in one member of the ball



and socket, so that the seat may be kept free of sediment and other extraneous matter.

The staybolt may readily be seen in the sleeve, so that there is never any question as to whether it is properly seated or not.

Questions and Answers for Boiler Makers

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

This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 6 *East 39th street, New York City.*

Oil Can Problem

Q.—Please advise me how to determine the size of an oil can to hold 10 gallons. This information is necessary so that I can figure out any size of can to hold any given number of gallons. G. B.

A.—In this case I assumed the diameter of the can to be 12 inches. The breast of the can is a 30-degree cone, having a spout attached as shown, Fig. 1. In making the calculations I have omitted the volume of the spout, and the area of the stopper at the top of the cone. In one gallon there are 231 cubic inches, therefore, in 10 gallons there are 2,310 cubic inches. The cubic content or volume of the cone *acd* is determined as follows: Multiply the area of the base of the cone by its height and divide

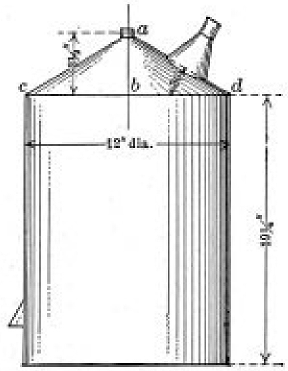


Fig. 1.—Oil Can Designed to Hold 10 Gallons

the product by 3. In this case the distance *cb* or height of the cone equals 3½ inches. The area of the base of the cone equals 113.1 square inches $\frac{113.1 \times 3\frac{1}{2}}{3} =$ 131.95 cubic inches. The area of the base of the cone is determined as follows: Square the diameter of the base and multiply the result by 0.7854. Subtracting the volume of the cone from 2,310 cubic inches, we have 2,310 — 131.95 = 2,178.05 cubic inches, which is the required volume of the cylindrical part of the vessel. Dividing the volume of the cylinder by the area of its base equals the required height of cylinder, thus, 2,178.05 ÷ 113.1 = 19.25 inches, height of cylinder.

Scale Remover

Q.—With reference to the article in THE BOILER MAKER for August on "Boiler Water Treatment," I would like to know the proportions of graphite and kerosene used for the removal of boiler scale. C. E. C.

A.—The improper use of scale resolvents or removers, so commonly called, has, no doubt, caused many serious boiler troubles. Untreated feed water contains chemicals, such as carbonates of lime and magnesium which are scale producers. These form a hard scale when the water is boiled, and which adhere to the sides of the boiler shell, tubes and crown sheet. This scale accumulates rapidly and if not removed from the shell or firebox plates directly in contact with the intense heat of the furnace, they soon become overheated and much damage may result.

To prevent scale forming on the plates and to remove scale, various compounds are used. Kerosene oil being volatile and penetrating, works into the scale and tends to loosen it up. If the kerosene oil is used, it is recommended that the oil be introduced when the boilers are emptied. The oil being lighter than the feed water, will float on top and thereby come directly in contact with the scale. After this application, the oil may be introduced daily with the feed water. The quantity of kerosene oil to be used depends on the size of the boiler. Some engineers use about one quart of the oil per day for each 100 horse-power.

If graphite is used in combination with the oil, stir the two ingredients together so that the mixture is fluid. The graphite having a higher specific gravity will settle in the oil, but it is lighter than water and will float on the surface of the water. Graphite is neither volatile nor penetrating. It will coat the boiler surfaces, and in mixing with the scale-forming substances, produces a soft scale that is more easily removed than hard scale.

Irregular Chute Problem

Q.—I would be very much obliged if your department will give me the general layout of the chute, Fig. 1. It is made of ¼-inch plate, all seams to be vertical with the bottom and the sides to be 15 inches high. As will be seen in the sketch, the narrow end of the bottom is half round and gradually becomes flat as it reaches the top. G. C.

A.—This layout involves the method of triangulation to develop the patterns for the sections of the chute. In this case we have made the curved section in three pieces at *A*, *B* and *C*, each section having an elliptical shape at the bottom on the miter lines. The development for one section will be sufficient to show how the principle of such a development is applied. Section *A* will be chosen for this purpose. Its plan is a triangular shaped section, the elevation showing the curvature of the bottom and its straight sides. The dimensions of this section Fig. 1 are transferred to Fig. 2, and the development made for the curved section on the miter line 1-2, 3-4. The outline is elliptical having a major diameter equal to the length of the miter plan view, and a minor diameter equal to the distance *X* of Fig. 1., which is measured on the projector drawn from *h* of the plan, as indicated at *x*. A semicircle is now drawn at *a* with a radius equal to *x*, and also one at *b* in the elevation. Both semicircles are divided into the same number of equal parts. From the points on *b* draw lines at right angles to the miter, intersecting it in points *f-g-h-i* and *j*. Vertical lines are drawn from these points to the elevation and corresponding ones from the profile at *a* intersecting at *f-g-h-i* and *j* in the elevation. Draw in the foreshortened view of the ellipse in this view, also the straight sides for the section and the true shape of end 7′-*c*-5′ for the outer end of the chute. Draw the triangulation lines, making the solid lines from *a* to *j*, *b* to *i*, *d* to *g* and *e* to *f* parallel to the horizontal.

