THE BOILER MAKER

VOLUME XXVI

JANUARY TO DECEMBER, 1926

4327

PUBLISHED BY

SIMMONS-BOARDMAN PUBLISHING COMPANY

30 Church Street, New York, N. Y., U. S. A.

34 VICTORIA STREET, WESTMINSTER, S. W. I., LONDON, ENGLAND

INDEX

JANUARY TO DECEMBER, 1926

Note—Illustrated articles are marked with an (*) asterisk; Book reviews (B. R.); Editorials (E); Engineering Specialties (E. S.); Letter to the Editor (L); Paragraphs (P); Questions and Answers (Q).

A

B

C

D

E

F

G

H

I

T

U

V

W

Y

The Boiler Maker

Volume XXVI January, 1926 Number 1

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Edward A. Simmons, *Pres.*
L. B. Sherman, *Vice-Pres.*
C. R. Mills, *Vice-Pres.*
Roy V. Wright, *Sec'y.*
Henry Lee, *Vice-Pres. and Treas.*
Samuel O. Dunn, *Vice-Pres.*
F. H. Thompson, *Vice-Pres.*
George Slate, *Business Manager*

Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ave.
Mandeville, La.
Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.
Cable address: Urasigmec, London

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies 1s 2d.

Request for change of address should reach us two weeks before the day of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

Watertube Boilers for Locomotives

THE recent trend towards higher pressures in steam locomotives has naturally focussed attention on the possibilities of adapting the watertube boiler for this purpose. As pointed out by Mr. Louis A. Rehfuss elsewhere in this issue, the existing type of firetube boiler will not lend itself readily to any considerable increase over present pressures due to the increase of weight involved and other factors. Watertube fireboxes have already been applied to locomotive boilers and the next step will undoubtedly be in the extension of this principle to the whole boiler, although the present limitations of outside dimensions and shape make the problem a difficult one to solve. In discussing some of the possibilities of the watertube boiler, Mr. Rehfuss makes out a good case for the new candidate in the railway field. The many advantages of the watertube type of boiler, proved by many years of service in the stationary and marine fields, are too well known to call for comment here. As applied to the locomotive, however, theory and speculation will be of little help until trial and experiment have shown exactly what difficulties, if any, are to be met and overcome. In general it is only by the extended performance in actual service of a radically new departure in locomotive design that a real knowledge of its possibilities can be gained. This, he believe, will hold true in the case of the watertube boiler.

Why Locomotive Accidents?

ALTHOUGH the fourteenth annual report of the Chief Inspector of the Bureau of Locomotive Inspection shows a commendable decrease in locomotive accidents during the past fiscal year, it is to be hoped that a still greater decrease will be made in the coming months as compared with precedings years. The decrease amounted to 31.3 percent in the number of accidents, 69.7 percent in the number of persons killed and 33.9 percent in the number of persons injured. The report also states that the number of locomotives found defective in the course of inspection decreased from 53.4 percent in 1924 to 46 percent in 1925.

This showing is qualified by the fact that investigations of the department indicate that a still greater decrease could have been realized if the requirements of the federal laws had been fully complied with. The number of accidents caused by low water have been reduced mainly through the insistence of the bureau on the installation of adequate water level indicating devices and their maintenance in good operating condition. The study during recent years of methods for promoting water circulation in locomotive boilers has resulted in a marked decrease in crown sheet failures.

Although the chief inspector does not repeat in detail his previous statements on the subject of autogenous welding as applied to the boiler, he does give a warning of penalties that will be imposed where the law in this respect is not complied with. The value of welding as an economical means of construction and repair is recognized fully by the inspection department, but its use according to the law is limited to those portions of the structure where welded seams and joints are not required to carry a strain. On certain roads the same effort to insure good welding is in effect as exists generally in other lines of industry. In the majority of cases, however, the railroad development of welding in the shop is far behind that of other commercial lines.

An example of the requirements which must be met in the construction of steel stacks for example is given in this issue of THE BOILER MAKER. Before a welder is permitted to do special work of any kind, his experience must qualify him for the job. In addition, tests are made that duplicate conditions under which the work will be carried out. The specimens which he is required to weld are examined and tested to destruction. During the actual construction, special check specimens are required frequently by the inspector.

The chief inspector has asked for complete co-operation from all mechanical departments of the railroads of the country in continuing the improvement in the condition of locomotives under their charge. Since both his department and the railroads have the same interest at heart—the betterment of service and the safeguarding of life and property—the coming year will undoubtedly show a still greater decrease in accidents than the past one.

Conserving Time and Cutting Costs

WHEN business is good and orders are piling up faster than they can be filled, the thing that usually is in greatest demand is time. The shop is speeded up to the limit, extra shifts are put to work and everybody from the boss down to the rivet heaters is kept on the jump by the growing momentum of greater and faster production. In the effort to make hay while the sun shines time becomes increasingly valuable—and scarce. An hour gained here or a corner cut there helps to swell the output.

Unless such conditions are a commonplace state of affairs, which unfortunately is not the case in the boiler making industry, the idea of conserving time is given too little consideration by either the management or the men engaged in actual production. It is a problem for the management to study in season and out. Simplified design of the product, standardization of parts, elimination of waste, improved processes and methods, increased efficiency of machinery, reduction of breakdowns, accidents and repairs, reduction in labor turn-over and, above all, the stimulation of the ambition and desire of each member of the organization to do a day's work in a day and to do it efficiently, all enter into the result. To the men in the shop, it is a field no less broad and fertile for the application of common sense, practical ideas and the exercise of ingenuity in making an hour's time or a day's work count for something above the average. By the combined efforts of management and producers in this direction, under competent leadership, some startling results might confidently be expected in almost any boiler shop.

Conserving time and increasing output per man-hour mean lower costs. Lower costs mean a better chance for more business in competitive bidding. More business means steady work and steady pay. Why wait until business is booming and the sudden demand for increased output drags all hands into untried expedients for getting rush orders out on time? Slack times can be profitably spent in grooming the whole shop organization and equipment into efficient trim.

Many of our readers have undoubtedly at some time or other developed ways and means that have been helpful in conserving time and reducing costs in production. We shall be glad to publish in later issues helpful ideas on this subject. All letters published will be paid for. We believe that a wide discussion of the subject will be welcomed in every boiler shop no matter whether it has to do with merely a minor change in the bookkeeping department, the adjustment of a machine, the purchase of a new device, the adoption of a short-cut method or kink or the reorganization of the whole plant. Tell us about your own experience and ideas and read what the other fellow has to say.

LETTERS TO THE EDITOR

Small Boiler Explodes

TO THE EDITOR:

In one of the suburbs of Newark, N. J., a boiler recently exploded and did considerable damage in the basement of a bank building. The janitor of the building started a fire beneath the boiler for the first time in the season and it is now thought that the safety valve was not working—that it had stuck. As soon as steam pressure became too high, the boiler therefore simply let go.

The boiler was entirely demolished, doors of the building were blown off their hinges, windows broken, beams broken, and the building in general badly damaged. Parts of the boiler which exploded struck a larger adjoining boiler and damaged the latter.

This, again, emphasizes the importance of trying the safety valve at regular intervals.

Newark, N. J. W. F. SCHAPHORST.

Design for Locomotive Barrel Patch

TO THE EDITOR:

There seem to be two distinct ideas regarding the proper manner of repairing a fractured locomotive barrel.

We will assume that Mr. Wilson in the September number of THE BOILER MAKER has designed a suitable patch for a possible fracture in the barrel of a locomotive boiler.

Likewise we will agree that Mr. Kirkland's idea of repairing the same kind of a fracture by the welding process if properly done would be equally as safe with possibly ten percent of the cost that it would take to apply two riveted plates over the assumed fracture.

Regardless of the easiest and cheapest manner of this repair, so far as I know there are rules that govern the proper manner of doing it as sanctioned by government and state officials along with laws relating to the same repair.

And even those who have no jurisdiction over such duties I don't believe would agree to the welding of an unstayed boiler barrel whether a locomotive or stationary boiler.

Franklin, Pa. R. L. HAMILTON,
Pennsylvania State Boiler Inspector.

The Safety of Welded Repairs

TO THE EDITOR:—

In the November issue of THE BOILER MAKER, J. G. Kirkland of Leeds, England, made comment on the design for a patch on the barrel of a locomotive boiler submitted by W. Wilson in the September issue of same publication. The design submitted by Mr. Wilson to repair the fracture in the barrel of the locomotive boiler requires the application of plates covering the fracture both inside and outside of the barrel sheet to be secured by rivets in a manner similar to the standard practice of constructing double riveted butt joints.

This is a safe method of making repairs and meets the requirements of the different state and United States government authorities. Mr. Kirkland suggests welding without using any rivets, which would not be permitted in the United States on the barrel sheet of locomotive boilers.

While welding is proving a good method of making repairs on a boiler where it is not dependent on its own structure for support, it has not yet reached the stage of development where it can be depended on with absolute safety to withstand bursting pressure on boilers. As the barrel sheets are subject to bursting pressure it can be readily seen why it is not permitted in that part of the boiler.

As barrel sheet cracks are not an uncommon occurrence in locomotive boilers it is only reasonable to assume that the cause is not always defective material, but from service conditions which are very exacting on a locomotive. Therefore repairs should be made by an absolutely safe method.

While riveting may belong to the "Stone Age" in boiler making, it has been with us so long that there are many inspectors and mechanics who by being familiar with this method can readily determine by inspection whether a riveted joint has been done properly or not. Experienced welders do not say they can determine by inspection whether a job done by another welder is absolutely safe or not.

In the November issue of the THE BOILER MAKER an article by John S. Spicer under the heading "Are Welded Tanks Safe?" speaks very eloquently on this subject.

Where riveting is a much slower and laborious method than welding, it is still necessary to use this method from the standpoint of safety on boilers where sheets are subject to pressure in connection with other stresses due to expansion and contraction.

Olean, N. Y. J. H. FLAHERTY.

The Merits of Locomotive Firebox Crown Sheet Slopes

TO THE EDITOR:-

In the department of "Letters to the Editor" of the November issue of THE BOILER MAKER, page 307, M. B. Erickson of Hagerstown, Md., says in part: "Concerning the safe slope of crown sheets as I see it, very little if any benefit is derived from any of the various reasons given for the existing slope. * * * I am curious to know what would happen, or rather what the results would be, if the present height of the rear end of the crown sheet were maintained and the forward end lowered, so as to eliminate forward crown sheet and back flue sheet defects."

To begin with, the leveling of the crown sheet of the firebox on existing locomotives would be an expensive proposition and a lot worse to design them that way for new ones. There would be no appreciable advance towards eliminating crown or flue sheet defects.

The sloping locomotive firebox crown sheet is as much a necessity as any other important functioning feature of the locomotive especially of the present-day designs where the crown sheet reaches as much as 186 inches in length. Try and visualize a crown sheet of this length, or better still—get a straight stick, measuring 186 inches in length and place one end on a horizontally drawn line and raise the other end to an angle representing a maximum 5 percent grade. The result will be the difference in water level of the front or back end of the crown sheet while the engine is going up or down this grade, were the crown sheet of the level design. From this, it will readily be observed, that the extra amount of water that would have to be carried in order to keep the crown sheet fully covered with it would lessen the maintenance of the original power of the locomotive under the circumstances.

ADVANTAGES DERIVED FROM THE SLOPE

Safety of operation, efficient performance and increased power are some of the important acknowledged features derived from the service of sloping locomotive firebox crown sheet design.

Under safety of operation, let us consider the particular crown sheet mentioned above as being 5 inches higher at the forward end than the rear. Now say, from some neglectful cause, while the engine is standing or running on level track, the water within the boiler gradually gets low and reaches the point that will cause the fusible plug to melt out and give alarm. The fire is then immediately withdrawn to check steam generation and before any danger from burning the crown sheet develops, the situation is controlled and hardly any damage done, because the crown sheet was entirely covered with water with the exception of several inches in the vicinity of the fusible plug. Were the crown sheet level in this case, the highest point of transverse curvature would be exposed and *bare of water throughout its entire length,* thus, with consequently greater rapidity of evaporation due to the thin layer of water covering same, the hazard of blowing down or damaging the sheet is greatly increased. This feature alone justifies the adoption of the sloping design.

Under efficient performance, the slope affords better circulation and more rapid ebullition of the water, thereby producing more steam. It also keeps the crown sheet better washed of mud, scale and incrusting matter.

Under increased power, the slope affords a considerable addition to the number of tubes or flues permitted to be used, which otherwise would have no space for insertion in the back flue sheet. It is also well known that the heating surface of the tubes or flues nested near the top are of more potential heating value than the rest, therefore, substantially increasing the heating surface and consequent number of boiler horsepower. Likewise, an increase in firebox heating surface is also gained, the surface of which is more efficacious than all other heating surfaces of a locomotive boiler, the evaporative value being 5½ times that of the tubes.

Level type crown sheets for locomotive boilers are a past issue, except for the dinky engine.

Jersey City, N. J. T. P. TULIN.

Autogenous Welding for Patches

TO THE EDITOR:

In the November issue of THE BOILER MAKER a patch design was presented by one of the readers of this magazine which the author claims was recognized by insurance company inspectors in Great Britain. It may be all well and good to patch boiler shells that way in Britain, but don't try to get away with it in the United States, especially on railroads under the jurisdiction and inspection of the United States Interstate Commerce Commission nor any state working under the A. S. M. E. rules.

The minute you apply such a patch you might as well call in the junkman, for your boiler is condemned until proper repairs have been made.

As we have several readers of this good magazine in this country of ours, many of whom are novices and apprentices, let me here call their attention to the fact that before attempting any repairs they should consult the boiler inspection department of their own state and not attempt repairs as outlined in other countries or provinces.

For the information of those who desire to know whether autogenous welding will be accepted on boiler shells or unstayed surfaces, I will submit the following extracts from different Codes:

New York State Boiler Code, Bulletin 14, *Page* 132, *Paragraph* 9: Autogenous welding in patches in the shell of a boiler will not be acceptable regardless of the size of such patches. Autogenous welding of cracks in the shell of a boiler—except those specified in Paragraph 4 (which is girth seam cracks)—regardless of the direction in which they may lie will not be permitted, unless such welding is only for the purpose of securing tightness and the stresses on the part are fully cared for by *properly riveted-on patches or straps placed over the weld.* The plates at the ends of joints may be welded together for tightness provided the straps or other construction are ample to care for the stresses on the parts so welded.

Pennsylvania State Code for Regulations for Boilers, effective October 1, 1925, *Page* 22, *Paragraph G*-12: Gives the same rules as the New York State Code.

Ohio State Boiler Inspection Law Rules and Regulations Code of 1925, *Page* 234, *Paragraph* 9: Gives the same rules.

The chief inspector for the Interstate Commerce Commission of the United States in the 13th annual report to the Commission states that, due to the many failures, I have taken the position that this process (autogenous welds) has not yet reached a stage of development where it can be safely used on any part of the boiler where the strain to which the structure is subjected is not carried by other construction which conforms to the requirements of the law and rules, nor in firebox crown-sheet seams where overheating and failure are liable to occur, nor on sheets which have been weakened from any cause to the extent of becoming unsafe.

I believe that I have given you sufficient rules and regulations of the different states and the government to show that a patch applied as on page 306 of the November issue does not conform or comply with requirements in the United States.

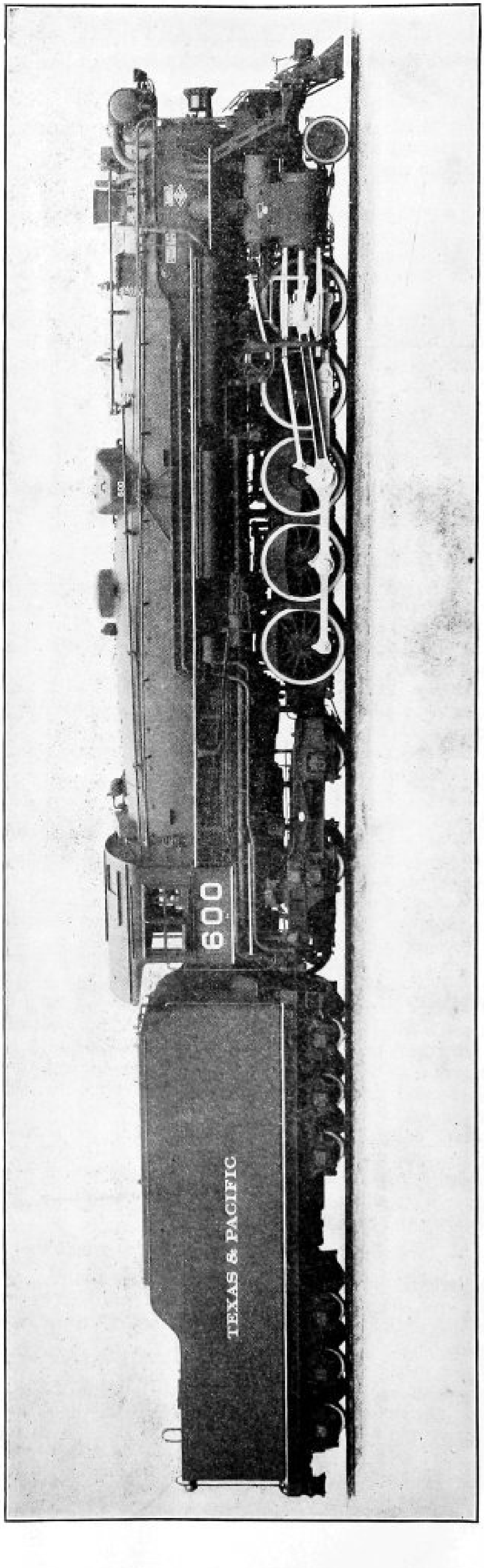
Further taking up the article published by the same author in the December issue, I would like to have him give our readers definite information and formula for figuring up welded joints or patches. This I know can not be done, for welding is not yet sufficiently advanced to do this. When we know that each individual knows how to weld and not merely attempt welding, perhaps we will recognize the welding, but until they do, we are off of it except on places where the strain is carried by other construction.

Binghamton, N. Y. CHARLES W. CARTER, JR.

BOOK REVIEW

DRAFT AND CAPACITY OF CHIMNEYS. By *J. G. Mingle. Size,* 5¼ *by* 8 *inches. Pages,* 339. *Illustrated. New York,* 1925: *D. Van Nostrand Company.*

The author has included in this book material which was published serially in *Combustion* and appeared through the years 1924 and 1925. The aim of the work has been to review and assimilate the field of draft and capacity of chimneys, arrange the matter in logical order and present the facts so that they may be applied to any condition of operation. It is primarily intended for the designer of power plants who is desirous of investigating all the conditions to which the contemplated chimney may be subjected to the end that the proper size may be obtained. It should also prove useful to the operator of power plants who wishes to check the size of his existing chimney with the view of discovering draft and capacity shortcomings and eliminating them should there be any. To a certain extent also it might be used by those individuals engaged in the actual construction of chimneys. The subject matter has been developed from the theoretical standpoint and then amplified by experimental data to conform with actual practice. No attempt has been made to develop theory or interpret practice of power plant factors other than that of the subject in hand but which of necessity must be included therewith; such as loss of draft through the boiler, loss of draft through the fuel bed, rate of combustion and the like. The logical manner in which the subject is covered is apparent from the arrangement of the chapters which take up in order the theory of natural draft, the losses due to velocity and friction, theoretical draft and draft performance, required draft and general draft equation, the height of the chimney, elements of combustion, theory of capacity, the diameter or area of the chimney, the chimney horsepower fallacy, altitude and its effect, chimney performance, relation between height and diameter, economical velocity.



The first Texas type locomotive built for the Texas and Pacific Railroad by the Lima Works

First Texas Type Locomotives for T. & P.

General description and boiler details of 2-10-4 locomotive developed by Lima Works

DURING the month of November, ten locomotives of a new type were delivered to the Texas & Pacific by the Lima Locomotive Works, Inc. These locomotives, which are known as the Texas type, are similar in the principal characteristics of their design to the 2-8-4 type locomotive, known as the Lima A-1, which was first placed in service by the builder on the Boston & Albany during the early part of this year and which has since received service tests on several other railroads. Both designs include the articulated four-wheel trailing truck carrying a large firebox; both have articulated main rods and the cylinders in both cases operate at a maximum cut-off of 60 percent. The new locomotives, however, have one more pair of driving wheels, making a 2-10-4 wheel arrangement, which increases the length of the boiler and the tractive force. They also differ from the Lima A-1 in that they are fitted for oil-burning service.

The new locomotives have a total engine weight of 448,000 pounds, of which 300,000 pounds is on the driving wheels. With a boiler pressure of 250 pounds and 60 percent cut-off, they develop a tractive force of 83,000 pounds, which is increased to 96,000 pounds when the trailer booster is in operation. A comparison of these and other of the principal dimensions, with similar dimensions of the Lima A-1, is given in the table.

Referring to this comparison, it will be seen that the weight on drivers of the new type locomotive averages 60,000 pounds per pair, which is 2,000 pounds less than the average driving wheel loads of the Lima A-1. The weight on both the front and rear trucks, however, is greater than in the case of the former locomotive, the total difference in weight amounting to 63,000 pounds.

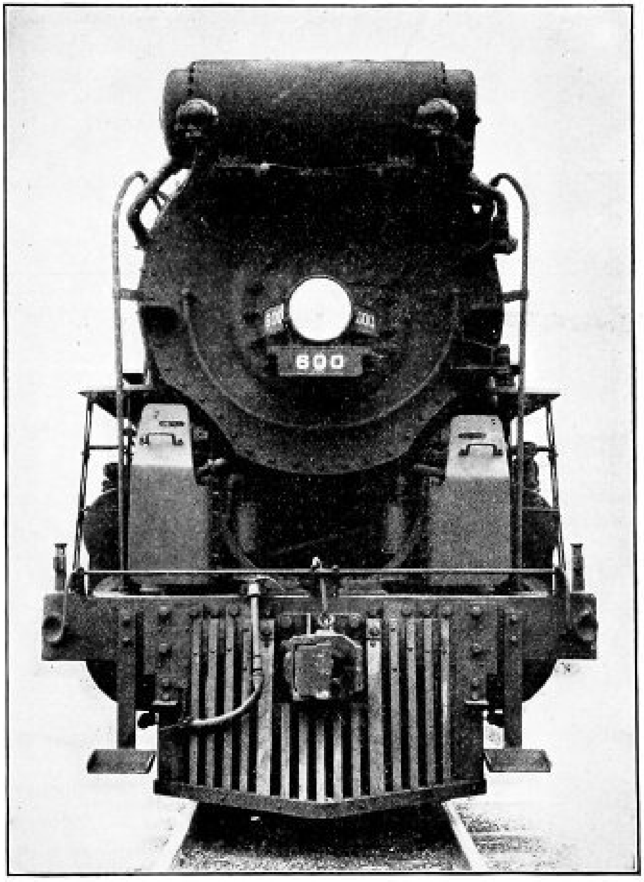
Comparison of Boiler Proportions

A comparison of the boiler proportions of the two designs is also of interest. While in total evaporating heating surface and superheating surface the new locomotives differ but slightly from the A-1 locomotive, there is a material difference in the distribution of the evaporating heating surface as between the firebox and tubes. The tubes and flues in the new locomotives are 1 foot 6 inches longer than those in the earlier locomotive, but are fewer in number, accounting for the reduction in the amount of tube and flue heating surface. The firebox, however, including the combustion chamber and the two Nicholson thermic syphons, has a materially larger amount of heating surface, the proportion of firebox heating surface to evaporative heating surface thus being increased from 6.6 percent in the Lima A-1 to 9.26 percent in the new locomotives, a difference which, on the basis of Cole's ratios, would account for approximately 10 percent more evaporating capacity. The increase in cylinder tractive force from 69,400 pounds to 83,000 pounds amounts to about 19 percent. The Texas type locomotives will be assigned to the Fort Worth and Rio Grande divisions between Marshall, Tex., and Big Springs, a distance of 450 miles. The ruling grades on these divisions approximate 1.5 percent and extend from five to eleven miles in length. Heavy curvature is encountered, making necessary the use of the booster in ascending the heaviest portions of these grades.

Comparison of Texas & Pacific 2-10-4 Locomotives with Lima 2-8-4 Locomotive

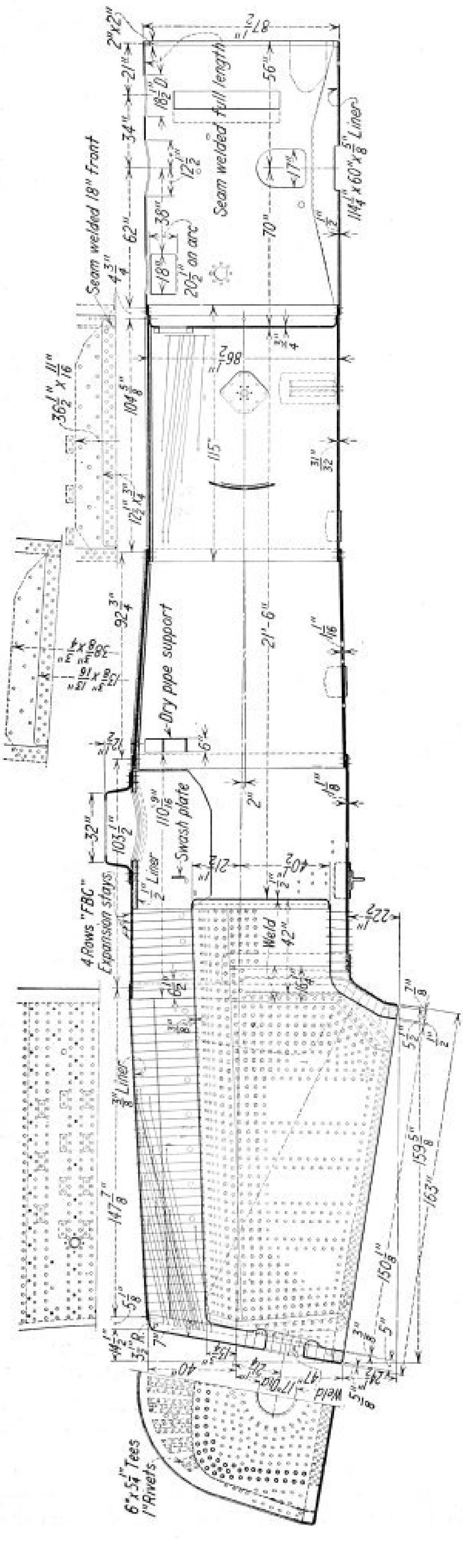
	2-10-4	2-8-4
Cylinders, diameter and stroke, in.	29 by 32	28 by 30
Cut-off in full gear, percent	60	60
Boiler pressure	250 lb.	240 lb.
Weights in working order:		
On drivers	300,000 lb.	248,000 lb.
Front truck	41,800 lb.	35,500 lb.
Rear truck	106,200 lb.	101,300 lb.
Total engine	448,000 lb.	385,000 lb.
Diameter of drivers	63 in.	63 in.
Heating surfaces:		
Firebox and combustion chamber	473 sq. ft.	337 sq. ft.
Tubes and flues	4,640 sq. ft.	4,773 sq. ft.
Total evaporating	5,113 sq. ft.	5,110 sq. ft.
Superheating	2,100 sq. ft.	2,111 sq. ft.
Combined total	7,213 sq. ft.	7,221 sq. ft.
Grate area	100 sq. ft.*	100 sq. ft.
Rated tractive force:		
Engine	83,000 lb.	69,400 lb.
Engine and booster	96,000 lb.	82,600 lb.
Factor of adhesion	3.62	3.58

*The firebox is fitted for burning oil.



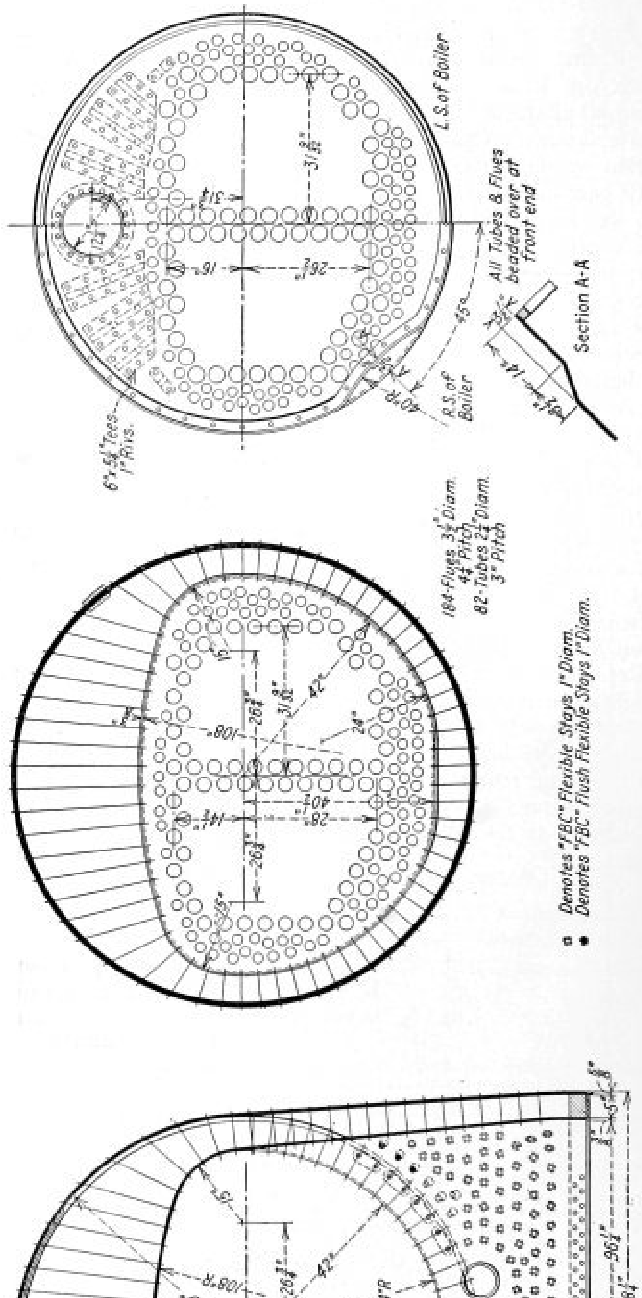
Front of the T. & P. locomotive, showing the location of the two cross compound air compressors

The boilers of the new locomotives, aside from the increase in length made possible by the increase in the wheel base, differ principally from the boiler of the A-1 locomotive in the inclusion of a 42-inch combustion chamber, in the location of the dome just in front of the combustion chamber, and in the use of an inside dry pipe. It will be remembered that the dome in the earlier locomotive was located on the front boiler course, with a short outside dry pipe. The dome course in the new boilers is 98 inches in outside diameter, this being reduced by a taper course to 86½ inches at the



General boiler details of new T. & P. locomotive

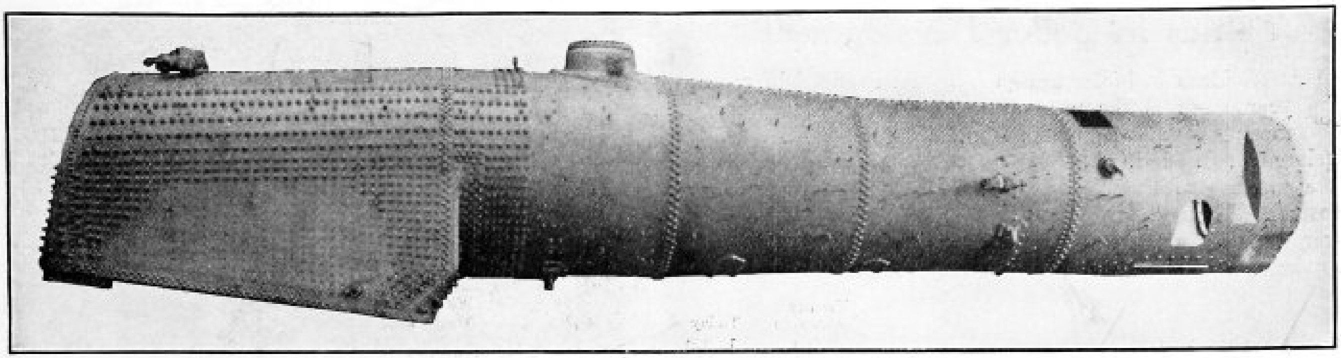
front course. A shut-off valve, by which the entrance to the dry pipe may be closed, is located in the dome, the operating handle extending out through the right side of the dome. The tubes are 21 feet 6 inches long and the tube sheets are laid out with 184 flues 3½ inches in diameter, for a Type E superheater of 92 units. With the exception of the change in the dry pipe, the front end arrangement is essentially the



Sections through boiler at the firebox and front and back tube sheets

same as that of the Lima A-1. The unit bolts of the superheater header are accessible through a rectangular opening in the top of the smokebox shell and the Chambers front end throttle is located between the superheater header and the branch pipes forward of the smoke stack.

The firebox, which has the same inside dimensions at the mud ring as the Lima A-1, is fitted for oil-burning service, with a 4-inch Booth burner entering the front of the draft pan which is set back about one-third the length of the firebox from the front of the mud ring. The locomotive is



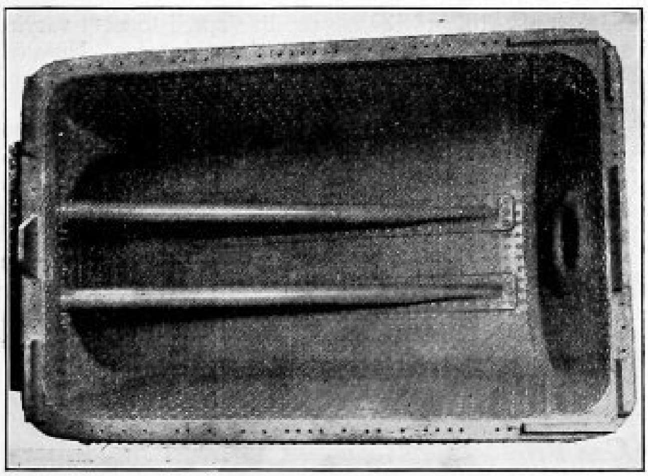
The boiler—the firebox measures 150⅛ inches by 96¼ inches at the mud ring

designed, however, for possible later conversion to coal-burning service, in which case the two Nicholson thermic syphons will serve as arch supports.

The locomotives are fitted with an Elseco feedwater heater carried on brackets on the front end. The feedwater pump is located under the running board on the left side of the locomotive.

Arrangement of Superheater

Superheated steam is carried back from the superheater header to a superheated steam turret on the left side of the boiler just in front of the cab. This header furnishes steam to the air pumps, the feedwater pump, the headlight generator, the blower and the fuel oil heaters and atomizer. The whistle, which also uses superheated steam, is located well forward on the boiler alongside of the bell. The whistle fitting is welded directly on the superheated steam pipe which



Interior of the firebox, showing the position of the Nicholson Thermic Syphons

feeds the turret. The sound of the whistle is increased in volume and sharpness by the use of superheated steam, and this location—made possible by the use of the Parsons pneumatic operating rigging—protects the occupants of the cab from the unpleasant effect of this sound at close range. Placing the whistle well forward on the boiler and to one side, where it is not directly behind the stack, is also expected to effect some improvement in the forward projection of the sound.

One of the interesting details on this locomotive is the Unit pipe clamp and bracket for the main reservoir and running board. This provides a secure anchor for holding three lengths of air radiator pipe above the reservoir. The clamps are securely held by the same bolts which hold the running board in place.

The locomotives are served by tenders with a water capacity of 14,000 gallons and a fuel oil capacity of 5,000 gallons. The tanks are of the Ralo-Acme type of construction, carried on Commonwealth cast steel frames and two Commonwealth six-wheel trucks. The tender has been designed to permit the application of a stoker with a minimum of alterations should it later become desirable to convert the locomotives from oil-burning to coal-burning service.

The principal dimensions and proportions of these locomotives are given in the following table:

Railroad	Texas & Pacific
Type of locomotive	2-10-4
Service	Freight
Cylinders, diameter and stroke, in	29 by 32
Valve gear, type	Baker
Valves, piston type, size	14 in.
Maximum travel	8¾ in.
Steam lap	2 1/16 in.
Exhaust clearance	1/16 in.
Cut-off in full gear, percent	60
Weights in working order:	
On drivers	300,000 lb.
On front truck	41,800 lb.
On trailing truck	106,200 lb.
Total engine	448,000 lb.
Tender	275,200 lb.
Wheel bases:	
Driving	22 ft.
Rigid	16 ft. 6 in.
Total engine	46 ft. 8 in.
Total engine and tender	86 ft. 8 in.
Wheels, diameter outside tires:	
Driving	63 in.
Front truck	33 in.
Trailing truck	36 in. and 43 in.
Journals, diameter and length:	
Driving, main	13 in. by 14 in.
Driving, others	11 in. by 13 in.
Front truck	7 in. by 12 in.
Trailing truck	6½ in. by 12 in. 9½ in. by 14 in.
Boiler:	
Type	Taper course
Steam pressure	250 lb.
Fuel, kind	Oil
Diameter, first ring, outside	86½ in.
Firebox, length and width	150⅛ in. by 96¼ in.
Height mud ring to crown sheet, back	60¾ in.
Height mud ring to crown sheet, front	93 in.
Arch tubes, number and diameter	2 Syphons
Combustion chamber length	42 in.
Tubes, number and diameter	82—2¼ in.
Flues, number and diameter	184—3½ in.
Length over tube sheets	21 ft. 6 in.
Grate area	No grate
Heating surfaces:	
Firebox and comb. chamber	3,755 sq. ft.
Syphons	98 sq. ft.
Tubes and flues	4,640 sq. ft.
Total evaporative	5,113 sq. ft.
Superheating	2,100 sq. ft.
Comb. evaporative and superheating	7,213 sq. ft.
Tender:	
Style	Rectangular
Water capacity	14,000 gal.
Fuel capacity	5,000 gal.
Rated tractive force	83,000 lb.
Rated tractive force, incl. booster	96,000 lb.
Weight proportions:	
Weight on drivers ÷ total weight engine, percent	67.0
Weight on drivers ÷ tractive force	3.62
Total weight engine ÷ comb. heat. surface	62.1
Boiler proportions:	
Tractive force ÷ comb. heat. surface	11.5
Tractive force × dia. drivers ÷ comb. heat. surface	725
Firebox heat. surface ÷ grate area	4.73
Firebox heat. surface, percent of evap. heat surface	9.26
Superheat. surface, percent of evap. heat. surface	41.1

Trends in Boiler Development

BASIC ideas in boiler design have not changed in recent years, and at the present time there is little tendency towards new departure in boiler development, recently declared P. C. Idell, of the Babcock & Wilcox Co. (Boston), at a meeting of the New England Plant Engineers' Club, Boston. When boiler practice and development are viewed over a period of twenty years, however, great changes are apparent, as indicated by the following table:

	Twenty Years Ago	Today
Heating surface, average sq. ft.	2,500	12,000
largest, sq. ft.	6,640	40,000
Working pressure, average, lb. per sq. in.	225	350-650
Working pressure, highest, lb. per sq. in.	....	1,200
Temperature, deg. F.	500	700-750
Max. rate of evap. per sq. ft., lb.	5	8-15
Max. rate of evap. per boiler, lb.	30,000	400,000
Volume of setting, cu. ft.	7,650	90,000

While it appears that the last word in design has been written into specifications, and while recent installations, notably the Edgar (formerly Weymouth) and Detroit stations, mark a high line in boiler achievement, there still remain a number of details in design and practice of sufficient importance to warrant a considerable amount of investigation and study. These are higher refractory linings, boiler tube endurance, and insulation against heat losses.

Marked Improvement in Tubes

One of the greatest achievements of late has been the progressive improvement in tubes. At present open-hearth process tubes are meeting the requirements. These tubes are tough, strong and durable; in addition they offer greater resistance to surface pitting as compared with many of the older types of tubes.

Insulation against heat loss remains one of the problems that must be given much attention by operators. A wall thickness of 22 inches is now common, and air-cooled walls have been advocated. Wall surfaces must be given attention, and the importance of joints, leakage through metal conduits, rods, and other outlets in the furnace should not be overlooked.

Central stations have been pioneers in boiler practice and design in the past. It is natural that they should lead because they, as a class, are large manufacturers of power and accordingly are most interested in opportunities which will insure a production of this commodity at a lower cost. The reduction in fuel per kilowatt-hour over this period has been considerable.

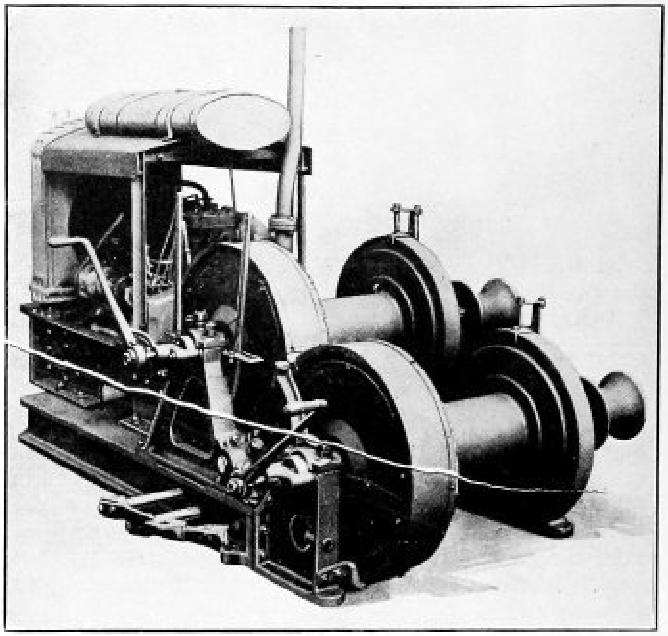
Whatever changes come in the future (and at present it seems as if they must be along the line referred to), the central stations are the logical agency to initiate and develop cost-saving devices and means.

At present a halt has been called on account of the fact that the limit of structural materials has been reached in design. No one, however, can predict how long this halt will last.

New Model of "American" Gasoline Hoist

THE American Hoist and Derrick Company of St. Paul, Minnesota, has recently redesigned its gasoline hoist, changing it from chain drive to gear drive. The new hoists are driven by means of spur and bevel gears with an intermediate longitudinal shaft placed at right angles with the pinion shaft, which is the crank shaft on a steam hoist, the gasoline motor being mounted lengthwise instead of crosswise on the hoist.

The pinion shaft of the hoist has a bevel gear near its center which engages with a bevel pinion on the end of the intermediate longitudinal shaft. On the other end of this shaft there is a spur gear which engages with the pinion on the engine crankshaft. The intermediate shaft is mounted at nearly the center lengthwise of the bed and is supported by heavy babbitted boxes.



Gear drive hoist for portable service

Equipping gasoline hoists with gear drive instead of chain drive gives a number of important advantages among which are speedier shipment of both hoist and driving mechanism repairs and ability to change the line speed to meet varying requirements without seriously delaying shipment. However, the principal advantage claimed for the new gear drive over the old chain drive is that power is transmitted directly to the pinion shaft of the hoist which is between the two rear drums and from there to the friction gears by at least two teeth—one to each adjoining friction gear—whereas on the old arrangement power was transmitted to the rear drum and from there to the rest of the drums by only one gear tooth.

The entire hoist is mounted on a cast iron bed plate, insuring rigidity and absolute alinement of gearing, shafting and bearings. The gasoline engine is mounted on the bed plate in place of the boiler or electric motor and the hoist is very compact and self contained.

Gas Products Association to Meet in January

The twelfth mid-winter convention of the Gas Products Association is to be held in Chicago on Wednesday, Thursday and Friday, January 20, 21, 22, 1926.

The executive committee have selected the New Palmer House as the Convention Headquarters.

The theme of the forthcoming meetings will be "Looking Forward." This symbolizes the purpose reflected in that part of the program already arranged. For example, there will be papers and discussions on the newer applications of the oxy-acetylene process, plans for developing those fields wherein gas welding and cutting ought to be more extensively employed, the much wider activities of the Educational Committee, plans for extending the Research work of the Association, etc.

Thomas O'Brien for the past fifteen years Engineer and Sales Manager for The John F. Allen Co., New York, has resigned to go into business for himself.

Fig. 1.—Boiler was thrown 305 feet in this low water explosion

Chief Inspector Makes Annual Locomotive Report*

Number of accidents and number of casualties from locomotive failures show decrease over previous reports

By A. G. Pack†

IN compliance with section 7 of the act of February 17, 1911, as amended March 4, 1915, and June 7, 1924, the Fourteenth Annual Report of the Chief Inspector covering the work of the Bureau of Locomotive Inspection during the fiscal year ended June 30, 1925, is respectfully submitted.

A synopsis is given, by railroads, of all accidents, showing the number of persons killed and injured due to the failure of parts and appurtenances of the locomotive and tender, including the boiler, as reported and investigated under section 8 of the locomotive inspection law, and those reported to the Bureau of Statistics under the accident report act of May, 1910, and not reported to this bureau as should have been.

The data contained herein cover all defects on all parts and appurtenances of the locomotive and tender, including the boiler, found and reported by our inspectors.

The tables show the number of accidents, the number of persons killed and number injured as a result of the failure of parts and appurtenances of the locomotive and tender, including the boiler.

Tables have been arranged so as to permit comparison with previous years as far as consistent and also show the number of locomotives inspected, the number and percentage of those inspected and found defective, the number for which written notices for repairs were issued withholding them from service because of being in violation of the law, and the total defects found and reported.

Investigation of Accidents

All accidents reported to this bureau as required by section 8 of the law and rules 55 and 162 promulgated thereunder were carefully investigated and report rendered as required and action taken so far as possible under the circumstances, which would tend to prevent recurrences. Copies of such reports were furnished interested parties wherever advisable for the purpose of acquainting them with the conditions disclosed, and in an endeavor to prevent accidents of a similar nature recurring.

A summary of all accidents and casualties to persons occurring during the year ended June 30, 1925, as compared with the previous year, covering the entire locomotive and tender and all of their parts and appurtenances shows a decrease of 31.3 percent in the number of accidents, a decrease of 69.7 percent in the number of persons killed, and a decrease of 33.9 percent in the number injured during

Table 1.—Number of Accidents, Number Killed, and Number Injured Caused by the Failure of Some Part or Appurtenance of the Locomotive and Tender, Including the Boiler, by Comparison

	Year Ended June 30—				
	1925	1924	1923	1922	1921
Number of accidents	690	1,005	1,348	622	735
Percent increase or decrease from previous year	31.3	25.5	[1]117	15.4	12.8
Number of persons killed	20	66	72	33	64
Percent increase or decrease from previous year	69.7	8.3	[1]118	48.4	3
Number of persons injured	764	1,157	1,560	709	800
Percent increase or decrease from previous year	33.9	25	[1]120	11.3	12.6

[1]Increase.

Table 2.—Number of Accidents, Number Killed, and Number Injured as a Result of the Failure of Parts and Appurtenances of the Locomotive Boiler to Which the Original Act Only Applied

	Year Ended June 30—				
	1925	1924	1923	1915	1912
Number of accidents	274	393	509	424	856
Number of persons killed	13	54	47	13	91
Number of persons injured	315	447	594	467	1.005

*Abstract of fourteenth annual report of the Bureau of Locomotive Inspection, Interstate Commerce Commission, Washington, D. C.

†Chief Inspector, Bureau of Locomotive Inspection.

Table 3.—Showing Number of Locomotives Reported, Inspected, Found Defective, and Ordered from Service

Parts Defective, Inoperative or Missing, or in Violation of Rules	Fiscal Years Ended June 30— 1925	1924	1923	1922	1921
1. Air compressors	1,574	1,221	1,390	971	692
2. Arch tubes	198	272	468	151	160
3. Ash pans or mechanism	216	257	306	161	147
4. Axles	14	19	21	15	12
5. Blow-off cocks	825	965	1,578	975	969
6. Boiler checks	991	1,329	1,913	949	1,006
7. Boiler shell	1,597	2,103	2,370	1,598	1,550
8. Brake equipment	6,497	6,920	8,213	4,577	4,836
9. Cabs or cab windows	2,541	1,627	1,423	1,276	1,171
10. Cab aprons or decks	1,165	1,293	1,476	1,098	893
11. Cab cards	665	758	1,449	567	671
12. Coupling or uncoupling devices	447	398	634	423	547
13. Crossheads, guides, pistons or piston rods	2,922	3,577	5,527	1,920	2,116
14. Crown bolts	283	418	630	331	392
15. Cylinders, saddles, or steam chests	4,352	5,712	4,875	3,234	3,304
16. Cylinder cocks or rigging	1,801	2,376	1,745	1,201	1,197
17. Dome or dome caps	371	494	626	331	396
18. Draft gear	2,283	1,981	2,613	1,526	1,418
19. Draw gear	3,273	4,160	4,513	3,042	3,134
20. Driving boxes, shoes, wedges, pedestals, or braces	3,241	3,722	4,269	2,776	3,361
21. Fire-box sheets	1,152	1,471	2,327	1,191	1,185
22. Flues	524	698	1,268	521	552
23. Frames, tail pieces, or braces, locomotive	2,036	2,580	2,683	2,078	1,998
24. Frames, tender	391	414	540	352	232
25. Gages or gage fittings, air	694	626	1,062	399	537
26. Gages or gage fittings, steam	1,809	2,026	3,075	1,595	1,769
27. Gage cocks	3,081	3,835	5,895	3,275	3,657
28. Grate shakers	832	1,006	569	425	565
29. Handholds	2,831	2,241	1,990	1,533	894
30. Injectors, inoperative	70	94	251	94	179
31. Injectors and connections	8,064	9,985	12,406	7,741	7,606
32. Inspections or tests not made as required	10,436	9,740	7,419	4,114	4,865
33. Lateral motion	659	939	1,625	976	1,066
34. Lights, cab or classification	86	72	90	80	86
35. Lights, headlight	928	904	1,164	705	539
36. Lubricator or shields	704	565	566	456	427
37. Mud rings	1,384	1,901	2,711	1,598	1,441
38. Packing nuts	2,761	3,304	4,755	3,151	3,294
39. Packing, piston rod and valve stem	2,411	3,187	3,359	1,756	2,176
40. Pilot or pilot beams	832	967	1,294	679	588
41. Plugs or studs	849	1,026	857	443	457
42. Reversing gear	1,274	1,217	1,272	789	745
43. Rods, main or side, crank pins or collars	4,813	6,507	10,080	3,915	4,464
44. Safety valves	234	188	192	162	144
45. Sanders	2,004	1,806	1,857	1,165	1,071
46. Springs or spring rigging	5,532	6,335	7,911	5,497	5,494
47. Squirt hose	1,008	1,221	1,098	935	916
48. Staybolts	741	916	1,313	722	716
49. Staybolts, broken	3,745	5,320	10,089	4,261	4,871
50. Steam pipes	1,590	2,305	2,467	1,461	1,678
51. Steam valves	869	981	1,168	791	792
52. Steps	2,867	2,829	3,289	2,038	1,917
53. Tanks or tank valves	3,352	3,393	3,788	2,817	2,385
54. Telltale holes	451	620	715	630	567
55. Throttle or throttle rigging	2,403	2,868	2,633	1,880	1,730
56. Trucks, engine or trailing	2,966	3,425	3,899	2,467	2,493
57. Trucks, tender	5,372	5,977	3,714	2,551	2,408
58. Valve motion	1,250	1,269	1,761	710	691
59. Washout plugs	3,588	3,204	3,641	2,449	2,306
60. Water-bars or combustion flues	19	18	24	57	24
61. Water-glass, fittings, or shields	3,713	4,201	5,641	3,640	4,045
62. Wheels	2,148	2,996	4,371	2,410	2,802
63. Miscellaneous—signal appliances, badge plates, brakes (hand)	1,510	1,342	972	403	504
Total number of defects	129,239	146,121	173,840	101,734	104,848
Locomotives reported	70,361	70,683	70,242	70,070	70,475
Locomotives inspected	72,279	67,507	63,657	64,354	60,812
Locomotives defective	32,989	36,098	41,150	30,978	30,207
Percentage inspected found defective	46	53	65	48	50
Locomotives ordered out of service	3,637	5,764	7,075	3,089	3,914

the year. There was also a substantial decrease in the percentage of locomotives, inspected by our inspectors, found defective as compared with the previous year. During the year 46 percent of the locomotives inspected were found with defects or errors in inspection that should have been corrected before being put in use, while during the previous year 53.4 percent of those inspected were found defective.

While there was a substantial decrease in the total number of accidents occurring during the year, our investigation shows that a still greater decrease should have resulted had the requirements of the law and rules been complied with, especially so with respect to parts and appliances which are sometimes considered unimportant. Especial attention is directed to the reduction in the number of boiler explosions caused by low water during the year. Boiler explosions are the most prolific source of serious and fatal accidents with which we have to deal, therefore, during the course of our regular work special attention has been given to conditions

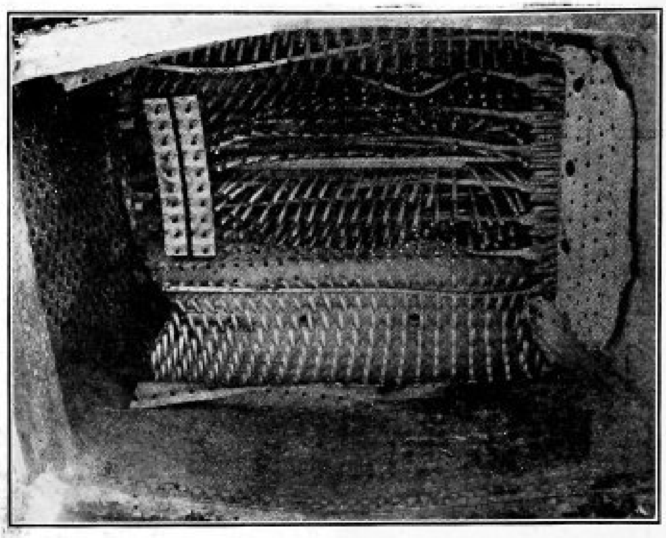


Fig. 2.—View of firebox after accident

which contribute to such accidents. A great deal of consideration has been given to the action of the water in the boiler and its effect upon the water indicating appliances and the result of our study in this matter has been brought to the attention of those in charge of locomotive maintenance and operation as well as those actually operating locomotives. The reduction in the number of crown sheet failures as shown is no doubt largely brought about as the result of our study with respect to the circulation of the water in the boiler and its effect upon water glasses and especially upon gage cocks when screwed directly in the boiler, and to our action in insisting that water indicating appliances and other parts, which may contribute to such accidents, be maintained to a high degree of perfection so that they will perform their functions in a proper manner.

Senate Resolution No. 438

In response to Senate Resolution No. 438, of February 26, 1923, we have been supplying information each month for Congress when in session, and when not in session for the President, showing the number of locomotives inspected, the number found defective, the percentage inspected found defective, number ordered out of service, and the number of accidents, killed and injured, by comparison with previous periods.

Extension of Time for Removal of Flues

During the year ended June 30, 1925, 146 applications were filed for extension of time for removal of flues, as provided in rule 10. Our investigation disclosed that in 14 of these cases the conditions were such that no extension could properly be granted. Fourteen were in such condition that the full extension requested could not be authorized, but an extension for a shorter period of time was allowed. Nineteen extensions were granted after defects disclosed by our investigation had been repaired. Eighteen applications were canceled for various reasons. A total of 100 applications was granted for the full period requested by the carriers.

Specification Cards and Alteration Reports

In accordance with rule 54, there were filed 2,181 specification cards and 11,590 alteration reports necessary in determining the safe working pressure and other required data for the boilers represented. In order to determine whether or not the boilers covered by these reports were so constructed as to be in safe and proper condition for service and that the stresses were within the allowed limits, these specification cards and alteration reports were carefully checked and analyzed and corrective measures taken with respect to numerous discrepancies found.

No formal appeal was taken from the decision of any inspector during the year.

Amendment to the Law

The act of June 7, 1924, further amending the locomotive inspection law extended our jurisdiction to all locomotives and tenders, their parts and appurtenances, used or permitted to be used on the line of a common carrier subject to the Interstate Commerce Act, which includes locomotives propelled by electricity, gasoline, compressed air, or other means, whereas prior to this amendment the law applied only to steam locomotives used by common carriers in the movement of interstate commerce. This amendment further brought within the purview of the law many steam locomotives operated by industrial concerns and lumber companies being used on the lines of common carriers subject to the law. The amendment of June 7, 1924, also provided for the appointment of 15 additional inspectors. Under date of November 5-6, 1924, the Civil Service Commission held an examination in accordance with that part of section 4 of the act of February 17, 1911, which provides:

"* * * Said inspectors shall be in the classified service and shall be appointed after competitive examination according to the law and the rules of the Civil Service Commission governing the classified service * * *"

for the purpose of supplying an eligible list from which this number of inspectors might be appointed. This number of inspectors was appointed and actively engaged in the performance of their duties for an average period of three months during the year ended June 30, 1925, as provided for in an urgency deficiency appropriation, which appro-

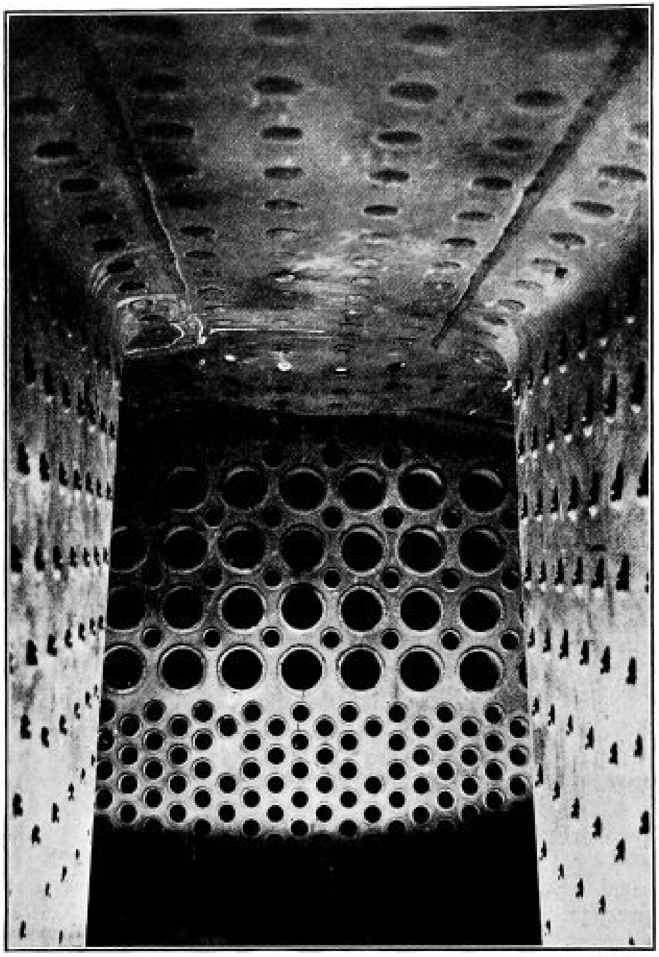


Fig. 4.—Syphons prevented sagging of adjacent portions of crown sheet

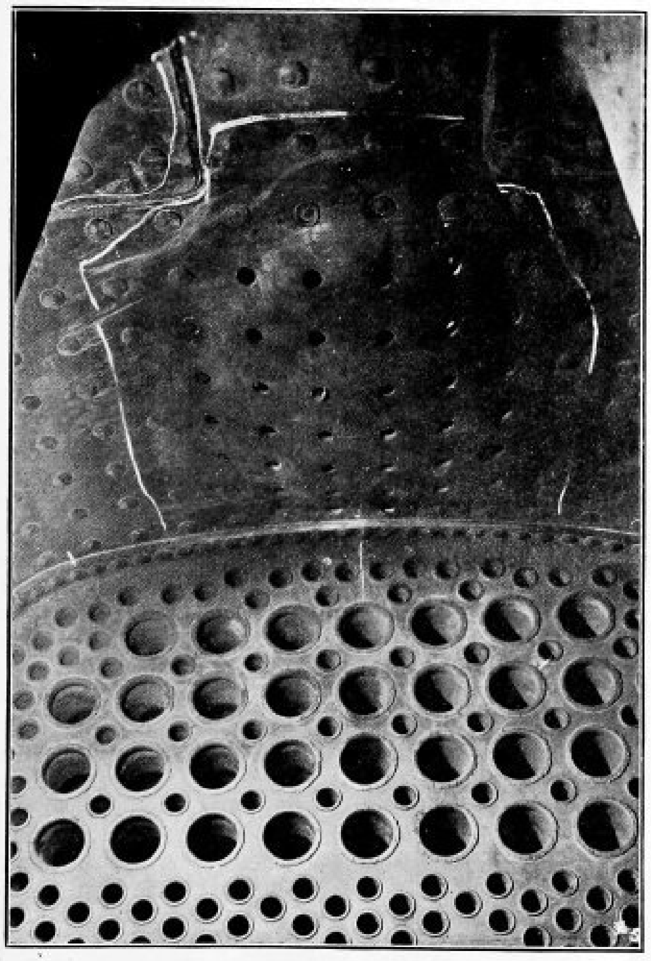


Fig. 3.—Bagged crown sheet resulting from low water

priated $54,145 to pay the increase in salaries provided in the amendment of June 7, 1924, and to provide for the appointment of 15 additional inspectors for an average period of three months during the current fiscal year, including their allowance for office rent, etc., and traveling expenses.

The preparation of rules and instructions fixing minimum requirements for all locomotives other than those propelled by steam power is being pursued as diligently as conditions will permit and arrangements are being made to put into effect the additional requirements as soon as possible.

The carriers having failed to file their rules and instructions for the inspection and testing of locomotives other than steam within three months after the amendment of June 7, 1924, became effective, it became my duty to prepare rules and instructions not inconsistent with the purpose of the law, which I did, in connection with which it has been deemed advisable to have a conference with the parties at interest for the purpose of coming to a common understanding so that the rules and instructions may be approved by the Interstate Commerce Commission.

Appropriations

The amount appropriated to carry out the work of this bureau during the year was $300,000, with a deficiency appropriation of $54,145 to cover the salary increases provided for in the amendment and the employment of 15 additional inspectors for an average period of three months during the year.

Recommendations for Betterment of the Service

In my ninth to thirteenth annual reports, inclusive, recommendations were made, in accordance with section 7

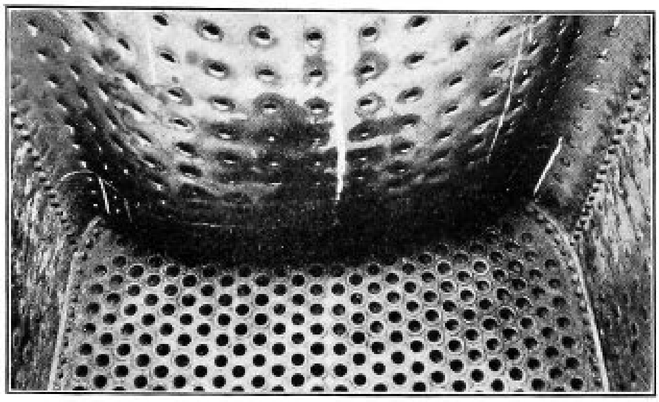


Fig. 5.—This sheet pocketed to a depth of 20 inches

of the act, for the application of automatic fire doors, power reverse gears, power grate shakers, automatic bell ringers, horizontal hand holds and stirrups on cabs, and water columns with water glass and gage cocks attached, and the reasons therefor given. In order to conserve space in this report, I have refrained from repeating in detail the reasons therefore; however, they are respectfully renewed as being in the interest of safety.

Section 9 of the law provides in part that it shall be the duty of the chief inspector to give information to the proper United States attorney of all violations of the act coming to his knowledge. These requirements cannot be carried out unless sufficient capable legal assistance and advice is provided. No provision was made in the act of February 17, 1911, nor the amendments prior to June 7, 1924, for legal assistance in this bureau. This deficiency was, however, recognized by the Congress in the act of June 7, 1924, wherein it is provided that the Interstate Commerce Commission shall provide such legal, technical, stenographic, and clerical help as the offices of the chief inspector and his said assistants may require. The necessity for legal assistance is made evident by the apparent disregard on the part of many carriers for the requirements of the law and the rules and regulations established in pursuance thereof until such time as the discrepancies are pointed out to them by this bureau.

A very large percentage of the accidents which we have investigated were caused by defects which could have been prevented had proper inspections and proper repairs been made at the proper time. Many locomotives are allowed to remain in use in apparent disregard for the requirements of the law sometimes until accidents occur and many times until our inspectors find them and order them out of service. We are daily writing many letters to various carriers calling attention to their failure to comply with the requirements of the law, such as failure to make the required periodical inspections and tests and the failure to make proper repairs to defects which constitute violations of the law. With the large number of locomotives in service, scattered over such a wide area, it is apparent that Congress never intended that the law should be entirely enforced by our inspectors ordering locomotives out of service because of being in violation of the law. It is a physical impossibility for the 65 inspectors now provided to keep in sufficiently close touch with the number of locomotives coming under the jurisdiction of the law to know at all times that they are in condition to meet the requirements thereof.

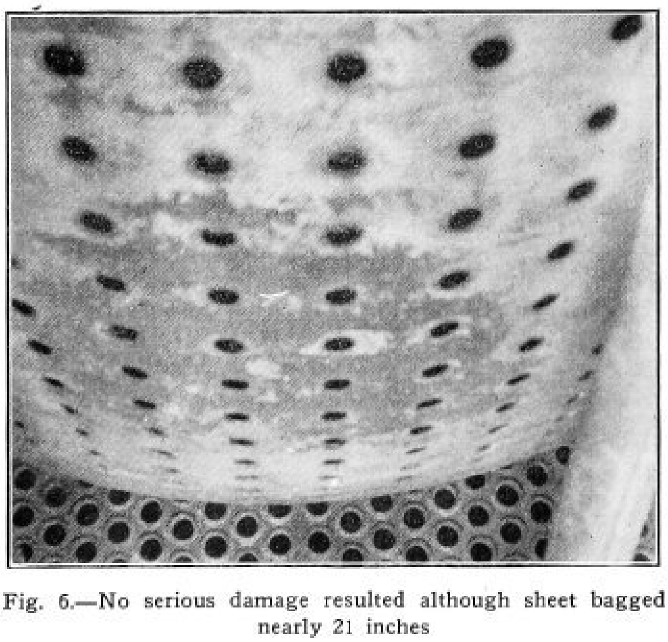


Fig. 6.—No serious damage resulted although sheet bagged nearly 21 inches

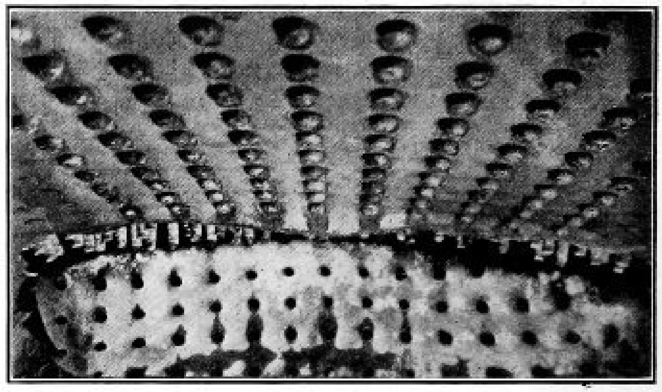


Fig. 7.—View of crown sheet failure caused by low water

Therefore, in the light of our experience, I most respectfully recommend that competent legal assistance be provided this bureau so that we may at all times have the benefit of such services in seeing that the law and the rules and regulations issued in pursuance thereof are complied with.

Locomotive Boiler Explosions and Locomotive Defects

Figs. 1 and 2 show the result of a boiler explosion caused by low water, which resulted in the death of the engine watchman. The line of demarcation indicated that the water was 4 inches below the highest part of the crown sheet at the time of the accident.

In this case the boiler came to rest 305 feet from point of accident.

Fig. 2 shows the firebox after the accident. The crown sheet with the top half of the side sheets was blown entirely out of the firebox and forced back under the front end of the tender. Approximately 23 feet of autogenously welded seams in this firebox failed at the time of the accident.

Figs. 3 and 4 show the damage to a crown sheet due to low water.

The line of demarcation indicated that the water was approximately 3½ inches below the highest part of the crown sheet at the time of the accident. This firebox was equipped with two Nicholson thermic syphons and the appearance of the crown sheet showed that the syphons had discharged sufficient water on the crown sheet between them and in their vicinity to keep this portion of the crown sheet from becoming overheated, while the portion in front of the syphons became sufficiently hot to pull off of thirty-six radial stays and pocket to a depth of 3 inches at the deepest point.

Fig. 4 is a view of the crown sheet taken between the syphons from the back end of the firebox. These plates very clearly indicate the overheated area and the damage to the crown sheet.

Figs. 5 and 6 show damage to the firebox crown sheets of two locomotives caused by low water, in which all seams were riveted. The sheets pulled off the radial stays and pocketed to a depth of 20 and 21 inches respectively, without other serious damage to the locomotive.

These cases, with others which we have, illustrate the value of having fireboxes constructed in the strongest practical manner.

Fatal Crown Sheet Accident

Fig. 7 shows the result of a crown sheet failure, due to low water, which caused serious injury to three persons. The autogenously welded seam between the combustion chamber and crown sheet failed for a distance of 51 inches. This boiler was equipped with an automatic fire door, which remained closed at the time of the failure, which no doubt greatly lessened the injuries to those in the cab at the time of this accident.

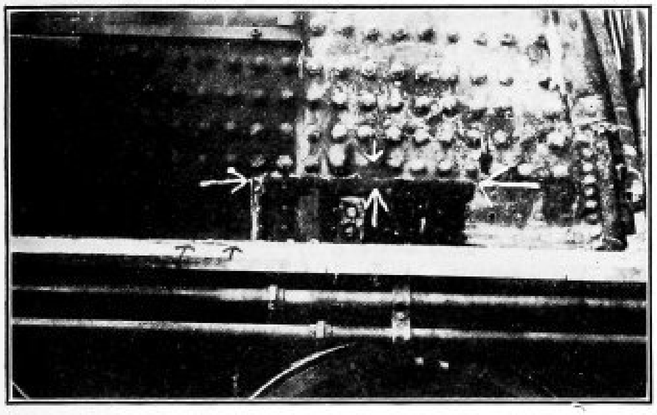


Fig. 8.—Outside firebox seam which failed a distance of 34½ inches

Failure of Firebox Seam

Fig. 8 shows an autogenously welded seam in outside firebox sheet which failed suddenly and without apparent weakness, for a distance of 34½ inches, nearly all of which was inside the cab, while the locomotive was hauling a passenger train at an estimated speed of 35 miles per hour, resulting in the engineer and fireman being seriously burned. When the seam failed the escaping scalding water and steam filled the cab. The engineer closed the throttle but did not apply the brakes, and the fireman, while attempting to escape, struck the firing valve which regulates the flow of oil to the firebox opening it, which caused the flames to come into the cab and set the cab, running boards, and packing on top of the back driving boxes on fire. The engineer, after making efforts to locate the brake valve and cut-out valve in the oil line, climbed through the right window to the roof. The fireman made his way to the front of the locomotive and stopped the train by opening the angle cock.

The seriousness of accidents of this character and previous cases which have been described in our reports, is apparent and can not be over estimated. It is because of such accidents that we have been compelled to take the position that autogenously welded seams within the cab, at or above the cab floor, would not be considered as being in compliance with the law unless the seams are covered with a properly applied patch held in place by rivets, studs, or patch bolts that would prevent the escape of scalding steam and water in sufficient quantity to cause serious injury should the welded seam fail. This is not held as applying to stoker hole tubes or thimbles where they are welded in the outside sheets; the calking edge of lapped patches in stayed surfaces held in place by rivets, screw studs or patch bolts; the calking edge of riveted seams in stayed surfaces; transverse cracks in door hole flanges, nor the ordinary door hole seam which is within the circle of the door hole, unless further developments show that an unsafe condition is created which would require another method of repair.

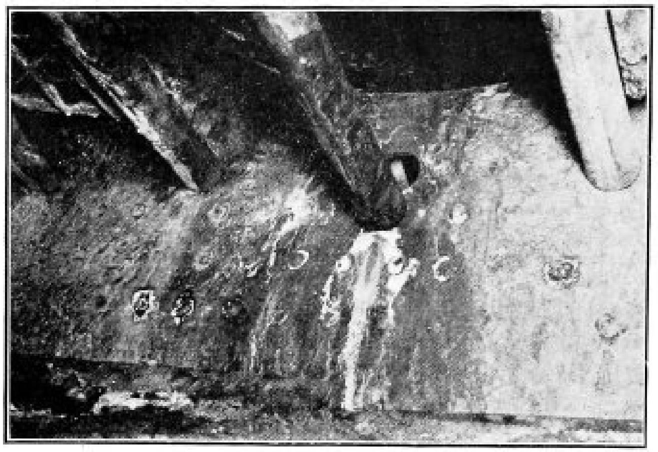


Fig. 9.—Arch tube which pulled away from sheet

Arch Tube Failures

Fig. 9 shows an arch tube which pulled out of the throat sheet causing the serious injury of three employees. This tube had not been belled or beaded to secure it in place.

Our records indicate that since the law became effective 124 accidents, resulting in the death of 7 persons and serious injury to 180 others, were due to failure of arch tubes, which forcibly illustrates the importance of proper application, inspection, and maintenance of such parts. These failures could have been prevented had suitable tubes been properly applied and kept clean of scale and mud.

Fig. 10 shows an arch tube which failed due to overheating causing the serious injury of an employee. This tube was coated with hard scale and was flattened at the bend and for some distance back which no doubt contributed to the failure.

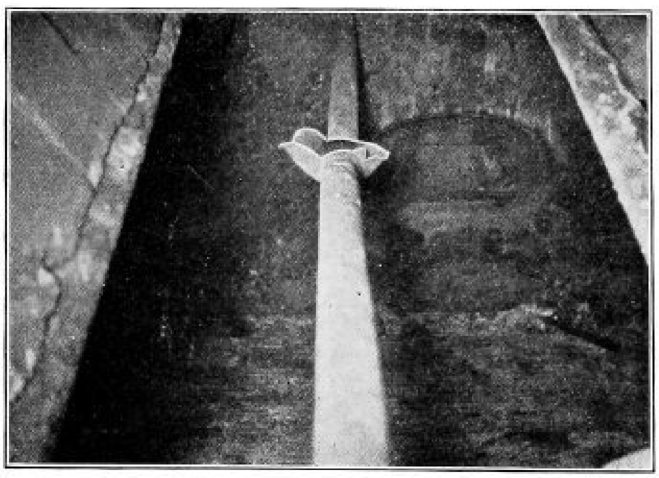


Fig. 10—Failure due to overheating arch tubes

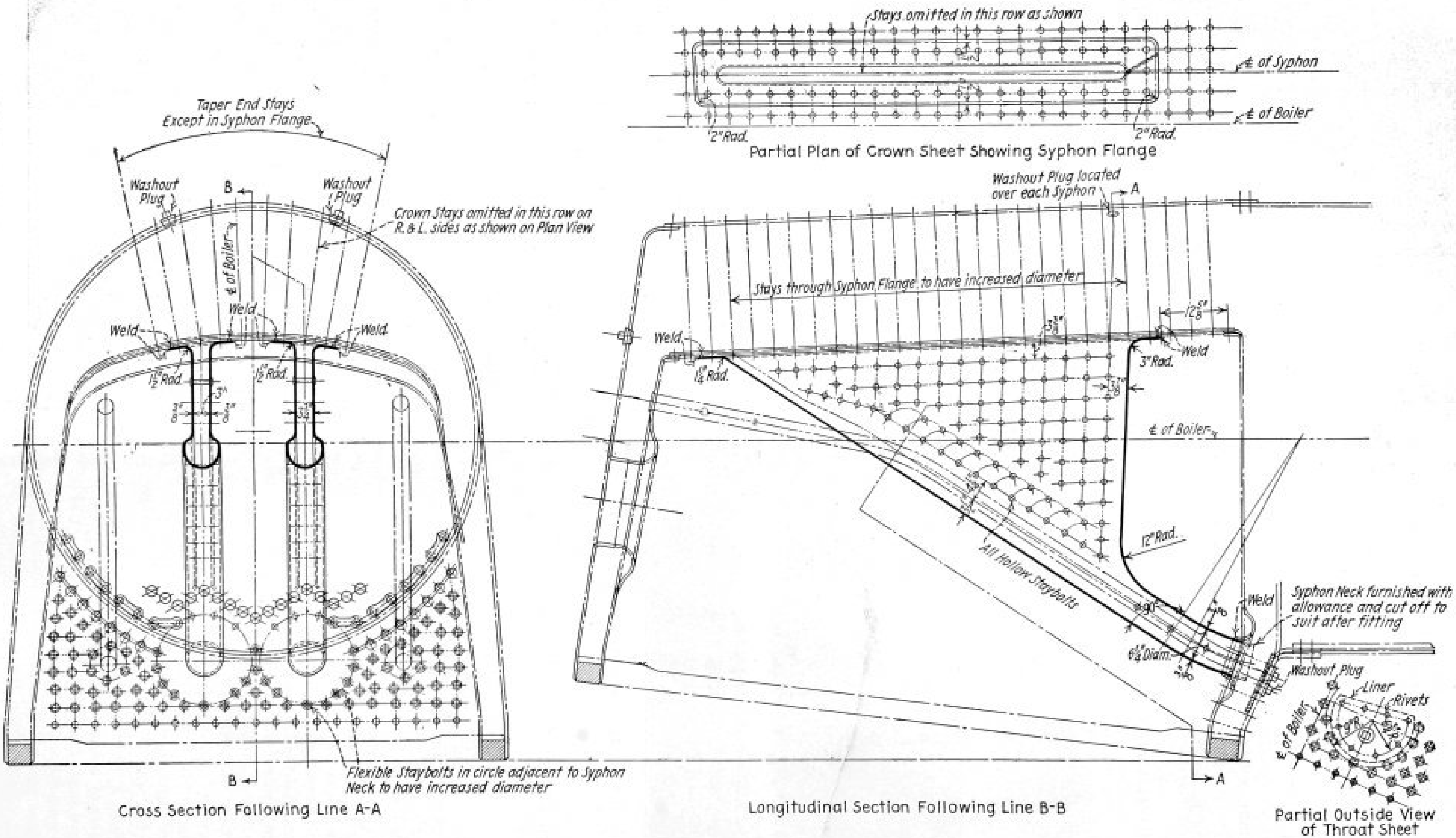


Fig. 50.—Arrangement of Nicholson Thermic Syphon

Laying Out Locomotive Boilers—XII*

Nicholson Thermic Syphons—Installing appliances—Riveting and calking—Data on staybolts and tubes

By W. E. Joynes†

FIG. 50 shows a longitudinal section, a cross section and a plan view of a two-syphon intallation in a locomotive firebox. The purpose of the syphons is to add heating surface to the firebox.

A brief description of the construction of the syphon and the change in the firebox construction for its application is as follows:

The syphon is made from a one-piece 3/8-inch thick firebox steel sheet, flanged into a triangular shaped waterleg when completed. The leg is 3 inches wide inside, having straight flat sides with a semi-circular bottom. It is brought together in a semi-circular shape at the front with a butt welded seam. Formed of the same sheet is a round neck 6 1/4 inches inside diameter extending from the front, at the bottom, to and entering the tube or inside throat sheet for supplying water to the syphon. The upper part of the sheet is flanged out all around to a width of about 12 1/2 inches, or 13 inches, so that it will fit the under or fireside of the crown sheet. This leaves a full length opening in the top of the syphon 3 inches wide and an opening in the crown sheet equal to the full length and width of the flange, minus 1/2 inch all around for a lap welded seam to connect the syphon to the crown sheet.

The width of the flange takes in three rows of crown or radial stays, two rows of which are tapped in and headed over on the fireside of the flange. The third or middle row of stays is omitted the full length of the top opening of the syphon. The pressure at the top of the flange is carried by the stays in the flange, thereby relieving the lap welded seam of any unnecessary stress.

The tube sheet, or inside throat sheet, on combustion chamber boilers, is flanged into the throat waterleg in a return semi-circular shape, to relieve the syphon and firebox of the expansion and contraction strain. The flat side of the syphon has staybolts to resist the pressure.

The semi-circular bottom is formed to a radius equal to one-half the diameter of the neck, carried around in the sides to form a bulged support for the fire brick. The bulge dies out from the end of the brick into the 3-inch semi-circular bottom of the body.

Due to the neck opening and flexible flange around it in the tube sheet, the outside throat sheet cannot be sufficiently stayed with staybolts. A liner riveted to the inside of the throat sheet opposite the syphon neck strengthens the sheet. A washout plug should be located in the roof sheet over each syphon and near the front of it.

One, two and three syphon installations are used, depending upon the width of the firebox. The stays in the side flanges must be larger than the regular crown or radial stays to compensate for the loss of the middle row of stays.

Nicholson Thermic Syphons are designed and manufactured by the Locomotive Firebox Company and furnished to the locomotive builder or railroad company complete for application to the firebox.

Appliances.—The following appliances which require holes in the boiler shell are usually studded to the shell with a steam tight ball joint connection as described above.

Throttle Stuffing Box.—The stuffing box is usually located on the center line near the top of the backhead or to the right of the center line and sometimes at the side of the dome. It makes a steamtight passage for the throttle rod which operates the throttle in the dome from the cab.

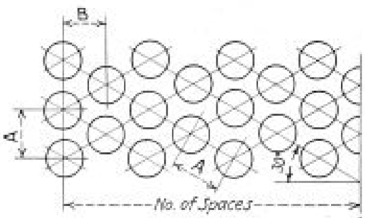
Cab Turret.—An iron pipe leading from the dome to the cab turret supplies the same with dry steam. This steam is used for heating the train, operating the injectors and other

TABLE 4

30° Layout

cos 30° = .86603

B = .86603 A



A	Number of "B" Spaces								
	8	9	10	11	12	13	14	15	16
2 1/8"	14 3/4"	16 9/16"	18 7/16"	20 1/4"	22 1/8"	23 15/16"	25 3/4"	27 5/8"	29 7/16"
2 1/4"	15 9/16"	17 1/2"	19 1/2"	21 7/16"	23 3/8"	25 3/8"	27 5/16"	29 1/4"	31 3/16"
2 5/16"	16"	18"	20"	22"	24 1/16"	26 1/16"	28 1/16"	30 1/16"	32 1/16"
2 3/8"	16 7/16"	18 1/2"	20 9/16"	22 5/8"	24 11/16"	26 3/4"	28 13/16"	30 7/8"	32 15/16"
2 7/16"	16 7/8"	19"	21 1/8"	23 3/16"	25 5/16"	27 7/16"	29 9/16"	31 11/16"	33 3/4"
2 1/2"	17 5/16"	19 1/2"	21 5/8"	23 13/16"	26"	28 1/8"	30 5/16"	32 1/2"	34 5/8"
2 5/8"	18 3/16"	20 7/16"	22 3/4"	25"	27 1/4"	29 9/16"	31 13/16"	34 1/8"	36 3/8"
2 11/16"	18 9/16"	20 15/16"	23 1/4"	25 9/16"	27 15/16"	30 1/4"	32 9/16"	34 15/16"	37 1/4"
2 21/32"	18 3/8"	20 11/16"	23"	25 5/16"	27 9/16"	29 15/16"	32 3/16"	34 1/2"	36 13/16"
2 23/32"	18 13/16"	21 3/16"	23 9/16"	25 7/8"	28 1/4"	30 5/8"	33"	35 5/16"	37 11/16"
2 3/4"	19 1/16"	21 7/16"	23 13/16"	26 3/16"	28 9/16"	31"	33 3/8"	35 3/4"	38 1/8"
2 13/16"	19 1/2"	21 15/16"	24 3/8"	26 13/16"	29 1/4"	31 11/16"	34 1/8"	36 9/16"	39"
2 7/8"	19 15/16"	22 7/16"	24 7/8"	27 3/8"	29 7/8"	32 3/8"	34 7/8"	37 3/8"	39 7/8"
2 15/16"	20 3/8"	22 7/8"	25 7/16"	28"	30 1/2"	33 1/16"	35 5/8"	38 3/16"	40 11/16"
2 31/32"	20 9/16"	23 1/8"	25 11/16"	28 1/4"	30 13/16"	33 7/16"	36"	38 9/16"	41 1/8"
3"	20 13/16"	23 3/8"	26"	28 9/16"	31 3/16"	33 3/4"	36 3/8"	39"	41 9/16"
3 1/16"	21 1/4"	23 7/8"	26 1/2"	29 3/16"	31 13/16"	34 7/16"	37 1/8"	39 3/4"	42 1/2"
3 1/8"	21 5/8"	24 3/8"	27 1/16"	29 3/4"	32 7/16"	35 3/16"	37 7/8"	40 5/8"	43 5/16"
3 3/16"	22 1/16"	24 7/8"	27 9/16"	30 3/8"	33 1/8"	35 7/8"	38 5/8"	41 7/16"	44 3/16"
3 1/4"	22 1/2"	25 5/16"	28 1/8"	30 15/16"	33 3/4"	36 9/16"	39 3/8"	42 1/4"	45"
3 5/8"	25 1/8"	28 1/4"	31 3/8"	34 9/16"	37 11/16"	40 13/16"	43 15/16"	47 1/8"	50 1/4"
3 3/4"	26"	29 1/4"	32 1/2"	35 3/4"	39"	42 1/4"	45 1/2"	48 3/4"	52"
3 7/8"	26 7/8"	30 1/4	33 9/16"	36 15/16"	40 1/4"	43 5/8"	47"	50 3/8"	53 11/16"
4"	27 11/16"	31 3/16"	34 5/8"	38 1/8"	41 9/16"	45"	48 1/2"	52"	55 7/16"

Tube spacing

steam appliances. The turret is usually located on the top center of the roof sheet and near enough to the back end to be within the cab. Sometimes the turret is located on the backhead, or one on either side of the roof sheet.

Safety Valves.—Usually three of these valves are screw connected to as many connections which are tapped in the top part of the roof sheet near the front end, or in the dome cap. The valves are set to blow off at a few pounds pressure apart, when the boiler working pressure is exceeded.

Injector Check.—One of these valves is usually located on

---

* Previous installments of this article appeared on page 1, January issue; page 40, February issue; page 72, March issue; page 99, April issue; page 129, May issue; page 166, June issue; page 235, August issue; page 263 September issue; page 293, October issue; page 324, November issue and page 350, December issue.

† Boiler Designing Department, American Locomotive Company, Schenectady, New York.

either side of the boiler, near the front tube sheet, or on top of the boiler, near the front tube sheet, in the form of a double check. These valves supply water to the boiler from the injectors and automatically cut off the steam pressure when the injectors are not operating.

The hole in the shell for all of the above steam appliances is usually large enough to weaken the shell and so must be re-enforced with a liner riveted to the shell.

Calking.—Bevel the calking edges of all circumferential seams, under pressure, inside and outside. Bevel the outside welt strip of all longitudinal seams for calking.

It is not necessary to calk the inside welt of longitudinal seams.

The firebox crown sheet and flanges are beveled for calking.

The inside and outside shell plates are beveled all around for calking to the firebox ring.

Riveting.—All rivets in the boiler shell seams, brace feet, etc., with the exception of the backhead to roof seam are driven with hydraulic pressure and have button-heads inside and outside after they are driven.

The backhead seam rivets are not all accessible with the hydraulic riveter and for the sake of uniformity all of these rivets are driven with a pneumatic hammer. The rivets have the same manufactured cone head on the inside and a hammered steeple shaped head on the outside after they are driven.

Rivet and Staybolt Holes.—All rivet and staybolt holes should be drilled and not punched. The following size crown stay and staybolt holes should be drilled in the flat sheet: Diameter of thread minus 5/32 inch.

Drilled rivet holes for all longitudinal seams equals diameter of rivet before driven minus 5/16 inch. All other seams, including the smokebox, diameter of rivet minus 1/16 inch. The minus size of the above holes when punches should be larger.

Stays or staybolts passing through the shell at a sharp angle should have holes drilled sufficiently small to insure a true hole for a perfect thread.

The following information is the average general practice in boiler construction.

Staybolt Spacing.—Varies from 3⅞ inches by 3⅞ inches to 4¼ inches by 4¼ inches.

Crown and Radial Stay Spacing.—Varies from 4 inches by 4 inches to 4¼ inches by 4¼ inches.

Plate Thickness.—Minimum and maximum thickness of ring courses 7/16 inch to 1 5/16 inches.

Roof sheet in one piece ½ inch and 9/16 inch.

Front tube sheet, ½ inch, 9/16 inch, and ⅝ inch.

Crown sheet: 5/16 inch to 7/16 inch—average ⅜ inch.

Firebox back sheet: 5/16 inch and ⅜ inch.

Back tube sheet: ½ inch and 9/16 inch.

Tubes.—Boiler Fire Tubes: 2 inches and 2¼ inches outside diameter.

Superheater Flues: 5⅜ inches and 5½ inches outside diameter.

Firebrick Tubes: 3 inches and 3½ inches outside diameter.

Rivets.—Minimum and maximum diameter before driven ⅞ inch to 1 5/16 inches for outside shell, ¾ inch for firebox seams.

Boiler Pressure.—Boiler working pressure per square inch 180 pounds to 210 pounds.

Part of the above information has been exceeded on a number of boilers as well as the above minimum information is too large for some boilers.

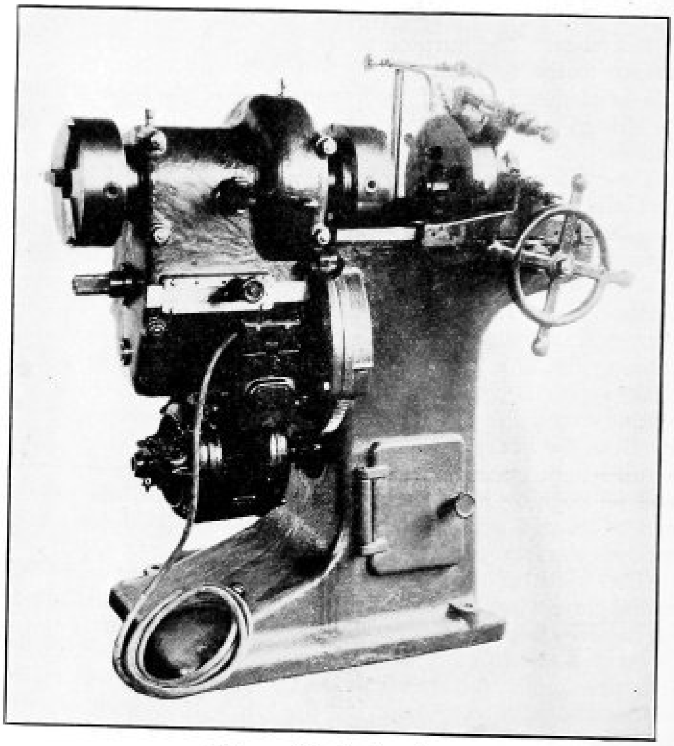
(The End)

The Garratt-Callahan Company, Chicago, Ill., announces that they are moving their offices to larger quarters at 310 South Michigan Avenue.

New Pipe Threading Machine

THE Chicago Pipe Thread Machinery Company, Racine, Wisconsin, has placed on the market a new ¼ to 2 inch power pipe threading machine for production and portable use. The machine can also thread bolts ½ to 1½ inches and drive hand stocks, with the addition of a universal drive shaft; up to and including 12-inch pipe.

The machine is designed to meet all the requirements of a machine of this type and while portable it is a production and precision machine. It is motor driven with the motor direct gear connected, protected from all oil and chips; also any material being handled about the machine—there is a power extension cord with a plug to connect to any electric light socket.



Pipe and bolt threader

There are three speeds which most aptly cover the range of the machine and obtained through sliding gears and lever control, a clutch for starting and stopping the machine is located on the spindle giving perfect control without reference to either the motors or the gears. All gears are machine cut running in oil and the shafts are of generous dimensions running in bearings that are easily replaced when wear may be apparent from years of service.

The Die thread embodies new and novel features—the life of any threading machine is determined by the wear of the die slots. The die slots in this machine when worn can be replaced with little effort and expense.

The quick opening device is most rapid and in the handle is contained the micrometer adjustment for exact, under or oversize threads, as may be required. At the rear of the die head is located the cut-off attachement which is extra heavy to more than withstand the most severe shocks.

The general design is modern in every respect and represents quite a departure from the conventional—it has a pedestal base in which the oil reservoir is located; also a tool and wrench cabinet for keeping dies, wrenches, etc.

The machine is designed to be mounted on wheels when desired for portable use and it can be readily moved from place to place with little difficulty.

Procedure Control for Welding a Guyed Steel Stack*

Outline of the precautions to be taken when selecting and testing the welder, preparing the pipe, and performing the work

GUYED steel stacks are in very common usage because of their comparatively low initial cost and the ease with which they may be erected.

The welded joint is rapidly winning favor in guyed steel stack construction, as it has in many other boiler shop applications, because of the ease of application and longer life as compared with the riveted joint.

The much greater life of a welded stack seems to be the determining factor in this application. The first welded stack of which we have any record was erected in 1919 and is still in use. Manufacturers of stacks for river boats who have used the welded joint are very much in favor of it as they have had an opportunity to check the comparative life of the two constructions. The maximum life of riveted stacks used on river boats is about two years. Some welded stacks put in similar service three years ago were recently examined and found to be in excellent condition.

The life of a stack is dependent upon the life of the joints, and lapped plates collect moisture and corrosive sediment from the stack gases. It is natural then that the life of welded stacks should be much longer, as in stacks made by the oxy-acetylene process there is no lapping and the structure is a single cylinder of steel.

Strength is not an important factor in guyed steel stack design as the wind load is taken up by the guy wires and the dead load due to the weight of the stack is of comparatively little importance.

When it is considered further that the single riveted lap joint, almost exclusively used in guyed riveted steel stack construction, has an efficiency of only about 50 percent, whereas the efficiency of the welded joint is at least 80 percent, the question of the strength of the welded joint is certainly not a factor to be concerned about.

The problems of assembling and erecting a guyed welded stack are no different than in riveted constructoin. Both types are completely assembled before erection, where necessary the sections being assembled in the field.

The comparative cost of welded and riveted construction is largely influenced by the facilities at hand for doing the work. Boiler shops have found it more economical to use the ox-welding process on tanks, gear guards, etc., where the metal runs about the average stack plate thickness. There is no evident reason therefore why properly applied methods should not bring the cost of welded stack fabrication within the limits of that of riveted construction.

A. Check of the Welders

1. Experience.—Welders should preferably be experienced in steel welding, both on light plate and pipe.

As a check upon the welder's ability to meet the requirements of the work he should successfully pass the following qualification test:

2. Qualification Test.—The qualification test should duplicate, as far as practical, the conditions encountered in the welding of a circumferential seam of average stack diameter and wall thickness. A diameter of 20 inches, overall length of 6 inches, and wall thickness of 3/16 inch may be used satisfactorily for test specimen dimensions. This size is fairly typical of the finished product.

The plate chosen for test purposes should be cut and rolled to desired diameter and two sections prepared and assembled for welding, as in Section B. The welder should first weld the longitudinal seams of the two sections.

He should then be required to make a complete circumferential rolling weld (see Section E) under the welding foreman's observation. The time allowed to make a test weld should fall within the limit set for production work.

Where the stack is to be shipped in sections and assembled in the field before erection, position welds will be necessary in some cases. Welders used on this work should be required to submit a test specimen similar to the one described in the preceding paragraph, except that a position weld should be made instead of a rolling weld.

At least four specimens 1½ inches wide and not less than 4 inches long should be cut from the circumferential weld for test, one specimen being taken from the finishing point of the weld. A cutting blowpipe may be used for this operation.

The test should consist of gripping each specimen in a vise with the weld flush with its jaws and sledging against the side from which the weld was made until the piece has bent through 90 degrees. A satisfactory test specimen should not fracture under this test.

The specimen should then be reversed and hammered from the opposite side until fracture occurs. The fracture of a satisfactory specimen either should occur outside the weld, or, if in it, should show full penetration and thorough fusion, without gas pockets, cold shuts or other defects.

3. Special Checks.—Test pieces may be required at any time of any welder, at the discretion of the person in charge of inspection. It is good practice furthermore to test the welder's work periodically.

B. Selection, Inspection and Preparation of Material

1. Plate Specifications.—Low carbon plate should be used (open hearth steel, carbon 0.20 percent maximum). The steel should be free from appreciable quantities of non-metallic inclusions and laminations and should be of good weldable quality.

2. Welding Rods.—Rods should be of low carbon content, conforming to the American Welding Society Specifications, and should flow freely, smoothly and without detrimental action.