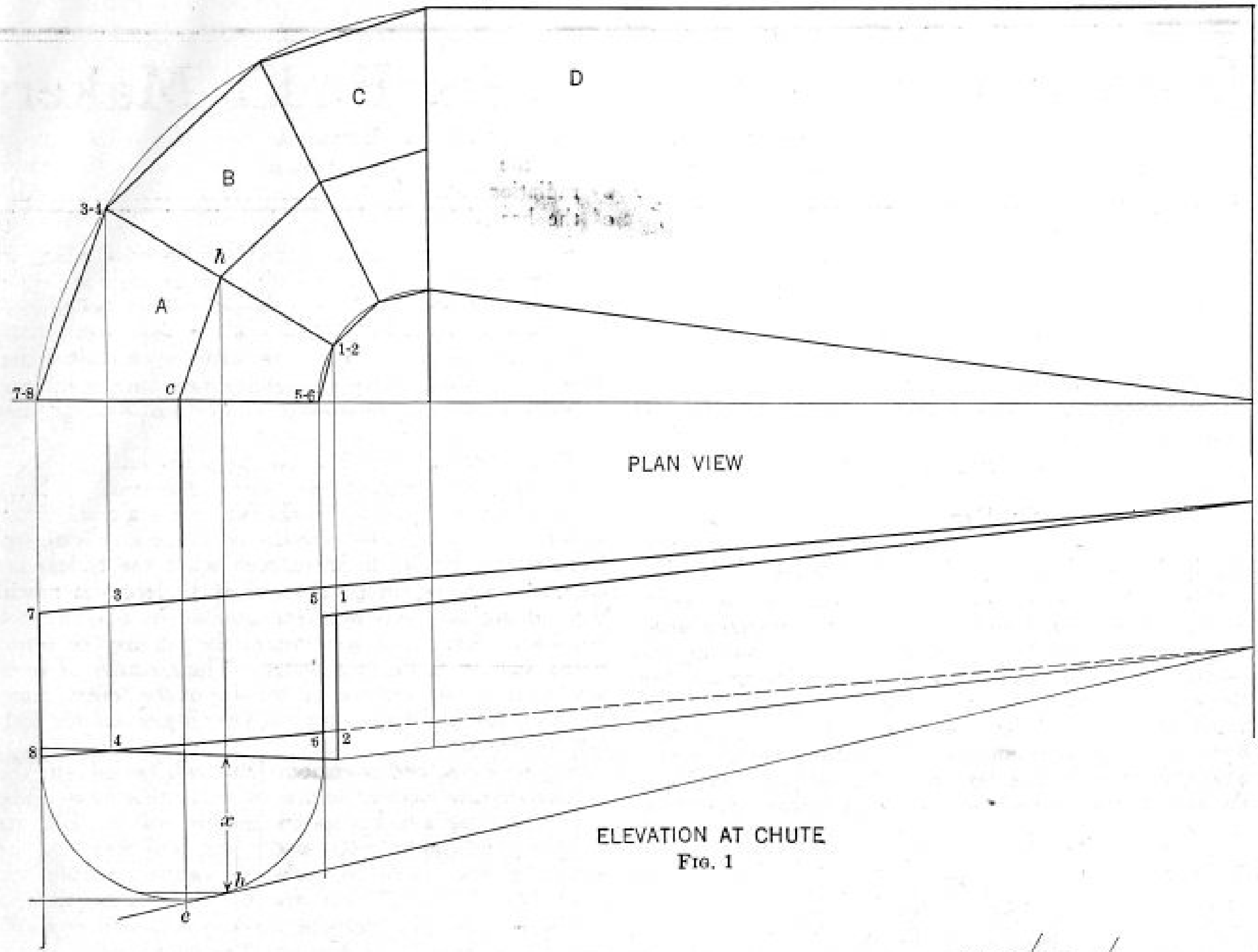


FIG. 1

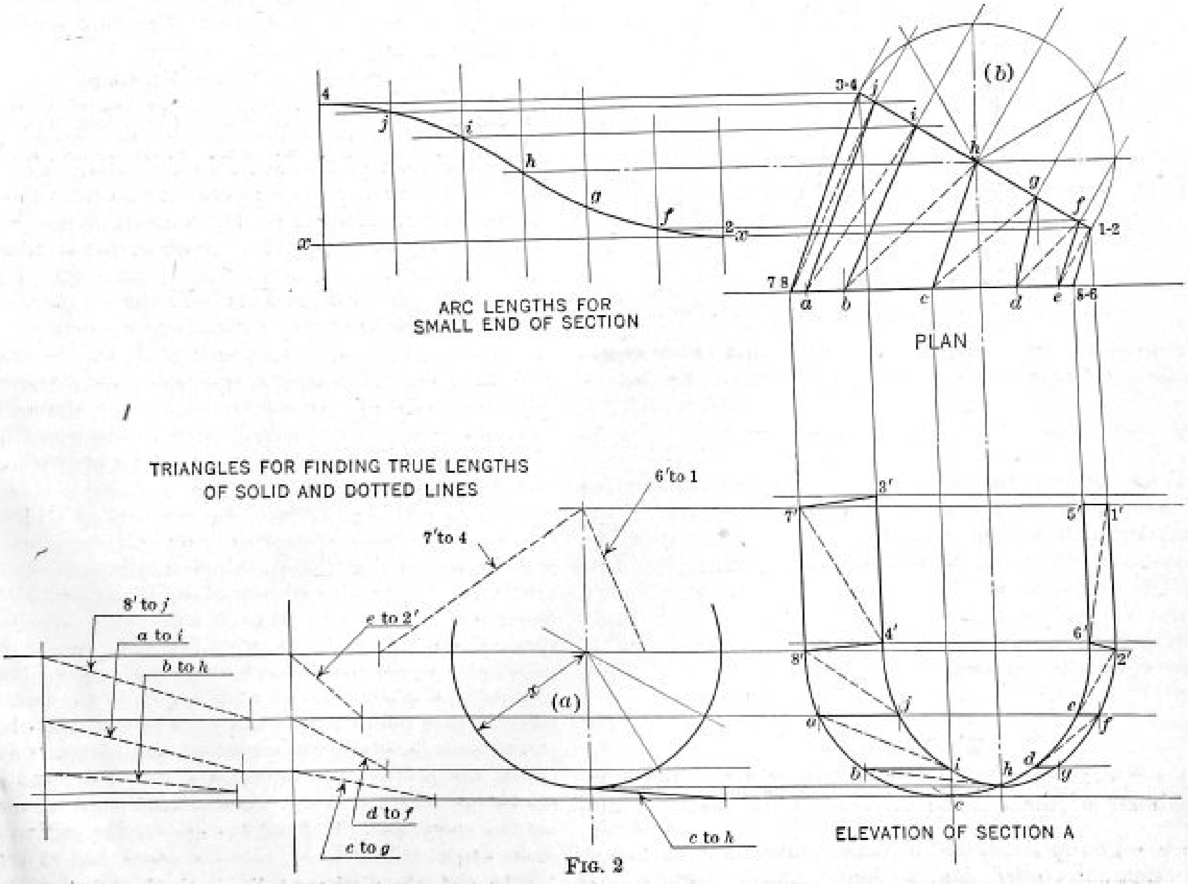


FIG. 2

General Layout of Irregular Chute

These lines being so placed, their true lengths are indicated in the plan. The dotted lines, are foreshortened. Their true length is established by constructing right angled triangles shown to the left of the elevation, Fig. 2.

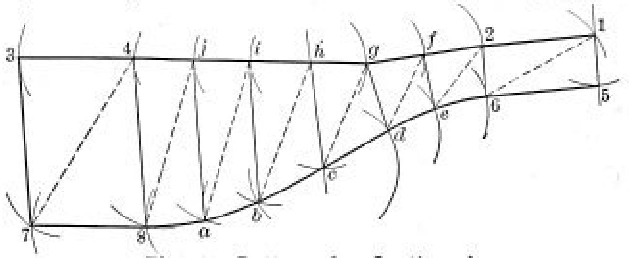


Fig. 3.—Pattern for Section A

The bases are taken from the plan and the lengths for the other legs are projected from Fig. 2 as shown and the hypothenuses are the required true lengths.

The true arc lengths of the elliptical section on the miter line 1-2-3-4, Fig. 1 of the plan view must also be found. Parallel to the horizontal edge line of the plan Fig. 2 draw a horizontal line from 1-2 of indefinite length. On this line set off the arc lengths of the elevation from 2′ to *f*, *f* to *g*, *g* to *h*, *h* to *i*, *i* to *j*, *j* to 4 and erect perpendicular lines from the points so established to the base line *x-x*. Parallel to *x-x* and from the points on the miter project lines from the plan, Fig. 2 to intersect the corresponding ones in the diagram for finding the true arc lengths.

PATTERN LAYOUT

Lay off the line *c-h* Fig. 3 equal to *c-h* of the triangles. From point *c* as a center describe arcs with a radius equal to the *arc* length *c-b*, Fig. 2 of the elevation. With *h* as a center and radii equal to *h-g* or *h-i* of the diagram on line *x-x* draw arcs. With *c* as a center and the true length *c-g* of the triangle draw an arc intersecting the arc drawn from point *h* to point *g*. With *h* as a center and *b-h* of the triangles as a radius draw an arc intersecting at point *b*. Continue in this manner until the pattern is complete.

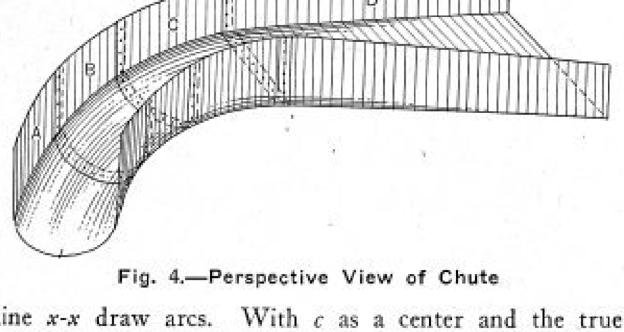