3. Beveling the Plate.—All plates should be accurately re-squared and where necessary beveled (see Section C, Paragraph 1) to meet the requirements of the work. Re-squaring may be accomplished in a shear or a planer. A rotary shear or a planer may be used for beveling. A tolerance of 1/16 inch in 3 feet should be allowed in re-squaring and beveling.

4. Rolling the Plate.—The plate should be rolled as nearly as possible to a true circle. The flat spots ordinarily left on the ends of the plates should be eliminated either by forming the ends in a press before rolling, or by breaking them over during the rolling operation. This latter operation may be accomplished by inserting a strip of plate under the end of the section being rolled, or by overlapping the edges of the rolled section slightly before removing it from the bending rolls.

C. Design and Layout of Welded Joints

1. Specifications for Beveling.—On plates 3/16 inch and under, no requirements for beveling should be made. The

*Published through the courtesy of *Oxy-Acetylene Tips*, of the Linde Air Products Company, N. Y.

plates, however, should be resquared as mentioned above. On all other plates the edges should be beveled to an angle of 45 degrees where possible to within 1/16 inch of the bottom, as shown in Fig. 1. Plate beveled to 45 degrees to its entire thickness is acceptable. Any beveling done with a cutting blowpipe must be properly cleaned and all oxide removed by means of a hammer and chisel or file.

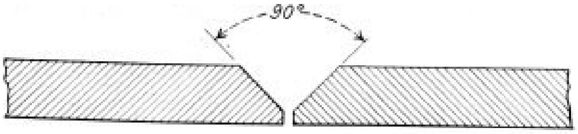


Fig. 1.—Bevel specifications for plate over 3/16 inch thick

2. Spacing of Plates.—(a). Longitudinal Seams. On plate which is not beveled, the longitudinal seams, at the end from which the welding is to be started, should be spaced 3/32 inch apart. Where beveled plate is used, the spacing at this point should be equal to 1/16 inch. The separation of the plate edges at the other end of the seam should be equal to about 2½ percent of the plate length or an allowance of ¼ inch to the foot. (See Fig. 2.)

(Note: The exact distance that the edges should be separated to allow for contraction is influenced by the length of the seam, the rate of welding, the application and intensity

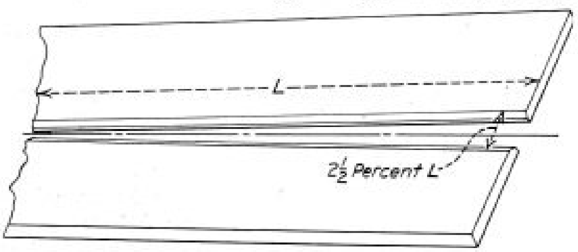


Fig. 2.—Spacing layout of plates for longitudinal seams

of the welding heat, etc., and can be accurately determined only by consideration of the welding conditions encountered in the fabrication of the stack.)

(b) Circumferential Seams. Where the plate is not beveled, the abutting edges of the sections, at all points on the circumference, should be spaced a distance equal to the plate thickness plus 1/16 inch. On beveled plate this spacing should be equal to the plate thickness.

(Note: The above spacing applies to plate thickness up to and including ¼ inch. On stacks of 36-inch diameter

Fig. 3.—Clamp for maintaining alinement in welding longitudinal seams

and over, the spacing should be increased an additional 1/16 inch.

3. Weld Metal.—(a). The weld metal should be thoroughly fused with the base metal at all sections of the weld. The penetration should include the unbeveled portion and extend to the inside wall of the stack.

(b) The weld metal should be thoroughly fused, and free from laps, cold shuts, gas pockets, oxide inclusions and other defects.

(c) The width of the weld should be a minimum of 2½ times the thickness of the plate. The welds should be reinforced about 25 percent of the plate thickness.

4. Location of Longitudinal Welds.—The longitudinal seams of adjacent sections should be staggered about 180 degrees.

D. PREPARATION OF THE PLATE FOR WELDING

1. Longitudinal Seams.—(a). The rolled plate should be placed on a solid and level base, either a concrete floor or on I-beams, angles or channels.

(b). The edges of the plate should be separated as recommended in Section C, Paragraph 2.

(c). The edges of the plate should be held in line and to a circle of correct curvature by special clamps, one to be placed at each end of the seam. The clamp shown in Fig. 3, or one of similar design, may be used. Wedges or pinch bars should be used if necessary to make sure that the plates draw together properly as the welding progresses.

(d). The edge of the plates should line up true to a circle of correct radius. There should be no flat spots at the longitudinal seams.

(e). All scale, dirt, oxide or other foreign material should be thoroughly removed from all edges before welding; clean with a wire brush or similar equipment.

2. Circumferential or Girth Welds.—(a). Preparatory to welding the circumferential seams, the sections should be lined up straight in horizontal and vertical planes. Rollers may be used for this purpose and should be shimmed up where necessary. The correct alinement may be secured by

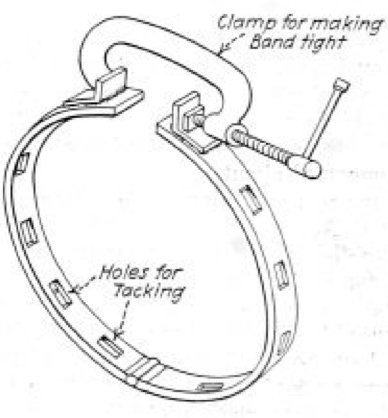


Fig. 4.—Clamp for lining up sections for girth welds

the use of a level or straight edge. If cranes are not available for removing the completed sections from the rollers, supports should be so designed as to allow quick and easy removal.

(b). In lining up and spacing the sections, recommended practices (Sec. C.) should be followed.

(c.) The abutting ends of the sections should be clamped concentric before tacking. (See Fig. 4.)

3. Tacking.—After the sections are lined up true and properly spaced, they should be tack-welded at equidistant points about the circumference, the distance between tacks being 6 to 8 inches. Tacking should be done at points 180 degrees apart simultaneously if two welders are engaged in this work. When only one welder is employed in tacking he should make the second tack 180 degrees from the first, and additional tacks midway between those already completed.

The purpose of the tacking is to hold the sections in alinement and to control properly the spacing between the edges. The tack weld need not be longer than four times the thickness of the plate and may be without reinforcement.

E. WELDING TECHNIQUE

1. Longitudinal Seams.—(a). The operator should start welding the longitudinal seam at the end of least separation between the plate edges and weld continuously until the seam is completed.

(b). The operator must watch and control the contraction of the edges of the plates, and see that the spacing at the point of welding is maintained at the proper distance.

(c). No flat spots should be left at the seam after welding. If necessary, internal forms should be applied to hold the edges of the plate to the correct curvature.

(d). If the welding has to be stopped for any reason, the welder, on restarting, should reheat the weld to a dull red for a distance of at least 3 inches and reweld into the previously welded portion.

(e). The tip size should be the equivalent of that specified in the Oxweld table.

(f). The type of weld may be either a ripple or a flat weld, the one essential being that complete penetration and fusion must be obtained.

2. Circumferential Seams.—(a). One welder should be assigned to each circumferential seam and should be responsible for its quality. Once the weld is started, the welding should be continuous until the seam is completed.

(b). The welding should be done in the upper quadrant of the stack, it being turned so that the welding is always done in a position convenient to the operator.

(c). The welder should reheat the weld at all starting and finishing points to a dull red for an overlapping distance of 3 inches, and at the point where the weld ties into a previously welded portion, he should remelt and reweld thoroughly.

(d). Where conditions in the field necessitate the making of position welds, two welders should preferably be employed to make this joint. They should start simultaneously at the bottom of the joint and work around on either side so that they meet on top. Where only one welder is assigned to this work, he should start welding at the bottom of the joint, and after completing one-half of the seam, should return to the starting point and weld up from the other side, taking care to observe the above-mentioned requirements with regard to reheating and rewelding.

F. INSPECTION

The shop foreman or superintendent should be in charge of inspection. He should be responsible for the quality of the work.

He should see that the dimensions of the weld conform to the specifications given under Section C and that penetration to the inside wall of the stack is obtained throughout.

He should see that the correct practice is followed in preparing, spacing and lining up the sections as given in Sections B, C and D.

He should make certain that the weld is reheated at starting and finishing points of uncompleted welds.

Examinations for Welders

The United States Civil Service Commission, Washington, D. C., announces an open competitive examination to fill ten vacancies for electric welders at the Norfolk, Va., Navy Yard, as well as other vacancies as they may occur in positions requiring similar qualifications in the Navy Yard Service in Norfolk. The salaries are $5.84, $6.24 and $6.64 a day.

A minimum of two years experience in the occupation must be established in order to qualify for this position. Full information and application blanks may be obtained from the Labor Board, Navy Yard Service, Norfolk, Va., or from the Secretary of the Fourth Civil Service District, 1723 F Street, N.W., Washington, D. C.

New System of High Pressure Steam Generation

By G. P. Blackall

An installation for the generation of steam at high pressure, based on a system devised by Professor Loeffler, of Vienna, was recently erected at the Weiner Lokomotivfabrik at Floridsdorf. The working pressure of the generator is 1,400 pounds per square inch.

This system constitutes a complete departure from the system of evaporating water by the application of external heat to the vessel in which the water is contained. Briefly, the arrangement consists simply of an evaporator outside the combustion chamber and a superheater which is placed inside the combustion chamber and is subject to the heat of the combustion gases. This superheater contains steam only and in it the steam is superheated to such a degree that its heat suffices to evaporate the water in the evaporator. This is done by applying the superheated steam internally. Naturally the superheated steam loses part of its heat, but this is regenerated in the superheater and the steam finally leaves the steam generating plant with a pressure of 100 atmospheres and a temperature of 750-940 degrees Fahrenheit.

The most important part of the system—the superheater —is made of ordinary Siemens-Martin steel as usually applied for superheater systems. This material has proved to be thoroughly reliable under the conditions of the process, in which no additional stresses through irregular heat transmission are possible. The steam is moved through the tube systems of the superheater by special pumps and as only really dry steam is circulating in the superheater no sediment of any kind whatever can be formed. The superheater tubes being of only small diameter are fairly reliable and the dangers of explosion are minimized. The evaporator, of course, the exposed to the full steam pressure as well as the superheater, but as its temperature is low as compared with that of normal boilers, it is small, light in weight and reliable.

To start the plant, auxiliary steam generated in an ordinary boiler must first be led into the plant. This steam may be taken either from some foreign steam plant or from an auxiliary boiler with a pressure of as little as 28 pounds per square inch. At a demonstration of the Floridsdorf plant, steam with a pressure of 170 pounds per square inch, was used, and the time necessary to increase the steam pressure up to 100 atmospheres proved to be only about one hour, or far less than the time needed for working normal boiler plants up to their pressure. In the evaporator, scale may be formed without objection and even with advantage, as it serves as a medium of heat insulation. The evaporator is placed near the steam engine, from which the steam generation may be automatically regulated. The Loeffler system, it is claimed, may be applied with advantage not only to large but also to medium and small power plants.

Oregon Adopts Boiler Code Section

The Bureau of Labor of the state of Oregon has announced that this state has adopted Section 8 of the American Society of Mechanical Engineers' Boiler Construction Code to become effective February 1, 1926.

This section consists of the rules for the construction of unfired pressure vessels and means that all such vessels constructed and installed in this state after February 1, 1926, must comply therewith.

The Globe Steel Tubes Company announces that the Chicago office has been moved from the People's Gas Building to 40 North Michigan Avenue, Chicago.

Industrial Democracy*

Government by representation applied to industry — Its possibilities and limitations

By D. S. Kimball†

CONTAINING no doubt the essence of a result greatly to be desired the term "industrial democracy" may, unless properly understood and delimited, lead us into serious industrial difficulties. Because of the prominence the expression has received, there are many people who have the idea that some great new principle of industrial management has been born into the world whereby large enterprises can be managed in a perfectly democratic manner, where all employees will have an equal share in the management, and where all the defects of modern management as it now exists can be eliminated. And there are not wanting prophets of the idea represented by this new slogan who tell us that here at last is the solution of the great problem which must be met.

In transportation and mechanic arts ownership of the tools of industry has, to a large degree, passed out of the hands of the actual worker and is now under capitalistic control. In these fields, division of labor has been extended to an amazing extent. These changes have tended naturally to widen the gap between the employer and the employee and to make the latter more and more dependent upon the former for his means of livelihood. The old social order has been broken up and the old friendly relation that formerly existed between master and man has been destroyed and nothing has been provided, as yet, that in a broad way replaces these losses.

These tendencies have been hastened, naturally, by the growth in the size of individual industries. The larger the plant the farther the distance between the management and the worker, the gap between being filled with the machinery of organization. And no doubt these changes have been intensified by the great influx of low-paid immigrant labor that has for many years flocked to our shores and found ready employment in the great mass-production industries. The introduction of these workers erected new barriers of *race* and *language* between management and men and no doubt this tide of immigration has done much to accent the false ideas that there are two kinds of people in the industrial world, those who work *for* money and those who work *with* money.

Why Socialistic Doctrines Fail

The rising tide of modern democratic ideals increasingly insists that industry shall be considered less as a personal matter and more as a general support of life and that personal profit and advantage shall be secondary to the general weal; or as it is sometimes stated that industry shall be "democratized." Our ideas of democracy in industry will be governed, therefore, largely by our interpretation of this democratic movement and within the group that is pressing for this democratization a wide variation of opinion will be found and many panaceas are offered for our industrial ills. Thus one group preaches the doctrine of anarchy which holds that all law and government is an evil and could be dispensed with. For the most part this belief has never gone beyond the realm of speculative philosophy. Another much larger and more important group holds as a basic tenet the need of restoring to the worker the ownership of the tools of industry.

This is the tap root of all socialistic doctrine though the advocates of socialism differ widely in their ideas as to the degree to which it is necessary or possible to bring about this result. In its most violent form this group would destroy modern industrialism with no adequate substitute to replace it. This has been almost accomplished in Russia where the extreme view obtained that the ownership of the tools of industry should be vested in those who actually produce. The brief but dreadful experience of that unhappy land has proven beyond doubt what every student of organized government already knew. *No organized industry that is capable of supporting a modern civilization can be successfully operated by manual labor alone.* The industrial manager, the functionalized worker or specialist, and the financier are as necessary to modern industry as the actual worker no matter how skillful he may be.

It should be carefully noted that there is nothing in the laws or public sentiment of this land that prohibits, in any way, the joint ownership of productive tools by any group of men in any number. Furthermore, there is no prohibition of any kind that would prevent such a group from operating such tools in the most democratic manner they may choose to elect or devise. The history of such co-operative efforts except where those involved have been held together by some extraneous bond, such as religion, has been, for the most part, a story of failure. While therefore these socialistic doctrines have exercised and are exercising a powerful modifying influence upon capitalistic industry they are not likely to be accepted, in the near future at least, as the controlling principles in industrial management. The widespread lack of thrift among present day workers and their lack of special knowledge and training in industry and finance will, unless our educational processes work a great change, long remain a great obstacle to co-operative ownership and control of the most democratic kind.

Government by Representation Applied to Industry

Recognizing perhaps these limitations of socialistic doctrines, some industrial reformers have turned to the principle of government by representation as illustrated in our national government and similar institutions elsewhere. In theory at least, this form of control is rational and fair. It recognizes that civilization requires many men of many minds and through the election of those best fitted to represent the varied and conflicting interests of the country, aims to confer the greatest good upon the greatest number. Some of the basic reasons why we have not obtained better results with representative government should be noted in connection with its application to industrial management. First there is a general lack of knowledge on the part of the populace of many of the most important issues of government and there is always a lack of intelligent leaders who are of the people and for the people. Democracy is blind in many respects and "where there is no vision the people perish." Because of this weakness also the aims of representative government are often defeated by minority groups who are interested in movements looking to their own selfish aims and who through skillful propaganda and the voices of dema-

---

* Address delivered before thirty-seventh annual convention of the American Boiler Manufacturers' Association, Watkins, N. Y., June, 1925.

† Dean of College of Engineering, Cornell University, Ithaca, N. Y.

gogues influence the popular vote in their own interest. Whether we shall be able to overcome this difficulty by universal education, as many hope we shall, remains an open question.

Despite these limitations, however, representative government as existing in this country is in many ways the best form of government, for our ideas of civilization, that has as yet been devised. It was quite natural, therefore, that an effort should be made to apply its essential features to industrial management in answer to this demand for democratization. For some time prior to the great war forward-looking employers, and employees who wished to obtain a more adequate means of presenting their desires, had in a number of instances organized joint committees of various kinds in an effort to reach a better mutual understanding. The labor difficulties incident to the war gave a considerable impetus to this movement. From the very diversity of industry itself these "Works Councils," as the joint committees are designated, must necessarily vary widely in character and scope. They have, however, one important common feature, namely, they are all based upon representation chosen by and from the employees of an individual enterprise. Otherwise, they vary in size, scope, method of formation and other specific features of organization. In small plants the Works Council is of the simplest and most informal type while in some of the larger enterprises they are very formal and quite complex.

For convenience of discussion all Works Councils may be divided into two general types. The first type includes those organizations that are modeled after the Federal Government and is, therefore, known generally as "Industrial Democracy." The chief sponsor of this method of employee representation is Mr. John Leitch who defines this method as "The organization of any factory or other business institution into a little democratic state with a representative government which shall have both the legislative and executive phases."

The Leitch Method of Organizing Industry

In this plan there is first a cabinet consisting of the executive officers of the plant. This body is not elective but owes its existence to the ownership of the enterprise. The cabinet holds a veto power over legislation, but it may suggest measures to the Senate and House of Representatives. The Senate consists of foremen and department heads and usually is not an elective body, though in one instance in a very large plant this body is also elected by the employees from the ranks of the foremen and departmental heads. Lastly, there is the House of Representatives which is elected by secret ballot by the actual workers in the institution on such a basis as may seem most desirable. These bodies are organized with the same general legislative machinery, committees, etc., as the Federal Government and are expected to transact business in a manner similar to that organization. As a basis of action and as a bond to hold the work of the several bodies in harmony there is a written "Business Policy" corresponding to the Constitution of the United States and containing a declaration of principles and reasons why the organization has been called into being.

The basic intent of this form of organization is to provide an opportunity for the workmen to express their views on all matters in which they are competent to do so. Bills or measures may originate in the Senate or House but they must pass both House and Senate and be approved by the Cabinet before becoming a "law" or shop regulation. Undoubtedly such a plan will provide the opportunity for a free exchange of opinions on many phases of industrial management and no doubt shop rules and regulations formulated thus by the aid and with the consent of the workers will be far more satisfactory than if imposed from above. If founded in a liberal spirit the deliberations of the House will, no doubt, bring many needed changes and grievances to the attention of the management and assist materially in obtaining a better understanding of the things that make for content and confidence in the management. Obviously, such a comprehensive plan as outlined in the foregoing is best adapted to plants of some magnitude.

One of the greatest defects of industrial democracy so-called, in the opinion of the writer, is the fact that the representatives of the workers meet by themselves in one body and the representatives of management meet by themselves in two other bodies. While it may be possible that such an arrangement is conducive to a greater freedom of speech on the part of the workmen it does not tend to restore in any great measure the old *personal contact* that has been lost in the great growth of modern industry. The intercourse between the management and the workers is necessarily quite formal. Of course in the hands of an enthusiastic and able man like Mr. Leitch or any industrial leader who can arouse and hold the loyalty of his workmen any plan can be made helpful, but in the abstract this lack of close personal contact in any way between management and men is a disadvantage at least.

The Committee System

For this reason the writer is inclined to believe that there is much more hope of securing better industrial relations through the second type of Works Councils which is based upon the committee system. The committee system offers a wide range of joint activity. Thus the Works Council may consist of a single committee or there may be a number of committees arranged in ascending order of importance and authority, or there may be a number of unrelated committees each having jurisdiction over some special field. Again, these committees may consist wholly of employees or of executives as in the plan of Industrial Democracy, or they may be joint committees of employees and executives. It is this last form of committee system that probably holds out most hope since this form of council offers more opportunity for personal contact between employer and employee than any other.

The most important and most difficult phase of all organizations of this kind is to fix the function and authority of the committee or committees. It is in this connection that the limitations of democratic government appear most strongly. It is almost obvious that the deliberations of a body such as the House in the plan of Industrial Democracy or of a corresponding committee, under the committee system, must necessarily be confined to the field of *human relations*. Such a body is fully competent to discuss working conditions but its usefulness in other directions appears to be limited. A report of the National Industrial Conference Board discussing the matter states: "It appears from the foregoing that practically all Works Councils deal with such subjects of bargaining as hours of work, wages and piece rates. In addition many such organizations concern themselves with the social and recreational life of the workers and with their living and working conditions. In some cases the Works Councils deal with shop discipline or with hiring, promotion and dismissals, but usually by way of review and recommendation only. Relatively few Works Councils concern themselves with the improvement of production or with general management problems."

Special Knowledge Essential in Industry

This last statement is very significant and indicates the direction of possible growth and development of such systems. It indicates clearly, also, the basic truth that *special knowledge and intelligence is not an elective faculty*. Important as these matters are that come within the scope of elected committees they constitute only a portion of the problems of management. They do not touch the difficult problems of financing the enterprise, deciding upon what shall be manufactured, nor any of the difficult problems met with in devising and furnishing ways and means, purchasing material and directing the general business activities. These functions require *specialized knowledge* which, as before stated, is not an elective possibility. If from any industrial enterprise there should be taken away the small body of specialists such as the financier, the chemist, the engineer and those who understand modern industrial methods, the entire fabric would collapse in exactly the same manner as did Russian industry when this class of men were put out of the way.

There is nevertheless an immense amount of industrial knowledge in the possession of any group of skilled workers that under ordinary methods of management is largely lost. The joint committee offers a means of cooperative effort that will make this practical knowledge of use and many such committees are in operation. Thus a committee consisting of the designing engineer, the toolmaker, the purchasing agent and a man from the shop who is fully acquainted with the processes involved can often do remarkable things in the way of reducing manufacturing costs. And the better personal understanding that comes from such conferences should be considered in no way as a by-product. The committee principle, in fact, can be applied to a very wide range of activities.

In a few instances an attempt has been made to secure a more democratic control by permitting the workers to elect representatives to sit with the managing directors and other administrative and executive bodies. While such representation may, if wisely organized, tend to a much better mutual understanding between employer and employee in that it may remove any mystery surrounding the administrative methods and assure the workers that they are getting their share of the profits, the limitations described in the foregoing hold true. In general, workmen are not prepared to assume administrative duties and less prepared to give intelligent decision on matters requiring special knowledge. We recognize this shortcoming in a broad way in the provision whereby we elect representatives and senators, but rely upon the President to appoint the specialists who make up the Cabinet. It is this limitation that makes cooperative efforts of all kinds difficult, and refined socialistic ideas a distant dream.

Results Obtained With Works Councils

Actual experience with representative government in industrial management has been far too limited to permit of any very definite conclusions as to the permanent value of the movement. Many questions as to the best procedure to be followed in operating Works Councils still remain vague and undetermined. Thus while the field of activity of such councils appears to be fairly well delimited the degree of responsibility and authority with which they may be invested is far from settled. No doubt this will vary widely with circumstances. In some plans for instance, final settlement of a disputed point over which the council cannot agree is vested in the higher officials of the enterprise, in a few cases compulsory arbitration by a disinterested party is provided for, while in many more no provision whatever is made for the final disposition of such an unsettled point if the Works Council, whatever its form may be, fails to settle it to the satisfaction of all concerned. Clearly we shall need much more experience with the idea before its possibilities and limitations are fully determined. We shall need to know much more concerning the relations between cooperative effort of this kind and financial incentives for increased productivity. There is considerable evidence, however, that a large proportion of employers and employees who have had experience with Works Councils have been favorably impressed by that experience.

The most important consideration in connection with Works Councils is not the particular method of their formation nor even their powers and jurisdiction. The main question is whether this *principle* offers a means of securing a better understanding between employer and employee. If the principle is sound, the best method of procedure is sure to be evolved. The history of welfare work so-called is filled with the records of misunderstandings and failures. Yet out of this movement have come certain basic principles and practices affecting working conditions in industry that today no thinking man questions. Aside from any humanistic motives it has been demonstrated that plenty of sunlight, air and comfortable and sanitary surroundings are good business investments. We are in need of a similar movement that will assist in evaluating these more intangible and more important human relations. Most industrial troubles have their origin in *distrust* and distrust usually has its roots in *selfishness*. It would appear that there must be some form of joint activity that will enable capital and labor to sit down together and, setting both of these darksome human characteristics aside, arrive at a decision on any debatable matter that will be acceptable to both sides. Perhaps Works Councils offer this opportunity.

More Light on the Strength of Rivets

THE usual form of rivet for holding together pieces of iron or steel is one with a full head, namely, a button-head, in bridge, building and car construction, and a conical head in boiler or tank work. There are cases, however, where the head must be flush with one or both faces of the members connected, requiring the use of countersunk rivets. In ordinary practice such rivets are used only where necessity demands because they have long been considered weaker than rivets with full heads and specifications definitely prescribe smaller strength values for them than for rivets with button or conical heads. That such depreciation of the value of the countersunk rivet has been founded on analytical studies rather than specific test data is indicated by the report of a series of tests of button-head and countersunk rivets made by J. B. Kommers, associate professor of mechanics of the University of Wisconsin. These tests show no particular difference in the strength of the two types of rivets but a lesser rigidity of the countersunk rivets under normal stress and a greater deformation at failure. The general conclusion of the report is that full head rivets should be used in joints requiring maximum rigidity, but that countersunk rivets are preferable in joints subjected to impact or collision, because of their greater capacity to absorb the energy of the blow. These tests, together with the conclusions offered, do not suggest any marked departure from present practice as regards bridges and buildings, but they do suggest the possibility of a thorough review of current specifications with a view to determining whether some modifications in the assumed strengths of rivets are justified in the light of these developments.—*Railway Age.*

Defective Eyesight

Defective eyesight is affecting the country's industrial output, is handicapping education, and is a growing menace to human welfare, it is asserted by the Eye Sight Conservation Council of America, Times Building, New York, in a comprehensive eyesight survey of two years' duration. Information was furnished by 170 companies located in 23 states and employing over 1,000,000 persons. The records of 40 companies cover the examinations of the eyes of 204,817 employees. The average proportion of defective vision was 44.3 percent.

Future Possibilities of the Locomotive Boiler

Trend to high boiler pressures indicates a serious consideration of the watertube type

By Louis A. Rehfuss

IN the last 50 years, steam locomotive development has followed lines that have been conservative to say the least, save in the one item of increasing size. Most of the great developments really occurred prior to 1850. Since that time the designers have been conservative, yet hardly progressive. They have been content to refine, to elaborate, to improve the original design. There has been little disposition to go back and question the first principles, to determine whether or not the traditional type of steam locomotive was all that it might be. Of late, locomotive design seems to indicate signs of a change.

In increasing the thermal efficiency of the steam power plant, the subject may be approached in two directions, up or down, widening the range from higher pressures to lower back pressures or vacuums. Recent experiments with turbine condensing locomotives have had to do with the extension of this range downward to work with vacuums with which the boiler has nothing to do, since it is a question of the utilization of the steam after it is made. On the other hand, with the extension of the range upward the boiler has a great deal to do, and it is with this phase that this article would treat.

Trend Towards Higher Pressures

The first steam locomotive sucessfully developed by James Watt, worked at a pressure of seven pounds. Today the steam locomotive boiler operates at a pressure of 200 pounds, and is apparently at its limit unless radical changes in its design are made. That these changes are at hand may be seen in the 350 pounds pressure locomotive boiler built for the Delaware & Hudson as well as in the 40 or 50 Brotan type boilers recently built for heavy railroad service in Hungary. These boilers dispense with the stayed back end and use walls of watertubes for the firebox, but still cling to heavy plate barrels, made heavier than ever to stand the pressure.

The whole reason for this trend towards higher pressures lies in the fact, that while the total heat to be imparted to a pound of water remains practically the same at all pressures, the heat of vaporization, which is never available as mechanical energy, steadily decreases as the pressure increases. This means that as the pressure rises a steadily increasing percentage of the heat is available as useful work. Theoretical savings, of course, are larger than practical, because of the greater condensation occurring at the higher temperatures used and other factors. Still with proper superheating to minimize the condensation and with normal precautions in design, undoubtedly the possibilities in increased thermal efficiency and coal economy point to increasing our boiler pressures to as great a degree as boilers and engines can be built to withstand them safely.

In the face of this plain trend of the future, what is the outlook for the steam locomotive boiler of today. Unfortunately the existing type will not lend itself readily to any considerable increase over present pressures, due to the question of the weight limitation on drivers and other factors.

With a barrel six or eight feet in diameter, locomotive boiler plates are already assuming alarming thicknesses and weights, so that even with a six-foot barrel, the thickness of boiler plate would be close to two inches for a 500-pound pressure boiler, and nearly four inches for a pressure of 1,000 pounds. With driving wheels already loaded to the maximum, doubling or tripling the weight of the present type of boiler through an increase in the pressure would soon impose a practical limitation to the extent of that pressure's increase. The difficulty of preventing heavier plates, where exposed to the fire, from burning, would be another limitation.

It seems likely that the trend of the times is passing from a firetube to a watertube type of boiler. This is partly foreshadowed in the D. & H. boiler and the Brotan boiler. Still higher pressures are likely to witness a still further application of watertube boiler principles on the barrel itself.

The reason for this is plain. Since the thickness of the plate varies as the diameter of the tube, barrel or drum holding the pressure, it is evident that a 3-inch tube with walls but ¼-inch thick will hold safely as high a pressure as a boiler barrel 6 feet in diameter with walls several inches thick. Herein lies the solution of the difficulty, and herein lies the adaptability of the watertube boiler to the high pressure steam locomotive of the future.

Objections to a Watertube Boiler

Many objections may be raised to a conclusion of this kind, and particularly to the use of an all-watertube boiler. It seems worth while here to consider a few of them:

1—Will the joints stand the rack and tear of locomotive service?
2—How will radiation be prevented to the outside air?
3—How solve the high temperature difficulty?
4—Lessened water and steam capacity.
5—The question of safety.

The first objection likely to be raised is that the joints will not stand the rack of locomotive service. The present firetube locomotive boiler has approximately 200 tubes ranging from 15 to 20 feet in length, which are absolutely unsupported except for rolling and beading at the ends. Suppose now the fire, or rather the furnace gases, are put outside the tubes and the water inside. This would not lessen the resistance of the joints to shock. If the weight of the water in the tubes increases the shock, there is still recourse to two expedients seldom used in locomotive boiler practice. The first is to place baffle plate supports at several points along the length of the tubes. With the furnace gases playing outside the tubes and therefore occupying a larger area, diverting the flames back and forth in their course is sound practice in watertube boiler construction. In a locomotive boiler, these baffle plates would help support the weight of the tubes as well, thus preserving them from too great a strain from the effects of their own weight. Where tubes give trouble from slipping and are required to carry an unusual load, the slipping point can be easily raised by serrating with an ordinary tube expander, the rolls of which are grooved 0.007- inch deep, 10 grooves to the inch. A tube thus serrated would have its slipping point raised between three and four times its usual value.

A second objection to the use of the watertube boiler for locomotive service is the question of the radiation of the heat to the outside air. With the locomotive rushing through space this is plainly of the greatest importance. When using a watertube boiler the hot gases pass outside the tubes instead of through them, and this heat must be confined. An outside shell lined with firebrick offers the best solution to this difficulty. Even in the customary firetube type of locomotive boiler, it seems strange that firebrick has not been used more in connection with the firebox.

Objections to a Waterleg Type of Firebox

The firebox construction of the D. & H. and Brotan locomotive boilers, in which watertubes are used for waterlegs, is an improvement over the stayed firebox side from the standpoint of improved circulation that keeps sediment from collecting. They are both inferior to straight firebrick walls, with watertubes used overhead in place of a crown, for several reasons.

The waterleg construction, in which the water cooled metal surface comes in contact with the fire itself, chills it and prevents it from burning to its best efficiency, causing coal only partially consumed to go in the ashes. The burning gases above, that are brought into premature contact with water cooled surfaces may well be lowered below the point of complete combustion, leaving valuable heat units to go up the stack. For these reasons it is not best to overload the firebox section with excessive water cooled area, even though such evaporative area, at the point of highest heat, is obviously most effective.

By the use of firebrick walls, the evaporation that would be normally done by the waterlegs at the fire is simply transferred to the tubes, which become much more effective because of the higher temperature of the furnace gases. No evaporation is lost. Rather it is gained through the more thorough combustion of the coal possible with firebrick walls which reflect the heat instead of absorbing it. Evaporation in the firebox itself is not lost, since a nest of watertubes would be used overhead in place of the present unsafe crown sheet of the firebox.

It is also obvious that firebrick walls would prevent radiation to the outside air to a greater degree than is possible with the waterleg firebox. This can be understood from the fact that the heat conductivity of water is four or five times as great as that of firebrick. All told, a simple wrapper sheet lined with firebrick, with water tubes overhead, should be not only less expensive than an elaborately stayed firebox, but more effective as well.

In the case of a watertube boiler, firebrick could also be used to line the barrel, varied if desired, near the smokebox end by a circle of tubes carrying the feedwater, which could be preheated and purified before entering into the boiler, while serving the purpose of preventing radiation to the outside air. For holding the firebrick lining, whether in the firebox or barrel, the key bricks could be molded with a bolt-end projection, permitting them to be bolted fast to the walls of the shell. Overhead, the brick would rest on top of the top layer of tubes.

Question of High Steam Temperatures

A third objection urged, not so much to the use of watertube boilers as to the use of high pressures, is the question of steam temperatures. Modern steam machinery is limited in its capacity to stand excessive temperatures. Even so, it is the practice to use high superheats, so that final temperatures of 600 degrees to 700 degrees are not unusual. Were no superheat used, these temperatures would correspond to saturated steam pressures of several thousand pounds. Steam at 500 pounds pressure in the saturated condition has a temperature of 470 degrees so we can still use a moderate superheat of 130 degrees and have but 600 degrees as the final temperature. Using saturated steam pressures of 1,000 pounds at 548 degrees there can be added still an initial superheat of 100 degrees and keep well inside the 700 degrees mentioned above.

In place of using a high initial superheat, the policy here would be to use a moderate initial superheat, expand the steam in two stages, which would be preferable with the high pressures employed, and superheat between the stages. Losses from condensation, one of the principal functions of superheating, would be thus overcome. Superheating at the intermediate stage would be more effective because the difference in temperature between the steam and the furnace gases would be the more pronounced.

A fourth objection to the use of watertube boilers for locomotive service is the lessened steam and water capacity involved. The area outside of the tubes now filled by the water in the firetube boiler is greater than the cross sectional area of the tubes, so that the firetube boiler of the same overall dimensions does have the greater steam and water capacity. However, because of this very fact, the average particle of water in the watertube boiler is at all times closer to its heating medium, so that steam can be obtained much quicker. In properly designed watertube boilers steam may be raised from a cold boiler to 200 pounds pressure in less than 30 minutes.

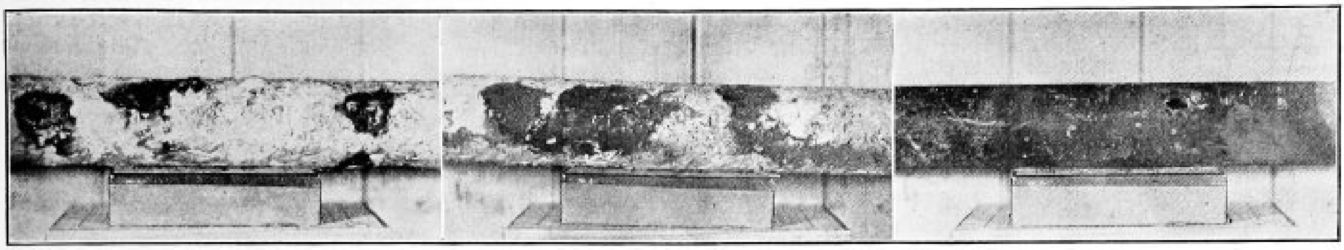
The necessity for high steam capacity is obviated by the use of high pressures. Thus a pound of saturated steam at 500 pounds pressure occupies but 0.90 cubic feet, contrasted with the 2.14 cubic feet occupied by saturated steam at our customary 200 pounds pressure. When the increased power available in the higher pressure steam is also taken into consideration, it will be seen that the steam capacity with a 500 pounds pressure need be but a third that used in the normal 200 pounds pressure employed today, even without the advantage of the quick steaming already mentioned.

From the viewpoint of safety the watertube boiler has much to recommend it. Disastrous explosions where the whole crown sheet gives way, such as are yearly occurrences on locomotive boilers, are scarcely possible with watertube boilers. They are designed so that the steam and water drums are seldom brought into direct contact with furnace gases until after these gases have lost their power to do harm by contact earlier with a mass of water tubes.

The positive, swift circulation of the water, which is a feature of most watertube boilers is also one of their surest guarantees of safety. Not only does this circulation tend to keep all parts at a more equable temperature, but it also lessens scale deposition, which causes burning, while the upward surge of the water at the firebox end, where most of the steam is formed, prevents any section from being left dry from low water conditions. This same factor of superior circulation is one of the best features of watertube boilers as a whole. Besides promoting safety, it positively increases the evaporative efficiency per square foot of tube surface.

The greater area of section occupied by the furnace gases around the tubes extends the combustion space, so that the tubes can be brought nearer the fire than might otherwise be deemed advisable. This greater area also lessens the friction encountered by the furnace gases in their path to the stack and decreases the necessity for high vacuum exhausts in the smokebox. Too easy a passage for the gases, which would result in their going up the stack at too high a temperature and wasting heat, is prevented by the appropriate use of baffle plates, diverting the gases back and forth across the tubes and lengthening their contact with the tubes.

The above are some of the many advantages that might be opened up by the use of watertube boilers in steam locomotive practice. Whether or not these advantages might be enjoyed without other great disadvantages would depend to a considerable degree upon the ability of the designer to make the best use of the limited areas within which he would be called upon to work. A watertube locomotive boiler could not reasonably depart very far in its general outside dimensions and shape from the present firetube type.



Three views of pitted and corroded tubes

Analyzing the Boiler Corrosion Problem*

A study of the factors causing corrosion and various means for eliminating them

By L. K. Sillcox†

I SHALL first refer to the necessity of your personally following up more closely the condition of each engine locally, so that a full and exact knowledge may be had of the situation in respect to individual locomotives, on the part of yourselves and your associates.

During 1924 we experienced 173 engine failures due to boiler conditions, this from a total of 856 failures due to all causes, or 20 percent chargeable to your branch of the service.

ENGINE FAILURES

Year	No. Due to Boiler Conditions	Total No. All Causes	Percent Chargeable to Boilers	Miles Run Per Boiler Failure
1924	173	856	20	300,000
1923	160	975	16	345,756
1922	514	1,792	29	98,006
1921	317	1,276	25	144,773
1920	1,130	4,321	26	47,417

In referring to I. C. C. Bureau of Locomotive Inspection, we have progressed as follows:

	Eng. Ordered Out of Service		Locomotives Inspected		
Year	No.	Percent to Locos. Owned	Locos. Owned	No.	Percent to Locos. Owned
1919	96	5.09	1,888	1,588	83
1920	98	5.14	1,907	1,319	69
1921	49	2.43	2,007	1,706	85
1922	15	.72	2,094	1,798	86
1923	58	2.82	2,054*	1,471	72
1924	9	.42	2,130*	1,721	80

*Steam locomotives only.

			Number of Accidents			
Year	No. of Locos. Defective	Percent of Locos. Defective	No.	Percent to Lo. Owned	No. Killed	No. Inj.
1919	853	55	16	.84	..	20
1920	764	59	30	1.57	3	33
1921	688	40	24	1.20	3	24
1922	563	31	22	1.05	1	21
1923	714	48	30	1.46	..	32
1924	473	27	17	.80	..	18

With the foregoing clearly before us and having in mind the promise made last year to give you the best information I could develop on the problem of corrosion, you will find what follows to be more or less a summary covering existing opinions on pitting, grooving, and other elements of severe deterioration affecting boiler maintenance. It has required a very considerable effort to gather the information as well as to submit it in time for your meeting. Its purpose will have been largely fulfilled if both careful and healthy discussions are provoked and more light thrown on this most elusive of problems.

The locomotive designer and the boiler maker are confronted with many perplexing and difficult questions affecting the various parts of the boiler which they must solve. It would be ideal if the conditions which give rise to the problems could be altered once for all, but due to the many kinds of water and of fuel, a number of which are unsuitable and frequently objectionable for boiler purposes, they are at once faced with breaking down factors bringing about corroded, cracked and leaking tubes, staybolts and sheets. Scale accumulates and soluble salts concentrate with all the attendant evils. At all times this situation must be regarded and the machine designed and adapted to meet and resist the harmful and injurious effects by making provisions to overcome the difficulties, even though theoretically it would have been better to have previously eliminated the causes. For example, to see that clean fuel is provided and that good water is furnished.

If excessive or too rapid expansion or contraction is allowed to obtain, the whole fabric of the boiler is very severely strained and it can be only a matter of time before some part must give way. If scale exists on tubes or sheets they become overheated because scale is a non-conductor. As the expansion varies with the temperature it is easily seen what the effect will be. It must be remembered that metals lose much of their strength and toughness at the higher temperatures. In addition, if scale contains sulphate of lime this will be decomposed when hot enough with the formation of sulphuric acid which attacks the metal, resulting in corrosion. This behavior explains, in some cases, the pitting under a layer of scale. Also, when expansion takes place there may be a slight separation of the rivet and bolt heads from the metal with which they were in contact, at the same time allowing scale to form in such space. When the boiler cools, the scale will not allow the parts to come together as originally, so this alternate expansion and contraction permits more and more scale to form, the condition continuing to grow worse. It is to be noted that scale once formed acts as a nucleus or center about which more gathers. It is this point that makes eternal vigilance in careful washing of boilers necessary. The concentration of the soluble salts causes foaming, the tendency to which is increased by the insoluble salts of lime and magnesia thrown out of solution by boiling and evaporation. It is, therefore, evident that the stability and long life of the boiler are best secured by adopting means that will eliminate the causes of excessive and rapid expansion and contraction and of the corrosion of the different parts of the boiler at their origin.

Conclusively stated, the only practical way is to provide

* Abstract of a paper read before the 1925 annual meeting of Boiler Department Supervisors on August 10, 11 and 12, at Minneapolis, Minn.
†General superintendent of motive power, Chicago, Milwaukee and St. Paul Railroad.

good fuel and water, to avoid excessive expansion and contraction by keeping the temperature of the boiler parts within reasonable limits. This can be done by using hot water for washing out, by taking a reasonable time for cooling down, and abstaining from generating steam too quickly.

Electrolytic Theory of Corrosion

The electrolytic theory is that generally accepted now as best explaining corrosion. The truest illustration is that of a simple primary battery, where there are two plates, one of copper and the other of zinc immersed in sulphuric acid or electrolyte so dilute that neither is apparently dissolved and no action takes place. If the plates are brought into contact, immediately bubbles of gas are seen to form on the copper or negative plate or cathode and if the plates were connected by a wire and a meter placed in the circuit it would be seen that an electric current was flowing from the zinc, or positive plate or anode, to the copper. The gas formed is hydrogen, and because it goes to the cathode is called the cathion.

You all know and will recognize how local corrosion or pitting tends to occur over areas or points covered by somewhat porous debris, sludge or scale and have noticed how it tends to become concentrated at the bottom of a few narrow crannies or holes where it even seems to burrow into the metal until it is perforated.

This action can only be intelligently explained by the electro-chemical theory. There are two possible ways in which the action can proceed:

First—Oxygen is taken up over the entire aerated surface producing a thin, adherent layer of oxide. This whole area then becomes the cathode and the unaerated area the anode. The former may become partially "passive" (that is, unaffected) by the change in potential.

Second—Where the metal is not uniform in composition either chemically or physically (due to unequal strains). At first, the points where the metal is segregated or contains foreign elements act as cathodes, the rest of the iron being the anode, but in a short time the supply of oxygen will be consumed at these points and they no longer will act as cathodes and the foreign particles at some distance will take their place and the solution of the iron at the anodes will continue.

Eliminating Corrosion

Many methods have been suggested to overcome the evils, some of benefit and others of very doubtful value. One of the best is to keep the water in the boiler alkaline at all times, in which case whatever iron is dissolved is precipitated in the form of a non-conducting film on the metal and electrolytic action ceases.

We are all familiar with the practice of putting zinc in boilers. This then becomes the anode instead of the iron and is dissolved in its stead. Sixty-five parts by weight protecting fifty-six parts of iron. The action is exactly similar as has been described for iron. It will protect the iron in a zone limited by the resistance of the boiler water. The voltage of a zinc-iron cell is limited and can only carry current through a liquid of a given resistance a certain distance. It is this fact that limits its successful application under service conditions. Outside of the protected zone corrosion goes on as described.

The zinc must be suspended and connected in such a way as to insure perfect electrical contact with the material of the boiler. A basket is so suspended from the zinc as to catch pieces of zinc oxide that may scale off. For the best effect the zinc should be near the incoming feedwater to neutralize the oxidizing effect of air liberated by the feedwater, and in such other places in the boiler as may be especially subject to pitting.

The theory on which zinc acts to save the boiler metal is based on the fact that it is electro-positive as compared to iron, so that when immersed in the boiler water a current is set up and flows from the zinc to the iron, with the result that the zinc oxidizes and corrodes and the iron does not. It is questionable what efficiency the zinc may have except for a short period after installation and when the contact with the boiler is known to be positive.

Many practical examples of corrosion, accelerated by the air entrained in the feedwater, may be found. Feedwater heaters and the top feed system do much to overcome this action. Injectors with sealed overflow are also worthy of consideration.

Galvanic corrosion is more or less local and is indicated by a pit that goes right straight through, while the whole surrounding surface will be untouched in any way. Chemical corrosion is like a bad burn—a large area etched out.

The purely electrolytic trouble is experienced in connection with soda salts when they concentrate in a boiler to such an extent that they form a sort of a battery cell solution. With these soluble salts, concentrated to that point, the corrosion is the type of electrolytic corrosion where the impurities such as carbon, sulphur, silicon, manganese, etc., set up their own centers of corrosion and pitting, stimulated and encouraged by water conditions which lead them on as it concentrates. In distinguishing between galvanic or electrolytic pitting and the ordinary chemical pitting or corrosion from appearance, the galvanic seems more apt to be irregular, producing pits like smallpox in appearance, while chemical corrosion generally affects larger areas. The reason for keeping copper flue ferrules short is to expose a minimum surface of copper to the action of the water and thus reduce local corrosion of steel tubes at this point, which is often the only reason for changing a set of tubes.

The feature illustrations show typical cases of pitting and corrosion with which you are all familiar. Some show the appearance before the scale has been removed and the others after the flues had been cleaned. Note where the pits had gone all the way through the metal.

As mentioned previously, corrosion is inaugurated and also accelerated by oxygen and carbon dioxide. Both are contained in the air, entrained in the feed water and the latter, of course, exists dissolved in all natural waters. If these gases can be removed, it is evident that corrosion incident thereto would be prevented. However, it is not possible to attain this result in practice until the boiling point is reached. To this end, experiments are being carried on by the use of an open type feedwater heater. While this is, undoubtedly, a step in the right direction, there is a considerable doubt that it will prove sufficiently effective to be of any real practical value.

This statement is based on the fact that to de-aerate the water, it must flow at a very low velocity and have a very large surface exposed in order to permit the air to free itself from the vapor. Even with the comparatively large feedwater heater used in stationary plants, the water is not completely de-aerated and there has been a considerable development in the way of additional appliances for completely de-aerating feed water.

Finally we may conclude that where perfect boiler water is used there exists no corrosion problem as to electrolysis, hence we should at all times aim to eliminate those waters which cause our greatest troubles. Again, where the water condition is not or cannot be remedied, we should decide to keep a positive minimum number of engines in service and accumulate mileage with them as rapidly as possible, so as to have no time during which corrosive action obtains when the engine is unnecessarily idle. In other words, have the miles build up before corrosion becomes master of the situation and sends your engines to the shop.

In addition, large tenders are important in order to allow of the proper selection even of poor waters.

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Camber Layout for Small Tapered Sections

Q.—Please advise of a convenient method of laying out a stack of a small diameter of fairly heavy plate so that the stack will be straight. For example, take a stack 12 inches in diameter with 30-inch courses and ¼-inch plate. F. X. D.

A.—With stacks of small diameter, and where the sections are tapered to overlap each other, the camber line is so small as to be practically negligible. For example, using the dimensions given, the difference in outside diameter of the respective ends of the pipe section *a*, Fig. 1, is 13 — 12½ = ½ inch. The slant height of the section equals,

$$\sqrt{30^2 + \tfrac{1}{4}^2} = 30.010415 \text{ inches.}$$

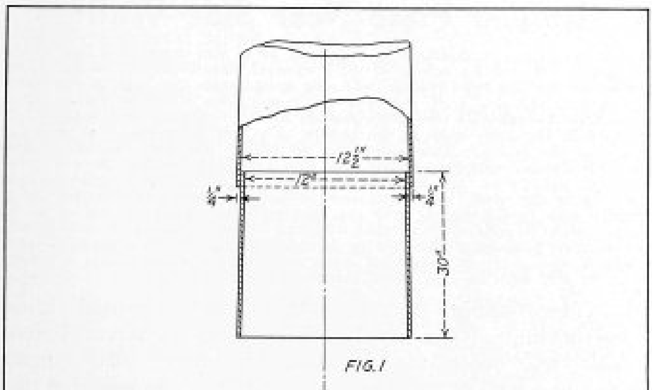
The circumference of the upper base, on the neutral diameter equals 12¼ × 3.1416 = 38.5 inches, and for the lower base it equals 12¾ × 3.1416 = 40.06 inches.

For the purpose of laying out the pattern, it is necessary to find also the dimension *x*, Fig. 2. This equals,

$$\sqrt{30.010415^2 - 0.78^2} = 29.823 \text{ inches.}$$

The dimension 0.78 inch is indicated in Fig. 2, it is one-half of the difference in length between the upper and lower base circumference.

The camber line may now be found from Fig. 2 graphically. Draw *m-p* at right angles to *n-4* and with the trammels set to *m-p* draw an arc to intersect the base *m-n*. Bisect the arc locating point *o*. Make *m-o* on the center line of the pattern equal to *n-o*. With *m* as a center and *m-o* as a radius draw a circle, divide one-quarter of the circle into a number of equal parts, likewise divide each half of the upper and lower base lines into the same number of equal parts. Draw the radial lines *1-1*, *2-2*, etc. Perpendicular to the center line of the pattern and from the points *2* and *3* as shown in the example draw projectors intersecting the corresponding radial lines as indicated in Fig. 2. Through these points draw in the camber line. To lay off the upper camber line, use *n-4* and set off the length on each of the radial lines in the pattern. The proportions in Fig. 2 have been enlarged in order to show the construction.



Development of sections for small stack

Successive Safe Ending, Testing Flexible Stays, Strength of Welds

Q.—There are a few questions I would like to submit to THE BOILER MAKER:

(1) How many safe ends are allowed to be applied to old flues, as I have seen as many as 12?

(2) Is it proper to test flexible staybolts with caps taken off before a hydrostatic test or after?

(3) Is butt welding flue and door sheet to side and crown sheet safer than lap weld? A. W. G.

A.—(1) The practice in safe ending tubes varies, in some shops not more than two safe ends are applied on tubes or flues. Afterwards the body of such tubes is cut down for smaller boilers, or a single long tube is welded on. There is no objection to successive safe ending provided the tubes are in good condition, it is recommended that the body of the tube contains not more than three welds at one time; also if the total length of the safe ends is over 21 inches cut off the welded section and weld on a new section of the required length.

Superheater flues should not have more than two safe ends at one time, each of which should not be less than 5 inches in length.

Tubes and flues should be tested hydrostatically after safe ending to a pressure of 25 percent in excess of the pressure carried by the boiler.

Tubes that have wasted away from ¼ to ⅓ their original thickness should be scrapped.

(2) The Locomotive Inspection Law 1915, gives the following requirement on the *method of testing flexible staybolts with caps:* All flexible staybolts having caps over the outer ends shall have the caps removed at least once every

two years and also whenever the United States inspector or the railroad company's inspector considers the removal desirable in order to thoroughly inspect the staybolts. The firebox sheets should be examined carefully at least once every month to detect any bulging or indications of broken staybolts. Each time a hydrostatic test is applied the hammer test required by rules 21 and 22 shall be made while the boiler is under hydrostatic pressure not less than the allowed working pressure.

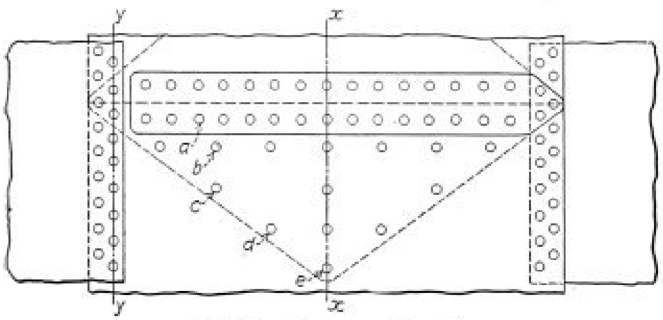
(3) The lap weld, with both edges welded, makes the stronger joint. An efficiency as high as 100 percent can be attained with this type of joint.

Diamond Seam Calculation

Q.—Yours of November 2, 1925, received but there is some mistake as my question was not for the efficiency of a diagonal seam, but for a diamond butt strap joint as used on many of the modern locomotive boilers. I enclosed a sketch and if you still have it I think my question will be clear to you. —A. C.

A.—The *diamond seam*, Fig. 1, is a locomotive boiler joint, and it is possible with a joint properly designed to obtain an efficiency of 98 percent.

Assume in these calculations the following values: tensile strength of plate, 55,000 pounds per square inch and 40,000



Problem in seam layout

pounds per square inch shearing value of rivets in single shear.

Refer to Fig. 1 for which the usual spacing of rivets in row *a* is on 3½-inch centers. Given a plate thickness of ¾ inch and rivet diameter (driven size) of 1 5/16 inches.

The joint may fail in several ways principally as follows:

(1) By breaking the net section of plate between the rivets in row *a* and shearing of rivets in the outer rows *b*, *c*, *d*, and *e*.

(2) By shearing all of the rivets.

(3) By breaking the net section of plate in the row *b*, and shearing of the rivets in the rows *c*, *d* and *e*.

(4) By shearing the rivets in row *a* and breaking the net plate section in the welt, row *a*.

The strength for each of the sections through which the joint may fail must be calculated, and the ratio of the strength of the weakest part to the strength of the solid plate section of equal length is the theoretical efficiency of the joint.

To illustrate, the calculations for cases (1) and (2) are given.

First determine the strength of the solid plate section between lines *x-x* and *y-y*. The pitch of rivets being 3½ inches, and, if the distance between the first rivet in the longitudinal joint and the adjoining rivet in the girth seam is 3 inches, then the length of the joint under consideration is:

$3\frac{1}{2} \times 7 + 3 = 27\frac{1}{2}$ inches.

Strength of solid shell plate

$= 27\frac{1}{2} \times \frac{3}{4} \times 55{,}000$

$= 1{,}134{,}375$ pounds.

Strength of net plate section

$= (27\frac{1}{2} - 10\frac{1}{2}) \times \frac{3}{4} \times 55{,}000$

$= 701{,}250$ pounds.

Before the net section of plate in row *a* can be broken, the rivets in rows *b*, *c*, *d* and *e* must shear.

The strength of these rivets which are in single shear equals

$1\ 5/16^2 \times 0.7854 \times 40{,}000 = 394{,}982$ pounds.

Add the value of the rivets to the net plate section, then

$701{,}250 + 394{,}982 = 1{,}096{,}230$ pounds.

$1{,}096{,}230 \div 1{,}134{,}375 = 98.4$ percent.

The strength of the rivets equals the strength of 7½ rivets in row *a* which are in double shear and 8 rivets in single shear in rows *b*, *c*, *d* and *e* and one rivet in the girth seam.

The strength of the rivets divided by that of the solid plate section of the shell gives the rivet efficiency.

On account of the great weakness of the net plate section in the row *a* the welts must be of sufficient thickness to resist the stress tending to break the joint at this point.

The practice of the American Locomotive Company is to base the thickness of the two straps from the formula:

$$\frac{p \times t \times E,}{p - d}$$

in which;

p = pitch of rivets, inches.
t = thickness of plate, inches.
E = efficiency of joint, in percentage.
d = diameter of rivet, inches, driven size.

Development of a Pipe With a Compound Curve

Q.—Wish to state that I am in possession of your book "Laying Out for Boiler Makers" and have discovered, much to my expense, that your problem illustrating the development of a pipe with a compound curve does not work out for some reason. I have also had difficulty in developing a spiral riveted joint when using ¼-inch material. How can I get lined out on this work? D. R. F.

A.—If you will send us a drawing of your problem, applying the principles given in the example, we will check the work. This arrangement will enable us to give definite assistance.

Bulged Plate Near Side Wall

Q.—Information or comment is requested as to the cause of a bag which appeared on the middle course of an horizontal return tubular boiler. The location of the bag was on the left side and up on the side of the shell very near to the side wall, rather a queer place for a bag to form. This was noticed by some of the boiler makers at the time they had been called back to calk the girth seam at the bottom of a half sheet that was recently applied to the boiler. This sheet was placed on the first course or fire sheet. It is the writer's opinion that this bag or bulge had been on the boiler for some time, but the superintendent in charge stated that it had only recently appeared. My contention is that this defect was caused by a defective spot in the metal, as I can find no other reason or cause, as it does not seem feasible to think that a sludge or accumulation of scale could cause this on account of the location of this defect. Would appreciate your or other's opinion or to hear from some one who had come across a defect similar to this and the real cause found. H. F. D.

A.—The condition is rather unusual, it was caused either by overheating of the metal, arising from an accumulation of scale, mud, or oil; or to a defective plate. We cannot advise you which of these caused it. If you can examine the inside side of the plate before it is removed and the bulged section after it is cut away you may possibly determine the cause. Will some of our readers give their opinion on this matter?

Ludlum Company Expands

Due to the great increase in business the Ludlum Steel Company, general offices and works, Watervliet, N. Y., is making many additions to its plant. The capacity of the billet grinding department has been doubled—the new addition to be completed and ready for occupancy early in January. This new department will be equipped with a modern exhaust system for the elimination of the dust incidental to all grinding operations.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

Steamboat Inspection Service of the Department of Commerce

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

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—C. D. Thomas, Salem, Oregon.
Statistician—E. W. Farmer, Rhode Island.

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

J. A. Franklin, International President, suite 522, Brotherhood Block, Kansas City, Kansas.
William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.
Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.
James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.
H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.
International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Ave., Columbus, Ohio.

Master Boiler Makers' Association

President—Thomas F. Powers, system general foreman, boiler department, Chicago & Northwestern.
First Vice President—J. F. Raps, general boiler inspector, Illinois Central.
Second Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.
Third Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.
Fourth Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.
Fifth Vice President—George B. Usherwood, supervisor of boilers, New York Central.
Secretary—Harry D. Vought, 26 Cortlandt street, New York.
Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.
Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—F. H. McCabe, McCabe Manufacturing Company, Lawrence, Mass.
Vice President—J. W. Kelly, National Tube Company, Pittsburgh, Pa.
Treasurer—George R. Boyce, A. M. Castle and Company, Chicago, Ill.
Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie, Pa.
Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.
Secretary-Treasurer—G. W. Glanzer, 40 Rockefeller Building, Cleveland, Ohio.
Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; W. A. Drake, The Brownell Company, Dayton, O.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Works, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

Chicago, Ill. (will accept)	Memphis, Tenn. (will accept)	Philadelphia, Pa.
		St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Los Angeles, Cal.		Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	New Jersey	Pennsylvania
California	New York	Rhode Island
Indiana	Ohio	Utah
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

SELECTED BOILER PATENTS

Compiled by

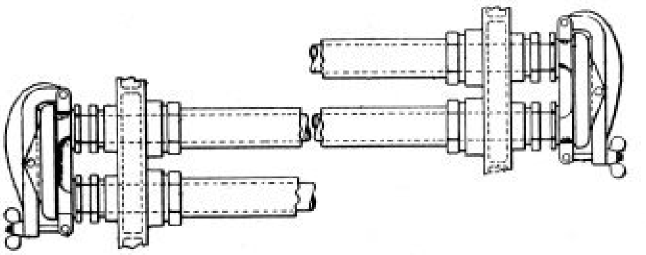
DWIGHT B. GALT, Patent Attorney,

Washington Loan and Trust Building
Washington, D. C.

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

1,559,949. RETURN BEND HEADER FOR PIPES. HARVEY FELDMEIER, OF LITTLE FALLS, NEW YORK, ASSIGNOR TO D. H. BURRELL & CO., INC., OF LITTLE FALLS, NEW YORK.

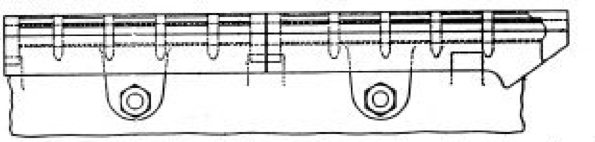
Claim 1. A return header for connecting the ends of adjacent tubes, comprising a base having openings therethrough in which the ends of the tubes are adapted to be secured, a cover for said base and co-operating therewith



when the cover is in closed position on the base to form a return bend passage establishing communication between the ends of said tubes, said cover being mounted on the base to move inwardly and outwardly toward and from the same substantially perpendicular to the plane of the cover-seat on the base for closing and opening said return bend passage, and means for releasably securing said cover in closed position. 4 claims.

1,561,620 FURNACE GRATE. LOUIS JOHN STEELE AND EDGAR FROSTICK KENT, OF PORTSMOUTH, AND GEORGE ALBERT MADDEN, OF SOUTHSEA, ENGLAND.

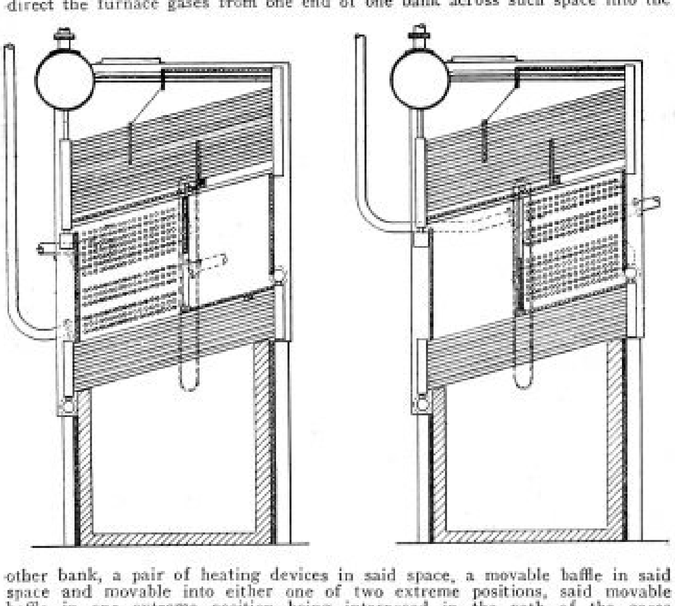
Claim 1. A furnace grate of the travelling type, comprising grate elements consisting of frames having integral straight end walls and a plurality of integral transversely disposed grate bars extending between said end walls, said transversely disposed grate bars being wider at the top than at the



bottom, and having the interstitial spaces between them diverging outwardly towards opposite sides upwardly, and a conveyor upon the transversely disposed members of which the said grate elements are supported in transverse series and members disposed at one side of said frames and integral therewith by which said frames are supported upon said conveyor, substantially as described. 3 claims.

1,561,574. STEAM BOILER. ARTHUR SPYER, OF LONDON, ENGLAND, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

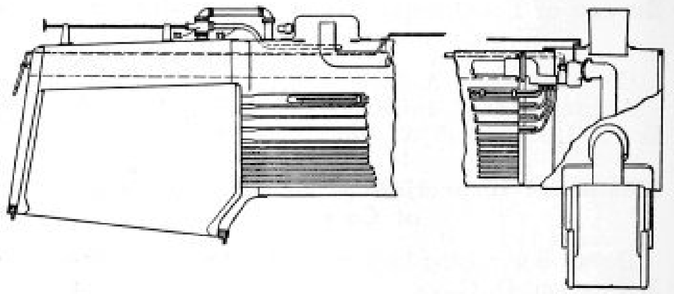
Claim 1. A steam boiler having banks of water tubes, said banks being spaced apart to form a superheater chamber therebetween, fixed baffles to direct the furnace gases from one end of one bank across such space into the



other bank, a pair of heating devices in said space, a movable baffle in said space and movable into either one of two extreme positions, said movable baffle in one extreme position being interposed in the path of the gases normally flowing across said space and across one of said heating devices, and in the other extreme position being positioned to direct all of the gases first across all of one of said heating devices and then across all of the other of said heating devices, and means to move said movable baffle. 6 claims.

1,560,755. BOILER WITH SUPERHEATER. BENJAMIN BROIDO, OF NEW YORK, N. Y., ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y. A CORPORATION OF DELAWARE.

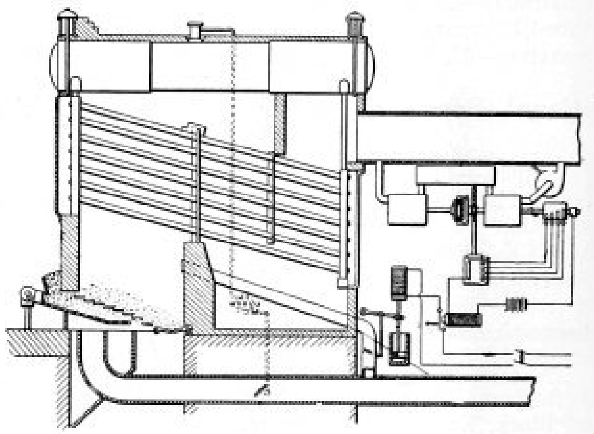
Claim 1. In apparatus of the class described, the combination of a boiler; means dividing the space above the water level into two parts to the first of which more of the steam is delivered upon its generation than to the



second; means to put these two parts into direct communication; a superheater; a pipe connecting the second of said parts of the space with the inlet of the superheater; a valved pipe leading from the outlet of the superheater; and a pipe connecting the first part of the space with the outlet end of the superheater. 6 claims.

1,562,087 METHOD OF AND APPARATUS FOR CONTROLLING COMBUSTION. JOHN WILLIAM GRISWOLD, OF WARREN, PENNSYLVANIA, ASSIGNOR TO HENRY L. DOHERTY & COMPANY, A CO-PARTNERSHIP COMPOSED OF HENRY L. DOHERTY AND FRANK W. FRUEAUFF, OF NEW YORK, N. Y.

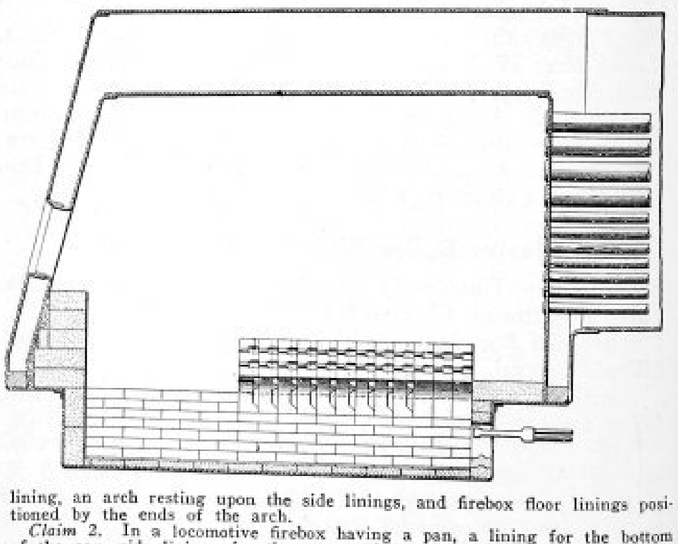
Claim 1. A combustion regulator for furnaces, comprising means continuously acting to increase the draft to a furnace, means governed by an elec-



tric current for intermittently decreasing said draft, a gas absorption chamber, means for drawing a portion of the products of combustion from said furnace through the gas absorption chamber, and means governed by the decrease in volume of the gas in passing through said absorption chamber for controlling said electric current. 23 claims.

1,560,604. LOCOMOTIVE FIREBOX STRUCTURE. LE GRAND PARISH, OF MOUNTAIN VIEW, NEW JERSEY, ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim 1. In a locomotive firebox having a pan, a lining for the bottom of the pan, side linings for the pan resting upon and securing the bottom



lining, an arch resting upon the side linings, and firebox floor linings positioned by the ends of the arch.

Claim 2. In a locomotive firebox having a pan, a lining for the bottom of the pan, side linings for the pan resting upon and securing the bottom lining, an arch resting upon the side linings, and firebox floor linings positioned by the ends of the arch, together with firebox side linings resting on the firebox floor linings. 8 claims.

The Boiler Maker

Volume XXVI | **February, 1926** | **Number 2**

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 CHURCH STREET, NEW YORK, N. Y.

Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ave.
Mandeville, La.
Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.
Cable address: Urasigmec, London

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

THE BOILER MAKER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies 1s 2d.

Request for change of address should reach us two weeks before the day of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

Cooperation in Management

IN the July, 1924, issue of THE BOILER MAKER details were given of the plan of cooperative management instituted by the Baltimore and Ohio Railroad as specifically applied to work at the Glenwood shops. This article was based on an exclusive report of one of the cooperative meetings held at this point and was one of the first accounts published after the plan had been in operation only sufficiently long to determine its practicability. At that time real savings had already been accomplished in material, production had been developed to a higher standard of efficiency, and above all a feeling of satisfaction with conditions prevailed throughout the entire works.

On Friday, February 5, the Taylor Society sponsored a meeting in New York of railroad engineers, the Metropolitan section of the American Society of Mechanical Engineers and other engineering groups to listen to highly qualified representatives of the three bodies involved in the scheme of cooperative management. During the course of the meeting the practicability of the future extension of the plan was discussed. The railroad management was represented by Sir Henry Worth Thornton, chairman of the board of directors and president of the Canadian National Railways, who traced the development of the labor unions from their inception to the present time when the interests of both labor and capital have become practically the same. Sir Henry in the course of his remarks developed the thought that "Union management cooperation in the railway industry seeks to achieve as a primary objective continuity of employment and in the accomplishment of this objective is destined to play a great and useful part. It already has been applied to shop work and if successful there, as it undoubtedly will be there is no reason why it should not be equally applied to other industries. The most fearsome thing in the life of the laboring man is the lack of knowledge that his job is secure from day to day and that his family will be as surely cared for a year from now as now. This is the heart of the plan. It will insure to capable, willing workmen continuity of employment. The only present problem is adapting the plan as tried in the shops to the whole line of the industry."

Bert M. Jewell, president of the railroad employees' department of the American Federation of Labor, presented the reactions of this body on the union management plan of cooperation. Mr. Jewell was one of the first and strongest supporters of the principles of cooperation and voluntarily extended the assistance of his men to the plan and to the railway industry.

The seven specific requirements of union management were explained by Otto S. Beyer, Jr., consulting engineer and sponsor of the first definite plan for cooperation in the railway industry. These requirements are:

Full and cordial recognition of the standard unions as the properly accredited agents to represent railroad employees with management; acceptance by managements of the standard unions as helpful, necessary and constructive in the conduct of the railroad industry; development between unions and management of written agreements governing wages, working conditions and the prompt and orderly adjustment of disputes; systematic cooperation between unions and management for improved railroad service and elimination of waste; stabilization of employment; measuring, visualizing and sharing fairly the gains of cooperation; perfection of definite joint union-management administrative machinery to promote cooperative effort.

In practice on the Baltimore and Ohio, which was the first to apply the system, revenues have been increased materially and, what is of far greater importance, the entire support of the men has been gained. Mr. Beyer cited the reports of the company to bear out his statements of the direct return that can be accomplished through the application of cooperation.

The system is unquestionably good and is destined to have a far reaching effect on the railway industry. The practical working out of its principles and their application to all branches of this and other industries deserves the support and good will of both groups involved in the matter, the management and the organization of the men themselves.

Stresses in Boilers

THE theoretical determination of stresses in certain portions of a boiler in service is almost impossible of accomplishment and yet a knowledge of how great the strain is on flanges, for example, would be invaluable in promoting the life of these parts. That the subject is one of importance was demonstrated in the discussion of a paper "Cracks in Flanged Knuckles," which was read at the last annual meeting of the Master Boiler Makers' Association. The prevention of failures in flanges has received considerable attention throughout the boiler shops of the country and various methods and types of supports have been used to eliminate the difficulty. On one road—the Norfolk and Western—where a definite method has been developed to measure the movement in the sheets real results have been accomplished in overcoming the defect.

In this issue of THE BOILER MAKER a paper by C. E. Stromeyer is published which is entitled "Experiments for Determining Strains in Boilers." In this article a practicable method is explained for accurately measuring the movement in boiler sheets. This system is particularly useful in just such portions of the boiler as the flanges and in dished and bumped heads where stresses are ordinarily difficult of determination. The mechanics involved are simple and the principles may readily be adapted to the study of strains in a great many places where definite knowledge would assist in prolonging the life of a boiler.

The author not only investigated the strains in flanges and corners but also applied the same principles to a study of the strains occurring in lap joints while in service and to the circumferential extension of shell plates. In every test valuable data were taken that should aid materially in clearing up many of the difficulties encountered in boiler operation and maintenance.

Similar methods for testing can be applied to nearly every portion of a boiler whether it is for locomotive, stationary or marine service. There would seem to be a particularly broad field in this connection open especially to the mechanical staffs of the railroads where the maintenance requirements of locomotives because of their rigid service are more strict than in the case of practically any other type.

Master Boiler Makers' Convention

Exhibit space at the 1926 convention of the Master Boiler Makers' Association is now being reserved by member companies of the Boiler Makers' Supply Men's Association through the secretary, W. H. Danzel, of the Lovejoy Tool Works, Chicago, Ill. This convention will be held at the Hotel Statler, Buffalo, N. Y., May 25 to 28 inclusive.

LETTERS TO THE EDITOR

Bulged Plate Near Side Wall

TO THE EDITOR:

In answer to the question of H. F. D. in the January issue of THE BOILER MAKER, relative to the cause of bulge or bag which appeared on the middle course of a horizontal return tubuler boiler up on the side of the shell near the side wall, I will say:

The cause of the "bulge" might be traced to the placing of a cushion in the boiler by a workman during the time the patch spoken of was applied. This cushion may have consisted of old waste cloth, burlap or other similar substance which was used by the workman while he was performing his work inside the boiler.

To complete his work he perhaps was forced to move his cushion, and he conveniently placed it between the tubes and the shell where it was the cause of the bulge of which you speak.

If the plate were defective the boiler would have exploded.

Hartford, Conn. E. O'C.

Bulged Plate

TO THE EDITOR:

In reply to the question concerning a bulged plate, published in the January issue of THE BOILER MAKER; I am a practical marine and stationary engineer and have been a boiler inspector for the past ten years. I ran across a case exactly like Mr. H. F. D.'s but this was in a steamer with four return flue boilers all connected as one unit.

The boiler shell bulged and a bag formed on the left side and upon the side of the shell near the side wall. When the boiler bagged, as stated above, a patch was put on over the defective part. I talked with the fireman and learned from him that the safety valve on this boiler was set to blow at 200 pounds pressure while the other safety valves did not blow until there was 220 pounds pressure, which was the pressure allowed on the boilers. I adjusted the safety valve on the defective boiler to blow at 218 pounds and put in a new sheet in the boiler and have had no further trouble. That was three years ago.

It was my opinion that this safety valve was kept blowing and the other three safety valves never blew. As soon as the safety valve on the defective boiler blew the fireman would ease up on the fire. I think this valve blowing so much and so often pulled the water away from the sheet and it became overheated and consequently the sheet bagged, as there was no scale or sediment found on the shell at any time.

Evansville, Ind. S. B.

Safety of Welded Pressure Tanks

TO THE EDITOR:

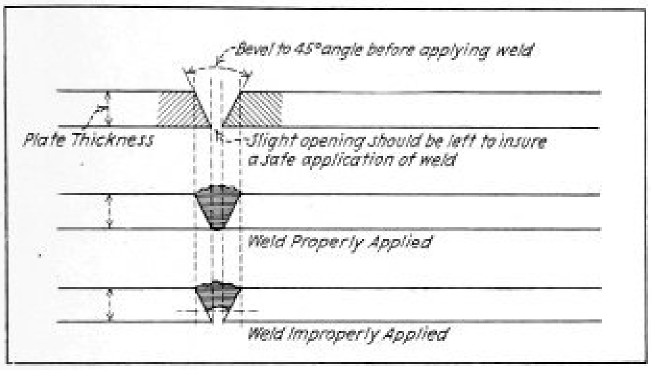
In connection with the article on welded pressure tanks by John S. Spicer in the November, 1925, issue of THE BOILER MAKER, I believe that all the readers will agree that Mr. Spicer has touched upon a subject of wide importance because of the numerous pressure vessels located in practically every institution where there is power equipment and because of the numerous failures of such vessels causing loss of life in many instances.

It has been the practice of many concerns to build such pressure tanks by means of the welding process, thus introducing the question of safety of these vessels with joints secured in this manner.

As Mr. Spicer says, there is no doubt as to the safety of these vessels constructed by the welding process, if such welding is properly done. However, this brings up a matter of debate as to what proper welding actually means. What I consider the proper method of preparing sheets for welding is shown in the accompanying sketch.

DETERMINING SAFETY OF WELDED JOINTS AND SAFETY OF VESSEL

After all joints have been welded and let cool, an application of water pressure not exceeding 1½ times the desired working pressure should be applied, thus insuring the safety of the joint. Not only should this hydrostatic test



Proper and incorrect preparation for welding

be made at the completion of the weld but it should be made at least once each successive year after completion and as long as the vessel is in actual service.

Stamping of each vessel after the hydrostatic test with date of test and the pressure applied should not be overlooked.

SAFETY VALVES ON ALL TANKS

In the last analysis it is certain that any vessel will fracture at the weakest point when the bursting pressure point has been reached. Without a safety valve to release the excess pressure no pressure vessel can be claimed safe.

Summarizing the distinct principles that insure a safe pressure vessel.

1. Proper beveling and spacing of joints previous to welding.
2. Proper application of welding.
3. Annual inspection and hydrostatic test of pressure vessel.
4. Application of a safety valve on every pressure vessel.

If the above precautions are observed, any pressure vessel is safe.

Franklin, Pa. R. L. HAMILTON.

Bulges in Boiler Plates

TO THE EDITOR:

From the particulars submitted by H. F. D. in his inquiry through the Questions and Answers column of THE BOILER MAKER, page 28, of the January issue, relative to the queer development of a bag on the left side of the middle course near the side wall of an horizontal return tubular boiler, I would regard this condition as most likely having been caused by overheating due to the accumulative adherence of a film of grease or oil.

Taking for granted that an internal inspection was made and that no evidence of scale or incrustation was observed, same being the most common cause attributable to the development of bulges or bags—it may be possible that the evidence of overheating from oil or grease adherence was overlooked in this particular case.

Investigation definitely determines this cause, as tangible evidence presents itself in the form of a local patch or blotch of powder-like discoloring, the shades of which vary with the grade of oil or grease causing the difficulty.

It may not seem possible to the average reader that a film of oil or grease adhering to the water surface of the shell or tubes can insulate them to the extent of overheating, providing the temperature reaches sufficient intensity.

To emphasize this action, quoting Mr. E. J. Rimmer, M. E., B. Sc., in his book on "Boiler Explosions, Collapses and Mishaps" to the effect that "grease on the plates or tubes of boilers is extremely likely to cause overheating, and that it offers *ten times the resistance to the transmission of heat as does scale.*" Likewise, Mr. C. E. Stromeyer, chief engineer of the Manchester Steam Users Association, points out that even a film of grease 1/1,000 of an inch thick may cause overheating.

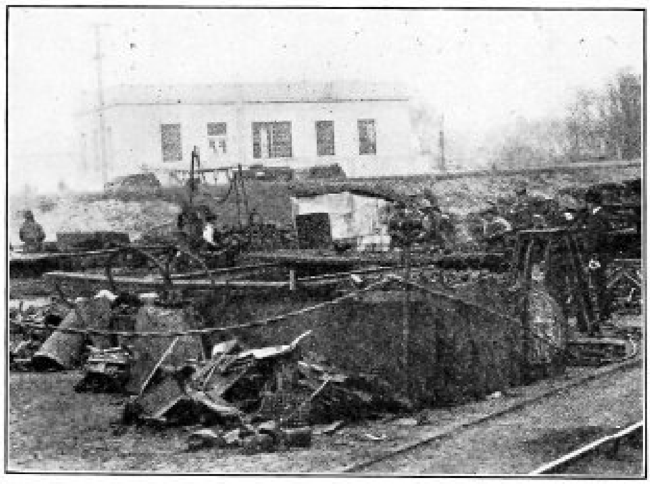
Conclusively, in the absence of any of the above disclosures of evidence, defective material must apparently be the cause whereby, investigation or analysis should definitely determine the cause in this case.

Jersey City, N. J. U. P. TULIN.

Protection for Acetylene Torch Outlets

By Charles W. Geiger

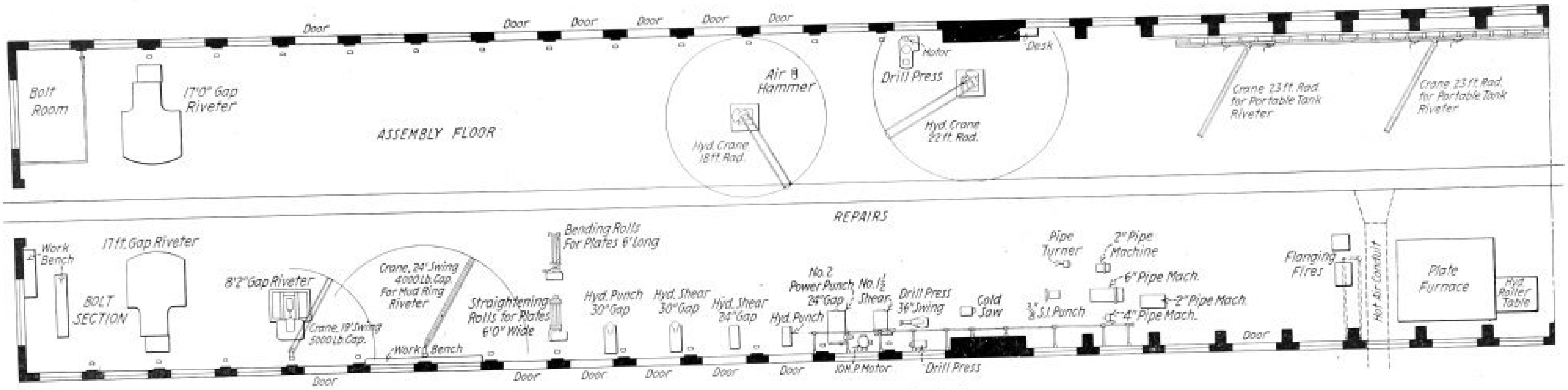
AT the reclamation plant of the Southern Pacific, Sacramento, Cal., there are nine cutting torch outlets for supplying acetylene gas. The gas is manufactured in a central plant and is piped to all parts of the yard. As shown to the left in the illustration, these outlets are protected by four steel rails bent into the form of a pyramid. This arrangement protects the outlets from being broken or bent by heavy material striking them as it is being handled about the yard. If the operator is using a torch at some



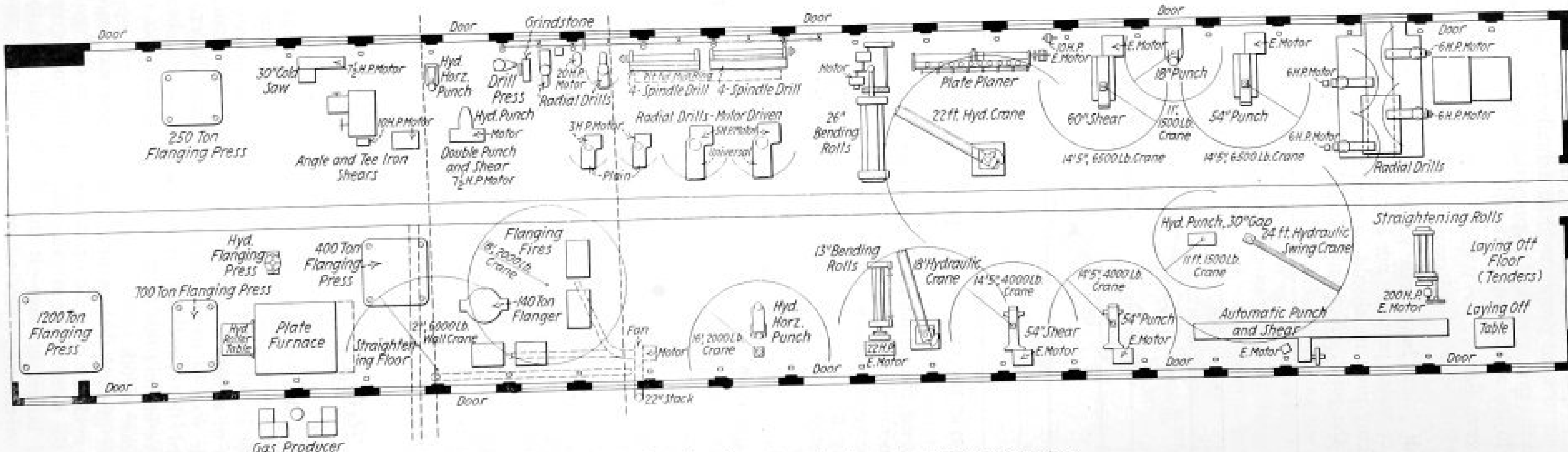
View showing reclamation plant of scrap yard equipped with protective device for acetylene outlet

distance from the outlet, the hose is carried on metal stands like that shown in the foreground of the illustration. This method of supporting the hose from the ground, protects the hose from being cut or broken by heavy castings falling on it or by trucks being run over it.

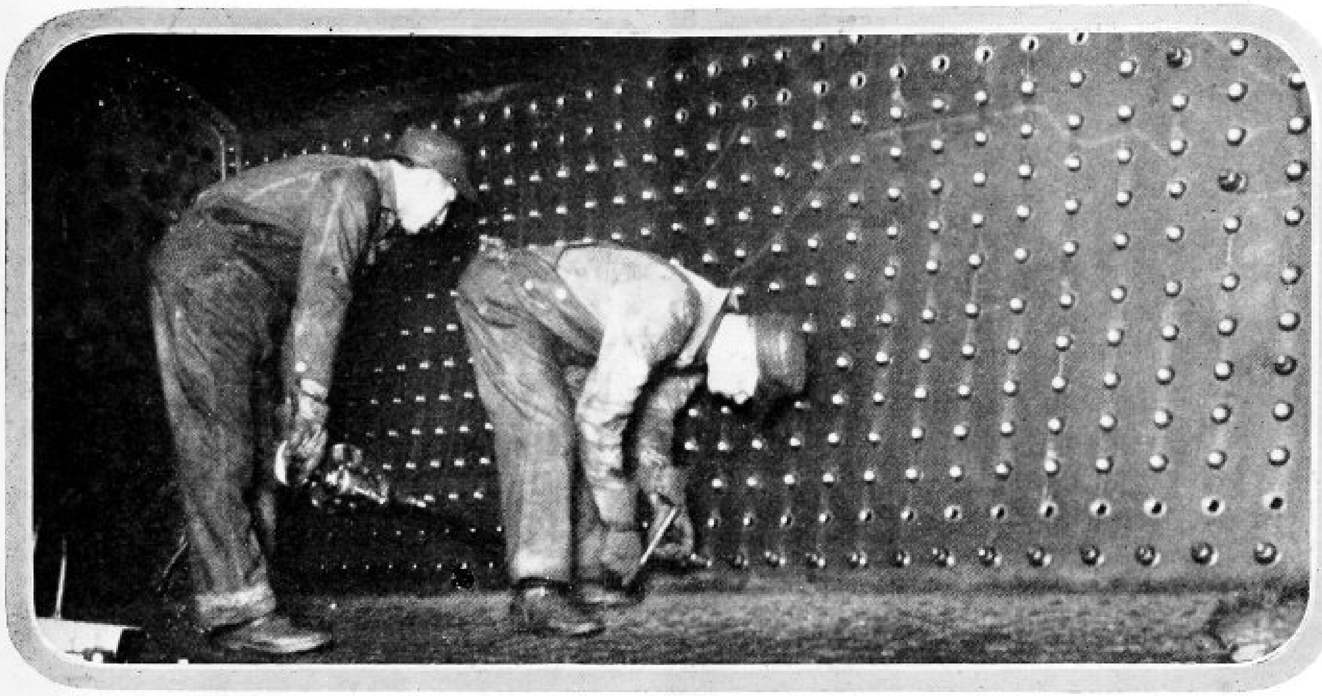
Three mains lead from the central plant where the acetylene gas is manufactured to the various departments of the general repair shops located at Sacramento. This system of providing gas has proven to be quite efficient in assisting in the performance of the work of the shop and scrap dock.



Assembly and test section at east end of shop



Layout and flanging department at west end of boiler shop



Installing staybolts in a large boiler

Boiler Shop Methods and Equipment at Juniata

The layout of this shop and its machinery is designed to promote production in boiler construction and repair

THE Juniata boiler shop of the Pennsylvania Railroad System, located near Altoona, Pa., offers one of the most remarkable studies of production as applied to the construction and repair of locomotive boilers that exists in the United States. The impression given by a visitor to the plant is of the magnitude of the work undertaken here. It has been the object in organizing this shop and, in fact, the entire Altoona Works, to centralize locomotive and car construction and repair insofar as they apply to fabricated materials. In fact it is the fabricating plant for the entire Pennsylvania System.

The boiler shop has applied the principles of centralization and standardization to an extent that would be difficult to appreciate without actually visiting the shop. A later article will be devoted to this phase of the work, the present one dealing largely with the plant layout, machinery and organization of the shop staff.

The shop organization is made up of 337 men all under the charge of the boiler shop foreman. This number is divided into two shifts. In the first trick the number of men in each main shop department is about as follows: Sixty-five boiler makers, helpers and machinists with one gang foreman and one inspector constitute the department handling the layout, press work, drilling, flanging and machine operations. One hundred and seven boiler makers, riveters and helpers with two gang foremen and one inspector do all the fitting up and assembly work. In the light sheet metal department there are 37 men in charge of a gang foreman. Twenty-two men operate the cranes and serve as shop laborers. The night force is composed of 81 men. The remainder of the staff is made up of office assistants, clerks and the like. All work is done on a straight piece work basis.

A typical month's production of the boiler shop, insofar as it is measurable, includes about 25 backends and fireboxes in addition to other work. In December, for example, 17 fireboxes were turned out and 6 complete backends. Two of the orders filled were for fitting new boilers. All this work was on the heaviest classes of Pennsylvania power.

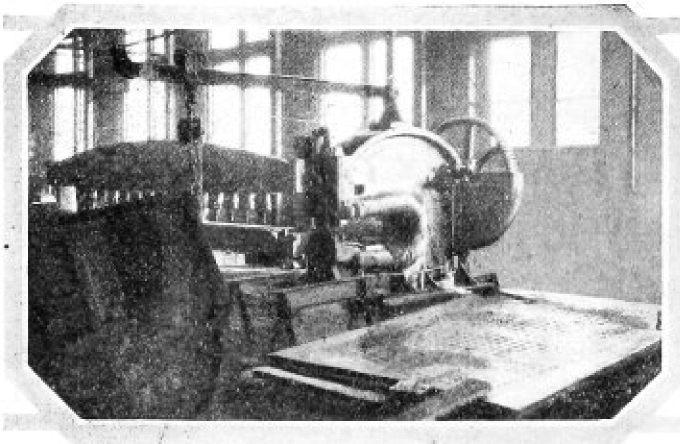
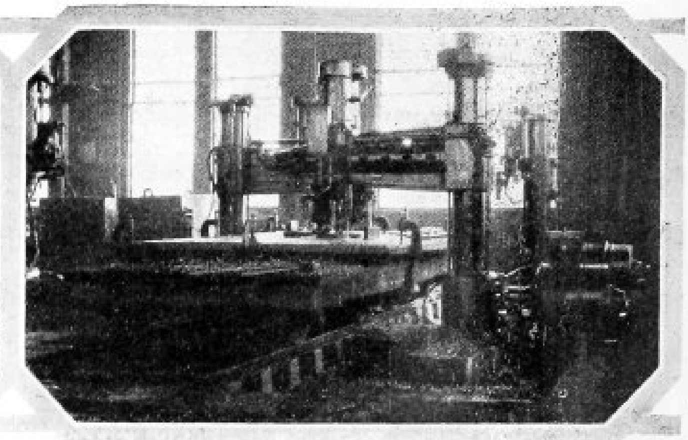
Besides this production, shop orders from the erecting department at Juniata and from the entire system were filled for various boiler sheets, patches, ashpans, light metal work of all kinds and a variety of miscellaneous orders. The amount of this work can be judged from the fact that fully one-third of the staff, or about 100 men, were exclusively engaged in turning out special order material, the remaining 200 odd men handling the regular class repair and construction work in the shop.

A weekly schedule of class 1 and 2 repair work is arranged by the mechanical staff working in conjunction with the erecting shop foreman and the boiler shop foreman; a second schedule is prepared for firebox and backend work that is being made up on special orders either for stock or for some other shop of the system. The remaining shop orders for repair sheets and boiler parts are not scheduled but are given a place in the shop routine and kept on record until filled.

Plant and Equipment

The layout of the boiler shop and its machine equipment is shown in the accompanying illustrations.

The layout floor is located in the west end of the shop. In this section will be found a complete equipment of radial drills, punches and shears, straightening rolls, one set of 26-inch bending rolls having a length of 15 feet between housings; another set of 13-inch bending rolls with a length of

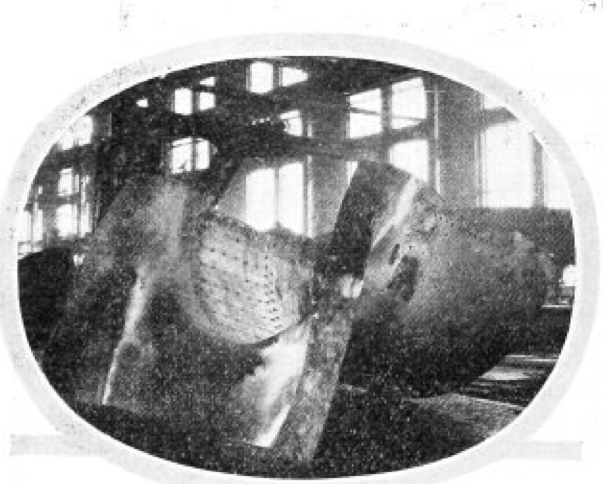
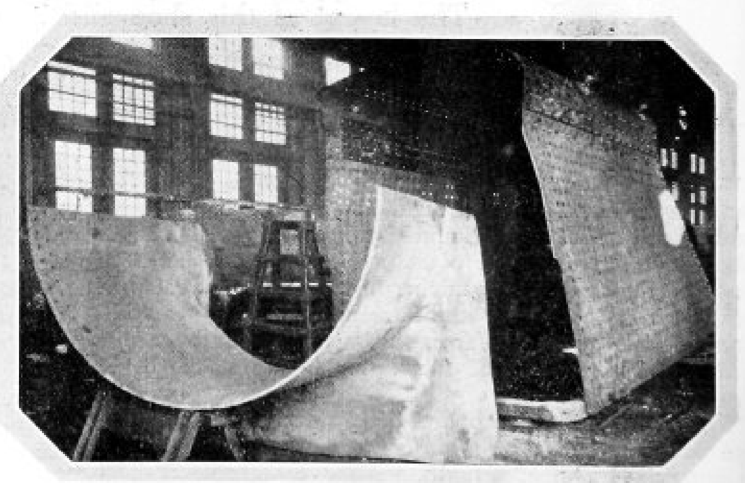
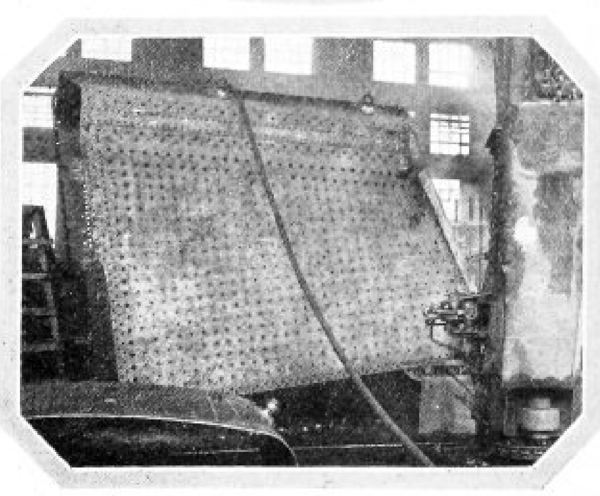
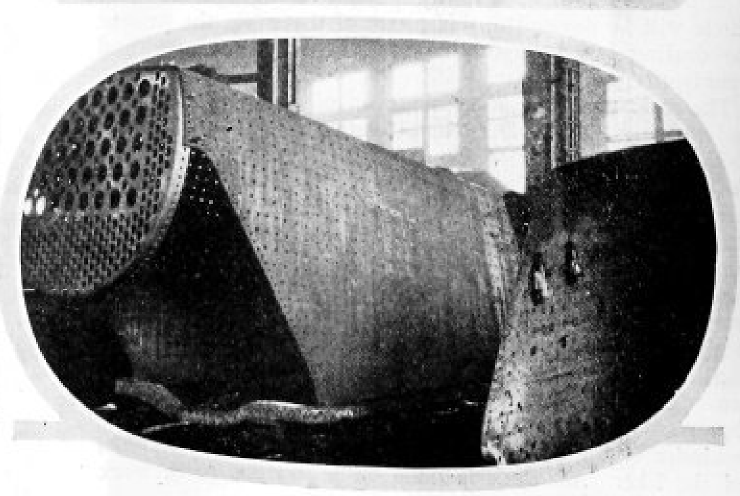



Machine operations in fabricating department

14 feet 2 inches between housings. A 20-foot plate planer is also installed in this department. Four radial drills of various sizes are included here as well as a boring mill for turning flue heads and finishing smokebox rings, etc. All boiler sheets are beveled on this machine, mud rings machined, etc. The location of the boring mill in the boiler shop eliminates the transfer sheets to the machine shop for beveling.