Fig. 4.—Perspective View of Chute

Water Circulation in a Scotch Marine Boiler

Q.—Kindly inform me how the circulation of water takes place in a single-ended Scotch marine boiler? Q. W.

A.—The circulation of the water is shown in the accompanying sketch. The rapidity of the circulation is due to the rapidity of the transfer of heat to the water by radiation, conduction and convection. About *one-half* of the heat from the furnace is radiated. The heat is conducted from the fire through the boiler plates and through the water by convection. Referring to the Fig. 1, it will be seen that the water nearest the shell or firebox plates becomes heated first, and as a result the water rises into the main body of water and cold water takes the place of the heated water. This movement of water creates a circulation.

The arrows indicate the circulation of the water. The water above the furnaces is heated first, rising between the tubes and alongside the tubes between the tubes and shell. Cooler water displaces the hot water, coming down between the shell and tube nests and between the nests of tubes. The water in the bottom of the shell is much cooler than the water in the upper half, owing to the poor circulation of the water in this part. This condition affects the life of the boiler and causes stresses in the shell plate. Devices for injecting steam at the bottom of the boiler are employed to promote the circulation of this cold water.

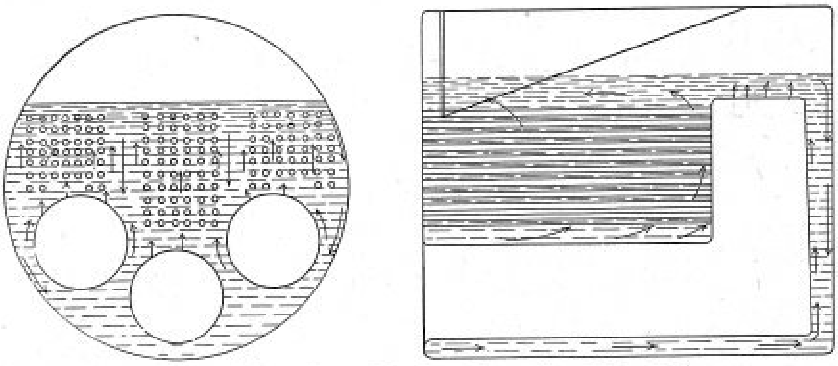


Fig. 1.—Water Near Fire Box Rises Into Main Body Thus Setting Up a Current

Spiral Riveted Pipe

Q.—Will you kindly inform me how to lay out a spiral riveted pipe? Any number of rivets, any degree of inclination and any diameter will serve to indicate the proper method of procedure.