The flanging department is equipped to handle the heaviest plates required by Pennsylvania power. The flange presses include one of 150 tons capacity; one of 400 tons; one of 75 tons; one of 700 tons and another of 1,200 tons pressure. These presses are supplied by two plate furnaces which burn producer gas. A producer gas plant is situated outside the main building adjacent to the furnace location. An additional 250-ton press is placed directly across the shop from the main battery. Further details of the flange work and the standardization and storage of dies for the entire system at this plant will be discussed in a later article.

Along the north side of the shop is located a complete equipment of machines for flue and light metal work. The assembly floor, which extends down through the shop for a considerable portion of its length, is served by numerous hydraulic and electric cranes which supplement the main

Firebox work in the process of assembly

shop cranes. The riveting department in the east end is equipped with 3 hydraulic bull riveters; one an 8-foot 2-inch gap machine with a capacity of 100 tons; one a 17-foot gap machine with 100 tons pressure and the third also having a 17-foot gap is of 150 tons pressure.

The shop traveling cranes include a 35-ton electric crane which serves the east end of the shop; a 15-ton and a 35-ton crane are also available through the greater part of the shop length; a 25-ton crane running transversely of the shop serves the machine in the riveting department. The north side of the shop is equipped with a 25-ton crane, while the storage yard and plate department are served by a 35-ton electric crane.

A completely equipped bolt department is located at the east end and here practically all staybolts, crown bolts and boiler bolts of all types are fabricated. Further details of the work in this department will be given in a later issue describing the status of staybolt work at Altoona. Bolts for the entire system are made at this point.

Outline of Plate Fabrication

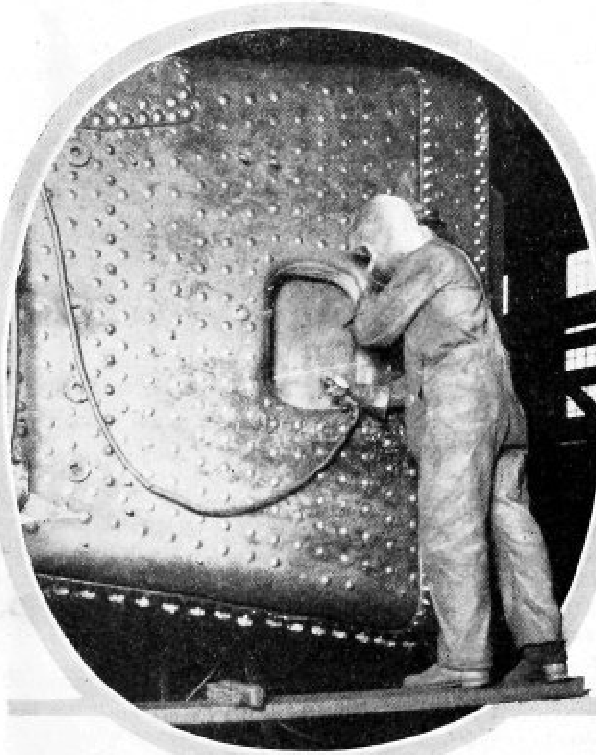
The order of operations for fabricating boiler sheets follows along more or less conventional lines with, however, the application of certain production methods that are original at this shop. The plates come from the storage yard to the layout floor where, if the order is for several locomotives, one sheet is laid out as a template from which the whole order is completed. The sheets go to the multiple drills where as many as ten ½-inch sheets, or their equivalent in thickness, are drilled simultaneously with the template on top as a guide. Throat sheets and other flanged parts are then returned to the layout floor for completing the marking. From here they go to the shears and planers and thence to the rollers. Very little punching is done on the sheets to be used in the boiler, practically all holes being drilled. The rolls in this shop have a capacity for the heaviest plates that are required by Pennsylvania power. A boring mill is provided in this department for turning flue sheets, for finishing smokebox rings; for beveling flue sheets, mud rings and the like. The location of this machine in the boiler shop, as previously noted, saves a great deal of time by eliminating the handling of these plates back and forth to the machine shop. All cylinder head casings are finished in this department.

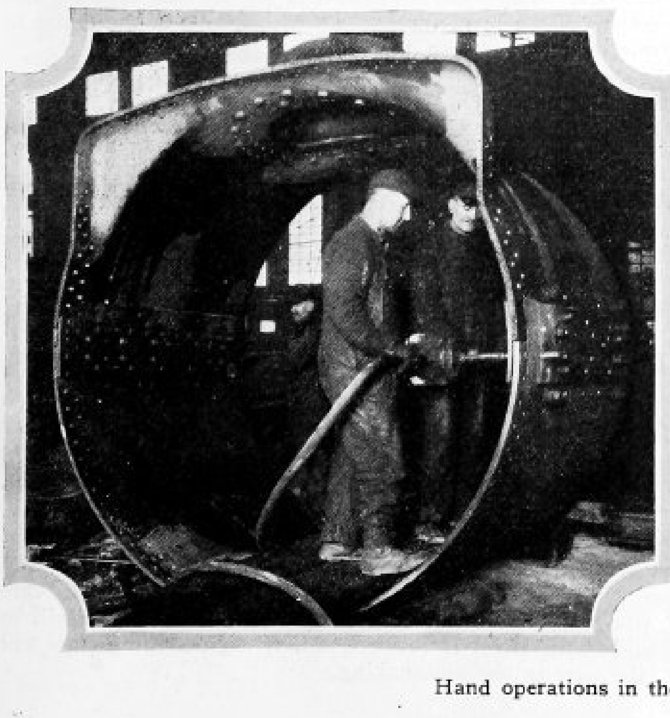
A special drill is set up at this plant with a pit in the floor for accommodating mud rings which are drilled all around. In addition, the battery of drills available here takes care of all small drilling operations.

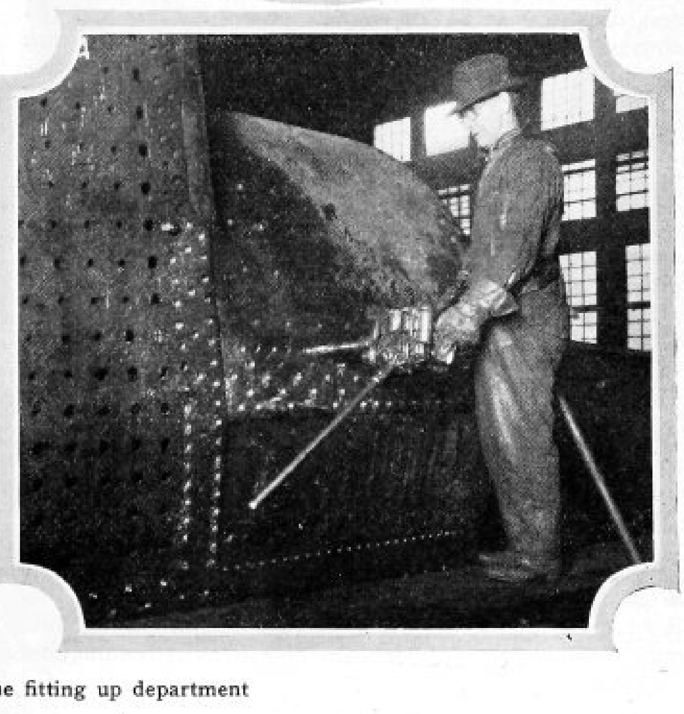
Numerous flange fires are located conveniently in this section where light hand flanging operations are carried out as well as special flanging jobs that require individual treatment.

Flanging Department

The central section of the shop is devoted to light and heavy flanging operations including all of the principal flanged boiler sheets such as flue sheets, throat sheets, door sheets, one piece domes and the like. Light sheet flanging

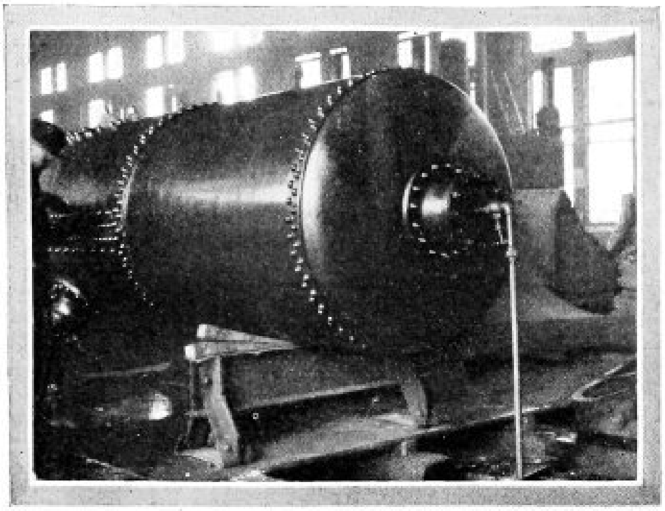






Hand operations in the fitting up department on a production scale is also provided for. Dome casings, ashpans, steps and an almost endless variety of pressed parts go to this department for fabrication. Special machinery for handling light work is provided.

The remainder of the shop is devoted to the assembly of new work—from backend units to complete boilers, as well as heavy repairs required when the boiler is brought to the shop from the erecting floor. All of the heavy riveting is



An air tank undergoing the hydrostatic test

taken care of on the bull riveters with a small amount of supplementary hand riveting. A well equipped hydrostatic testing plant for boiler and tank work is installed on one side of the assembly floor.

In addition to boiler work a great variety of pressure tanks are fabricated here, stationary boilers are built and repair sheets made up for the entire system. Ashpans, dome casings and other light sheet metal parts are pressed at the plant and a stock maintained to supply shops all over the system.

Among the miscellaneous shop equipment are two portable electric welders, one of which is mounted on a roller bearing hand truck. This machine has current characteristics of 175 amperes and 230 volts; the second welding unit, a two-man outfit, has an output capacity of 300 amperes and 106 amperes at 230 volts. Two welders devote their entire time to welding work in the boiler shop while on occasion additional men and welding units are brought from the erecting department.

One other important feature of the boiler shop is the apprentice school in connection with it, as well as with other departments. Classes are held Fridays, the remainder of the time being given over to shop work. Monthly reports are sent to the foreman of the shop giving a measure of the progress made by each apprentice. Apprentices making a grade of 80 to 85 percent are allowed half pay for their time and those above 85 percent receive full pay.

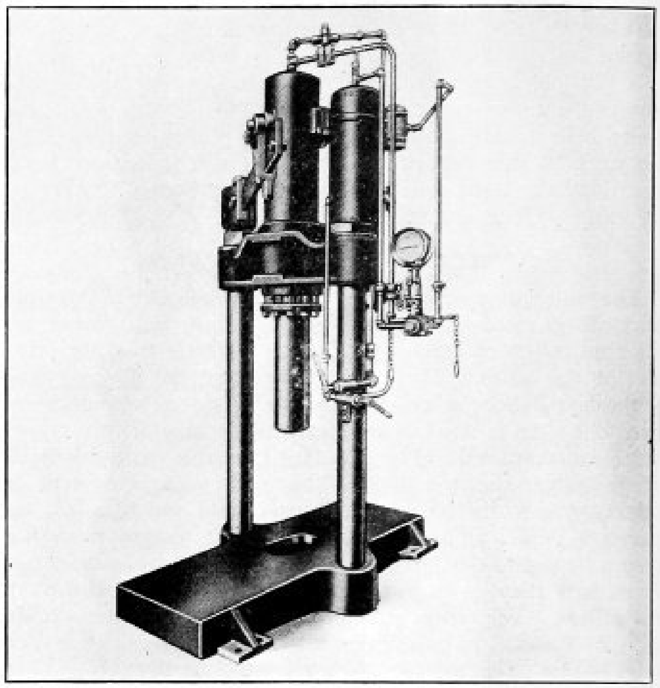
Further details of this shop and its methods will appear in later articles.

Two-Rod Hydro-Pneumatic Forcing Press

A PRESS designed for operations involving forcing, pressing and bending, and adaptable more especially to railroads and other large shops has been placed on the market by the Watson-Stillman Company, New York. This press can be used for many operations of bending and straightening.

The press is of the two-rod type having the ram movement from the top downward. The ram movement is actuated by hydro-pneumatic force obtained by an air engine pump which is designed to be connected to the air line of the shop. Thus, it will be seen that the press can be operated in any shop having air pressure and does not require a motor or any other source of power.

A jib crane is provided as part of the press to facilitate handling work into and out of the press. The bottom platen



Watson-Stillman hydro-pneumatic 100-ton capacity forcing press

is amply strong for bending with blocks on its ends up to the full capacity of the press.

The valve control is simple and easily operated and a gage is provided to register in tons the pressure exerted by the ram. The press illustrated is of 100 tons capacity and bottom platen is 72 inches long with a hole in the center to receive shafts, etc.

LeGrand Parish has retired as president of the American Arch Company, New York, and has been succeeded by H. B. Slaybaugh, who has been executive vice-president of the company and has been associated with Mr. Parish throughout the life of the company. George A. Price, treasurer, has been made secretary and treasurer; F. B. Johnson has been made assistant secretary, and H. W. Muller has been made assistant treasurer, all with headquarters at New York.

Hugh H. Dyar, chairman of the Cleveland Section of the American Welding Society, has been appointed a member of a special committee to cooperate in preparing an unusual technical program to occur throughout the week of May 10 to 15 in conjunction with the Second Chemical Equipment, Machinery and Process Engineering Exposition in Cleveland, Ohio. The convention will be held in the Public Hall in Cleveland and the technical sessions, which will begin Monday, May 10, and continue throughout the week will be held at the Hotel Hollenden. Many engineering groups will take part in the undertaking.

History and Development of the Marine Boiler*

Outline of progress made in the construction of Scotch type and watertube boilers for marine installations

By W. M. McFarland †

WHILE the use of steam on a large scale as motive power goes back only a little more than two hundred years, a form of steam engine and boiler goes back to about the beginning of our own era, when Hero of Alexandria brought out the contrivance known as the aeolipile, which combined the boiler and engine in the same piece of apparatus. Curiously enough this contained in embryo the most advanced form of modern steam engine in the shape of the steam turbine. About 1600 Giovanni della Porta had a primitive form of steam apparatus to operate a fountain. Others followed whose work always involved some sort of steam boiler until we come to Thomas Savery in 1698 who devised an apparatus for a water-raising engine somewhat like the pulsometer of today.

In 1705 the Newcomen engine was introduced and was so much more economical than the one of Savery as to displace it. The change in boilers, however, was not material. The Newcomen engine had a long life, until about 1770, when the invention of the separate condenser by Watt caused his engines to supersede those of Newcomen. All of these engines were for land use and there was, of course, no demand for a marine boiler until the steam engine itself was adapted to marine purposes. Tentative work along this line began in the latter part of the 18th century, after the perfection of Watt's engine and, as you will all remember, the *Clermont* was given a successful trial in the Hudson river in the year 1807, with engines and boilers supplied by Bolton and Watt. We may therefore consider the beginning of the marine steam boiler as about the year 1800.

In those days steam pressures were low, the manufacture of iron plates had not advanced to a high degree and there was more familiarity with the working of copper plates, so that the early boilers were built of copper. This was true of the *Clermont* and it was also true of the early steam vessels for the United States Navy. The first of these was the *Fulton*, which was started in 1814, at the time of our second war with Great Britain. She was not finished until 1815, and so never performed any real war service. The second United States war vessel was also named the *Fulton*. Captain Bennett in his history of "The Steam Navy of the United States," says: "The boilers were built by the contractors at the New York Navy Yard for eight and one-half cents a pound, the government furnishing the material, which consisted of copper plates and rivet rods. Originally there were four wagon-shaped boilers of the return flue type each 16 feet long, 10 feet 6 inches wide and 9 feet 3 inches high, but these were afterwards changed for two boilers 25 feet 9 inches long, the other dimensions remaining unchanged. The *Fulton* was launched May 18, 1837.

Wrought Iron Plates Become Factor

With progress in the manufacture of wrought iron plates it was not long until the boilers were all built of wrought iron, copper being entirely too costly a material. The space on board ship available for boilers in those days was rather cramped and this had its effect on their shape. Although cylindrical boilers had been used on land before there were any marine boilers, this limited space prevented the adoption of this strongest form and the boilers were generally of a somewhat cubical shape, but often with the lower corners cut off to allow for the turn of the bilge. They depended for their strength on the braces which ran in the three necessary directions and made the interior of the boiler a place to be carefully avoided except by very small men. From almost the earliest times the boilers for seagoing ships had internal furnace flues or tubes. These were in embryo the present well known single-ended Scotch boiler. Nearly all of these boilers were of the firetube type, although here in the United States shortly before the Civil War a type of box or tank boiler with vertical watertubes in place of the horizontal firetubes was brought out and was used in our Navy to a considerable extent. This boiler had none of the advantages of the modern watertube boiler.

During my own naval career I served on the old *Michigan* on the Great Lakes which then had the Martin vertical watertube boilers which had been put on board about 1859, just before Isherwood's celebrated experiments on the expansion of steam.

We all know that a difference in conditions brings about a difference in the way they are met. The ability to give the necessary weight for low pressure boilers and machinery in seagoing vessels led to the continued use for many years of low pressures with condensing engines. Meanwhile, however, and almost contemporaneously with the success of the *Clermont*, the steamboats on our western rivers, where light draft of the hull was a vital necessity and consequently light weight of machinery, used high pressures in cylindrical boilers. These were what we would now call "externally-fired return-flue boilers," that is, their setting was very much the same as obtains nowadays on shore with the externally fired return tubular boilers. The boiler was set in between brick walls and with what we would now call a "dry back connection." The bottom of the shell was the crown sheet.

The compound engine was invented almost as soon as Watt's great improvements on the simple engine, but with the low pressures then obtaining there was no particular benefit from their use. As time passed, however, and pressures were gradually raised compound engines were built and it was found that there was a decided economy in their use. This led to steady increase of pressure. Meanwhile vessels had been increasing in size so that there was more room for boilers and this led to the displacement of the old box type boiler by the cylindrical boiler whose shell needs no bracing. The only braces are the ones between the heads, making the interior much more accessible. Pressures with wrought iron cylindrical boilers went as high as about 80 pounds per square inch. Contemporaneously with the advance in pressures, there had been the invention and development of the open hearth method of making steel. This material possessed a homogeneity and strength which had not been obtained with wrought iron, so that when the manufacture of steel had advanced to a point where every reliance could be placed in the product, the metallurgist was able to meet the demand of the engineer for higher pressures. The advent of the triple expansion engine soon jumped the pressures to double what they had been with the compound engine, so that by about 1890 pressures had gone up to 160 pounds. It was not long until they went up to 200 and even more. The cylindrical boiler has been built for pres-

* Abstract of a lecture delivered at Columbia University, January 19, before a body of naval engineers.

† Manager Marine Department, Babcock and Wilcox Company, New York.

Editor's Note: The remainder of this lecture dealt with the operation and maintenance of boilers, particularly of the watertube type.

sures as high as 250 pounds, but in boilers of any size this necessitates very heavy shells, sometimes as much as 1¾ inches thick, and in present day practice it is rare for cylindrical boilers to be built for more than 200 to 210 pounds.

Development of the Scotch Boiler

The cylindrical or Scotch boiler has rendered very valuable service in engineering and deserves to be remembered with satisfaction. The earliest examples in small sizes generally had two furnaces with a common back connection. As the size increased three furnaces were fitted and finally, in those of largest diameter, four. It was very early seen that by making the boiler double ended the weights were reduced by the saving of the weight of two heads so that double-ended boilers with three furnaces at each end were common and followed in the large sizes by those having four furnaces at each end. A serious drawback to the Scotch boiler is the great weight of the shell for high pressures and also the great weight of the contained water. The weight of the water is frequently 50 percent of the weight of the metal in the boiler. As we shall see later in considering water tube boilers, the reduction of weight by their use is very great.

Another serious drawback to these large heavy boilers is the great care needed in raising steam and laying them off after use to avoid undue temperature stresses. Special devices for circulating water when raising steam were used and also the practice of pumping out through the bottom blow and feeding in again to insure circulation.

In naval vessels of small size and high speed, where reduction of weight was imperative, an intermediate step was the use of what was known as the locomotive boiler. This in effect was almost exactly the same as the boiler of the locomotives used on land, slightly modified to meet the conditions on board ship. The facilities for expansion in this type of boiler were better than in the Scotch boiler and they could be forced much more severely.

It is curious to note that little pieces of apparatus almost identical in shape with some of the most successful modern watertube boilers were found in the ruins of Pompeii, so that they date back to earlier than 79 A.D. I believe the antiquarians, however, are satisfied that these were not boilers but worked the other way and were used for cooling wine by circulating the wine through the tubes and packing the outside with hard snow. Watertube boilers date back to the time of the beginning of marine steamers, as Colonel John Stevens built one as far back as 1804. From that time on there has been a succession of watertube boilers of all kinds, shapes and sizes. Loftus Perkins, an American resident in England, built small watertube boilers carrying pressures as high as 600 and 700 pounds before the middle of the last century, but conditions were not yet suitable for such high pressures and nothing practical came of it. In marine work the Herreshoffs brought out a watertube boiler in the late '70's but this was a pipe fitter's job with screwed joints and incapable of being cleaned. Watertube boilers have finally been divided into two classes, those with large tubes, 2 inch diameter and upwards and those with smaller tubes, around 1 inch in diameter. The latter class are still almost entirely for express service, that is, for destroyers and other light craft of that kind in the Navy; in the very latest of our battleships, including the two big airplane carriers, the boilers are to be of this type also. The reason, of course, is the great reduction in weight because boilers of this type capable of carrying 300 pounds pressure, weigh with water about 13 pounds per square foot of heating surface. Incidentally I may also add that the boilers for the airplane carriers are the largest marine boilers ever built, having 11,250 square feet of heating surface per boiler. The tubes of these boilers are very thin, from 95 mils to 109 mils thickness. As a result they do not commend themselves for the merchant service where they cannot receive the same care as in the Navy. The chief varieties of this type of boiler have been very numerous, but they have finally come down to practically one with slight variations, which is commonly known as the three drum type, where the upper and larger drum about 54 inches in diameter is the steam and water drum and the lower ones about 24 inches in diameter are filled with water. The general shape is that of the letter "A," the tube banks forming the straight sides of the letter. Where the tubes are carefully spaced and close enough together this type has proved highly efficient. Tests with the most efficient oil burners have given efficiencies of this type of boiler with oil fuel as high as 83 percent at low rates of driving and almost 80 percent when burning 1 pound of oil per square foot of heating surface.

For the merchant marine the watertube boilers with tubes of large diameter, 2 inch to 4 inch, are the favorites and in all of these the tubes are straight. As showing the advance in size of watertube boilers I may remark that at the Engineering Congress in connection with the Chicago Exposition of 1893, Colonel Soliani, a distinguished Italian naval engineer, in discussing a paper on watertube boilers by Mr. Charles Ward referred to the small size of the watertube boilers of that day. Generally they did not have much over, say, 1,000 square feet of heating surface while the total in a large Scotch boiler would be about 4,000 square feet. Just at that time a favorite installation was four double ended Scotch boilers and Colonel Soliani said that he believed it was easier to drive four big horses than sixteen ponies. At the present day the conditions are reversed. Two-inch tube boilers of the watertube type have been built with 6,000 square feet of heating surface while, as already stated, the 1-inch tube boilers have gone over 11,000 square feet. These large tube boilers while not weighing so little as those of the express type are nevertheless very much lighter than Scotch boilers. The ones with 2-inch tubes will weigh in the neighborhood of 25 pounds, including water, while ones with all 4-inch tubes will weigh about 36 pounds per square foot including water. The foregoing weights are for boilers that will carry from 250 to 300 pounds pressure. Scotch boilers to carry from 200 to 210 pounds will weigh, with water, from 55 to 60 pounds per square foot of heating surface.

Ingot Iron Tested for Locomotive Boiler Staybolts

By G. P. Blackall

SEVERAL exceedingly interesting endurance tests have been carried out recently by the Inspecting Department of the Union of South Africa on ingot iron ⅝-inch rounds for the purpose of ascertaining its value for locomotive boiler staybolts. The specimens employed in these tests withstood 7,000 vibrations before fracture. This performance will be better appreciated when it is mentioned that the best Yorkshire (England) iron is considered satisfactory if it will withstand 1,200 vibrations before fracture.

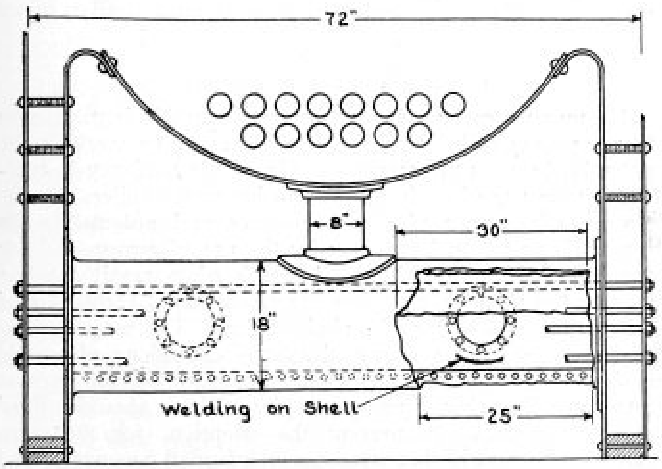
The equalizing of long locomotives and four and six-wheel trucks of goods and passenger coaches involves as a prime requisite the selection of material that will both effect the proper distribution of weight in the original design and satisfactorily maintain this amount on the various axles. These members, equalizer bars, arch bars, and spring hangers, which are required to withstand shock vibration, repeated and reversed stresses, call for a material that is tough, ductile, and slow to fatigue. In this connection it is of interest to note that many colonial railway mechanical designers are adopting a commercially pure iron—i.e., 99.84 percent pure iron—as standard for drawbars, equalizer bars, staybolts, and boiler tubes.

Boiler Explosion on the Steamship Mackinac*

Inspection analysis of a boiler disaster in which fifty-two persons were killed and many others injured

ON August 18, 1925, one of the boilers exploded on the steamer *Mackinac* while in Narragansett Bay returning from Newport to Pawtucket, Rhode Island, and resulted in the death of fifty-two persons and the injury of over one hundred others. There have been boiler explosions that caused indirectly a greater number of fatalities through resulting fires or disasters incident to the explosions, but this is the largest recorded casualty list directly attributable to a boiler explosion in this country. Regularly a freight boat, the *Mackinac* had been put on an excursion route for the summer and at the time of the explosion was carrying nearly seven hundred excursionists, most of whom were members of either one of two groups holding annual outings. It was built in 1909 on the Great Lakes and was operated there until last year.

The boilers on this vessel are of a rather unusual type said to be peculiar to the lake boats. The upper part of the boiler is similar to a return tubular boiler, but in place of a setting, the firebox and combustion space are enclosed by waterlegs which run along each side of the boiler for its full length. These waterlegs are connected near the center by an 18-inch diameter circulating cross drum, which serves also as a bridge wall. This drum has an 8-inch diameter vertical connection to the wet-back at the rear of the combustion chamber, as indicated in Fig. 1.



Type of boiler installed on steamer Mackinac

The failure was in the circulating cross drum of the forward boiler. Leakage in this drum had become evident and repair men from a local boiler shop were called in to weld the leak before the boat left Pawtucket on the morning of the accident. The welders reported a crack about 7 inches long near the longitudinal seam, which they were unable to repair because of lack of room and too much moisture from the leak; so that the boat set out for Newport forty-five minutes late and with only the aft boiler, which had not been giving trouble, under steam.

A fire was later started under the forward boiler and the return trip begun about 5:30 p.m. with both of them in operation at reduced pressure. When but a short distance out from Newport the circulating cross drum of the forward boiler failed. The rupture began at a line about 25 inches long parallel and very close to the longitudinal seam—which was near the bottom of the drum on the side away from the grates—and tore a strip of this width circumferentially around more than one-quarter of the drum. The nature of the failure is clearly shown in Fig. 1.

Most of the killed and injured were on the main, or freight deck, where dancing was in progress, and were immediately enshrouded with live steam. The absence of a non-return valve on the steam line permitted the other boiler to continue to empty itself through the rupture. Although no parts of the boiler were violently projected about the boat, the pressure attained in the boiler room was sufficient to raise the steel main deck about 12 inches. The reaction of the escaping jet moved the boiler forward about one foot. The steam pressure allowed was 142 pounds, although only about 100 pounds was being carried at the time of the accident.

The cause of the failure was external corrosion. External corrosion is a wasting away of the outside surface of the boiler, accelerated usually by the presence of moisture and soot. Sometimes the moisture comes from the boiler itself through a leak, and sometimes from other sources such as leaky valves or fittings in overhead pipings. Sometimes it may be produced by the sweating of a cold boiler, or perhaps by exposure to the elements. Deposits of soot, usually in comparatively inaccessible places which are likely to be slighted when cleaning the exterior of the boiler, retain this moisture and, by reason of the composition of soot, almost invariably result in corrosion of the plate which, if not checked, will soon become dangerous. The original thickness of the plate of the ruptured drum in this case was 3/8 inch, but it had been seriously reduced by the corrosion. The reduction in thickness of the shell began on a line running parallel to the axis along the lowest part of the drum and increased toward the seam, tapering off sharply to practically a knife edge at the line of initial failure. The defect—variously reported as "pin holes" and a "crack"—that prevented full use of the boiler just prior to the accident was evidently a place where the corrosion had penetrated through the plate. This wasting away of the plate, however, had been so uniform and so free from signs of pitting or grooving that, except where it had actually penetrated through, there were practically no visible indications that the plate was dangerously thin.

Both of the boilers on this vessel had been inspected in April, 1925, by the government steamboat inspection service. While it would seem that the plate must have been seriously reduced at that time, yet we cannot attempt to say whether its condition could then have been detected as this depends entirely upon the nature of the inspection, a matter on which we are not informed. We do believe that if an experienced inspector examined this boiler when its latest defect developed just before the boat started on its fatal trip, the boiler would not have been approved either for temporary operation or for repair. It is hard to believe that anyone at all familiar with boiler construction would even consider repairing a boiler that had wasted away over a large area to the extent that there was an actual opening more or less continuous for a distance of approximately 7 inches. Yet the welders called in on the morning of the accident attempted to weld this opening, and undoubtedly would have done so had conditions permitted. Moisture and the inaccessible position of the opening were given as the reasons for not making the

*Published through the courtesy of *The Locomotive*, of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

repair. There is no doubt that this leak would have been stopped by welding had conditions been more favorable for, about six weeks previous to the accident, an almost identical repair was made on the rear side of this same drum, and only a few inches from the final rupture. It too was apparently an opening about 7 inches long running approximately in a longitudinal direction and at a place where the metal was less than 1/16-inch thick.

A still further indication that the generally corroded condition of certain parts of the boiler had become evident is given by the fact that on the 6-inch diameter pipes connecting the ruptured drum with the wet-back, 75 percent of their external surfaces had been welded over. It might be well at this point to call attention to the apparent readiness of autogenous welders in general to apply their methods to boilers without giving any consideration whatever to the strength of the vessel. It is true that welds have been made which under test proved to be as strong and even stronger than the original plates joined; and it is perhaps with a knowledge of this fact that the welder undertakes to patch any opening in any vessel, placing sublime faith in his own work—done frequently under adverse circumstances—as being always the equal of the best. That so much of this work is imperfect and that there is no indication when such is the case is apparently lost sight of entirely. As a result, many repairs are made and defects covered over that should have had radically different attention. Until welders are frank to admit the limitations of their methods, it will be best to take your boiler troubles to a boiler inspector—a man who is not interested in any one kind of cure, but only in the safety of the boiler.

This explosion is an outstanding one because of the number of casualties resulting from the explosion itself. Others have surpassed it although the number of killed and injured in each case was increased by accompanying disasters. One such instance is the explosion that occurred in March, 1905, in a shoe factory at Brockton, Massachusetts, in which the instantaneous collapse of the building and the ensuing fire resulted in the death of 58 and the injury of 117 persons. Another one, and one which undoubtedly will never be equaled, is the explosion of a boiler on the Mississippi River steamer *Sultana* in April, 1865. The boat was packed beyond its capacity with Federal soldiers returning from prison camps. Fire followed the explosion and the boat was completely destroyed. Out of nearly 1,900 soldiers on board, 1,101 perished, together with 137 of the civilian passengers and crew, a total of 1,238 killed.

Unsafe Compressed-Air Storage Vessels

An account of a fatal accident, published recently in a newspaper, furnishes a text for a brief sermon on the danger of using objects for purposes for which they were not intended, and especially with regard to the hazard created by subjecting containers of various kinds to internal pressure without first ascertaining the strength of them.

According to the information given, an employee in a railroad roundhouse had constructed a device for emptying heavy oil from barrels by means of compressed air. While using the device he stood over a metal barrel or drum that was to be emptied in this way, and had given the signal to turn on the air when suddenly the barrel exploded. A part of one end of it struck the man and carried away his head.

Metal oil drums are subjected to rather hard usage and as a rule withstand remarkably well the shocks and strains of ordinary handling. They are not, however, constructed in such a way as to make them capable of withstanding an internal pressure greatly exceeding the static pressure to which they are subjected when full of oil, and it is highly dangerous to use them for any purpose which requires them to be subjected to materially higher pressures. An ordinary drum having a capacity of 45 to 50 gallons is about 32 inches long, and the heads are approximately 20 inches in diameter. The metal of which it is composed is probably not more than ⅛ of an inch in thickness. The shell or body of the drum is stiffened and strengthened to some extent by hoops, but the heads are flat and are not braced or stiffened in any way.

Let us assume that the heads of a drum are 20 inches in diameter and ¼ of an inch in thickness (this being an extreme case so far as the thickness is concerned). According to the rules of the United States Board of Supervising Inspectors for unstayed wrought iron or steel flat boiler heads, not exceeding 20 inches in diameter, the allowable working *steam* pressure on the heads of the drum under consideration would be 11.4 pounds per square inch. If the heads were ⅛ of an inch in thickness (this being nearer the actual thickness of ordinary oil-drum heads) the allowable pressure would be only 2.85 pounds. It is quite possible that the longitudinal seam of the drum, or the joint between the heads and the shell of the drum, might be weaker than the flat heads, in which case the allowable working pressure for the drum would be correspondingly less.

The rules to which we refer relate to vessels subjected to *steam* pressure. They might be modified to some extent where *air* pressure only is concerned; but in any event it is certain that an allowable working pressure of 90 pounds per square inch would be entirely out of the question for a vessel designed and constructed in a manner similar to an ordinary oil drum.

Compressed Air Dangerous

On many occasions and under a variety of circumstances there appears to be a tendency to disregard or overlook the potential hazards of compressed air. This tendency is typified by the use of ordinary kitchen hot water boilers for the storage of compressed air in garages and automobile-tire repair shops and sales rooms; by the use of compressed air for so-called "practical jokes" which often result fatally; and by the use of the devices described in the early part of this article, and others of a similar kind. The records show that there have been many disastrous explosions of vessels designed and constructed with all due care for the express purpose of storing compressed air. These should afford sufficient warning to prevent the adoption, for the same purpose, of vessels that were never intended nor considered suitable for such use by the manufacturers of them.

It seems to us that a man with sufficient ingenuity to conceive the idea of a device for emptying oil barrels or sprinkling floors by the use of compressed air, should also be capable of realizing the danger of employing oil drums for the pressure-containing part of his apparatus. The fact that he acted unwisely in this respect was probably the result of the same kind of thoughtlessness that is responsible for a large proportion of the accidents which cause so much suffering to the human race.—*The Travelers Standard.*

Beveled Cylinder Development

The "Method of Developing a Beveled Cylinder" described by O. H. Tomlin on page 323 of our November, 1925, issue was originally worked out by I. J. Haddon and published in his book "A Treatise for Boiler Makers," the first edition of which was published in England over 20 years ago. The boiler making industry is indebted to Mr. Haddon as the originator of this method of laying out this problem.

Experiments for Determining Strains in Boilers*

Tests conducted in England on various types of boilers to measure stress in curved surfaces

By C. E. Stromeyer

CORNERS of boilers are still counted among unsolved problems, partly perhaps because of the difficulty of measuring the local strains. My own attempts in this direction were made with mirrors, at Lea Bridge, but this method is very cumbersome. Subsequently, a very simple arrangement was devised, which gives reliable and permanent records.

In Fig. 1, C represents a section of a corner of a boiler, A B are the two points between which the bending strain is to be measured. Two scribing wires W_1 W_2, of about

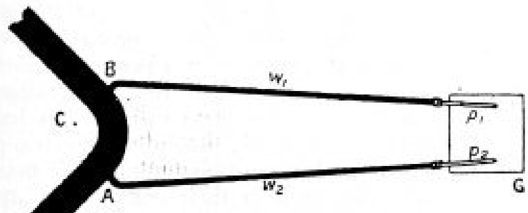


Fig. 1.—Boiler corner section

3/16-inch diameter are electrically dab-welded on to the A B spots. The ends of these scribing wires are provided with light sleeves p_1 p_2, in which pins are fixed crossways. The points of the pins are adjusted so as to be normal to the wires. A small piece of glass fixed in a suitable carriage, and slightly blackened by being held over a flame of burning camphor, is lightly passed under the pins, with the result that two traces appear on its surface. The desired test pressure is then applied to the boiler and another pair of lines scribed. Any bending of the corner results in a closing in or opening out of the traces. These records are fixed by allowing methylated spirits with a little shellac varnish to spread over the glass. The distances between the traces are then read off under a travelling microscope, and their difference divided by the distance A B and by the ratio of the lengths of the wires to half the thickness of the plate and multiplied by the modulus of elasticity gives the average stress of the outer fiber between A and B. Slight corrections for curvature of the corner and for cross contraction—say, 10 percent—should be applied. The effects of average longitudinal stresses are negligible on short spans. Using scribing wires, 12 inches long, spaced 1 inch apart, readings which are correct to 1 percent have been obtained. Probably much greater accuracy could be attained, for so far the difficulty has not been with the definition of the scratches, which were beautifully clear, but with the vernier readings of the micrometer. Using a more delicate measuring instrument, the records can be measured with greater accuracy than has been possible up to the present. Also, as the records are preserved they can be re-measured at any time.

The following measurements were carried out and they demonstrate the use to which this device can be put, and throw light on the nature and intensity of bending strains, which up to now have not been measured. A special reason for entering on this very difficult study is that information from several sources is to the effect that English locomotive boilers are more prone to crack their corners than are continental ones. Probably their scantlings are lighter than ours.

RESULTS OF TESTS ON A SMALL LOCOMOTIVE PORTABLE BOILER

Fig. 2 shows an elevation and a horizontal section, the positions of the pairs of wires being indicated by thick black lines. Readings were taken for successive pressures,

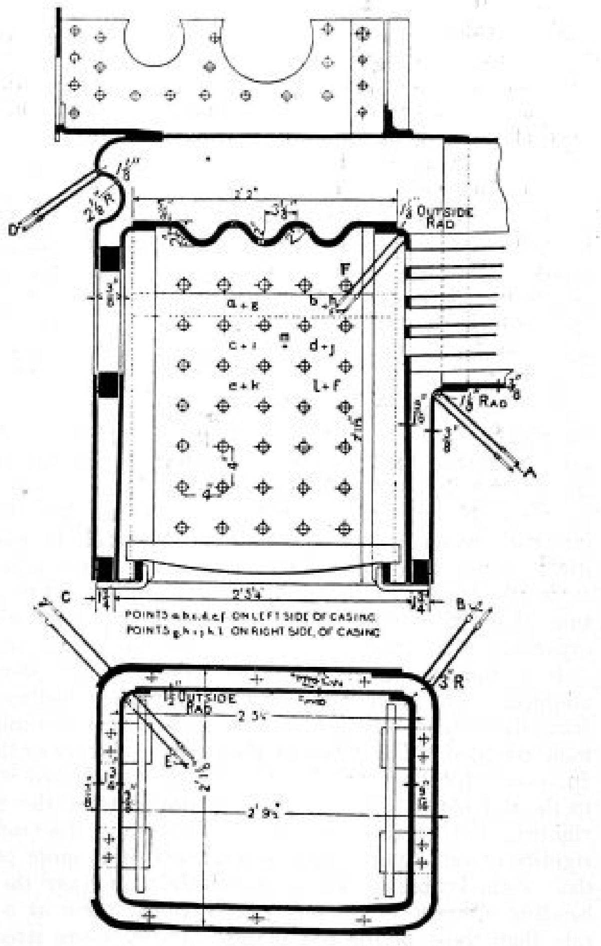


Fig. 2.—Elevation and section of locomotive type boiler

but as slight permanent sets seem to have occurred in some parts of the structure, though not necessarily at the corners, only those results corresponding to a drop of pressure from 360 pounds to nothing are given in the following table. The following allowances and corrections have been made: The modulus of elasticity has been increased from 30 to 33 million pounds per square inch to allow for the effect of cross contraction. The spans between the centers of the roots of the scribing wires were measured along the curved surfaces of the plates to which they are welded. Allowance has been made for the shifting of the neutral fiber of the plates due to the curvatures at the

*From a paper presented by C. E. Stromeyer before the Manchester Steam Users' Association, Manchester, England, and reported in *The Engineer*.

corners. These are given in the following table under corrected half thicknesses. The surface radius has been obtained by measurements from templates supplied by John Fowler & Co., Ltd., who very kindly gave all possible facilities for making these tests.

TABLE I.

Span	Plate thickness. In.	Span between scribing wires measured on surface. In.	Surface radius. In.	Corrected half thickness. In.	Length of scribing wire. In.	Measured separation of scratches. Cm.	Estimated tension stresses at 360 lb. lb./sq. in.
A	3/8	1.03	.73	.178	10.50	—.056	11,760
B	3/8	.93	3.00	.195	9.38	+.036	10,120
C	3/8 (2)	.74	2.30	.477	9.38	+.044	33,400
D	3/8	.86	1.66	.192	9.25	—.030	9,400
E	3/8	.83	.80	.167	9.25	+.046	11,850
F	3/8	1.04	.74	.216	9.25	+.036	10,650

The estimated stresses are those due to bending. If, by calculation, average stresses are found in the plate, they should be added to these bending stresses. For instance, in this boiler the difference between the dimension of the outer case and the firebox should create stresses of this nature; so should the screwed stays, but their combined effect is not easily calculated.

When calculations fail, it may occasionally be possible to measure the combined bending and average strain. In such cases the average strain is found by deducting the bending strain, as found by scribing wires, from the combined strain as found by strain indicators of the usual type.

In a memorandum for 1912 a detailed analysis of all published tests of stayed flat plates was made, which leads to the conclusion that a first permanent set takes place when the hydrostatic pressure reaches $667 \times t^2 D^2$ pounds per square inch. Here t is the thickness of the plate in sixteenths of an inch and D is the diameter of an inscribed circle which just touches the inner circumferences of the stays. In the present boiler t is 6/16 inch. The stays were 7/8-inch diameter, pitched 4 inches apart, therefore $D = 4.79$ inches, and the pressure at which permanent set should take place would be 1,050 pounds per square inch. Assuming the elastic limit of the material to be 30,000 pounds, the stresses in the stayed part of the plates at 370 would be about 10,500 pounds. This is somewhat less than the estimated corner stresses in the table, particularly when the direct stresses are added, which means that the corners of locomotive fireboxes and their casings are somewhat weaker than their flat plates. This result is in harmony with the experience that cracks in these corners are fairly frequent.

It is difficult to visualize the remedy which should be adopted. The edge stays might be placed further away from the corners than at present, and the corners might be more rounded. The plates might be made thicker or thinner. Increased thickness would, of course, give increased strength to the flat plates, but because it would increase the general rigidity, and because the corner stresses are due rather to rigidity of other parts than to weakness, it is quite possible that a thickening of the corners might increase the local bending stresses, or, at any rate, decrease them at a lesser rate than those of the flat plates. These severe stresses at the doubled corner C suggest that stresses would be reduced by thinning the plates; but then, of course, the wasting would grow in importance.

The following additional tests were made. A frame was placed round the center of the firebox casing, and the bulgings of its sides measured. They amounted to 0.0335 inch on either side. In addition, the outer surfaces were trammelled, and it was found that on a span of 16 inches between the outside rows of stays the acquired camber amounted to only 0.002 inch. The difference of 0.315 inch represents the outward movement of the outer rows of stays, and as these would carry the firebox plate with them the firebox corner should have opened out. The scribing wire measurements show that it bent in.

A much more detailed test than the one carried out would be required to settle the outstanding points, and such detailed tests cannot be carried out when, as in this case, advantage has to be taken of an official test to attach some instruments, which, few as they were, nevertheless must have interfered with the general testing arrangements. John Fowler & Co. (Leeds), Ltd., Leeds, very kindly permitted the tests to be made and also had the necessary wires welded to the plates.

While these pages were in the press, John Fowler and Co., Leeds, kindly invited me to witness another test of a firebox of a similar design to the one shown in Fig. 2, but the corrugated crown was slightly altered. The hydraulic test and careful micrometric gagings revealed no permanent set up to 550 pounds per square inch. Just as 600 pounds was reached some shell seams started to leak heavily, but the pressure could be maintained while readings were being taken, and, on releasing the pressure, slight permanent sets of the corrugations were discovered. They were of the order of 1/16 inch in a span of 18 inches. Evidently, the elastic limit had just been reached. Information as to the tenacity and the yield point of the material has not yet come to hand, but it will probably be of the order of 15 tons, or, say, 34,000 pounds per square inch. An estimate of the stress under which the corrugations gave way can be made by assuming them to be beams having a depth of 2½ inches at the center, due allowance being made for the corrugated section, and assuming also that these girders are freely supported at their ends. The stiffening due to the vertical side plates is not likely to exceed 5 percent, and has here been neglected. The estimated bending stress in these corrugated beams, under a pressure of 600 pounds, works out at 43,000 pounds per square inch, or 26 percent in excess of the probable elastic limit. This is a very satisfactory result, for it shows that corrugated beams, like beams of other sections, offer greater resistances than those estimated from tensile tests. This result deserves to be widely known.

DONKEY BOILER DISHED CROWN PLATE

Somewhat similar experiments to the above were carried out on a donkey boiler at Clayton, Son & Co., Ltd., Moor

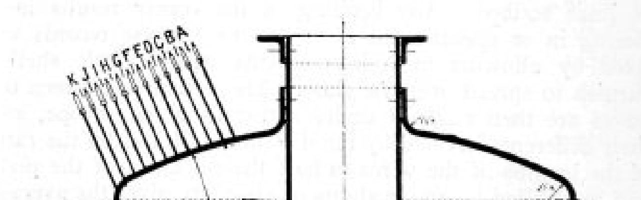


Fig. 3.—Tests on donkey boiler

End Works, Leeds, to whom I also wish to offer my best thanks. A series of twelve scribing wires was welded to the top dished end—see Fig. 3.

The dimensions of the boiler are:

Diameter of shell	4 ft. 3 in.
Length of shell plate	8 ft. 6 in. approx.
Thickness of shell plate	7/16 in.
Firebox diameter	3 ft. 6 in. mean approx.
Firebox heights	5 ft. 1½ in.
Firebox plate thickness	10/32 in.
Number of cross tubes	4
Firebox crown plate	9/16 in. thick.
Firebox crown plate	3 ft. 6 in. radius
Boiler top end plate	½ in. thick
Boiler top end plate	4 ft. 3 in. radius
Diameter of uptake	11⅜ in. internal
Thickness of uptake	½ in.
Radius of curvature at root of flanges	2½ in. and 1½ in.

The lengths of the scribing wires were about 10½ inches. It had been intended to use only one long smoked glass plate for each reading, but it was found difficult to carry out this plan, and therefore the eleven traces had to be taken separately. This was done before starting and again when the hydraulic pressure had reached 200 pounds, and after it had been released. There was no permanent set, and the results in the following diagram—Fig. 4—are based on the mean of the up and down reading.

Dished Heads

In dished ends without an uptake acting as a stay, the negative stresses at K would be very severe, and would rapidly change to tension stresses, say, at *I* or *H*. Looking on the uptake as being a stay which draws the dished end down, a spreading out of the tension stresses towards the

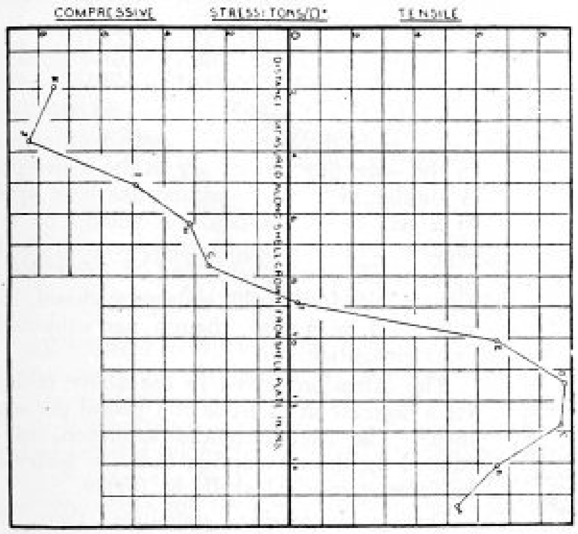


Fig. 4.—Results of donkey boiler test

circumference might be expected. But the reverse action has taken place, which suggests that the uptake acted like a strut. This is likely to have been the case for, due to cross expansion of the shell and cross contraction of the firebox, the uptake would exert a thrust on the top dished end plate. This tendency would be increased under working conditions, and particularly when, due to incrustation, the firebox might become overheated.

The following are a few of the estimated stresses in other parts of the boiler:

Between rivets of shell plate = 9,700 pounds per square inch.

Compression stress in furnace at 200 pounds per square inch = 8,960 pounds per square inch.

Lap Joint Bending

With a view to studying the behavior of lap joints, the following experiment was made on a double lap joint—a single lap joint was not available—of a vertical boiler, 3 feet 6 inches diameter and ⅜-inch plates, to which scribing wires were welded—see Fig. 5. The readings were very consistent, but the results unsatisfactory, and suggest that secondary strains were interfering with the primary ones. Over a span of about 5¾ inches the average decreases of convexity expressed in angular measure were as shown in Table II:

Table II

Pressures	0–75	0–100	0–150	0–200
Angle	0.00142	0.000335	0.000258	0.000091

During this test there was much hammering on adjoining boilers which may have produced some effect.

The readings for the *D* and *E* spans are therefore given in Table III:

Table III

Pressure, lb.	0–75	75–100	100–150	150–200	200–0
Readings—					
Span D, cm...	—.008	—.005	+.006	+.014	—.019
Span E, cm...	......	—.018	+.014	+.022	—.063
Surface stresses—					
D, lb..........	—1610	—1006	+1207	+2820	—3830
E, lb..........	......	—3620	+2820	+4430	—12680

It will be seen that until the pressure 100 pounds was reached the bending was in a contrary sense to what might be expected. On releasing the pressure the movements were all in the right direction, but they exceeded the sums of the earlier movements. This suggests that the limit of elasticity had been exceeded in some part of the boiler during the testing, though not at the seam.

Stresses Near Lap Joints

The following comparative tests were made during the test of the Pilkington boiler—see Memorandum, 1923, for dimensions. In the measuring instrument used the interference of monochromatic yellow sodium light, reflected from two surfaces, is made use of. The shifting of the interference bands through one pitch corresponded to a stress of about 30 pounds per square inch. The instrument was so placed that it measured the circumferential strains close

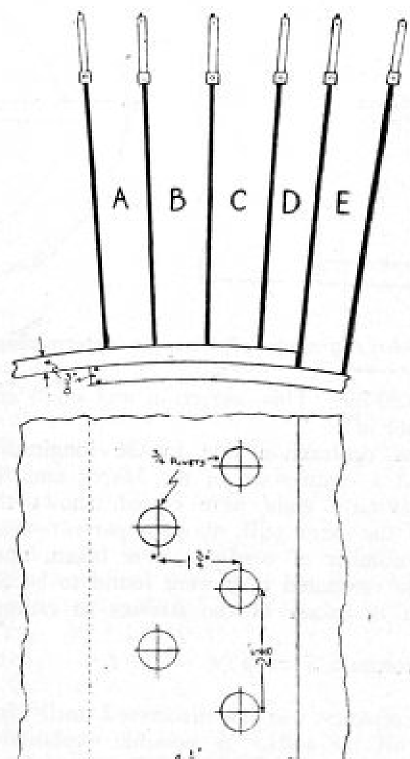


Fig. 5.—Test on double lap joint

to a lap joint; first, in the solid plate which covered the end of a lap seam, and, secondly, in the solid plate which was covered by the end of the lap seams. The bending of the solid plate, due to the irregular shape and the elasticity of the lap, would be in an opposite sense, and would combine with the average shell tensions.

In the first case the interference bands hardly moved, say, one band for about 25 pounds pressure. In the second case, sixteen bands passed the datum point for a change of pressure of 25 pounds. Thus the bending and tension stresses in the solid plate near the lap were about sixteen times greater with the lap covering the plate than with the plate covering the lap.

Shell Extension Experiments

During the Lea Bridge tests an attempt was made to measure the circumferential extension of the shell plates.

The general arrangement of these experiments will be seen from Fig. 6. A series of set-screws was screwed into the one side of the shell plates, and a wire was secured to each, and wound round the circumference of the boiler. It was carried clear of its surface by means of a number of small rocking frames. The end of each wire was secured to a helical spring whose end was held by a stud. Small ivory scales and verniers—not shown—were attached to the wires at a convenient point. An expansion of the shell would hardly alter the length of the wire. Its helical spring would stretch, the scale and vernier would slide past each other and their movement could be read off direct. No levers or other magnifying arrangements were employed, so that the results ought to be absolutely reliable. After the fixing of one of the wires, it was strained by pulling its helical spring a definite amount, and the stretching of the wire was read

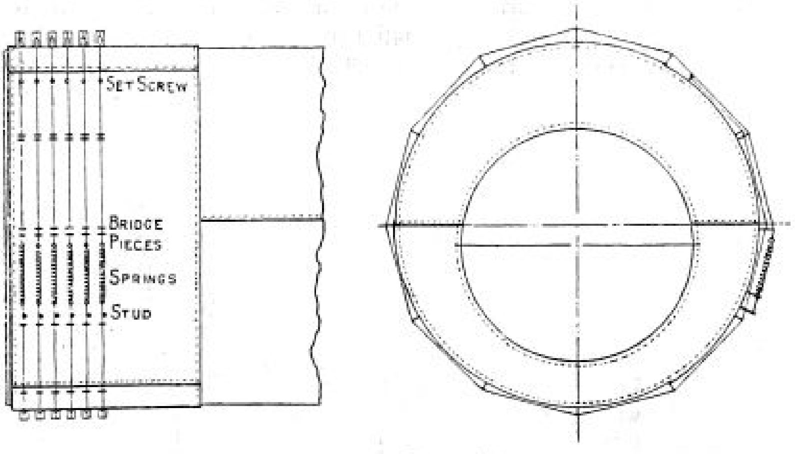


Fig. 6.—Arrangement of wires in determining shell plate extension

off on the vernier. This correction was small and has been taken account of.

The cross contraction due to the longitudinal tension is small, but a comparison of the March and August tests, when the furnace ends were closed, shows the reducing influence of the extra pull, about 8 percent—see Table IV.

A large number of readings were taken, and when the stresses were estimated they were found to be 50 to nearly 100 percent in excess of the stresses as estimated by the customary formula $S = p \times \frac{D}{2} \times t$.

This discrepancy was not discovered until after the completion of all the tests. A possible explanation was the placing of the rocking frames for the circumferential wires. In order to keep their number as low as possible, three of them were placed high on the edges of the lap joints. If these joints have tilted with increasing pressure, the rocking frames would be lifted and an extra movement of the verniers of about 1.5 times the average lift would be recorded.

The practical conclusion to be drawn is that in future experiments a much larger number of rocking frames than the twelve of these experiments should be used.

The results of these several sets of tests are contained in the following Table IV, which gives the average circumferential extension of the shell at nineteen points of its length. It contains the elongations as measured with the help of the verniers. Then follow the average tiltings of the three lap joints of each belt (multiplied by 1.55). The next columns contain the circumferential elongations of the several shell belts, less the lap joint tilting corrections.

Table IV

Position from each front seam	Shell extension in inches as measured per 1 lb. pressure: March, 1922	Shell extension in inches as measured per 1 lb. pressure: August, 1922	Correction for tilting of lap joints (1.55 × average tilt)	Corrected values of shell extension, per 1 lb. pressure: March, 1922	Corrected values of shell extension, per 1 lb. pressure: August, 1922
a. 0 in.	.00019	.00021		.00015	.00017
b. 2 in.	.00009	.00008		.00007	.00006
c. 4 in.	.00018	.00019		.00014	.00015
d. 6 in.	.00044	.00044		.00036	.00036
e. 8 in.	.00065	.00054	.00017	.00053	.00042
f. 10 in.	.00079	.00072		.00064	.00057
g. 18 in.	.00091	.00087		.00074	.00070
h. 30 in.	.00060	.00066		.00049	.00055
j. 0 in.	.00064	.00055		.00052	.00043
k. 6 in.	.00062	.00060		.00022	.00020
2. 18 in.	.00039	.....	.00026	.00013	.....
3. 18 in.	.00087	.00080	.00039	.00049	.00041
4. 18 in.	.00076	.00082	.00043	.00032	.00039
5. 10½ in.	.....	.00082	.00039	.....	.00042
6. 18 in.	.00069	.....	.00050	.00019	.....
7. 25½ in.	.00068	.00063	.00039	.00029	.00024
8. 18 in.	.00068	.00055	.00031	.00037	.00024
9. 18 in.	.00060	.00063	.00019	.00041	.00044
10. 18 in.	.00061	.00063	.00019	.00042	.00044

The measurements *a* to *j* were not taken at the centers of the belts; they have in the last two columns been corrected in the same proportion as *g* in the center plane. A similar modified correction has been applied to *k* on the second belt. It should be noted that the March measurements are with the furnace in place with open ends. After the collapse of the furnace its ends were closed, but it still acted as a stay, though not subjected to cross elongation.

The extensions given in the above table are for a decrease in pressure of 1 pound per square inch. The circumferential extension, as calculated on the assumption that the boiler is a uniform cylindrical shell, is .00049.

During increasing pressures there were numerous slippings of the lap seams, as revealed by leakages. During the August tests the lap seams were covered on the inside by white lead and strips of waterproof sheeting, but even this precaution failed when the seams began to gape.

Summary of Table IV

Belts	1 (*g*)	10	2	9	3	8	4	7	5	6
March	.074	.042	.013	.041	.049	.037	.032	.029	...	.019
Means	?		?		.043		.0305		?	
August	.070	.044	...	.044	.041	.024	.039	.024	.042	...
Means	?		?		?		.0315		?	
Mean at March-Aug.	.072	.043	...	.0425	.045	?	.0355	.0265	...	...

It will be seen that the front end plate has a marked effect in barrelling, at least on the first belt. The readings for *h*, *j*, *k* show that the double thicknesses of the circumferential laps produce a similar effect. The results of the center readings of the belts ought to be symmetrically distributed over the length of the boiler. No. 2 and No. 6 are out of harmony and reduce the reliability of the results, but they should prove of interest.

The high values for *g* at the center of belt 1 may be due either to the presence of a blow-off hole at the center of this belt, or to a rocking bridge having been placed over this hole. Neither 5 nor 7 wires were in the centers of their respective belts, on account of a manhole in the one case and a stand-pipe in the other. Their results should be increased.

The above experiments had been preceded by similar ones at Messrs. Pilkington Brothers' works on a short-return tubular boiler. The circumferential wires had been stretched by means of weights instead of springs, and much trouble was experienced when these weights were accidentally touched. Then the carefully built-up series of rocking frames would all collapse. No measurements of the tiltings of the lap joints were taken; errors due to this cause could not therefore be corrected, but these errors seem to have been small, for the readings are what might be expected. The results of these tests are summarized in the following table:

TABLE V

Position from each front seam	Mean circ. extension in inches per 1 lb. increase in pressure	Position from each front seam	Mean circ. extension in inches per 1 lb. increase in pressure
(1) 0 in.	.00018	(5) 1½ in.	.00118
(2) 9½ in.	.00084	(6) 26¾ in.	.00074
(3) 1 in.	.00061	(7) 16 in.	.00137
(4) 14¼ in.	.00077		

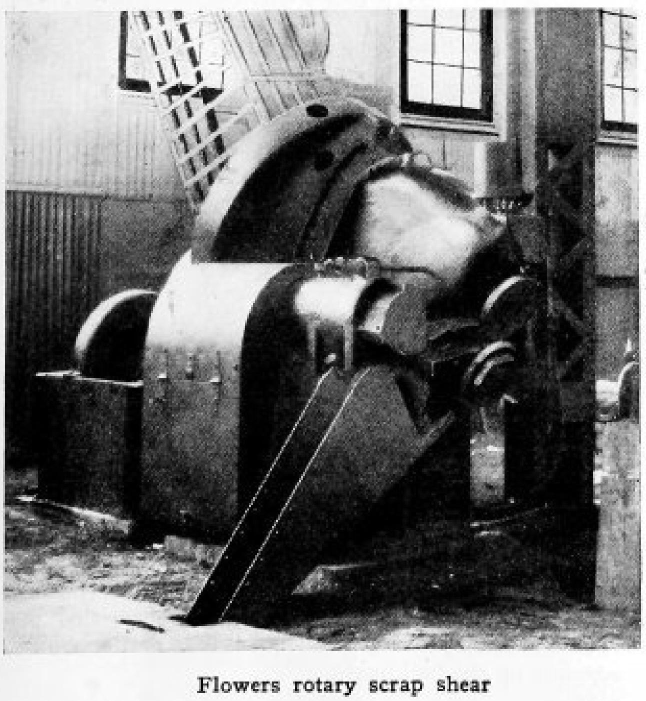
An estimate of the circumferential extension of the boiler, regarding it as a uniform cylindrical shell, leads to the value .00076 inch for the extension per 1 pound increase in pressure.

Nos. 5 and 6 were respectively 1½ inches from the circumferential seams on either side of the manhole strengthening ring; No. 7 was close to the dome; Nos. 3 and 4 were on either side of a patch, covering the opening for the junction valve block; and No. 2 was over a patch covering the opening for the blow-off block. No. 4 is the only measurement for the center of a belt, and agrees with the above measurement.

Machine Designed to Cut Bevel Shear Scrap Without Rehandling

THE Flowers rotary scrap shear, an illustration of which is shown, is designed to be attached to bevel shears for automatically cutting the scrap into short lengths without rehandling. The scrap, as it is sheared in short lengths ready for the mill, drops into a receptacle which may be placed under the floor. The scrap shear is geared direct to the bevel shear and becomes a complement to the machine; consequently, the two operations of beveling and cutting the scrap into short lengths become one operation. The operation is said not to complicate nor retard the operation of the bevel shear.

Scrap from bevel shears is usually accumulated at or near the machine and must be rehandled and sheared into short lengths. Coming from the bevel shear in long, slender spirals, this class of scrap is expensive and dangerous to handle, the cost of rehandling being estimated as averaging from $5 to $8 per ton, according to conditions. The Flowers machine is intended to eliminate this expense.



Flowers rotary scrap shear

The scrap shear can be applied to any make of rotary shear already installed and can be made an integral part of a new machine as well as to certain conditions existing in connection with squaring, slitting and Quickwork rotary shear installations. Many of these machines have been installed recently in plate shops. The machine is the invention of J. C. Flowers, formerly with one of the large tank manufacturers, but now associated with the Thomas Spacing Machine Company, Fulton Building, Pittsburgh, with plant at Glenshaw, Pa.

Large Pipe Made from Steel Plate

A MOST interesting piece of engineering has just been completed at Portland, Oregon. Growth of the city necessitated the laying of seven miles of new steel gas mains—3 miles of it 30 inches in diameter and the rest 24 inches in diameter. Freight rates to the Pacific Coast on pipe of this diameter make its cost almost prohibitive. It is so bulky that only a small amount entirely fills a freight car. After canvassing the situation thoroughly, the engineers decided to reduce this item of freight by ordering an equivalent amount of flat boiler plate cut to the proper size and shipping it from the eastern mills by way of the Panama Canal. The plates were then to be formed and made into pipe by oxy-acetylene welding in Portland.

The gas company itself did not do the actual oxwelding, but let the contract to the Steel Pipe and Tank Company, a concern specializing in such work. Fabrication of pipe lengths in the shop began April 15, 1925, and was completed August 1, 1925. The field work which involved joining the lengths into a continuous line by welding, was finished about October 1.

Before starting the contractors consulted engineers of The Linde Air Products Company, the oxygen suppliers, who worked out a "Procedure Control" for fabricating pipe of this style by oxwelding. The Procedure Control (which is a detailed and carefully prepared set of instructions taking up each operation step by step) was followed out to the letter, with a Linde service operator at the plant to aid in its interpretation and application and to help train the welders.

The plates, which were 5/16-inch thick and came in 12-foot lengths, were first shear-beveled on the ends and sides to an angle of 45 degrees to form the vees for welding. They were then passed through a set of rolls to bend them into rings. After the longitudinal seams had been oxwelded, three of the rings or courses were lined up on rollers and the circumferential seams welded to form a 36-foot length of pipe. During the latter operation the work was continuously rotated so that the weld was always in a position convenient for the operator.

After 36-foot lengths had been fabricated, these were subjected to 150 pounds hydrostatic pressure, and while under this pressure the welds were hammered with a 12 pound sledge. Air pressure of 50 pounds per square inch was then introduced, soapy water being applied to the welds with a paint brush to locate any pin-hole leaks that might have developed under the hydrostatic pressure and the hammering. Only three of the hundreds of joints were returned to the shop to be rewelded.

After testing, the lengths were given an alkaline bath to remove grease, then dipped in asphaltum and rolled in grit. The units were then ready for the stringing gang.

Welding of the pipe in the field was carried out in accordance with standard pipe line welding practice. Using a caterpillar crane for handling, three 36-foot lengths would be welded into a 108-foot section on skids over the trench. This section would then be tied in to the line already completed and lowered into the trench.

Engineers on the Pacific Coast have watched this welded line with keen interest, and already several other lines of similar construction are under consideration.

Safe Handling of Oxygen Cylinders

AT first, most welders and storekeepers have the proper respect for an oxygen cylinder, for they realize that within the seamless steel shell is confined a great amount of pressure. But day in and day out these cylinders are safely handled, and before very long they are usually considered in about the same class as a hammer or wrench—that is, as a tool.

Correct handling of oxygen cylinders is not a difficult matter. It is only necessary for the welder or storekeeper to remember and apply a few precautions. These can be stated very simply.

Cylinders kept in stock should be kept out of the passage ways so they will not be knocked over. Never store them near oil or grease. Preferably, they should be stored in a convenient space by themselves and separated from combustible material.

Oxygen cylinders should not be used to hold the door open, or as a coat rack, or as a substitute for the missing leg of the old coal-stove in the corner. It is also bad practice to stand them near a forge or preheating furnace. Pressure increases when the cylinder is heated. Oxygen cylinders are all equipped with a safety device which acts as an excess pressure release. So if the temperature is raised, the pressure also increases, the safety device acts, and the oxygen escapes into the air.

One often hears a welder say, "Bill, bring me over a tank of air." What he means is that he wants a cylinder of oxygen. The words "air" and "oxygen" should not be used to mean the same thing, for they are by no means the same. Air contains some oxygen, but also four times as much nitrogen. Nitrogen is very inactive, oxygen very active.

So it is safe to do many things with air, which it would be very hazardous to do with pure oxygen. For instance, compressed air may be used for blowing out pipe lines operating pneumatic tools, starting Diesel engines, to place head pressure in a tank, and dusting clothing. Never use oxygen for these things or as a substitute for compressed air.

"Oxygen—Use No Oil"

For years oxygen and equipment suppliers have preached the slogan "Oxygen—Use No Oil." They mean what they say. Oil and oxygen should never be brought in contact with each other. They will flare out a quick protest in no uncertain terms. Oxygen, although it will not burn, will aid in rapid combustion, and will cause oil or grease to ignite and blaze furiously. Therefore do not handle oxygen cylinders with oily or greasy hands or gloves. Sometimes a valve may stick a little and because the welder's hands are slippery with oil he will pick up a piece of oily waste and try to turn the wheel. This is very careless practice for it gives an excellent opportunity for the oxygen to come in contact with the oil and a fire to start. Everyone handling oxygen cylinders should write this slogan indelibly in his mind, "Oxygen—Use No Oil."

Whenever an oxygen cylinder is in use it should always be secured to something; either chained on a truck or fastened to a stanchion or to the wall. If anyone should stumble over the hose and knock the cylinder over, the least that may be expected is a broken regulator, which will cost money to replace. In moving a cylinder it should not be dragged along using the valve as a handle. That's not what a valve is put on a cylinder for!

After attaching the regulator to a cylinder, the valve should be opened by *hand*. A hammer or wrench should not be used for it is easy to twist off the valve stem. If a valve will not open by hand, notify the supplier giving the serial number of the cylinder and the character of the trouble, and return the cylinder. (It might not be amiss to point out here, too, that all empty cylinders should promptly be returned.)

Observe All Precautions

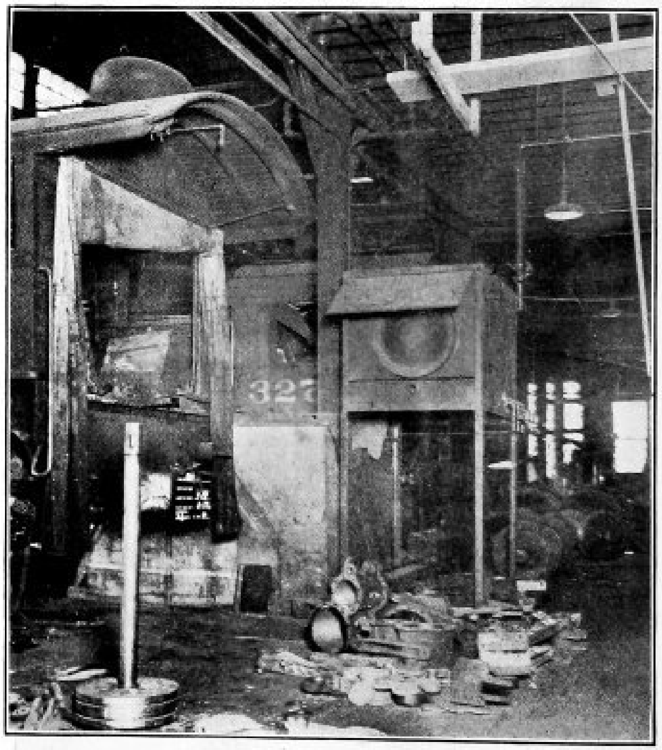
When the cylinder is not in use the valve should always be closed as tightly as possible *by hand*, and the cap which protects the outlet valve should be screwed down over the neck ring.

Sometimes when a casting has to be moved, a welder may use a cylinder (or two) as a skid or roller. It seems hardly necessary to call attention to the fact that oxygen cylinders either full or empty should not, under any circumstances, be used for such a purpose.

In handling oxygen cylinders, a second of stopping to think is better than being stopped for lack of thinking. What's that old adage?—"An ounce of prevention is worth a pound of cure."—*Oxy-Acetylene Tips.*

Unit Heater for Railroad Shops

THE unit heater recently developed by the ILG Electrical Ventilating Company, Chicago, is a cabinet open at both ends in which is housed heating coils for steam or hot water and a self cooled motor propelled fan. This cabinet serves as a heating chamber for the air which is drawn in over the heated coils on the intake side at low



Unit heater installed in New York Central locomotive repair shop

velocity—about 500 feet per minute and discharged in volume at high velocity at about 200 feet per minute. The heaters are intended for shops, factories and warehouses and similar localities and it is claimed for them that they effect a considerable saving in fuel as well as greater rapidity in warming up the buildings.

British Boiler Shop Practice*

A discussion of welding methods and of various types of boiler furnaces in general use

By Engineer Captain, T. J. Drover, R. N.

THE following notes bear special reference to longitudinal joints of furnace flues of boilers of the Lancashire or Cornish type. Avoid all riveted joints for longitudinal seams of flues subject to external pressure. Always keep the flues working in a true circular form, otherwise small deviations from the circle have an important effect on the strength. There are various methods of welding these seams, the three most commonly used being shown in Fig. 1.

Fig. 1

Glut Welding

The plates are rolled to a true circle as though a bent joint is being formed, having first chamfered the edges of the plate, see Fig. 1. Straps or chains are placed round the tube to prevent spreading as the welding proceeds. At the same time as the edges of plates are heated, a strip of iron to fit the gap is also heated, and the strip is welded into the gap. This method usually results in a tight job, and little fullering is afterwards required.

Lap Welding

The plates are rolled until the edges lap well over each other (see sketch). The plates are then heated up and welded up in the usual manner. In this case there are no thin edges exposed to the fire and consequently the burning of edges is reduced to a minimum. Sometimes a few tapping studs are placed on the lap and strips passed around the tube to prevent spreading.

Scarf Welding

In this case the edges are beveled to a long scarf and the plate is rolled until the long edges are well over each other. The edges are then welded in the same manner as before. This method is frequently adopted, although the thin edges of the scarf are liable to overheating. In all these methods of welding a length of from 6 inches to 1 foot is finished at a time when a machine is used, but when hand welded rather less is done at a time. After the welding has been completed there should be no openings or fractures on either side of the weld and the weld throughout the ring should be even and smooth. After the welding the rings are trued and then placed in a flanging machine where the flanges are formed. During this operation the weld may open, but this can be remedied by another welding operation.

Furnaces for Firetube Boilers

The furnace is subjected to external pressure and for the purpose of withstanding this pressure it is made circular. If the furnace is absolutely perfect in form no distortion from a uniformly distributed pressure can occur. However, such perfection is almost impossible to attain and consequently in designing and manufacturing furnaces a large margin has to be allowed, based on practical experience. Consider a furnace not quite cylindrical with its horizontal diameter somewhat greater than its vertical diameter; then the resolved vertical forces tend to produce collapse and, as the vertical diameter decreases, the resolved horizontal forces also decrease thus reducing the resistance to collapse. This is directly opposite to the action when the boiler shell is subjected to pressure internally. With low pressures the plain cylindrical furnace is strong enough to resist collapse when made of moderate thickness. An increase of thickness causes a loss on the rate of conduction of heat through the plate, but only in extreme cases is it likely to lead to overheating of the plate itself. In an ordinary boiler from 50 to 60 percent of the total heat absorbed by the boiler water is conducted through the boiler plates.

Various methods are adopted to strengthen the furnace against collapse:

1. Adamson's ring joint: objections—number of rings necessary for high pressures; too cumbersome for practical use.
2. Bowling hoop joint: objections—rivets exposed to fire and hoop supporting the furnace merely through medium of rivets. Fig. 2 shows these furnaces.

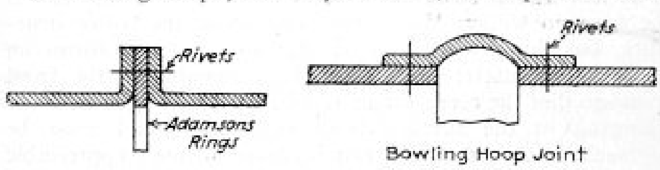


Fig. 2

For plain unstiffened furnaces $T = \dfrac{PD}{8,000}$

Where T = thickness in inches
D = mean diameter in inches
P = working pressure in pounds per square inch

From the plain furnace the corrugated furnace was evolved.

The Fox Furnace

This furnace is made with a number of uniform corrugations, each of which is the same height and length, and the thickness is uniform throughout the entire length. The pitch of corrugations is 6 inches, the depth 2 inches, i.e. 4 inches difference between the greatest external and internal diameters. The practical objections to the Fox furnace are that the scale accumulates at the bottom of the corrugations on the water side at the top of the furnace; the opposite side of the plate at these points is exposed to the greatest heat of the fire, and there is, in consequence of the difficulty of removing the scale, a great tendency to overheating, with a reduced efficiency. The furnace also tends to elongate too much under pressure and expansion, producing unnecessary

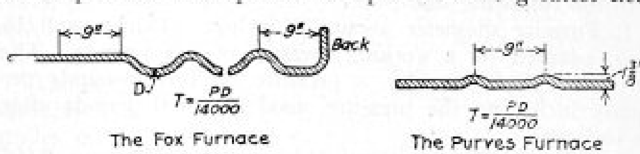


Fig. 3

*The first article on British practice appeared on page 355, of the December, 1925, issue.

stresses on the boiler plating in connection with the furnace. The increased surface area is, however, all in favor of corrugated furnaces. See Fig. 3.

Purves Furnace

This furnace reduces the objection against the Fox to a minimum, but the lack of uniformity in thickness is in itself objectionable; in this case the ribs are rolled in the flat plates, which are then rolled up and welded in the ordinary way, so that ribs form parallel rings on the outside of the tube—pitch of ribs 9 inches and height 1⅜ inches (see Fig. 3).

The Morison Suspension Furnace

The corrugations are pitched 8 inches apart, and the depth is as shown in Fig. 4 in the Morison furnace. The plate is uniform in thickness throughout and the curve is that of a catenary. The tendency to elongate under expan-

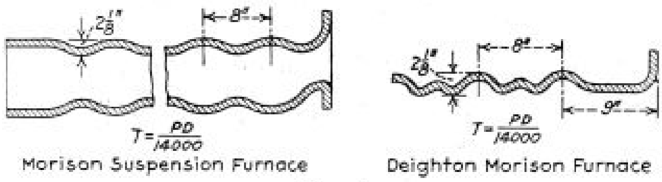


Fig. 4

sion of the furnace is not so great as in the Fox furnace. The illustration shows this furnace arranged so that it can be removed without disturbing any part of the boiler structure, but this construction has for very high pressures an objection in itself; it entails a large opening in the front plate so that the corrugations can be passed through it. The flanging at the furnace front is outward and must be of such curvature that it can be made without appreciable loss of strength. Removable furnaces entail a boiler of somewhat larger diameter for the same width of grate, and there is subsequently an augmented thickness of shell plate, and hence a greater weight. The Stephen Gourlay back-end is very much used. Furnace mouths are made ½-inch larger in diameter than the diameter over the corrugation. The length between the water side back tube plate and the center of the first corrugation should not exceed 10½ inches. The set-up portion at back bottom should not exceed 8 inches.

Deighton Morison Furnace

In this furnace there is a combination of alternate small and large corrugations, as shown in Fig. 4. The pitch of the latter is generally 8 inches and the difference between the greatest and the least diameters is 4½ inches. The furnace is lap welded and of uniform thickness throughout. The longitudinal elasticity is about one-third that of the Fox type, but it is sufficient for the necessary following of the expansion of the tubes. There is about 18 percent more heating surface than in a plain cylindrical flue. Collapsing tests were made of Deighton furnaces by Lloyd's with the following results:

1. Furnace diameter about 33 inches. Thickness 9/16 inch, adapted for a working pressure of 245 pounds. The furnace collapsed under a pressure of 1,475 pounds per square inch, and the pressure stood at 1,000 pounds after the collapse.

2. Furnace diameter about 31¾ inches. Thickness 9/16 inch, adapted for a working pressure of 178 pounds per square inch. The furnace collapsed under a pressure of 1,200 pounds and the pressure stood at 800 pounds after the collapse. In all cases it is usual to fit the furnaces in such a way that the corrugations of any one furnace are alternate with those adjacent to it.

Brown's Cambered Furnace

The corrugations are pitched about 9 inches apart in the Brown furnace and the depth is about 1⅝ inches; the plating is about 40 percent thicker at the ridges (as in the Purves furnace), and the curve from ridge to ridge is similar in form to that of the Morison type; but in the improved type, shown in Fig. 5, the thickness is apparently uniform. For nearly all cylindrical boiler plating it is the common practice to fit plates 1/16-inch thicker than the specified minimum thickness; thus shell plates 1 5/16 inches specified 1¼ inches; furnace, 21/32 inch specified 19/32 inch at the midpoint between the ridges and 20/32 inch at ridges for which no thickness is specified. The extra thickness allows a fair margin for any inequality in manufacture and for wear. For the same reason stays are larger in diameter than that specified.

Suspension Bulb Furnace

Special attention should be paid to this furnace. It is comparatively modern and its resistance to collapse is the highest yet recorded. The experiments were made officially with furnaces of very large diameters, tested to destruction. Note the formula $\frac{15{,}000 \times T}{D} = P$, higher than any other. It can be made so that both ends are thicker than the body, thus allowing for flanging at back ends and turning if desired through the front end without reduction in thickness to normal. It has a greater factor of safety than any other furnace, viz.: 6. The furnaces under test were 3 feet 2½ inches and 3 feet 10½ inches inside diameter respectively. The latter is the largest diameter ever experi-

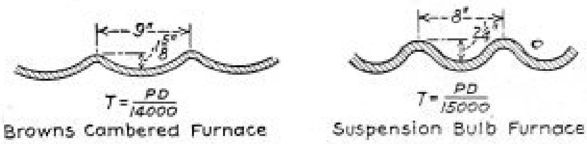


Fig. 5

mented on and although only 9/16-inch thick, it stood a pressure of 1,105 pounds per square inch before giving way. Fig. 5 shows this furnace.

General Remarks

With an ordinarily designed boiler it is very seldom that steam pressure itself is able to collapse a flue, providing that the boiler is well looked after and kept free from scale. Collapse commonly takes place when the flue is very old and the plate is thinned down by rust, etc. In nearly every case where the flue has collapsed it can be shown afterwards that the plate was overheated through there being insufficient water in the boiler and overheating was due to oil being contained in the water, probably in the condenser; or overheating may have been caused by a thick layer of scale or sediment being deposited on the crown of the flue. Should such overheating occur it is quite clear that a corrugated flue would be far better off than a plain one. In collapsing, a plain flue breaks and steam would consequently rush out. When a corrugated flue is pressed down by steam pressure it is almost a certainty that the plate will not crack. It is often stated that in time corrugated flues get out of round; this only happens, however, when the boiler is forced to do more than it was intended to do, by excessive use of forced or induced draft. The furnaces will not get out of round to any extent if the grate is not made to burn any more than 28 pounds of coal per square foot of grate per hour which is a good average rating.

High Temperatures Hurt Rivets*

Tests show that heating above 1,950 degrees Fahrenheit produces a structure which will not withstand rapid alternate compression and tension

By A. L. Spencer, Jr.

When rivets break in driving or thereafter, if not subjected to severe outside stresses, the general tendency is to blame the quality of the steel or the method of manufacture of the rivets. Chemical, physical and microscopic investigations of the broken rivet samples submitted from time to time by the various rivet users have failed to disclose anything in the quality of the steel or in the method of rivet manufacture to account for the failures.

Almost invariably the fractures of sample broken rivets illustrating complaints show the failure occurred at a comparatively high temperature. The fractures present a dull, lusterless appearance with little or no reduction of area.

A specific investigation of complaints on breakage of rivets made at seven different shops, including locomotive, boiler, car and structural fabricators, showed two outstanding conditions in their practice which appeared to be the cause of breakage. These conditions were:

High Heating Furnace Temperatures

Coal or Coke Forges.—The tendency with this type is to maintain a bed of fuel which is not deep enough, with the result that the hot rivet is subjected to the direct action of the flame produced by the air blast and is very likely to be overheated or burnt in a few seconds under this extremely oxidizing condition. When burning occurs, it is readily apparent by characteristic sparks, even before the rivet is removed from the fire.

Electric Heaters.—By this method of heating, on account of the radiation of heat away from the surface or the chilling effect of the atmosphere, the color of the outside cannot be taken as representing the temperature of the rivet throughout. Unless this difference in temperature between the surface and the interior of the rivet is taken into consideration, overheating will result

Oil Forges.—The tendency with oil fuel is to use a high pressure air burner, frequently connected directly with the line operating the rivet hammers. With an air pressure of 80 to 100 pounds per square inch it is very difficult to maintain uniform combustion and constant and proper furnace temperature. It is common practice to employ a furnace of inadequate size, with the result that it must be run at 2,400 degrees Fahrenheit, or over to provide for the more rapid heating of the rivets. When the furnace is of adequate size it is often overloaded with rivets. In either case, any interruption of the work will result in overheating. A baffle wall, or muffle, is seldom provided between the burner and the rivets and the flame impinges directly on them with resulting harmful oxidation and overheating.

Gas Forges.—The heating with gas fuel is generally better than with oil, coal or coke, due to the lower pressure of air employed and the consequent easier control of furnace temperatures.

Riveting Stresses

In commercial shop practice it is a very difficult and slow process to fit structural members so that there will be close contact with no looseness or lost motion between the members to be riveted. Where there is no lost motion the rivet will be subjected in driving to compression only. As soon as any looseness is present the rivet is subjected in driving to alternate compression and tension with their accompanying stresses. These stresses are generally termed "vibration."

The object of this investigation was to determine the separate and combined effect of high temperatures and stresses during riveting.

The testing device was made to determine the effect of opposed stresses in driving heated rivets. The device consists of a rectangular frame, or holder, in which is fitted a die made in half sections. These half sections are clamped together by means of the threaded bolt extending through the frame. Through the center of the die is a drilled hole, 13/16-inch diameter, for driving ¾-inch rivets. The die is made up of two 1-inch plates and two ⅝-inch arched spring steel plates riveted together. The arch of the spring steel plates is 0.090 inch (3/32 = 0.094). The function of the arch is to produce the opposed stresses in driving the rivet.

In conducting these tests the two half sections of the die were tightly clamped together in the holder by means of the bolt. A ¾ by 5-inch rivet was heated to the desired temperature and inserted in the central drilled hole of the die. Two air riveting hammers were used in driving. The action in the device during driving was as follows:

Each blow of the riveting hammers flattened the arched spring plates and at the same time subjected the rivet to compression. Between blows the spring plates sprang back and subjected the rivet to tension. The result was rapid alternate compression and tension stresses. After the rivet was driven the bolt was loosened, thereby effecting quickly the separation of the two half sections of the die and the removal of the rivet.

Heating Apparatus Used

In making these tests the four types of heating previously mentioned were employed. The oil forge was a duplicate of one used at a shop where there was much serious breakage of rivets. The hearth was 7 by 9 inches, air pressure 70 pounds, single burner inserted in end, and there was no baffle, so that the flame impinged directly upon the rivets. Flame temperature ranged from 2,300 to 2,700 degrees Fahrenheit. The gas forge was regularly used for forging work. The hearth was about five times as large as the oil furnace. The air pressure was low, not over two pounds. There was a baffle wall between the burner and the rivets. In these tests the furnace temperature could be easily controlled and ranged approximately the same as in the oil furnace. The coke forge was the ordinary hand-blown portable type. The electric heater was of the Berwick type, made by the American Car & Foundry Company.

Two grades of steel were used in these preliminary experiments: A. S. M. E. boiler grade, 0.10 carbon, hereafter designated as B, and high-sulphur cut thread bolt grade, 0.20 carbon, hereafter designated as D.

Preliminary Results

Every rivet of each grade broke in driving when heated in the coke forge so as to emit sparks, or to what is commonly termed a "spitting heat."

* From a paper delivered at the third annual convention of the American Institute of Steel Construction, White Sulphur Springs, W. Va., Nov. 11-14. The author is associated with the Pittsburgh Screw and Bolt Company, Pittsburgh.

A certain percentage of rivets of both grades, heated by any method to temperatures approximately 2,000 degrees Fahrenheit or over, either broke in driving or failed to withstand a cold bend test 180 degrees flat after driving.

No rivet of either grade, heated to a temperature under approximately 2,000 degrees Fahrenheit, failed in driving and invariably stood a cold bend test of 180 degrees flat after driving.

By alternating one grade of steel with another, one rivet at a time in the oil furnace, so that heating conditions were duplicated as nearly as possible, it was observed that the cut thread bolt stock stood a higher temperature without failing in driving or subsequent bending, than the A. S. M. E. boiler grade, as shown in the following table:

Number of Rivets	High Sulphur Cut Thread Bolt D	A. S. M. E. Boiler B
Driven	22	18
Broke in driving	2	14
Broke in bending	10	2
Driven and bent O. K.	10	2

Similar results were also obtained using the gas forge and the electric heater. In all cases where rivets broke in driving, their temperature was sufficiently high to show above visible color when removed from the die.

As a result of these and subsequent investigations it was found that heating the rivets to 2,300 degrees Fahrenheit for 3 minutes and cooling in the air did not materially affect the physical properties, although a large increase in grain size occurred. Ten rivets of the same size, used in these tests (A. S. M. E. grade) were heated to temperatures of 2,256 to 2,340 degrees Fahrenheit and driven in a die composed of two solid half sections. The results of tensile tests prepared from these rivets showed the physical properties were not materially affected.

Critical Temperatures

It was found that for each grade of steel there was a critical driving temperature below which there was a slight increase in elastic limit and tensile strength, with ductility comparing favorably with that of the steel as rolled. When the critical temperature was exceeded, there was a decided falling off in the ductility, both the elongation and reduction of area decreasing with the increase in temperature. As the temperature was further increased the result was the breaking of the rivet in every case.

The critical temperatures of driving were consistently lower when oil was used for heating than when gas was used. The breakage in driving occurred at a lower temperature with the oil-heated rivets. The gas-heated rivets, although showing loss of ductility, did not actually break in driving until higher temperatures were used. This may be accounted for by the oxidizing or "cutting" flame produced by the high air pressure of the oil burner. The critical driving tempertures for various grades were as follows:

Serial	Grade	Temperature Deg. F.
"B"	A. S. M. E. boiler	1,975
"A"	A. S. M. E. boiler	2,060
"E"	High manganese heat (selected)	2,125
"C"	Lloyds	2,110
"D"	High sulphur cut thread bolt	2,065

Conclusions

From this investigation, the following conclusions are drawn:

1. High temperatures combined with alternate compression and tension, generally termed "vibration," are the cause of rivets breaking in hammer driving.

2. High temperatures combined with alternate compression and tension, if not resulting in breaking in driving, destroy the physical properties to such an extent as to render rivets unfit for service.

3. Heating rivets to over 1,950 degrees Fahrenheit produces a structure which will not withstand rapid alternate compression and tension. These opposing stresses produce strains which result in intergranular weakness and rupture.

4. A rivet heated to 1,950 degrees Fahrenheit as a maximum limit and a sufficient time allowed for soaking will drive just as easily and fill the hole equally as well as a rivet heated to a much higher temperature.

5. A rivet which "runs," emits sparks or "spits" should never be driven.

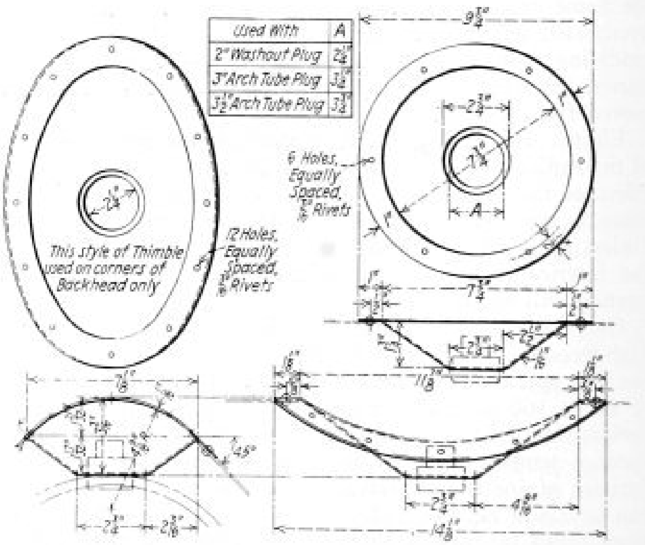
6. For each grade or composition of rivet steel there is a "critical" temperature for driving which must not be exceeded, or the result will be breakage, intergranular weakness and interior rupture.

7. This "critical" temperature increases consistently with the manganese content within the range covered by this investigation, as shown by results with steels "B," "A" and "E," containing respectively 0.33, 0.48 and 0.60 percent of manganese.

8. High sulphur, accompanied by high manganese, is not a cause of rivets breaking in driving. The "critical" driving temperature of grade "D" rivets with 0.10 sulphur and 0.84 manganese was higher than those of the A. S. M. E. boiler grades "B" and "A," containing 0.035 and 0.033 percent sulphur, respectively.

Jacket Thimble for Washout Plugs

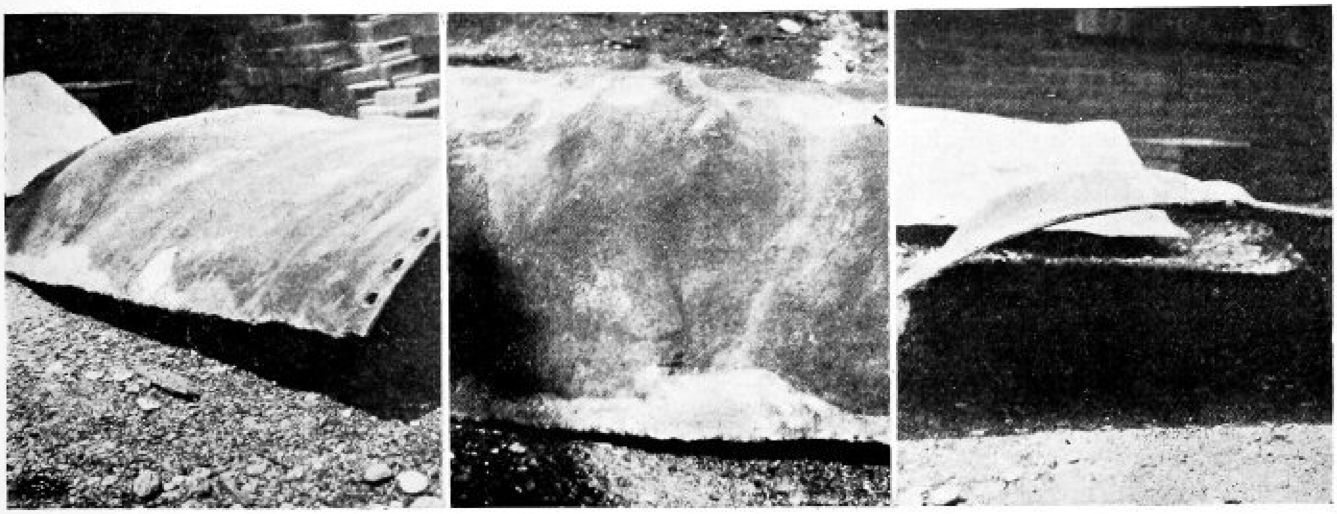
A DESIGN of jacket thimble for washout plugs which has been adopted as standard by the Union Pacific is shown in the drawing. Two styles are shown, one for application to the flat sheets on the backhead and also for the slightly curved sheets on the sides of the firebox, and the other for application to the corners of the backhead. These thimbles are riveted securely to the jacket.



Drawing showing the detail dimensions of jacket thimbles for backhead corners and sides of firebox

The feature of these thimbles is that they enable the workman to use either a box or open-end wrench without any possibility of damaging the jacket, as is quite frequently the case when the ordinary type of thimble is used.