A.—The development of the sheet or pattern for a spiral riveted pipe requires first the layout shown in Fig. 1. In this figure the helical path of the rivet line for the given pitch must be developed. The plan view is distorted somewhat so as to illustrate more clearly the method of making the helical construction. The circles taken in the plan represent the neutral layer of the plate, and the reason that there are two circles is because there are two different diameters in the pipe length. The difference in diameter between the two circles equals two times the plate thickness. The strip of metal for the spiral pipe must, therefore, be laid out so that the center line on one edge is larger than the one on the opposite edge, so that the pipe will be rolled to have a uniform inside diameter throughout its entire length. The large end being so rolled as to overlap the smaller end produces the spiral.

The elevation is laid off for at least one and one-half turns of the helical seam, being produced as show in Fig. 1. Lay off the pitch and divide the length into the same number of parts as the circles in the plan are divided into, as shown from 1 to 16 in this case. From the plan project vertical lines to the elevation to intersect the corresponding lines drawn horizontally from the points 1-2-3-4, etc. Their intersections as at *a, b, c, d*, etc., establish the points on the required helical seam line. Connect the points *a-a, b-b, c-c*, with the dotted and solid construction lines, but note that the curve *a-c-i* at the bottom of the helical outline is on the outside edge and the upper section is on the inner edge all for the purpose of having and *B-C* equal to the circumference of the larger circle. *A-B* equals the pitch of the helix and the line *A-C′* the length of the helical curve of the small section and *A-C* of the larger. Projecting the vertical distance between any two of the points on the pitch to the lines *A-C* and *A-C′* gives the true arc lengths as *m-n* for the small end and *o-p* for the large end.

The pattern Fig. 2, is developed complete for one and one-half turn of the spiral. The development involves

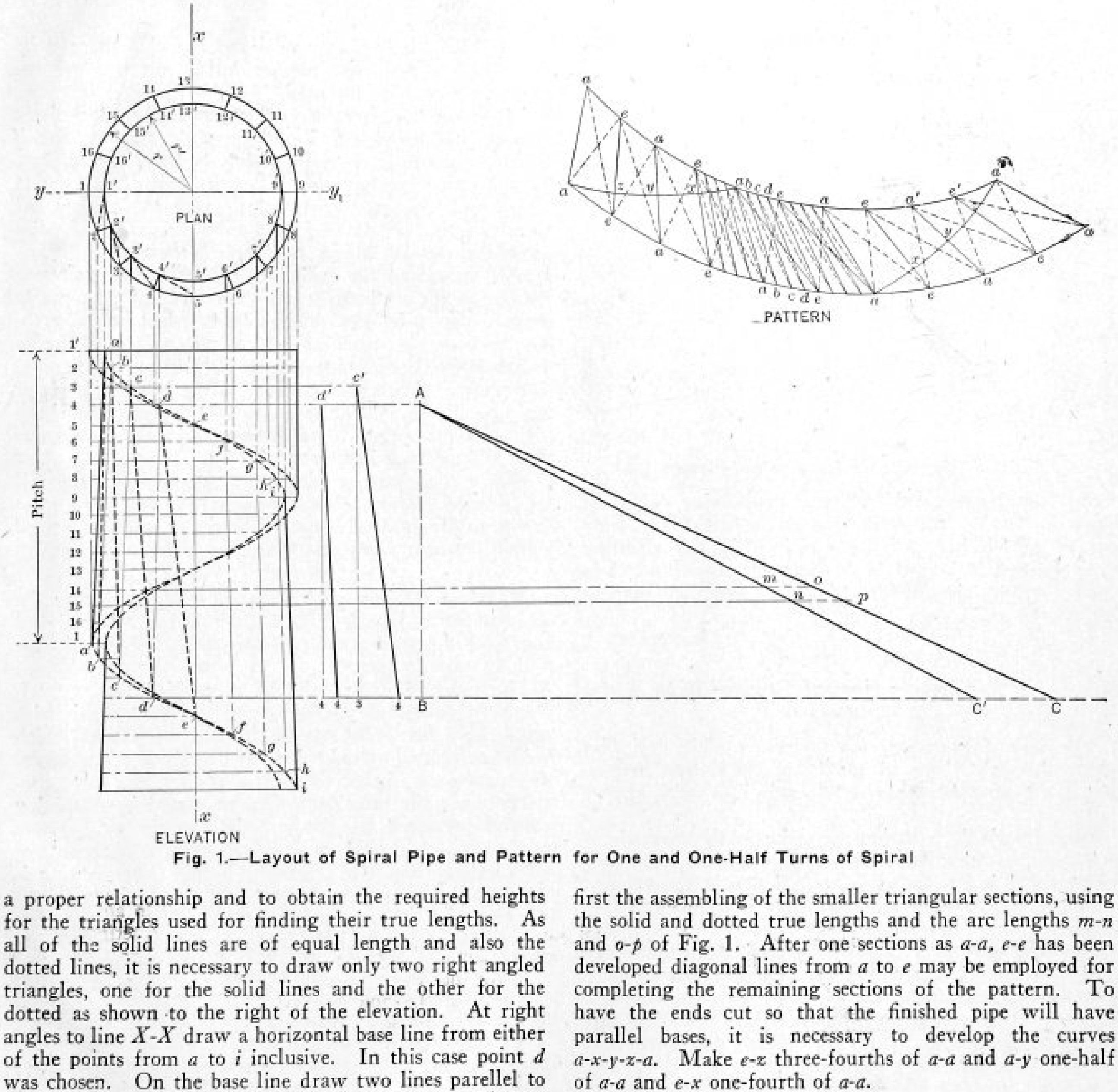


Fig. 1.—Layout of Spiral Pipe and Pattern for One and One-Half Turns of Spiral

a proper relationship and to obtain the required heights for the triangles used for finding their true lengths. As all of the solid lines are of equal length and also the dotted lines, it is necessary to draw only two right angled triangles, one for the solid lines and the other for the dotted as shown to the right of the elevation. At right angles to line *X-X* draw a horizontal base line from either of the points from *a* to *i* inclusive. In this case point *d* was chosen. On the base line draw two lines parellel to *X-X* as from the points 3 and 4. On these vertical lines lay off the vertical distance between points *d-d* and *d-c*. The horizontal base for the solid line *d* to *d* equals the distance between the solid lines in the plan and for the dotted line *c* to *d* the dotted diagonal length shown in the plan. Laying off these lengths on the base line for the respective triangles and drawing the hypotenuses gives the true lengths.

The next step is to find the true lengths of the arcs on the inner and outer edges of the spiral seam, which is done as follows:

On the base line from point *B* lay off *B-C′* equal to the circumference of the smaller circle in the plan view, first the assembling of the smaller triangular sections, using the solid and dotted true lengths and the arc lengths *m-n* and *o-p* of Fig. 1. After one sections as *a-a, e-e* has been developed diagonal lines from *a* to *e* may be employed for completing the remaining sections of the pattern. To have the ends cut so that the finished pipe will have parallel bases, it is necessary to develop the curves *a-x-y-z-a*. Make *e-z* three-fourths of *a-a* and *a-y* one-half of *a-a* and *e-x* one-fourth of *a-a*.

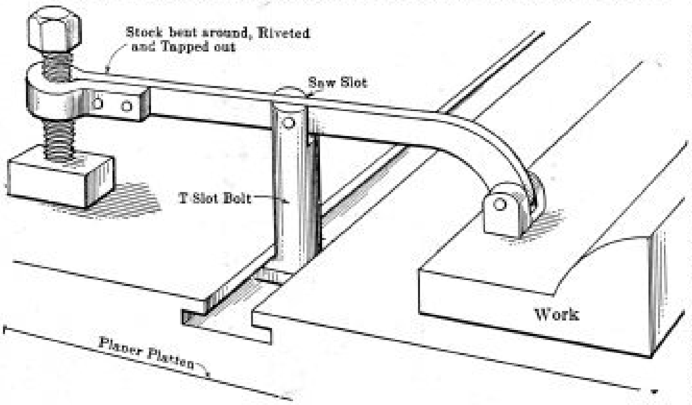
Make haste slowly when opening an oxygen cylinder valve. There are two reasons why. In the first place, it is injurious to the high-pressure gage to admit a pressure of 1800 pounds into the Bourbon tube suddenly. The impact may burst the tube and ruin the gage. In the second place, the sudden compression of the air or gas in the regulator passage is accompanied by heat. The heat may be sufficient under certain conditions to destroy the regulator seat, thus letting the high pressure oxygen into the diaphragm chamber and bursting the regulator.—*Autogenous Welding.*

Letters from Practical Boiler Makers

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

Handy Planer Clamp

This simple type of planer clamp was evolved by a planer hand to supply a quick-acting clamp for holding special parts, of which he had a quantity to machine. He made up a set of eight of these clamps, and speeded up the



Quick-Acting Clamp for Use on Planers

work of setting up considerably. The drawing shows the clamp in detail. The bolts were ⅞-inch and the clamp arm ⅜- by 1-inch stock. The end in which the adjusting screw is used is formed by bending the stock around in a small circle, riveting the two parts and then tapping out.

MACHINIST.

Notes on the Inspection of Locomotive Type Boilers

The following notes refer to boilers with steel fireboxes, although where other parts of the boiler are mentioned the remarks apply equally to those with copper boxes.

I have noticed a curious diversity in the methods of examiners, ranging from the cursory to the needlessly minute, and it has therefore seemed not inopportune to set down the points that experience has shown me to be useful.

We need not here discuss the testing of the plates at the steel works, as only in a small minority of cases is that done, and except in the case of copper firebox plates it is generally superfluous. But, assuming that one goes to inspect a finished boiler under hydraulic test, what are the things to observe?

Before pressure is put on observe the firebox plates inside and out for level and see that they are undisturbed when the full pressure is on. The common custom of taking deflections all over the boiler is probably a survival of Lancashire boiler practice and is of little use on a locomotive boiler. The firebox is the only important part to watch in this respect.

Examine carefully the tubes, especially at the firebox end, for any sign of leaking. It is well to insist before the boiler is tubed that the old pattern of 3-roller expander is not to be used, for ordinary sized tube expanders with 5 to 6 rollers are available for this operation. Much better work can be done with them, and the reason is obvious. Examine the firebox stays to see that:

(*a*) They are perpendicular to the plates.

(*b*) That the screwing is good and the size not reduced thereby.

(*c*) That the heads are well and smoothly snapped inside the box and that neither inside nor out are the plates cut into with the snap.

(*d*) That the rivets are not too near the edge of the plates. The plate will almost certainly crack in use if rivets are too near the edge. Only bad drilling or planing can cause this, but nevertheless it does occur.