Oscar Ostby has become vice-president and general sales manager of the Burnoil Oil Burner Corp., New York. He was formerly general manager of the Prest-O-Lite Company at Indianapolis, Indiana.



Three views of bulged plates cut from a boiler after a disastrous explosion

Bulges and Patches in Boiler Plates*

Method of removing bulges and how to apply hard and soft boiler patches

IT often happens, during the operation of steam boilers, that more or less oil, grease, mud, or scale collects on the fire sheets and prevents the water from coming in direct contact with the heating surfaces. A deposit of this kind, if allowed to remain, will sooner or later cause the metal beneath it to become overheated and softened, so that the internal pressure will force the plate outward and give rise to a bag or bulge. The seriousness of the hazard created in this way is best realized by considering what might happen if the boiler were *entirely empty*. With a bright and lively fire, the temperature in the hottest parts of the furnace would be something like 2,500 degrees F., which is close to the melting point of mild steel plate; and in boilers of certain types we have in fact known some of the parts to be fused together into a shapeless mass, when the conditions were specially favorable to such action. It is unusual, of course, for the steel or iron parts of a boiler to actually *melt;* though if the boiler is empty, the margin of safety in respect to melting may be a good deal smaller than one could wish. Steel loses its strength at high temperatures, and when there is a bright fire in the furnace the water in the boiler is the only thing that stands between us and disaster. It is the water that keeps the metal of the boiler from becoming overheated, when things are working as they should; but if the water is very low, or if, for any other reason, *it cannot come in contact with the metal so as to keep it cool,* a bulge or an explosion may logically be expected.

The temperature of the saturated steam in the boiler can be ascertained by reference to a table of the properties of steam, and we know that the water that is present must have substantially this same temperature also. For example, even if the gage pressure were as high as 200 pounds per square inch, the temperature of the water that is present could not be greater than about 387 degrees F.; and although 387 degrees is a high temperature when considered in some aspects, it is frigidity itself in comparison with the heat that prevails in the furnace.

If there is plenty of water in the boiler, and if the heating surfaces are reasonably clean, so that the water *comes in good contact* with the metal, the water will keep the boiler cool enough to prevent bulging or other untoward consequences of high temperature. If there is a deposit of scale or mud or grease or oil on the heating surfaces, however, so that the water cannot properly exert its cooling action, we may confidently expect the metal to become overheated and softened to such an extent that a bulge is formed. The plate may even be ruptured (as it is in the case of a low water explosion) though if there is an abundance of water in the boiler this is not likely to happen when the bulge first forms. As a rule, the stretching of the metal which takes place as the bulge is formed cracks open or otherwise disturbs the internal deposit sufficiently to let a considerable amount of water get through to the overheated metal, and this usually checks the development of the bulge, for the time being.

The significance of a bulge, so far as safety is concerned, depends largely upon the composition, location, area, and thickness of the deposit that has caused it, and upon the size, depth, and location of the bulge itself, and upon the time that the bulge may have existed without discovery, or that it has been allowed to continue without correction after discovery; and also upon the duty that is required of the boiler, and the temperatures that exist in its combustion spaces. A thin deposit over a small area may cause only a slight bulging, and the treatment may consist merely in removing the deposit in a thorough manner, and taking precautions to prevent further deposition of a like kind. Judgment should never be passed on this point, however, by the owner of the boiler, nor by the engineer or fireman in charge of it, unless these men have had an exceedingly unusual amount of experience in such matters. When a bulge is detected, the company carrying your boiler insurance should be immediately notified, by the most expeditious means practicable; and the boiler should also be put out of service, at once, until expert advice can be had from the insurance company's inspection department. This is the only safe course to adopt, and it will bring definite counsel from men who have had to deal with a great many cases of bulging, and who will know just what course should be followed in handling the difficulty.

*This article is reprinted through the courtesy of *The Travelers Standard*, published by the Travelers Indemnity Company, Hartford, Conn.

"Setting-back" Bulges

If the bulge is too large and deep to be passed with simple cleaning and subsequent careful watching, it may be possible, after cooling and emptying the boiler, to heat the affected area by means of a portable furnace or an acetylene blow torch, and to work the plate gradually back to its original form. A job of this kind should never be undertaken, however, without the full knowledge and free consent of the insurance carrier.

If it proves to be feasible to restore the plate to its original shape, the job should be done by a skilled repair man, and preferably by one who has had extensive experience in this particular kind of work. The setting back of a bulged plate is a rather highly specialized operation, however, and it sometimes happens that the job must be done by a man who has not had a thorough training in this particular line, even though he may stand high in the community with respect to his skill in the making of boiler repairs of other kinds. To assist a man of this type we are about to offer certain specific suggestions as to the way in which the work be done; but it should be clearly understood that these suggestions are not to be construed as working directions, to encourage unskilled men to undertake the job. We should disapprove most heartily of allowing anybody but a first-class repairman to attempt to setting back of a bulge,—whether he had read this article or not.

The setting back of a bag or bulge should be effected by repeatedly heating the plate in small, local areas, and pressing it back slowly and carefully, a little at a time; and the total number of heats required may be very large, if the bulge is at all extensive.

The top part of a rivet-heating furnace may be used for the heating of the plate, but an oxy-acetylene torch is far more convenient. If the bulge is close to the bottom of the shell (as usually happens in externally fired boilers), it is a good plan, before applying heat, to cover the inner surface of the affected part of the plate with a thick layer of charcoal, to cut down the radiation. This tends to facilitate the work; but when charcoal is used inside the boiler, in this way, the manhole cover should be left off and one or more of the handhole plates should also be removed, in order to ventilate the interior of the boiler. Otherwise the carbon monoxide that is given off from the hot charcoal may overcome anybody who has occasion to go into the boiler during the work or after it.

The plate should be brought to a cherry red where it is to be worked, but no attempt should be made to heat more than a small portion of it at a time. As already stated, the idea is, to push the bulge back little by little, by means of repeated local operations. Usually it is best to heat up an area not more than five or six inches in diameter, for any one operation.

The inexperienced man would be likely to start with the center of the bulge, but this is not the proper method. The first heat should be made near the outer edge of the bulge, where the deformation first becomes noticeable. When the plate has been locally heated over a limited area at this point, a small hand jack should be applied and the heated part of the plate pushed back slightly. A small piece of flat sheet iron should be interposed between the jack and the boiler sheet, to prevent the head of the jack from indenting the shell. Before the heating is begun, the jack should be adjusted for exerting the pressure where it is to be wanted, and a good support should be provided for it,—all being made ready as though the plate were to be pushed back cold. Then, with as little disturbance of the arrangement as possible, the jack should be removed and the plate heated as described, and the jack should then be put back into place and the pressure applied. When some slight gain has been made locally in this way, a new area should be heated, close to the one that has been pushed back, and the operations just described should be repeated on the new area. This should be continued until the bulge has been treated all around the margin. An area just inside of the circle or contour that has been treated in this way should then be heated and pressed back somewhat, after which another region close beside this last one should be heated and pressed back, and so the work should be continued until a *second* circuit of the

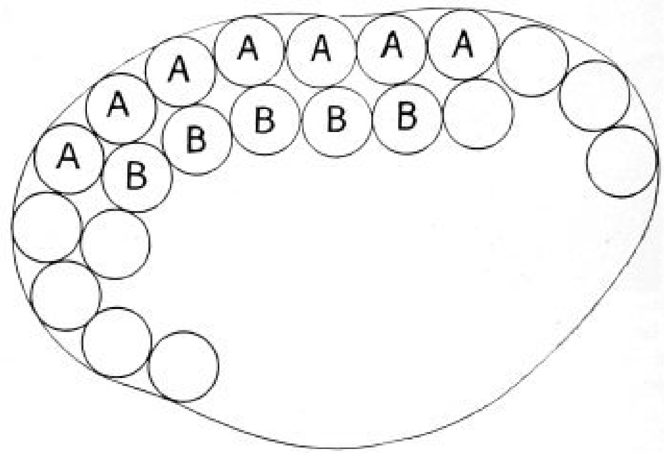


Fig. 1.—Illustrating the heating of the bulge

bulge has been made, and a second series of areas has been pushed back, just inside the first one. This is suggested in the diagram, Fig. 1, where the "A's" indicate the areas that are treated in the first operation, and the "B's" indicate those that are next treated, and so on. Go over the whole surface of the bulge in this way, but do not try to force any part of it back too far in one operation. It is best to force back each area by only about 1/16 to ⅛ of an inch in any one operation.

After treating the entire bulge as here described, begin over again along the outside margin,—applying the heat, now, so that each heated area (as suggested by the small circles in Fig. 2) will overlap two adjacent ones that were pressed back in the first operation. After going around the

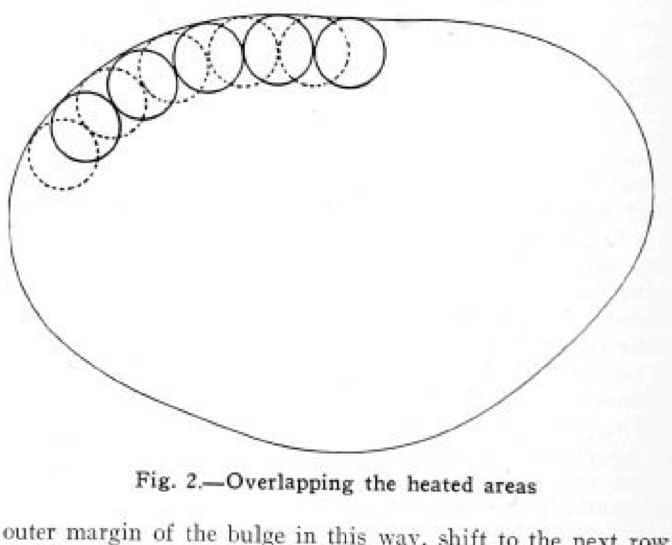


Fig. 2.—Overlapping the heated areas

outer margin of the bulge in this way, shift to the next row inside and make a second circuit there also,—pressing back, always, by just a small amount,— and proceed in this way, by local heating and gradual forcing back, until the shell has been restored to its proper form, as tested by a templet cut to the normal curvature of the plate. This operation is slow and tedious, but it is by far the best way to secure a good job, and it is much cheaper than the putting in of a new sheet. A hammer should never be used on a bulge, if it can possibly be avoided.

If a bulge is so deep that it opens up at the apex, or if it appears to be necessary to drill a hole at the apex in order to be able to force the metal back without causing crumpling or the development of other irregularities of contour, it may be unwise to attempt to force the bag back,—especially if it covers any considerable area.

When large bulges or bags form, it is sometimes necessary to remove the affected sheet and replace it by an entirely new sheet or course; but it is often quite practicable to cut out the bulged part of the plate and replace it by a satisfactory patch, in such a way that the safety and serviceableness of the boiler will not be impaired. A patch that is improperly designed or applied may become the weakest part of the boiler, however, and may necessitate a reduction in the working pressure. Hence it is specially important, in every case, to seek the advice of the inspector first, in order to make sure that the boiler is not needlessly weakened. It is equally important to have the work done in a first-class manner, and by a skilled boiler maker who thoroughly understands work of this kind. The suggestions that are made below are offered in precisely the same spirit as those made above in connection with setting-back bulges. Applying a good patch is a job that calls for skill and experience, and it should never be attempted by a man who does not possess those qualifications. We hope, however, that the discussion here given may be of value even to experienced men, and that it may tend to bring about a certain measure of improvement in boiler practice generally.

When putting on a patch, care should be taken to avoid cutting out an unnecessarily large section of the shell, because this will weaken the boiler needlessly. In order to have the patch as small as possible, the bulge, *before any cutting is done,* should be treated as described above in connection with the setting-back operation, until as much as practicable of the bagged area has been restored to the true curvature of the shell. When this has been done, and it is evident that further attempts to diminish the size of the bulge by the process of pressing it back will be impracticable, the rest of the affected area may be cut out and the opening made ready for patching.

When cutting away the boiler plate preparatory to applying a patch, care should be taken to remove all the metal that has been damaged by the bulging action; and trained judgment is here required, if this is to be done without making the opening any larger than necessary. All burrs and ragged edges produced by the cutting operation should be carefully smoothed off, to insure a tight, well-fitted patch. After the bulged section has been cut out, the opening should be measured by means of a flexible rule, to determine the size of the patch required, after which the patch-plate should be properly cut out, drilled, and rolled and formed to the true curvature of the plate. The patch may then be used as a templet to mark off the rivet holes on the shell plate. A rivet punch of the same diameter as the rivet hole makes an excellent punch for marking the positions of the rivet holes in the boiler plate.

It is well known that in an ordinary plain cylindrical boiler shell or tank that is subject to pressure, the pull or tension on the metal is different in different directions. If there are no tubes or braces present, the tension is twice as great in the circular direction as it is in the fore-and-aft direction; and if tubes or braces *are* present, the difference is still greater. Now the tension that runs circularly around the boiler has to be resisted by the longitudinal joints, and that is why it is important to design these joints with the greatest care, even though single riveted construction is admitted to be strong enough for the girth joints. If the girth-seam joint has an efficiency at least half as great as the efficiency of the longitudinal joint, the boiler will be safe against rupture along the girth joint.

This principle should be borne in mind in designing boiler patches. Double riveted joints should not be used for patch seams when they are situated so as to be exposed to the flames from the furnace, and the single riveted lap joint that is ordinarily used has a low efficiency as compared with the longitudinal seam of the boiler. Therefore, if any considerable part of the patch joint extends in a lengthwise direction the boiler will be correspondingly weakened and it may become necessary to reduce the allowable working pressure. (The laws of some states have special requirements in this connection.) The importance of this point will naturally vary with the size of the patch. If the hole that is to be covered is quite small, comparatively little attention need be paid to the shape of the patch; but when the patch is large, it is important to consider this feature with a good deal of care. In such a case it may be necessary to make the patch triangular, semi-elliptical, or diamond shaped,—the idea being, to avoid (if possible) driving the patch rivets in such a way that any considerable number of them will lie on a straight line that is parallel, or nearly parallel, with the length of the boiler. The job will be stronger if the patch joint everywhere consists of sections that run either diagonally or circularly. If the diameter and pitch of the rivets are the same as in the girth seam of the boiler, any part of the patch joint that may run in a girth-wise direction will be as safe as the girth joint itself,—provided the patch is made of first class material, having a thickness equal to that of the main boiler shell. If it is not practicable to design the patch joints as here suggested, it may be necessary to reduce the allowable working pressure on the boiler.

The effective efficiency of any part of the joint which runs diagonally will vary according to the angle which a line passing through the center of the rivets in this part of the joint makes with the longitudinal axis of the boiler,—that is, it will vary with the "inclination of the joint," being greatest when the joint is parallel with a girth seam, and least when it runs lengthwise of the boiler.

After the patch plate has been cut out and the burrs have been trimmed off around the edges, it is bent to fit the curvature of the boiler. Practice differs somewhat with regard to the making of the rivet holes, and details of this part of the work will be given in a later installment.

(To be continued)

American Boiler Manufacturers' Mid-Winter Meeting

The American Boiler Manufacturers' Association held its mid-winter meeting on February 12 at the Mid-Day Club, Cleveland, Ohio. The meeting was opened by the president, George W. Bach, at 9:30 a. m. After a short general talk, A. G. Pratt, chairman of the Stoker Committee, presented a current report on the work of this body which acts in conjunction with a committee from the Stoker Association. A report of the Standardization Committee for horizontal return tubular boilers was given by James A. McKeown and H. E. Aldrich. E. R. Fish presented two reports, one on the joint committee of the American Boiler Manufacturers' Association and the American Society of Mechanical Engineers' Boiler Code Committee and a second on the work of the Commercial Committee. The Steel Heating Boilers' Committee was represented by its chairman, W. A. Drake.

The afternoon session was opened with an address on budgeting by H. I. Shepherd, vice-president of the Guardian Trust Company, Cleveland. Following this, a report was given on the progress of the Bolt, Nut and Rivet Proportions Committee. A general discussion was held on topical questions, such as advertising in all its forms as applied to the boiler industry, general business conditions and statistical information pertaining to the industry. The secretary-treasurer outlined the financial standing and membership standing of the association.

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Hydraulic Machinery Trouble

Q.—We have been experiencing considerable difficulty at the present time with our hydraulic equipment due to cold weather. We have made several experiments recently attempting to use oil in our hydraulic line, the results have been that the oils seem to attack the packing in the various glands and parts of the hydraulic equipment which develops considerable leakage.

We have attempted to secure reliable information on this subject in our vicinity with no results. It appears there is no one in this part of the country using oil in hydraulic equipment who can advise us and thought perhaps that you might be able to assist us in this matter due to your publication having a wide circulation among the boiler and tank shops.

We are using oil at the present time in all of our hydraulic equipment, four post press, straight bending press, sectional flanger and hydraulic riveter, and the results which we are getting are very unsatisfactory.

Any information which you can furnish will be greatly appreciated. —H. B. and T. C.

A.—Write to the manufacturers of your equipment for their advice. Oil in the system will affect the packing, tending to disintegrate it. You do not mention the specific trouble you are having, but we suppose it is leaky joints. Will some of our readers please give the required information?

Stack Data

Q.—Some months ago we bought from you your book entitled "Laying Out for Boiler Makers," 4th edition, and we have used this book to a good advantage in a number of instances. We have occasion to use data for working out the sizes of self-supporting stacks and we would like to have you advise us of some formula for attaining the proportions of the base diameters, both bottom and top of bell and also height, in figuring the necessary sizes on different heights and diameters of stacks. We note that you give some of this data in the above book, but we do not think you fully cover the information which we want. We would appreciate any data which you have on this subject. M. I. W.

A.—There are a number of conditions governing the height and diameter of chimneys, namely, type of boiler, character and amount of fuel burned, grate bars, breechings, adjoining buildings, etc. There are no definite rules governing all of these. In general the height of the stack should be at least 10 feet higher than surrounding buildings. A stronger draft is required for the burning of anthracite coal especially the fine grades such as "buckwheat." The intensity of the draft may be governed by the height of stack; and the intensity of the draft is the difference in pressure between a column of hot gases in the chimney and the weight of the same volume of air, outside the chimney; therefore it will be understood that heated gases are lighter than the same bulk of gases when cool. Since the pressure within the chimney is less than the outside air, the air flows from the furnace to the stack. Since the draft pressure is dependent on the height of chimney and temperature of the gases, it is evident that the higher the stack the lower may be the temperature of the gases to obtain the same draft. By maintaining a low stack temperature economy in the operation of the furnace is obtained. Ordinarily the stack temperature ranges from 400 to 500 degrees F.

The capacity of a stack is not measured by the intensity of the draft; the capacity varies as the square of the diameter, and as the square root of the height; thus the theoretical flow of gases through a stack 200 feet high is two times that through a stack 50 feet high; for $\sqrt{200} = 14.14$ and $\sqrt{50} = 7.07$.

Draft pressure is measured by a draft gage and the pressure required for burning different fuels varies according to conditions in the plant.

A stack 75 feet high should be used in plants burning a fair grade of soft, or bituminous coal, and from 125 to 150 feet high for anthracite.

The height of stack being given, the effective area, that is, cross sectional area of the stack required to carry away the gases may be figured from the following formula:

in which, $H.\ P.$ = horsepower of boiler, or boilers
H = height of stack in feet
E = effective cross sectional area of chimney, square feet

$$E = \frac{.3\ H.\ P.}{10\sqrt{H}}$$

A stack over 75 feet should be self-supporting, without guys. The common method is to make the bottom in the form of a *bell-shape* or *conical* section. The height of the bottom being about one-seventh of the total height of the stack. The base diameter of the bell or conical bottom should be 1½ to 2 times the diameter of the stack, and the larger the base, the less anchorage bolts are required.

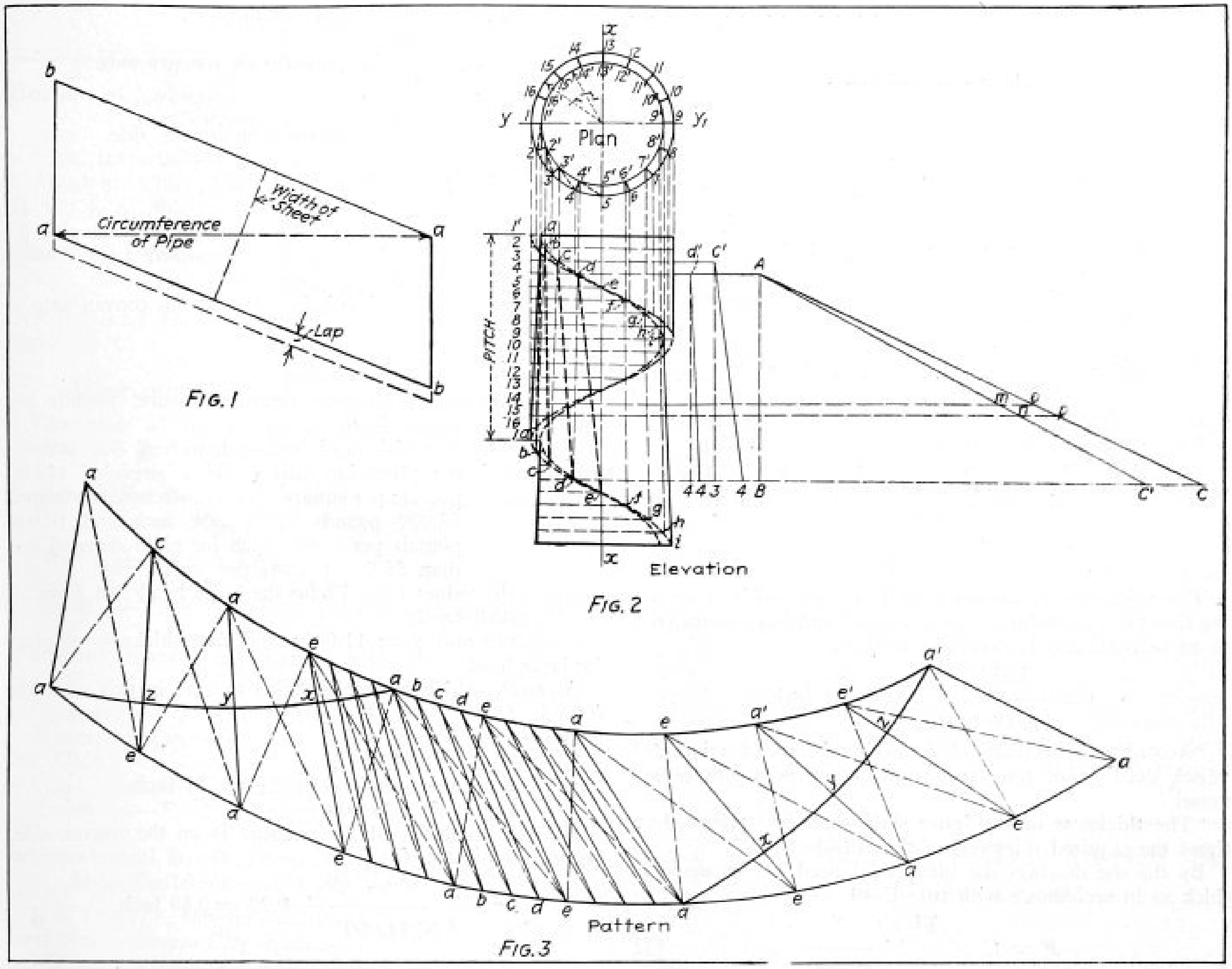
Spiral Riveted Pipe

Q.—Will you kindly supply a layout for a tube with a diagonal seam. Please explain fully the development of the plate to form the cylinder or tube 36 inches long, 24 inches diameter inside, ⅜-inch thickness of plate: diagonal seam to be half circumference.—R. L.

A.—The pattern for a spiral riveted pipe made of light gage material is in the form of a parallelogram as shown in Fig. 1.

Layoff on the straight line *a-a* the circumference of the pipe, at each end erect a perpendicular *a-b* to *a-a* equal in length to the lead or pitch of the seam which is the distance advanced along the seam for one complete turn of the pipe. The diagonals *a-b* form the joint line.

Fig. 2 illustrates the development required for the layout of spiral riveted pipe made of heavy plate and Fig. 3 is the pattern construction. In the plan, Fig. 2, the circles represent the neutral axis of the plate drawn respectively with a radius r for the overlapping plate section and r' for the inside plate. The elevation is laid off in this case for 1½ turns of the pipe and the pitch indicates the length of the spiral for one turn of the pipe. The helices are developed by dividing the pitch into a number of equal spaces likewise the circles are also divided into the same number of parts, and the intersection of the projectors drawn from the plan and the pitch line, establishes the points in the helices. Lines



Layout of tube with diagonal seam

are drawn between corresponding points of the inside helix with those of the outside helix, as between *a-a*, *b-b*, etc. Their true lengths are then found as indicated to the right of the elevation.

It is also necessary to find the true length of the arc lengths between the respective points on the helix, which is done as shown by erecting a right angled triangle *A-B-C* in which *A-B* equals the pitch and *B-C* the circumference of the outer circle plan view. The hypotenuse *A-C* is the true length of the outside helix and *A-C'* is the true length of the inside helix. By dividing these lengths into the same number as the pitch gives the length between adjoining points on the helical curve. With these data the pattern may be constructed as shown in Fig. 3, using the lengths 4-*d'* and 4-*c'* and the true arc lengths as *m-n* and *o-p* of Fig. 2.

The end cut in the pattern is found by making *x-e* equal one-fourth of *e-e* and *a-y* equal to one-half of *a-a* etc.

Jacketed Dryers

Q.—We make steam jacketed dryers of the following type: inside diameter 18 inches with a jacketed shell 22 inches outside diameter, leaving a 2-inch steam space all around, 20 feet long, with the ends closed. This machine has a shaft through the center with paddles or stirrers in a horizontal position and we carry about 70 pounds of steam on the jackets, which is equal to 317 degrees Fahrenheit. What we would like to know is, if we could raise the degrees of this steam from 600 to 700 degrees by superheating? If this is impossible, is it practical to build a furnace and use a pump or fan for pulling the hot gases and heat from the furnace and distribute them around the jacket in order to get about 800 degrees of heat? Would we have to use pressure on the jacket to prevent instant cooling?

We do not care to pass any heat through the inside as this would effect the material. The material is in the shape of wet sawdust containing 60 percent of moisture dried down to 10 percent, and about 250 pounds per hour wet material.—H. R.

A.—It is practically impossible to use superheated steam for the purpose you mention, and especially at the high temperatures given. Direct heating, by means of gas or electricity, appears to us the best solution. Another means for increasing the evaporation of the moisture is to increase the heating surface of the dryer; or by the method of passing hot air through the substance and removing the moist air as fast as it is produced.

Unfired Pressure Vessel Calculations

Q.—In reading over the December issue of THE BOILER MAKER, I found on pages 357-358 an article on tank construction. Regarding the allowable working pressure on an unstayed head as per the formula

$$P = \frac{3/8 - 1/8 \times 2 \times 55{,}000}{5.5 \times 36.515}$$

I note Mr. Lindstrom gets the answer of 131.4 pounds per square inch. Possibly this was a typographical error as I get for the answer 136.9 pounds per square inch. I would be interested to know if my solution is right.

(2) Please let me have the formula for finding the thickness of shell plates for an unfired pressure vessel carrying 150 pounds per square inch as per sketch below. Also size and pitch of staybolts required and thickness of heads.—D. MacC.

A. (1) There is an error in the problem referred to, the result should be 136.9 pounds per square inch.

(2) Refer to the A. S. M. E. Boiler Code reports on Rules for the Construction of Unfired Pressure Vessels.

According to *rule U-20*. For internal pressure, the maximum allowable working pressure on the shell shall be found from the following formula:

$$P = \frac{S \times t \times E}{R}$$

in which, P = maximum allowable working pressure pounds per square inch.

S = maximum allowable unit stress, in pounds per square inch.
= 11,000 pounds per square inch for steel plate stamped 55,000 pounds per square inch.
= 10,000 pounds per square inch for steel plate stamped less than 55,000 pounds per square inch.
= 9,000 pounds per square inch for material used in seamless shells.

t = minimum thickness of shell plate in weakest course, inches.

E = efficiency of riveted, longitudinal joint, in percentage.

R = inside radius of weakest course of the shell, inches.

From the formula given, to find the maximum allowable working pressure, the value of t may be found as follows:

$$t = \frac{P \times R}{S \times E}$$

The value of t in the outer shell of your problem, assuming that the longitudinal joint is riveted and has an efficiency of 88 percent, may be found as follows:

$$t = \frac{150 \times 36}{11{,}000 \times 0.88} = 0.562 \text{ inch.}$$

"According to section U-105, the inner tank of a jacketed vessel shall be of the same construction as a single-shell vessel.

"The thickness of the inner shell shall be at least 1.65 times the required thickness of the outside shell."

By the use of stays the inner shell need not be made so thick as in accordance with rule U-40.

$$P = C \times \frac{T^2}{p^2} \times \frac{S}{11{,}000} \qquad (1)$$

in which,

P = maximum allowable working pressure, pounds per square inch.

T = thickness of plate in sixteenths of an inch.

S = maximum allowable unit working stress, pounds per square inch.

C = 112 for stays screwed through plates not over 7/16 inch thick with ends riveted over, and 120 stays screwed through plates over 7/16 inch thick with ends riveted over.

p = 1

Transposing the values in the formula (1) to find T we have

$$T = \sqrt{\frac{p^2 \times P \times 11{,}000}{C \times S}} \qquad (2)$$

to find p^2,

$$p^2 = \frac{C \times T^2 \times S}{P \times 11{,}000} \qquad (3)$$

Given the values, $C = 120$, $P = 150$, $S = 11{,}000$, and $p = 8$, find the plate thickness T.

Use formula (2).

$$T = \sqrt{\frac{8^2 \times 150 \times 11{,}000}{120 \times 11{,}000}} = 8.9 \text{ in sixteenths of an inch} = 9/16 \text{ inch.}$$

For dished heads, the rule U-36 states that the thickness required in an unstayed dished head when it is a segment of a sphere shall be calculated as follows:

For $P \times L$, equal to or less than ½ S.

$$(1) \quad t = \frac{3\,PL}{4\,S} \text{ for pressure on concave side.}$$

$$(2) \text{ and } t = \frac{5\,PL}{4\,S} \text{ for pressure on convex side.}$$

For $P \times L$ greater than ½ S.

$$(3) \quad t = \frac{PL}{2\,S} + 1/8 \text{ for pressure on concave side.}$$

$$(4) \text{ and } t = \frac{5\,PL}{6\,S} + 0.2 \text{ for pressure on convex side in}$$

which

t = thickness of plate, inches.

P = maximum allowable working pressure, pounds per square inch.

L = radius to which head is dished, inches.

S = maximum allowable unit working stress of 11,000 pounds per square inch for steel plate stamped 55,000 pounds per square inch and 10,000 pounds per square inch for plate stamped less than 55,000 pounds per square inch.

Given the values $L = 72$ for the large head and $L = 60$ for the small head:

$P = 150$ and $S = 11{,}000$; find first thickness of plate for large head.

Ascertain which of the formulas to use; in this case, the formula (3) then,

$$t = \frac{150 \times 72}{2 \times 11{,}000} + 1/8 = .57 \text{ inch.}$$

For the smaller head the pressure is on the convex side, hence use formula (4).

$$t = \frac{5 \times 150 \times 60}{6 \times 11{,}000} + 0.20 = 0.89 \text{ inch.}$$

BUSINESS NOTES

George Bartol, treasurer of the Otis Steel Company, Cleveland, Ohio, has been elected vice-president and will be succeeded by L. Kemper, vice-president of the Midland Steel Products Company, an affiliated company.

J. H. Redhead, formerly assistant to vice-president and assistant manager of sales of the National Malleable & Steel Castings Company, Cleveland, Ohio, has been elected vice-president and general manager of the Columbus Malleable Iron Company, with headquarters at Columbus.

TRADE PUBLICATIONS

AIR COMPRESSORS.—The construction details and operating characteristics of single-stage centrifugal air compressors are given in a four-page, illustrated folder issued by the General Electric Company, Schenectady, N. Y.

SAFETY VALVES.—"The High Pressure Steam Testing Laboratory of Manning, Maxwell & Moore, Inc.," is the title of a catalogue issued by Manning, Maxwell & Moore, Inc., New York, illustrating the use of Consolidated safety valves on the large 1,200-pound boiler recently installed and put into operation at its Consolidated Safety Valve Company Works in Bridgeport, Conn.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

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

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—D. N. Hover, Jr., Washington, D. C.

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.

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

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

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.

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

Vice-Chairman—C. D. Thomas, Salem, Oregon.

Statistician—E. W. Farmer, Rhode Island.

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

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

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

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

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

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

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

Master Boiler Makers' Association

President—Thomas F. Powers, system general foreman, boiler department, Chicago & Northwestern.

First Vice President—J. F. Raps, general boiler inspector, Illinois Central.

Second Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.

Third Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.

Fourth Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.

Fifth Vice President—George B. Usherwood, supervisor of boilers, New York Central.

Secretary—Harry D. Vought, 26 Cortlandt street, New York.

Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.

Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—F. H. McCabe, McCabe Manufacturing Company, Lawrence, Mass.

Vice President—J. W. Kelly, National Tube Company, Pittsburgh, Pa.

Treasurer—George R. Boyce, A. M. Castle and Company, Chicago, Ill.

Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie, Pa.

Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.

Secretary-Treasurer—D. W. Glanzer, 840 Rockefeller Building, Cleveland, Ohio.

Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; W. A. Drake, The Brownell Company, Dayton, O.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Works, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

Chicago, Ill. (will accept)	Memphis, Tenn. (will accept)	Philadelphia, Pa.
		St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Los Angeles, Cal.		Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	New Jersey	Pennsylvania
California	New York	Rhode Island
Indiana	Ohio	Utah
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

SELECTED BOILER PATENTS

Compiled by

DWIGHT B. GALT, Patent Attorney,

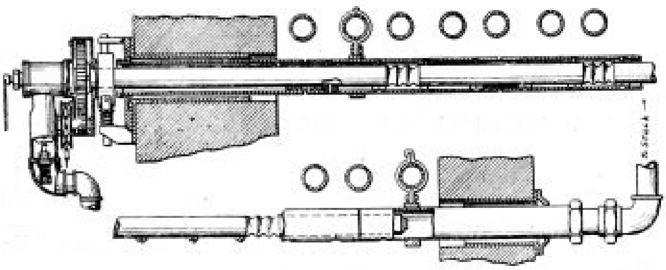
Washington Loan and Trust Building

Washington, D. C.

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

1,557,792. SOOT BLOWER FOR BOILERS. LEO JOHN BAYER, OF ST. LOUIS, MISSOURI.

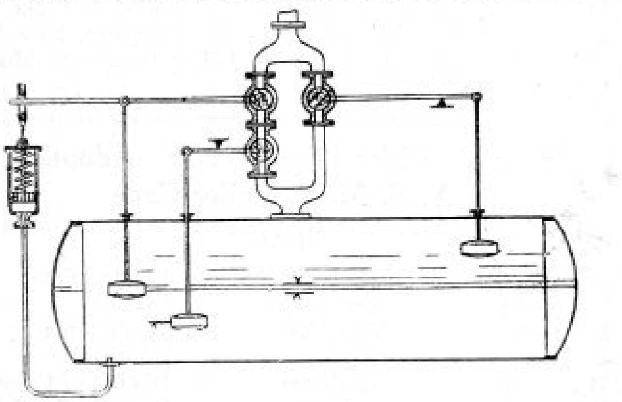
Claim 1. In a soot blower for boilers, a steam supply pipe, a valve for controlling the steam supply in said pipe, and a blower unit in com-



munication with the supply pipe, said blower unit comprising a blower pipe composed of a plurality of relatively movable sections and a cooling jacket surrounding the blower pipe, said cooling jacket also being composed of a plurality of relatively movable sections. 3 claims.

1,558,997. METHOD AND MEANS FOR CONTROLLING THE WATER LEVEL IN STEAM BOILERS. FRIEDRICH MUNZINGER, OF BERLIN-WILMERSDORF, GERMANY.

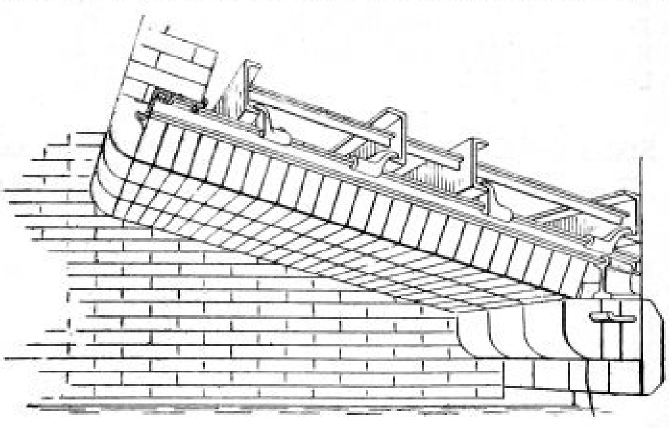
Claim 1. Boiler feed water apparatus comprising a feed conduit, means to control flow through said conduit under normal pressure conditions solely



in response to water level in the boiler, and means modifying the action of the first mentioned means for controlling the flow through said conduit under abnormal conditions solely by pressure in the boiler. 20 claims.

1,556,125. FIRE ARCH. HERMAN A. POPPENHUSEN, OF HAMMOND, INDIANA, ASSIGNOR TO GREEN ENGINEERING COMPANY, OF EAST CHICAGO, INDIANA, A CORPORATION OF ILLINOIS.

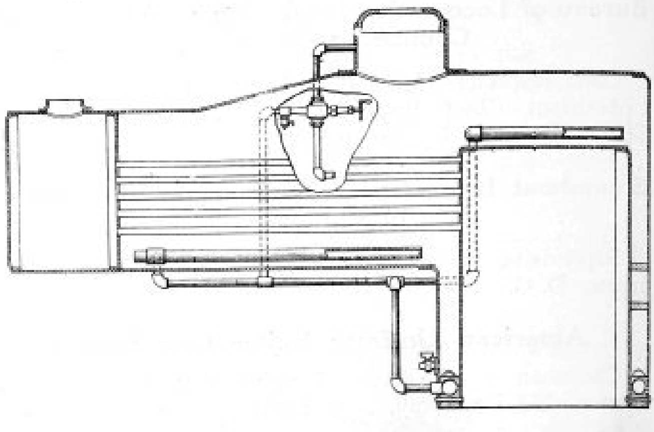
Claim 1. In a fire arch, two laterally spaced beams, a row of tiles between said beams and suspended therefrom, said tiles being in contact with each other, a plate extending between said beams above said tiles, an end



tile at one end of said row and in front of said plate, and means for suspending said end tile from said plate, said plate having engagement with said beams so that said end tile may be adjusted into contact with the tile to the rear thereof. 6 claims.

1,557,752. MUD RING FOR BOILERS. HENRY V. YOWELL, OF EL RENO, OKLAHOMA, ASSIGNOR OF ONE-HALF TO SARAH A. GARRITY, OF EL RENO, OKLAHOMA.

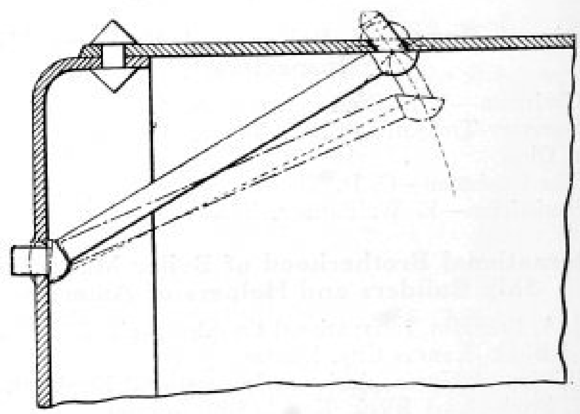
Claim 1. The combination with a locomotive boiler, of a hollow mud ring interposed between and connected to the boiler sheets at the bottom of the legs and having apertures in its upper wall in communication with



the interior of the legs and also having above said apertures caps disposed to assist in the passage of water toward a blow-off valve connected to one leg at a point slightly above the mud ring, and means for causing the water to pass through the mud ring. 3 claims.

1,557,084. DIAGONAL STAY. JOHN PETTY, OF LEBANON, PENNSYLVANIA.

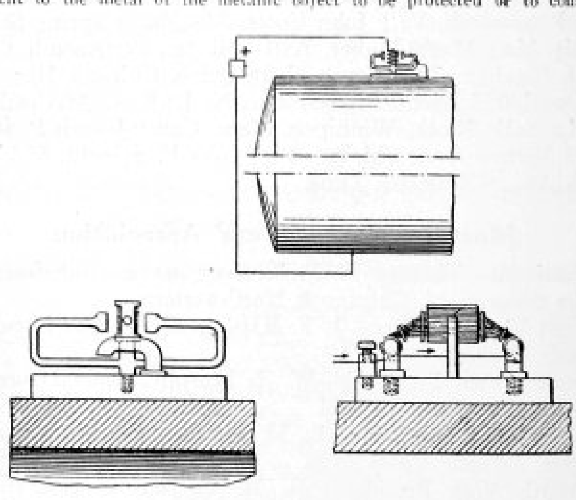
Claim 1. A diagonal stay having at one end a head adapted to lie against one of the plates to be connected and a rivet extension projecting



from said head and adapted to extend into a rivet hole in the plate, said stay having at its other end means for securing it to the other plate to be connected. 5 claims.

1,558,647. PROTECTION OF METALLIC SURFACES AGAINST INCRUSTATION AND CORROSION. WALTER THALHOFER, OF VIENNA, AUSTRIA, ASSIGNOR TO A. G. FUR CHEMISCHE INDUSTRIE IN LIECHTENSTEIN, SCHAAN, LIECHTENSTEIN.

Claim 1. Method of protecting from incrustations metal surfaces in contact with liquids, which comprises connecting both poles of a source of current to the metal of the metallic object to be protected or to connected



metallic parts, at spaced points to get a distributed flow of current through the metal of said object and causing a "pulsating" electric current to flow through said object of a magnitude insufficient to produce a drop of potential across said connected points high enough to decompose water. 17 claims.

The Boiler Maker

Volume XXVI — March, 1926 — Number 3

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Edward A. Simmons, *Pres.*
L. B. Sherman, *Vice-Pres.*
C. R. Mills, *Vice-Pres.*
Roy V. Wright, *Sec'y.*
Henry Lee, *Vice-Pres. and Treas.*
Samuel O. Dunn, *Vice-Pres.*
F. H. Thompson, *Vice-Pres.*
George Slate, *Business Manager*

Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ave.
Mandeville, La.
Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St.
Westminster, S. W. 1.
Cable address: Urasigmec, London

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies 1s 2d.

Request for change of address should reach us two weeks before the day of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

Master Boiler Makers' Association

On March 1, a list was received at this office of over thirty firms in the railroad supply field who had reserved space at the forthcoming convention of the Master Boiler Makers' Association. With this representation of members of the Boiler Makers' Supply Men's Association already supporting the exhibit feature of the meeting, the convention is bound to be a success. Additional members of the association are making reservations daily through the secretary, W. H. Dangel of the Lovejoy Tool Works, Chicago, Ill., who recommends that any member companies desiring to show their products at the convention select space in the immediate future while desirable locations are still available. Members of the Master Boiler Makers' Association who require information in connection with the meeting should address the secretary, Harry D. Vought at 26 Cortlandt street, New York. The convention will be held at the Hotel Statler, Buffalo, N. Y., from May 25 to 28 inclusive.

Application of the A. S. M. E. Boiler Code to Marine Boilers

With the A. S. M. E. Boiler Code in force in 19 states and 15 cities of the United States, as well as in the Panama Canal Zone and Alleghany County, Pennsylvania, the possibilities of its further adoption appear encouraging. The fact that 1925 was an off year insofar as state legislation is concerned simply means that further progress in the field of stationary boilers must wait until the various state legislatures are again in session when the claims for uniform boiler laws throughout the country can be vigorously renewed.

In the meantime, attention is being given to the possibilities of the adoption of the A. S. M. E. Code for marine boilers in order that the principle of uniformity may be extended to all branches of boiler construction. According to statements made by C. E. Gorton, Chairman of the Administrative Council of the American Uniform Boiler Law Society, at the annual meeting of the American Marine Standards Committee in Washington on January 26, the present A. S. M. E. Code is entirely applicable to marine watertube boilers and meets all requirements of the General Rules and Regulations of the United States Steamboat Inspection Service with the exception of those applying to the tensile strength of boiler plates. The class of steel plate specified in the A. S. M. E. Code is calculated on the basis of a tensile strength of 55,000 pounds per square inch, while that required by the Steamboat Inspection Rules is permitted a tensile strength of 62,000 to 70,000 pounds per square inch, which means that an A. S. M. E. boiler would be considerably heavier than one conforming to the Steamboat Inspection Rules. Weight on board ship, of course, is an important matter and some method of reconciling the two Codes would be necessary before the general adoption of the A. S. M. E. Code could be secured for marine boilers. It is a fact, however, that certain boiler manufacturers are building A. S. M. E. Code boilers for marine use and it is understood that the Board of Supervising Inspectors of the Steamboat Inspection Service is favorably disposed toward making amendments to the present law that will permit the general application of the A. S. M. E. Code to boilers built under their supervision. It is understood that the Secretary of Commerce, under whose jurisdiction the Steamboat Inspection Service functions, advocates an act of Congress by which the present laws governing marine boiler construction may be revised along more modern lines. If such legislation is secured, consideration will undoubtedly be given to the application of the A. S. M. E. Code to marine boilers.

National Board of Boiler Inspectors

THE annual meeting of the National Board of Boiler and Pressure Vessel Inspectors will be held this year in Chicago, Ill., May 3, 4 and 5. The place of meeting has not as yet been selected. Communications on matters pertaining to the National Board should be addressed to C. O. Myers, secretary-treasurer, 14 Commercial National Bank Building, Columbus, Ohio.

An Encouraging Message from Canada

AT the last annual convention of the National Board of Boiler and Pressure Vessel Inspectors D. M. Medcalf, chief inspector of boilers in the province of Ontario, Canada, expressed the wish that when boiler rules and regulations were being formulated and adopted in Canada the A. S. M. E. Code had been adopted so that it would become a universal law throughout America including both the United States and Canada. That his wish is heartily reciprocated by boiler manufacturers in the United States goes without saying but its fulfilment is quite another matter. In Ontario, however, a progressive step is indicated by Mr. Medcalf's further statement, that boilers inspected by any boiler inspector of any state who is a National Board representative will be accepted for operation in the Province of Ontario. Just what this means is shown more clearly in the following letter from Mr. Medcalf to Charles E. Gorton, chairman of the Administrative Council of the American Uniform Boiler Law Society:

This will serve to confirm officially the statement that I recently made to you at the Conference of the National Board of Boiler and Pressure Vessel Inspectors in Milwaukee, that I have arranged with my superiors in office to accept the inspections made by any member of the National Board of Boiler and Pressure Vessel Inspectors for all boilers built for use within the Province of Ontario.

Of course you will understand that the boilers must be constructed from designs that have first been submitted to this branch of the department, approved and given a registration number. It does not necessarily follow that we will accept an A. S. M. E. boiler but this decision was made to facilitate matters for manufacturers who contemplate constructing boilers to comply with our regulations.

Value of Discussions

THE discussion of the use of fusion welding in making boiler repairs, which has been conducted in the department of "Letters to the Editor" since last September, is a specific example of one function which THE BOILER MAKER seeks to perform for our readers—that of a clearing house for differences of opinion in the boiler making industry. There are many other subjects of importance on which our readers hold different views and to these individuals the suggestion is made that by writing a letter to the magazine, outlining such opinions, real information will be gained from a study of the ideas presented in replies from other readers.

LETTERS TO THE EDITOR

Boiler Explosions Can Be Prevented

TO THE EDITOR:

I note in the February issue of THE BOILER MAKER, page 48, an article by A. L. H. Street. The legal aspects of a boiler explosion by a Kentucky Court and the opinion of the court which was gratifying to A. L. H. Street as the verdict of the court exonerated the defendant from any liability for a fatal accident to a visitor in a grist mill power plant.

Boiler explosions can be prevented and are prevented by owners of power plants who use properly designed, well-made boilers, inspected regularly by a competent person who has had actual experience in constructing, repairing, testing and who has practical knowledge of the operation of high pressure steam boilers and is capable of recommending proper repairs when necessary, or, will order boilers out of commission before they become dangerous.