A strong tendency exists for a crack to occur in the corner of the firebox back and tube plates at the point marked in the sketch Fig. 1. These corners should therefore be examined for evidence of fullering or acetylene welding or for a minute crack. The cause of these cracks seems to be as follows: The plater, when finishing the box, knocks this corner up cold to an angle considerably less than 90 degrees, for ease in putting on the foundation frame. When the box goes to the hydraulic riveter the corner is brought again cold to 90 degrees, and if the edge of the wrapper plate is badly thinned, possibly to less. A bad crack is the result.

Where roof bars or sling stays are used, see that all are in equal tension when the pressure is off. The same applies to longitudinal stays. The result of inequality of tension between different stays is too plain for statement.

CALKING

Allow no calking with a narrow tool, producing the result shown in Fig. 2. Such is the resort of a shop where more regard is paid to the rapid production of boilers than to their value in service.

The roots of flanges should be studied for any evidences of fullering. Many serious accidents have with reason been attributed to the fracture of flanges which had been fullered to make them fit barrels or other objects which were too big for them.

These are the principal points to regard in examining a boiler presented for the first time on the pit. There are, however, some things which no examiner can answer for unless he has seen the boiler built. The riveting is one. The examiner should certainly see the boiler when it is ready for the riveting bay, and should make sure that the alinement of the holes is accurate, that no drifting has been done, and that the rivets are of the corerct size.

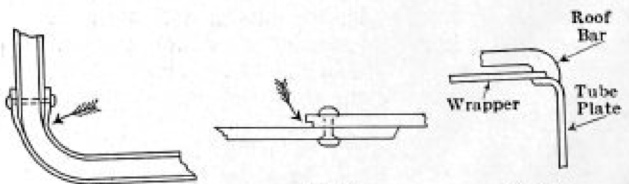


FIG. 1 FIG. 2 FIG. 3

Points to Notice in Locomotive Inspection

The fit and quality of the firebox stays are other points. It cannot be too emphatically stated that the threads of the stays are intended to and should carry the load. They can only do this if they are properly tapped. In a well conducted shop the stays are all passed to screw gages. The inspector seeing a boiler built should insist on all stays being cut to length before they are screwed in, if they are too tight to be moved by the fingers. If not cut to length they should subsequently be knocked about before the riveting is over. The inspector should also take tensile and bend tests and an analysis of the stay material. This is a point most frequently neglected, yet an important one. Many so-called stay steels are quite unsuitable for the purpose. For a steel of ordinary composition—not an alloy steel—the following are the maximum carbon, phosphorous and sulphur contents that in the author's opinion should be permitted: C. 0.25, P. 0.04, S. 0.03.

An admirable material, not at all difficult to obtain, is of the following analysis: Carbon, 0.10; silicon, 0.12; phosphorous, 0.004; sulphur, 0.026; manganese, 0.32. This steel gave the following tensile results: Maximum stress, 46,200 pounds per square inch. Yield point, 42,000 pounds per square inch, extension 26 percent, and bent double, cold, with no sign of fracture.

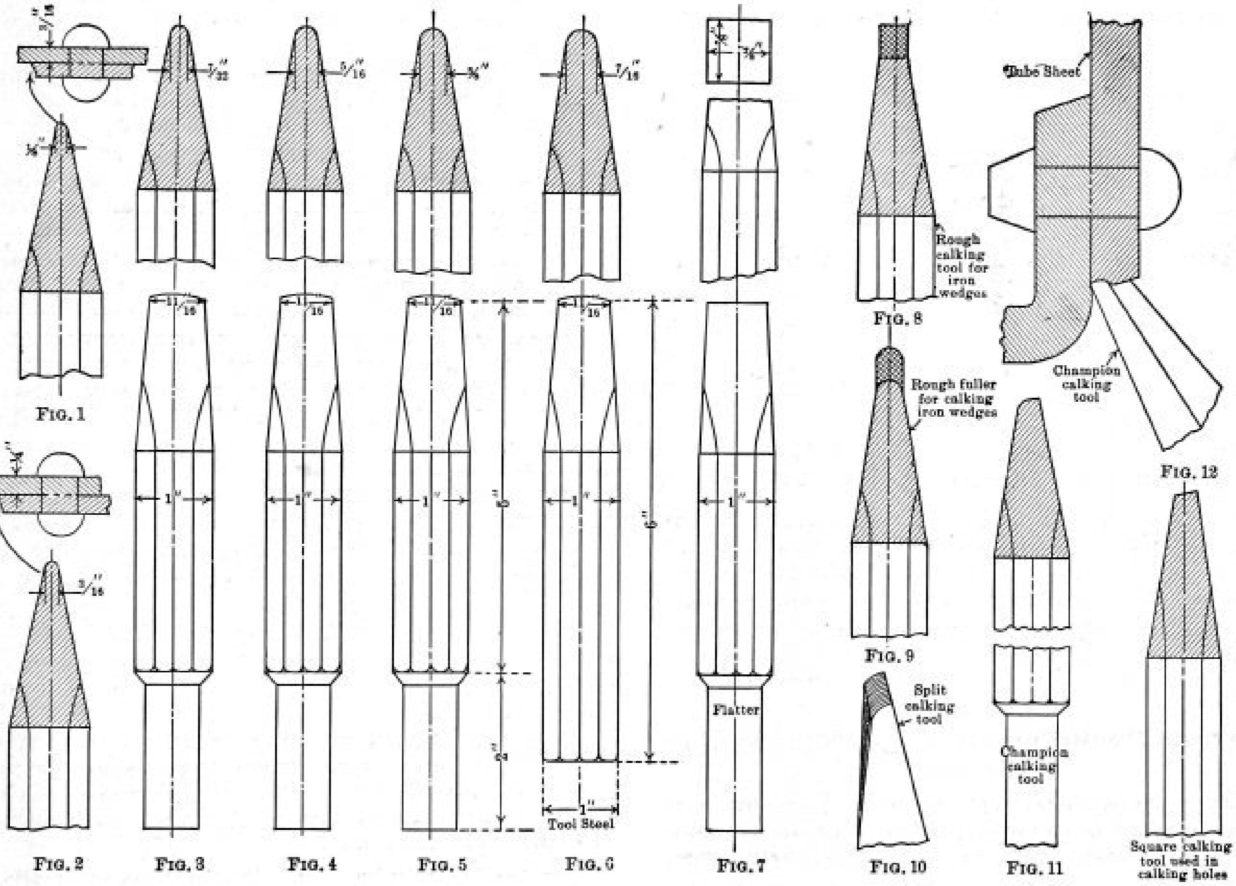
The next point is the relative size of the tubes and the tube holes. A hole in which the tube is free means an unnecessary and deleterious amount of expanding before a proper joint is made. Tubes should be reduced at the firebox end and swelled at the front end and should be a driving fit in the holes.

The final point applies only to boilers having the old pattern roof-bars. The fit of these on the box is not easily seen in the finished boiler, and though important, is not always good. They should bed on the tube plates, see Fig. 3, as well as on the wrapper-plate.

If the above points are observed one may safely pass the boiler. CHARLES RUSSELL.

Standard Calking Tools for Boiler Work

The writer has heard interesting discussions at the various conventions of the Master Boiler Makers' Association as to standard shop practice in sealing the joints on boilers, but never any mention of the standard calking tools which should be adopted by all boiler shops. This particular subject is given very little consideration. No doubt the old time boiler man understands what size calking tools he should use on various thicknesses of plates, but for the present day operators and as general information to all boiler makers the following sketches, showing the different sizes of fuller calking tools which should be used on different thicknesses of boiler plates, are submitted.



Standard Types of Calking Tools

Fig. 1 is for the calking of a $\frac{3}{16}$-inch sheet; Fig. 2 for ¼-inch sheet; Fig. 3 for $\frac{5}{16}$-inch to ⅜-inch sheet; Fig. 4 for ½-inch to ¾-inch sheet; Fig. 5 for ¾ to 1¼-inch sheet. Fig. 6 for 1¼ to 1⅝-inch sheet. Fig. 7 shows the flat face tool commonly called a flatter. This is used for smoothing up the work. Figs. 8, 9 and 10 are tools which are being used on ship work. Fig. 11 calking tool known as the "champion." This is a tool which is being used extensively on the up-to-date high pressure boiler and is productive of very excellent work. Fig. 12 is the old-time square calking tool which is now rarely ever used.

Jersey City, N. J. HARRY A. LACERDA.

F. W. Sinram, president of the American Gear Manufacturers' Association, has been elected president of the Van Dorn & Dutton Company, Cleveland, Ohio. For several years Mr. Sinram has held the position of General Manager of this company.

Franklin Schneider, who holds the position of president of the Van Dorn Electric Tool Company, has been elected vice-president of the Van Dorn & Dutton Company, Cleveland, Ohio. Mr. Schneider is well known among the gear manufacturers and users of the country.

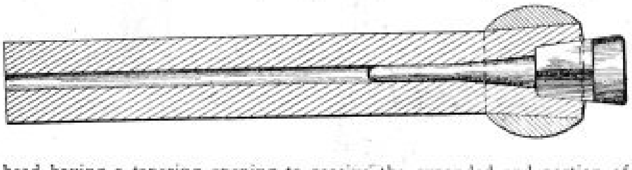
Selected Boiler Patents

Compiled by
GEORGE A. HUTCHINSON ESQ. Patent Attorney
Washington Loan and Trust Building,
Washington, D. C.

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

1,298,318. STAY BOLT FOR BOILERS. JOHN ROGERS FLANNERY AND ETHAN I. DODDS, OF PITTSBURGH, PENNSYLVANIA, ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

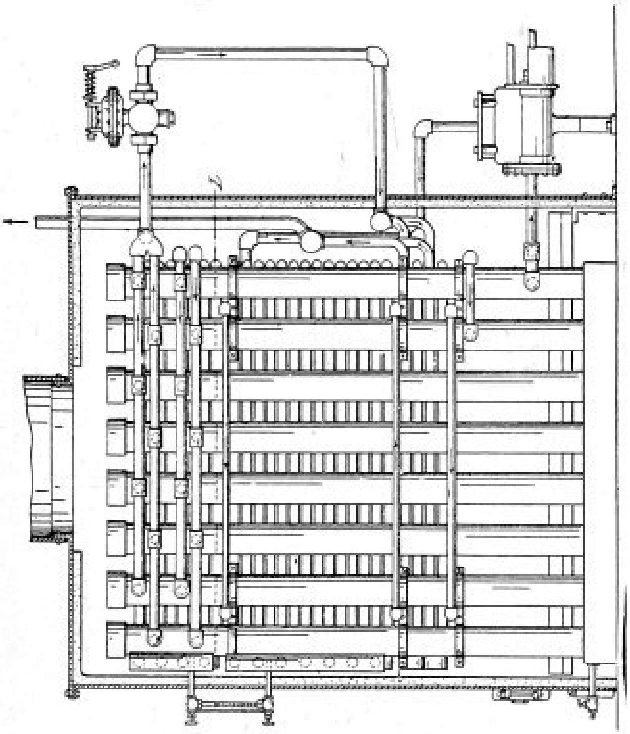
Claim 1.—A stay bolt comprising a body and a separate head, the



head having a tapering opening to receive the expanded end portion of the body of the bolt, the said head being rigidly secured on said expanded end portion. Three claims.

1,296,799. STEAM BOILER. ADOLPH C. J. HENNIG, OF SEATTLE, WASHINGTON.

Claim 1.—In a steam boiler, the combination with the upright steam and water containing headers, and a feed water pipe connected there-



with, of series of superposed steam generating coils connected with the headers at different elevations, a pump for effecting the flow of water and steam produced in said coils downwardly through all of said coils and returning the fluids into the steam spaces provided in the upper ends of the headers, and a series of coils connected with the upper ends of said headers and disposed below the aforesaid coils for superheating the steam subsequent to its delivery thereto from the headers. Ten claims.

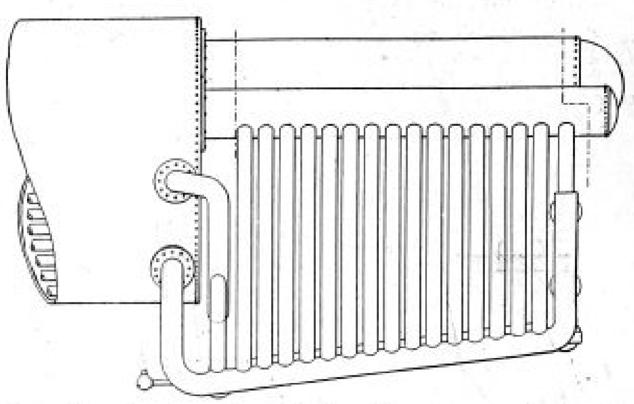
1,297,589. FUEL OIL FURNACE BURNER. MANUEL ROCHA PAVON, OF OAKLAND, CALIFORNIA.

Claim 1.—An oil burner having a rear member with twin passages therein converging forwardly to a single passage, hollow members extending forwardly from said rear member, a shell gripping one of said

hollow members and having an extension therefrom forming a tube having an opening therein, and an inner tube secured in said tube and spaced therefrom so as to form a channel leading from said opening rearwardly to the rear end of said inner tube, the said inner tube containing the front end of the front member of said hollow members and the caliber of said inner tube being greater than the exterior of said front member so as to form a channel between the same continuing from the channel first mentioned. Four claims.

1,319,184. FIREBOX FOR BOILERS. DAVID SMITH, OF WELLESLEY, MASSACHUSETTS.

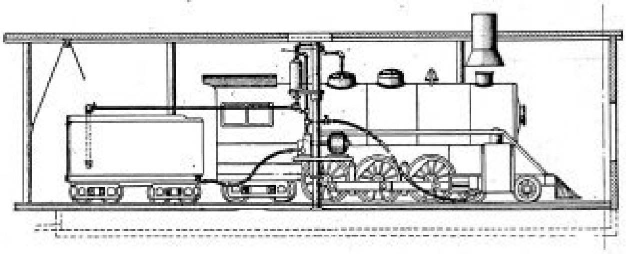
Claim 1.—In combination with a fire tube boiler having forwardly extending drums, a firebox construction comprising a grate, conduits extending downwardly from opposite sides of said boiler, a manifold



having side and end members inclosing said grate communicating with said conduits, vertically extending tubes connecting with the side members of said manifold and with said forwardly extending drums, a series of tubes extending upwardly from the rear member of said manifold, a curved header connected to said tubes and communicating at its ends with said boiler, said curved heater being so disposed as to protect the seam of the boiler and with the vertical tubes to form the rear wall of the firebox. Eight claims.

1,318,786. APPARATUS FOR BLOWING OFF, WASHING, AND REFILLING LOCOMOTIVE BOILERS. FRANK W. MILLER, CHICAGO, ILLINOIS.

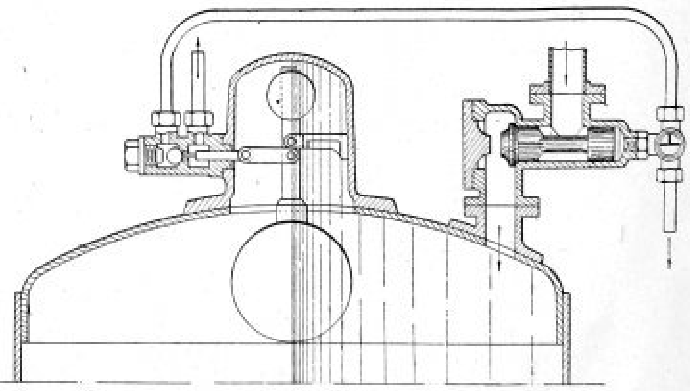
Claim 1.—In a locomotive blow-off, washing and refilling system, the combination of a steam condenser located adjacent a track, a flexibly



jointed steam pipe leading from said condenser and adapted to be connected into a boiler of a locomotive on said track, another flexibly jointed pipe leading from said condenser and adapted to be entered into the water tank of a locomotive tender on said track, a pump, an intake pipe for said pump adapted to be connected to said water tank, and a connection from the discharge side of said pump to said condenser. Five claims.

1,296,206. AUTOMATIC FEED REGULATOR FOR STEAM BOILERS. RICCIOTTI MORALI, OF GENOA, ITALY, ASSIGNOR TO SOCIETA ANONIMA ITALIANA GIO. ANSALDO AND C., OF GENOA, ITALY.

Claim 1.—The combination with a boiler, of a valve chamber mounted above the water level of the boiler and comprising upper and lower communicating compartments, a control valve mounted in the upper one



of said compartment, a float located in the boiler and operatively connected to said valve, a piston and valve chamber arranged below the water level of the boiler and communicating with the interior of said boiler, a feed water pipe connected to the piston and valve chamber for conveying feed water to the boiler, a feed water valve located in the piston and valve chamber and adapted to control the passage of feed water to the boiler, a piston connected to said feed water valve and mounted in said valve and piston chamber, said piston and valve piston chamber having a clearance space between the same to permit feed water to pass to the underside of the piston, a pipe placing the underside of the piston and valve chamber in communication with the upper compartment of the control valve chamber to permit feed water to exert pressure on the control valve and force the same toward its seat, and a pipe placing the lower compartment of the control valve chamber in communication with the atmosphere. Two claims.