In connection with efficient inspection a competent engineer and fireman should be retained, who will not let the water get out of sight.

The cause of any steam boiler explosion can readily be determined if the investigation is made immediately after the occurrence by capable boiler inspectors that have been trained in this line of investigation, by examining the parts at point of rupture and testing the appurtenances.

The State of Kentucky, in my opinion, would add to the protection of employees, visitors and the public in and around steam power plants by enacting a law creating a Bureau of Boiler Inspection.

The present day "Safety First" movement has apparently taken all by storm but, if full credit is to be given where credit is due, it must be remembered that "Boiler Inspection" was the *first* "Safety First."

Indianapolis, Ind. JAMES DONOHUE.

Rewards to Labor in Boiler Shops

TO THE EDITOR:

In our trade in England and in America too there can be many varieties of bonus systems. Old-fashioned methods of fixing piece rates were very much abused during the great war. Straight piece work may be all right in some shops; others prefer the sharing of time bonus, but to me they all leave something to be desired; that is, satisfaction all around.

The main principle to be kept in the forefront, in any system of rewards for services rendered, is that not only must a man be paid a good wage, but that it shall be earned. By making his pay depend on his output, he should at least be able to make 25 percent more than when paid day work.

A system should be in operation, whereby the interest of employee and employer are in harmony; that is, while affording justice to the employee it also expects him to work to the best interest of his employer. Such a system I think is the card system, which has found acceptance in some shops, with marked success in British shops. A card is made out for a job, say plating a boiler, showing thereon the best known methods of doing same and tools necessary with times allowed for each operation, the sum of the times given on the card being of course the time allowed for the job. If the task is completed in the time given the man is paid a definite bonus, if not of course no bonus.

The great thing to my mind in the card idea is that the workman can see at a glance as he goes along how he is progressing or otherwise. Careful pains must be taken in making out the cards before being sent into the works. Errors in times given should be as few as possible. The best methods known should be described on the cards for doing the work.

The ordinary boiler maker if left alone seldom does any part of his job in the most economical manner either in time or labor expended and even on day work much time can be saved by giving men instructions as to how to perform the job allotted to them.

The time saved is often beyond our expectations. The main idea is to find the most efficient way of doing a specified job and we all have different ways of coming to the same goal, but the object to be attained by the card system is to do the greatest amount of work in the shortest time with efficiency, hence we put on the cards, after carefully analyzing every known method, the very best.

SYSTEM RECEIVED FAVORABLY

I think on the whole the men take kindly to the system. Of course there are always men to be found with a grouch at any innovation introduced. They always imagine the boss is getting at them again but this idea will soon commend itself because when one man begins to make a bonus it soon proves an incentive to the others or they are not worth a place in the shop.

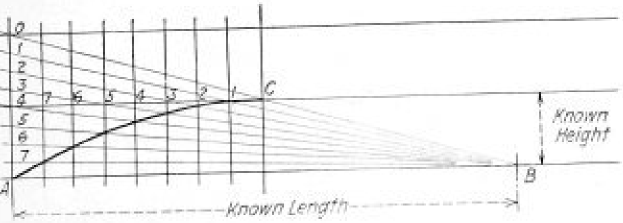
Another thing that commends this system to my mind is that the tools are looked after better as the men know that carelessness in throwing tools about causes waste of time in doing the job because of time lost in seeking tools required, and consequent loss of bonus. I should be pleased to hear from your readers of any good system of reward in boiler shops in America.

Leeds, England. WALTER WILSON.

Finding the Radius of a Flat Arc

TO THE EDITOR:

In the December issue of THE BOILER MAKER I saw a method of finding the radius of a tank head when the diameter and depth is known. Herewith I offer an alternative solution. First, lay off a line equal to the diameter; second, lay off a line parallel to this the depth of the disk apart; third, lay off another line parallel to this the depth of the disk apart. Divide twice the depth of the disk *A E*



Method of finding radius

into any number of equal parts, say 8, then divide half of the diameter into the same number of equal parts, say 8.

Drop the vertical lines and project the diagonal lines. The points of intersection connected up will give the true radius. The problem is quite simple and applies to tank heads, boiler ends, gasometer roofs, beams, etc. In the case of a rafter for a ship's hurricane deck, where the span may be 40 feet and upwards with about 12-inch camber, the radius would be considerable and a mathematical calculation would no doubt give the radius but would not find the trams to scribe it. It is usual in large spans to draft out on the floor the true camber and from it lift a template from which to bend the rafters. The mathematical solution is no doubt a splendid method but, as a rule, the boiler maker is more at home with a pair of trammels and a piece of chalk.

Leeds, England. JOHN GORDON KIRKLAND.

Metallic Arc Welding

TO THE EDITOR:

Probably no invention has met with so much suspicion and non-constructive criticism as electric welding. This may be due to the fact that the practical results are in advance of theory, and as the technical men control the designs and formulae for boiler making, they hesitate to advise anything they cannot prove by figures. Evidence of this is available in the January issue of THE BOILER MAKER where the letters of Messrs. Hamilton, Flaherty and Carter scorn the idea of an electrically welded patch submitted by the undersigned in the November issue, their principal objections being that it does not meet certain American requirements. Review the development of boiler making over the past 20 years and you will find that patents, designs, improvements and processes have generally come from outside the regulatory bodies. I am prepared to admit that these bodies are necessary in the interest of the public and property but they do not lead the way.

Electric welding is a process of fusion that produces a homogeneous weld. The welding of two plates together is done by an electric current passing through a piece of flux coated wire called an electrode. Immediately the live electrode is brought in contact with the plate an arc fusion is struck with an approximate heat of 3,900 degrees centigrade. This intense heat melts both the steel plate and the rod, the metal from the latter flowing freely into the former.

Unfortunately a small percentage of slag is deposited in the weld, this however is easily discerned and is generally removed with a pointed hammer and wire brush. The process of welding and cleaning is continued until a satisfactory weld is obtained.

The point at issue now is "What strength is the weld as compared with solid plate?" the answer is not technical but absolutely practical, viz.: Messrs. A. J. Riley and Son, Bathy, England, made a series of tests for their own satisfaction; pieces of steel were welded together and sent to the tensile testing machine. Forces ranging from 60,000 pounds to 63,000 pounds were applied to tear the weld asunder and curious to relate the solid bars broke, not at the weld but always from 2 inches to 4 inches away from the weld. This should be ample proof that an electrically welded joint is more than 100 percent efficiency. How much more we cannot tell because the plate fails first. And now Messrs. Hamilton, Flaherty and Carter I challenge you to produce a section of a longitudinal seam, riveted for 84 percent efficiency in plate and rivet section, *that will not* shear through the rivets or tear between the edge of the hole and the lap before the solid plate fractures. To get this matter cleared up, I suggest that 4 tests be made in America under your direction:

(1) An electrically welded butt joint with cover straps in and out, representing a section of a longitudinal seam.

(2) A similar section of a *riveted* longitudinal seam.

(3) A welded lap joint with welding in and out representing a circular seam.

(4) A lap joint and single or double riveted circular seam of the usual efficiency.

I am not going to presume that my critics, represent America in their knowledge of metallic arc welding; for that continent is a leader in this work; but it will probably come as a surprise to all three that electrically welded boilers are made and sold by Stevensons of Leith, Scotland, for 80 pounds steam working pressure, and by German firms for much higher pressures; this being so, then why not a repair? By all means do what your rules and regulations demand, but make the confines of your wisdom world-wide instead of province-wide. Each country or continent has at times got useful information and improved ways from another; in fact, it is common practice for engineers to visit foreign countries for no other purpose. Mr. Flaherty says that welding is all right provided it does not depend on its own structure; that is ridiculous, so far as we in England are concerned, as witness the following: Combustion chambers are being welded to the flues in marine boilers, Lancashire boilers wasted over large areas to a depth of 3/16-inch, are built up by electric welding and their pressures raised on that account.

Leeds, England. JOHN GORDON KIRKLAND.

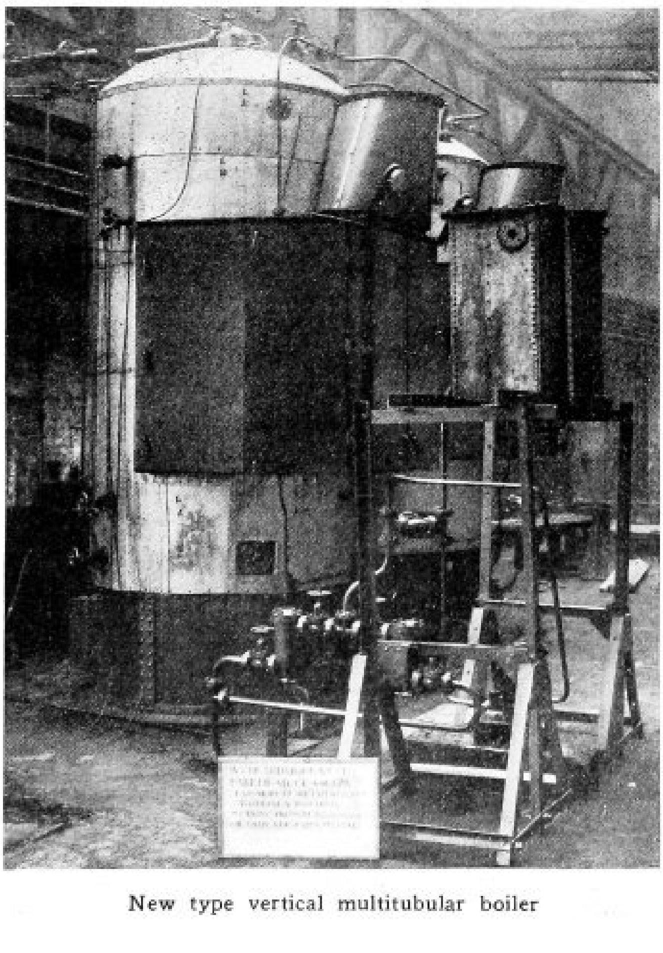
The Beardmore-Blake Patent Vertical Multitubular Boiler

By F. G. Bailey

CONSIDERABLE importance has been attached to trials carried out on an entirely new type of multitubular boiler, as illustrated, which has recently made its appearance on the English market.

The special features connected with this type of boiler are its compactness, requiring a minimum of space and no brickwork settings, thereby avoiding tube plates or stay tubes. It is suitable for marine auxiliary purposes or for general use on land and burns coal or oil as desired—it also utilizes waste heat.

There are no flat surfaces in the boiler. The circularity of the shell and combustion chamber is not broken into by the introduction of flat tube plates. The tube plates are truly circular; the tube holes being drilled by special machines providing a true bearing for the tubes, and ensuring a perfect joint by rolling with an ordinary tube expander.



New type vertical multitubular boiler

The high efficiency, evaporative power and economy of a boiler provided with a wet back combustion chamber is well known to experts, every square foot of same being equivalent to three square feet of tube surface. These boilers are provided with large wet back combustion chambers, having from 25 to 80 square feet of heating surface according to size of boiler, thereby greatly increasing the evaporative efficiency of the boiler.

The original order was for two of these boilers, each of 18 feet in height by 7 feet in diameter, and having a working pressure of 165 pounds per square inch. It also included oil fuel plant and boiler house equipment.

The conditions of the contract were that each boiler under easy steaming was to be capable of evaporating 3,360 pounds of water per hour from and at 212 degrees Fahrenheit and under heavy steaming 4,400 pounds of water per hour from and at 212 degrees Fahrenheit, with natural draft using oil having a calorific value of 18,500 British thermal units per pound and that the oil consumption was not to exceed 360 pounds per hour.

Test results indicated that the maximum evaporation of 4,400 pounds of water per hour and 12.3 pounds of water per pound of oil—figures which represent an efficiency of 64 percent—were exceeded by a considerable margin, the actual figures attained being 5,140 pounds of water per hour and 13.52 pounds of water per pound of oil, representing an efficiency of 69.9 percent.

This boiler is the product of Messrs. Wm. Beardmore & Company, Limited, of Dalmuir, Scotland.

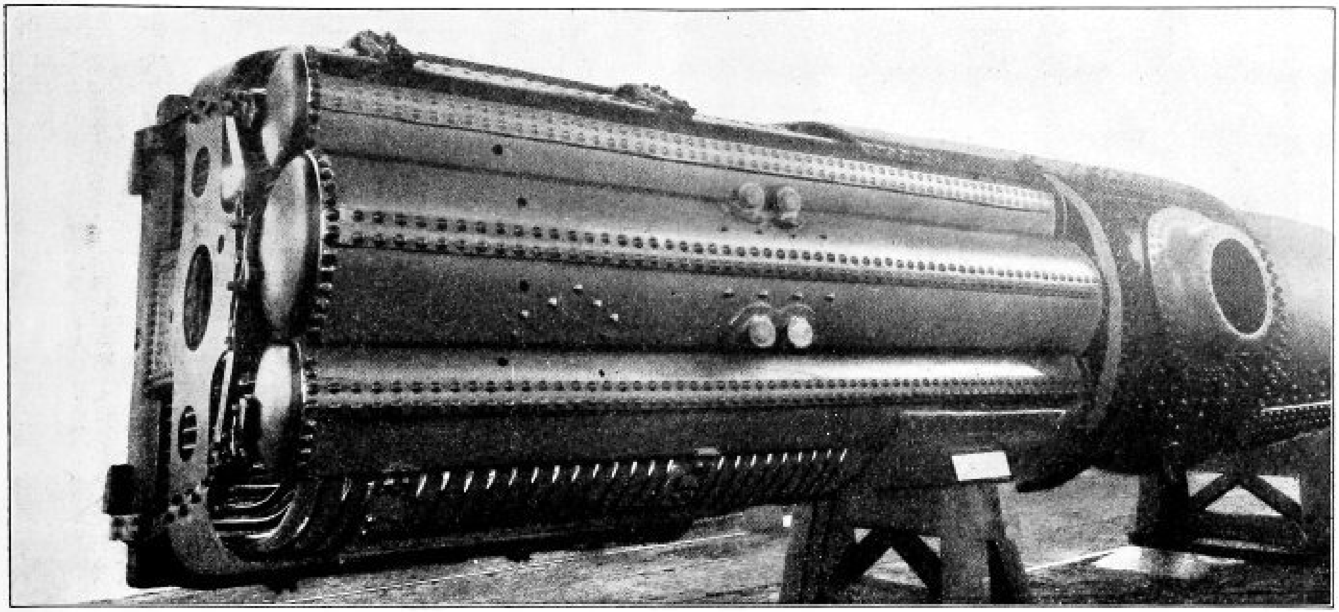
Reading Iron Company Announces New Sales Service

R. M. Thomas and Donald Charlton have been appointed technical representatives of Reading Iron Company, Reading, Pa. The technical department which they head is a newly created service division in the sales department. Virtually all their time will be given over to railroad work and they will be required to give technical and practical counsel to any railroad which has pipe, engine, bolt, staybolt and boiler tube problems.

R. M. Thomas, for the past four years associated with the Chicago office of Reading Iron Company, received his technical training at Cornell University and Carnegie Institute of Technology. He is a member of American Institute of Mining and Metallurgical Engineers and Western Society of Engineers. Mr. Thomas will represent Reading Iron Company in offices of various railroad systems of the west. His headquarters will be 449 Conway Building, Chicago, Ill.

Donald Charlton has been for the past six years in the manufacturing division of Reading Iron Company, the last two and one-half years of which he served in the capacity of assistant engineer of tests. His duties during this period required an intimate knowledge of railroad work and furnished an excellent opportunity to become acquainted with numerous railroad inspectors and technical experts of several systems. Mr. Charlton will call on eastern railroads, and his headquarters will be the general office of Reading Iron Company, Reading, Pa.

The Annual Spring Meeting of the American Welding Society will occur in New York in the Engineering Societies Building, 33 West 39th Street, April 21, 22 and 23.



Top of the firebox and combustion chamber—Note the heavy plate cross-member on the back head

McClellon Watertube Type Locomotive Boiler

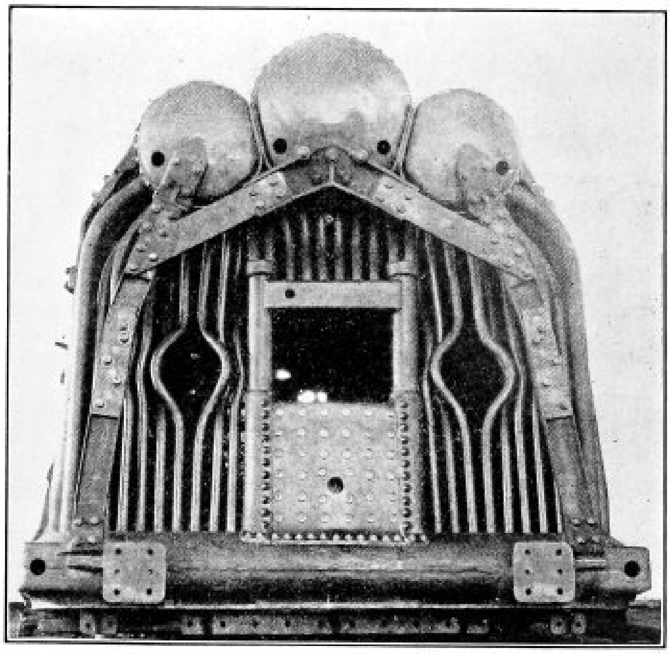
New Haven development indicates the way for increasing efficiency and capacity of modern power

IN 1916 the New York, New Haven & Hartford, placed in service two Mikado type locomotives fitted with McClellon watertube fireboxes, of the type for which a patent was granted to the late James M. McClellon, and is now owned by the McClellon Boiler Company, Boston, Mass. These two boilers met with indifferent success. The original design developed some weaknesses in the details of its construction but showed that its fundamental principles were mechanically sound and that with a modification of the details that were giving trouble, the boiler would probably give satisfactory service. Unfortunately, Mr. McClellon died at this time, just as the boiler had demonstrated its possible practicability.

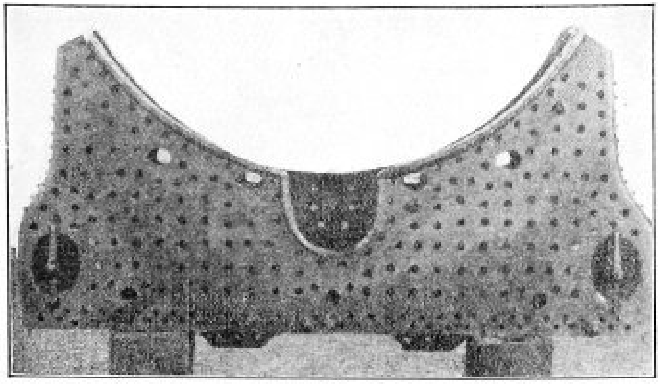
W. L. Bean, mechanical manager of the New York, New Haven & Hartford, feeling confident that this type of firebox construction possessed advantages over the ordinary radial-stayed firebox, undertook to study fully and to correct the troublesome features which had become apparent in actual service. These changes were made in 1920 to the two original boilers, which are still in service. In 1924, having 10 mountain type locomotives on order with the American Locomotive Company, it was decided to equip one of these locomotives with the McClellon firebox, embodying such changes in the structural design as had already been made in the two existing boilers, and including further modifications which were felt might prove to be advantageous.

Realizing that this design of boiler is particularly adaptable to high pressures, one of the modifications made in the new locomotive was to increase the boiler pressure from 180 pounds to 250 pounds, which, with the use of a 70 percent limited cut-off, would give greater steam economy. Viewed from the standpoint of the present design, it is of very simple construction and well adapted to meet and properly withstand the stresses inherent in locomotive service.

The character of the construction is clearly shown in the illustrations. It will be seen that the ordinary parallel sheet construction of the back head, sides and combustion chamber are replaced with walls of watertubes. The roof and crown sheet area in the conventional type is replaced with a section formed of three longitudinal drums extending the complete length of the firebox and combustion chamber and attached at the front end to the rear tube sheet.



The construction of the back boiler head—Note the pads on the channel braces to which the heavy plate cross member is bolted



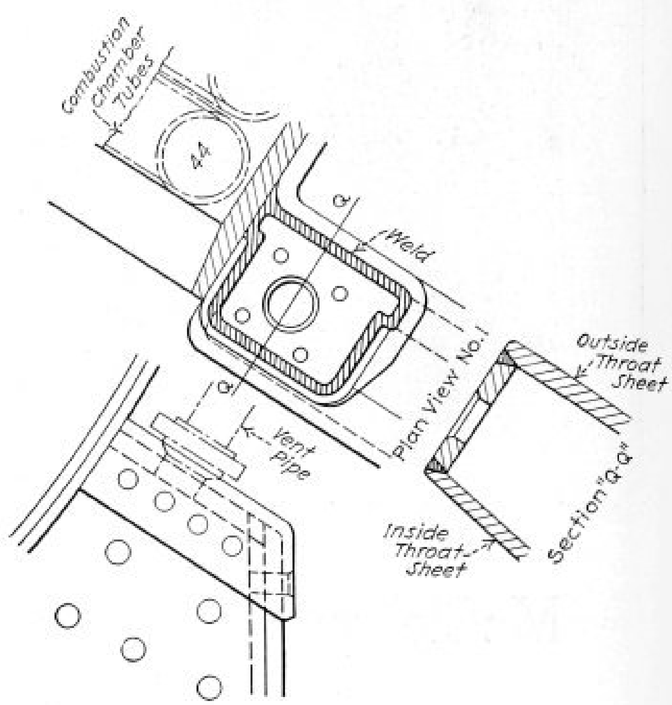
The front side of the throat construction, showing the handholes and circulating trough flange—The mudring flanges are opposite the handhole openings

These drums are in contact with each other throughout their length and are so flattened at the contact areas as to permit the largest possible steam and water space. They are prevented from separating by screw rivets that keep the flat sections in continuous contact throughout.

Combustion chamber and side tubes are 4 inches in outside diameter, swaged to 3 inches at the ends, with walls ¼ inch thick. The back head tubes are 2 inches in outside diameter for their entire length, with walls 3/16-inch thick. All tubes are rolled and beaded at the top ends in the drums, but are rolled and flared in the mudring at the bottom ends. The arch tubes are conventional in size but at the top the ends are turned up into the drums and rolled and beaded. All tubes entering the drums are on the drum radius and perpendicular at the point of entrance.

To accommodate proper seating of the tubes in the mudring, the top wall is flattened inside and outside. The outside of the bottom wall also is flattened. Through it holes are tapped opposite each tube to permit the initial installation of tubes and such inspection and maintenance as may be necessary. These holes are closed with plugs, all of which do not constitute washout plugs but on the contrary are so-called "construction plugs."

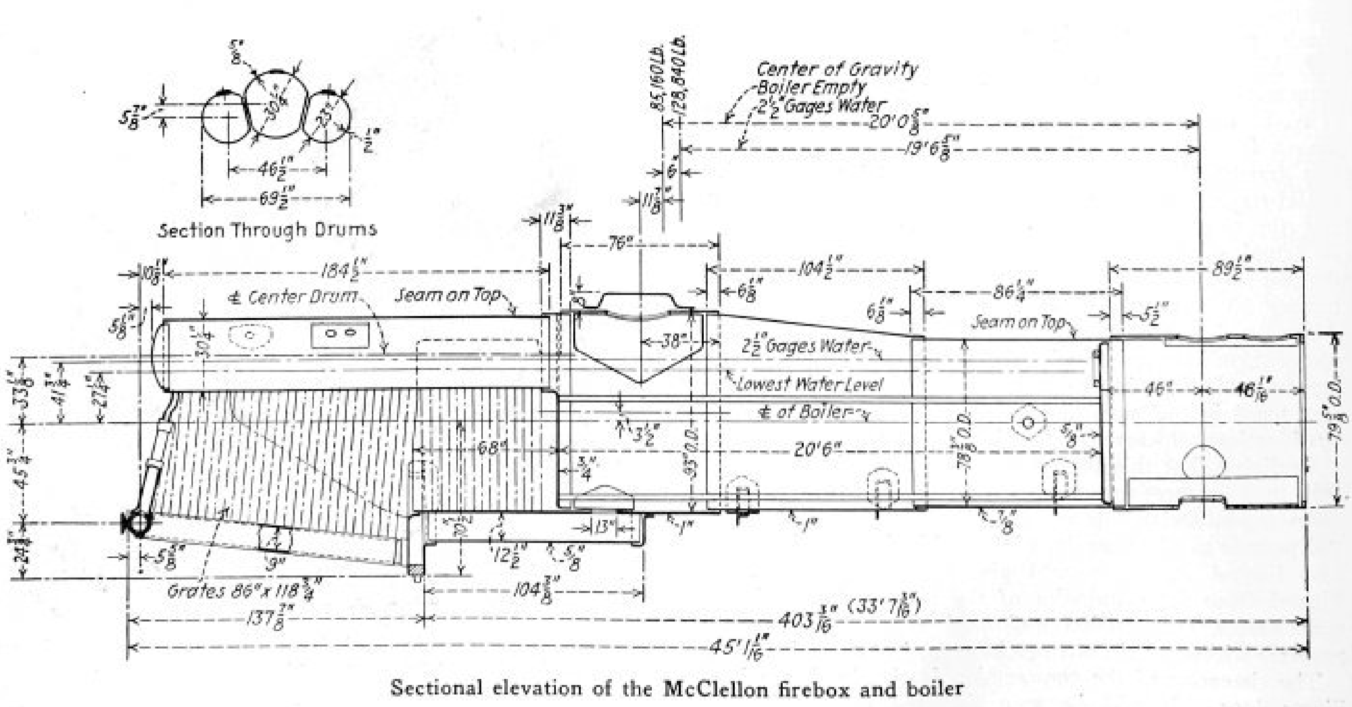
There is a slight clearance between all tubes forming the firebox construction in order to permit of easier installation. Lagging and protection is applied on the sides and back head, outside of the tubes, to which reference will be made later. All back head tubes are staggered at the entrance into the drums because of the relatively restricted



Method of closing throat sheet corners—A plate is first welded in the opening, the lap of the sheets at the end of the throat is smoothed by welding and scarfing, and the flanged cap fitted in place hot, after which it is secured by screw rivets and welded to the dry shell and to the inside plate at the edges of the vent opening—The opening is then reamed and the studs applied

section forming the crown, as compared with the length for tube spacing available in the mudring.

The illustrations given are all taken from locomotive 3500,



Sectional elevation of the McClellon firebox and boiler

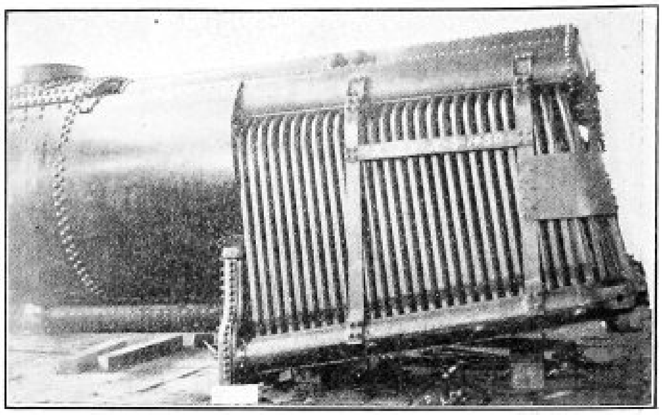
which is equipped with a Duplex stoker. Several of the back head tubes are bent away from their normal position in order to permit entrance of the stoker distributor tubes. This construction is used where the Duplex stoker is applied but is not used when the Standard stoker or similar types are applied.

Fire Door Opening

The fire door opening is a combination water-leg and watertube construction. The section below the door is of a conventional stayed construction. It is made up in three pieces: a single inverted U-shaped piece flanged and riveted to the mudring, with the ends closed by semicircular sheets bent and riveted in place. The sides of the door opening are formed by large tubes joining the stayed section at the bottom and connected near the upper ends by the top door member which is formed rectangular in section from round tubing. Regular 2-inch tubes are carried from the top member of the door frame up to the drums in the same manner as the main back head tubes, with plugs located on the underside of the rectangular member opposite tube holes. The large side tubes are capped at their top ends with steel castings, welded in place, into each of which two 2-inch tubes are applied and carried up to the drums.

Difficulties With Former Type

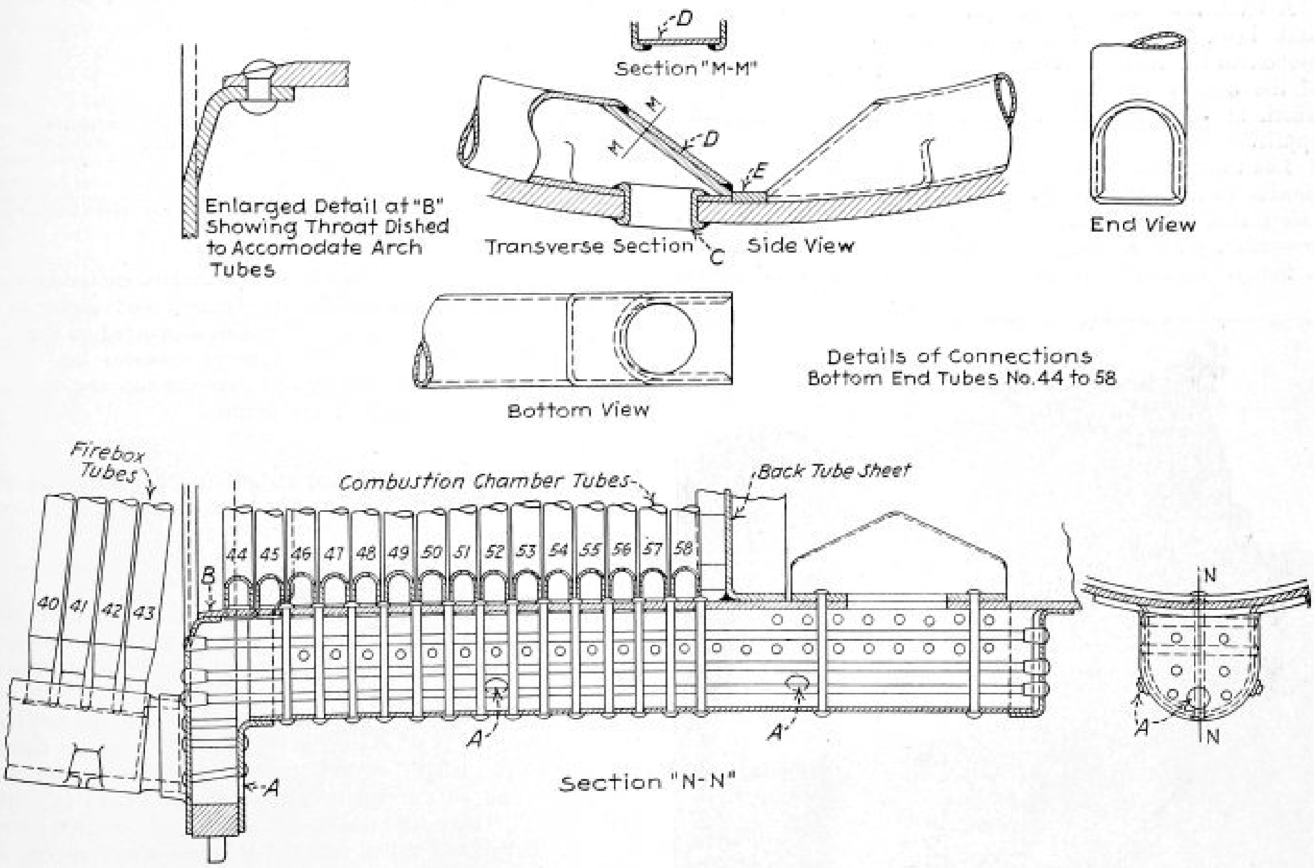
One of the troubles with the original construction was lack of provision for any column action to take the stresses between mudring and drums independently of the tubes. This situation is avoided by a series of braces between the mudring and the drums so arranged as to form, in combination with the drums and mudring, a hollow box girder type construction. This relieves the tubes of any duty other than that of steam and water containers under pressure.



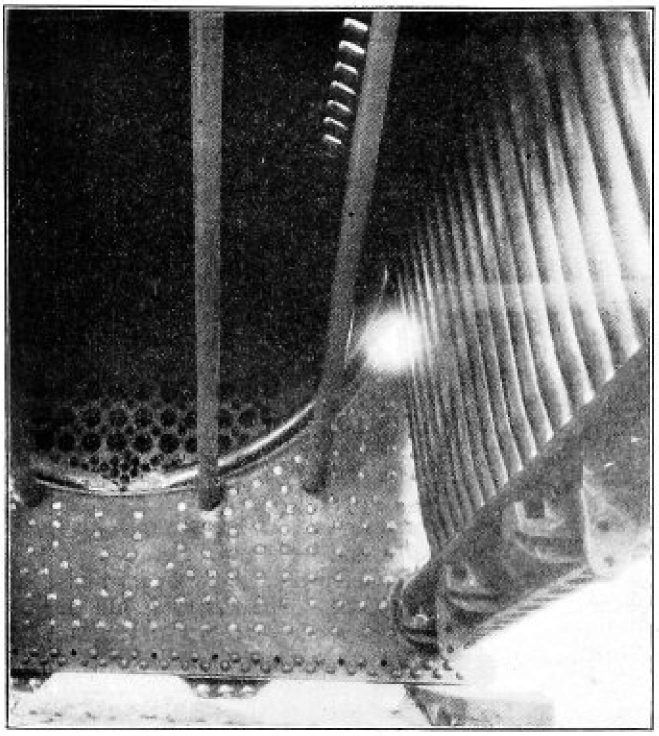
Side of completed firebox

Shocks incident to locomotive service are transmitted through this bracing construction and kept away from the tubes, so that they remain continuously tight, even under severe and unusual operating conditions. The braces at the sides of the firebox are of channel section secured with fitted bolts to the mudring and to castings applied to the drums. The braces are seated against shoulders so that the bolts are relieved of shears. Horizontal members of rectangular section connect the main side braces to give additional stiffness.

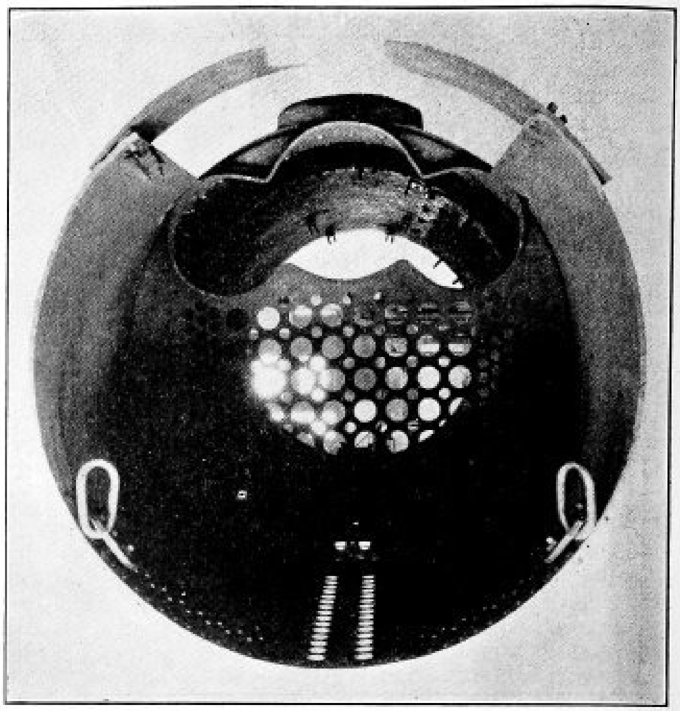
The arrangement of bracing, being free from triangulation, permits the necessary free longitudinal movement of drums relative to the mudring resulting from temperature differences between the mudring and crown sheet areas. Similar construction is employed at the back head. The top connections of the back head braces into the saddle



Circulating trough and combustion chamber tube construction—Washout plugs as shown at A; circulating nipple at C; combustion chamber tube end at D, and space block to relieve nipples of shearing, at E



Interior of the firebox before the walls were closed

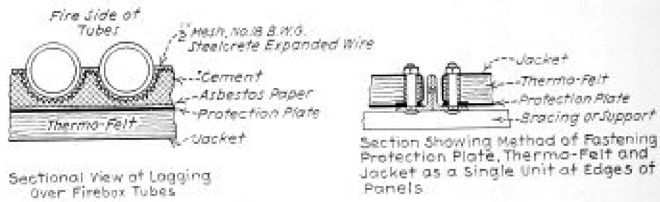


Interior of the combustion chamber dry shell, showing the opening in the tube sheet for the firebox drums

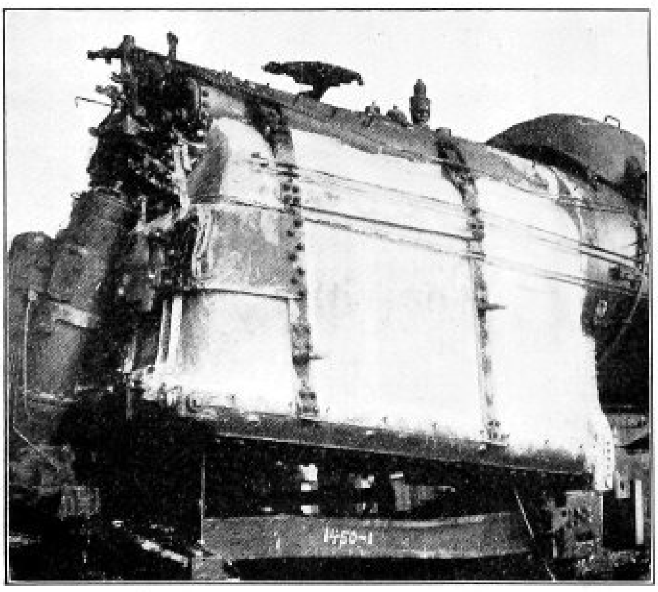
castings on the drum heads are so arranged as to permit inspection and attention to the seams between drums and drum heads. An arch effect is obtained through the use of the diagonal braces which connect the column members to the center drum.

A back head belt of wide plate section is bolted to the back head braces and carried around the corners of the firebox to the rear side braces. This not only forms a part of the back head bracing, but serves as a foundation on which all of the back head as well as the cab fittings are applied.

The throat sheet at the front end of the firebox is generally similar to the ordinary throat sheet in conventional boilers, except that it is vertical and is arranged so as to give greater accessibility for washing out. The back plate of the throat is flanged outwardly to receive the front ends of the hollow mudring, and opposite the mudring connections, the front throat sheet is fitted with hand hole plates similar in construction and arrangement to those used in marine and stationary practice. The top points at the sides of the throat are fitted with caps and vented through copper pipes which permit the escape of steam into the steam space in the central drum. One of the drawings shows a detail of this construction.



Details showing the construction of the firebox enclosing wall and the method of attaching the lagging and jacket in panel units, to a framework of angles supported on the firebox braces—The usual type of asbestos lagging and jacket are applied over the top and ends of the drums



The firebox walls closed, ready for the lagging and jacket

Conventional Combustion Chamber

The combustion chamber, like the firebox, is of watertube construction, but it is encased in a dry shell extension of the third barrel course. This course provides the structural strength for the connection of the firebox and the barrel portions of the boiler. It will be seen in the illustrations that at the top it is securely riveted to the two outside drums throughout the length of the combustion chamber and that the inside and outside throat sheets are riveted to it at the bottom. The rear tube sheet is also riveted in this course with the flange extending forward into the water space. It is flanged in the opposite direction to receive the front ends of the three drums which form the top of the firebox, no flanging or swaging of the drums being required. To permit the calking of the tube sheet flanges at the sides of the two outside drums where the dry shell overlaps the flanges, a recess has been cut in this shell. The opening thus made into the combustion chamber is closed with a fitted cover plate, to prevent the escape of gases into the lagging.

To permit the transfer of water from the barrel of the boiler to the firebox and combustion chamber a circulating trough is riveted on the outside of the third course at the bottom. The front end extends ahead of the tube sheet and opens through the sheet into the boiler, while the rear end is riveted into a flanged opening in the outside of the throat sheet.

All combustion chamber tubes enter the side drums at their upper ends in line with the firebox tubes. The bottom ends of all except the rear tube on each side enter the circulating trough through holes in the dry shell. The rear tubes open directly into the throat sheet water space.

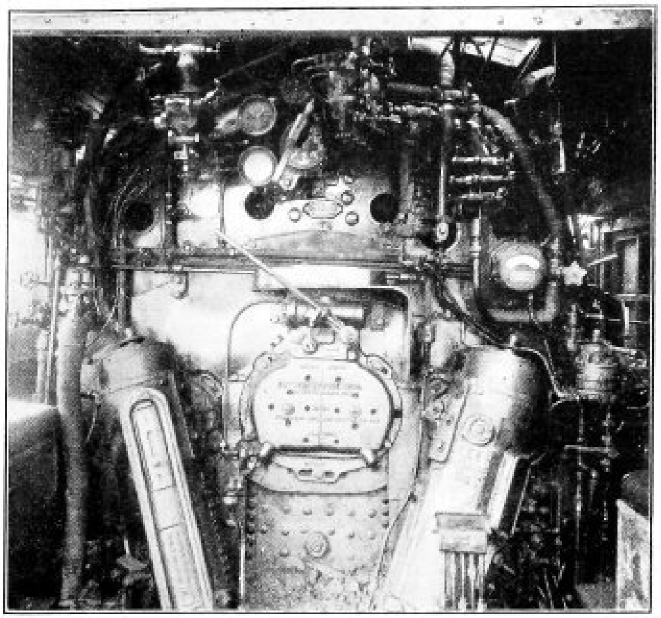
Attaching Combustion Chamber Tubes

The attachment of the combustion chamber tubes to the circulating trough involves a unique type of construction, which is shown in detail in one of the drawings. The tubes are flattened and curved to fit the dry shell at the bottom and their ends are cut away on an angle. A hole through the flattened wall of the tube fits over a nipple, applied through the hole in the dry shell and rolled, beaded and welded, before the circulating trough is in place. The upper end of the nipple is rolled, beaded and welded in the tube, working through the open end of the tube. The end of each tube is closed by plate welded in place, over which the edges of the tube are flanged and welded. A space block is applied between the right and left tubes of each pair to relieve the nipples of shearing action.

The lagging on the outside of the firebox is composed of a protection plate, insulation and jacket. The lagging is made up in sections with each panel self-contained in order to permit the removal of lagging in sections without the necessity of wholesale stripping for access to tubes and other parts. The lagging is applied after the tubes have been covered with an asbestos cement.

Water Circulation

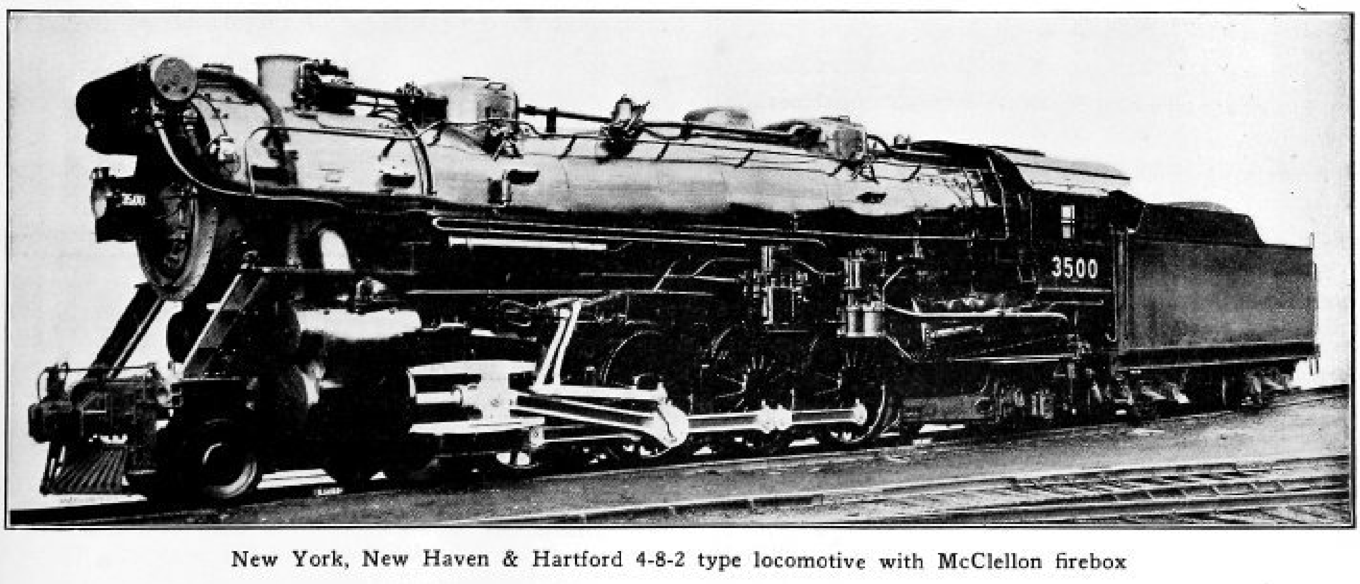
No detailed study has been made of circulation in this boiler, but observations of the bare boiler, fired-up during construction and without any lagging or insulation whatever, indicate a very uniform warming up of the entire boiler from front end to back head without the usual unequal heating normally experienced in the radial-stayed construction. The time required to fire up the cold boiler is only two-thirds of the time usually required with the radial-stayed construction. There is a very noticeable scouring action through the tubes of the firebox and combustion chamber, undoubtedly due to the rapid and positive circulation and indicated very definitely by lack of mud and scale in the mudring and tube area. Most of the mud accumulated is relatively soft and is deposited in the trough section. In other words, the dead corners of the conventional boiler and firebox are absent in the McClellon construction.



When lagged, the boiler head does not differ in appearance from that of a staybolt type firebox

The freedom from unequal heating, momentary distortion of the firebox while warming up, more rapid circulation and absence of dead corners that give rise to mud and scale accumulation all indicate a better type of boiler construction than normally used. The time required to wash one of these boilers is only about one-half or two-thirds of the time required for the ordinary boiler. Stresses due to unequal temperature conditions are greatly reduced as indicated by considerably less maintenance on the firebox and combustion chamber portion of the boiler.

There is greater potential capacity in this type boiler



New York, New Haven & Hartford 4-8-2 type locomotive with McClellon firebox when the locomotive is running with leaky flues or superheater units. It is possible, but of course not practicable, to operate these boilers with a far greater number of flues and units leaking before low steam conditions are experienced than is the case with the conventional locomotive boiler.

The arrangement of outside throttle and superheated steam on most of the auxiliaries is in keeping with present day practice. An Elesco feedwater heater and Duplex stoker are applied, the front end is fitted with Okadee hinges and the air operated whistle uses superheated steam.

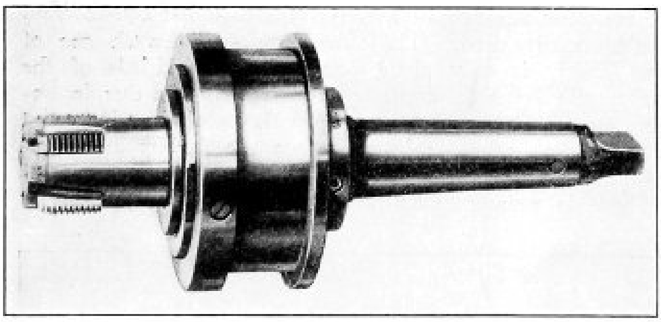
When this locomotive was built as many dimensions and characteristics as possible were kept the same as the conventional engines built at the same time from the U. S. R. A. light mountain type design for fast freight service. Thus, all tests could be made on a comparable basis as between the McClellon firebox and the standard locomotive, thereby eliminating variables that would tend to influence conclusions. Consequently, the cylinder and wheel sizes, grate area, heating surface, superheater surface, etc., were all kept at the same values and the changes in the McClellon equipped locomotive were confined to the firebox arrangement, boiler pressure, valve events and, to some extent, the weight on drivers. Virtually the same limitation on axle loads held good for the McClellon equipped engine as were imposed in the case of the standard type.

(*Continued on page* 82)

New Adjustable Collapsing Taps

A NEW adjustable and collapsing tap which is available in four classes, designated as S, SA, SB and SC, respectively, has recently been placed on the market by the Geometric Tool Company, New Haven, Conn.

The class S tool, shown herewith, is of the hand machine type, having a closing handle and trip plate. Contact with the work at the required time collapses the chasers; resetting is done by hand. The class SA is of the rotary type with a plate trip and is the same as class S but without the handle. Contact with the work collapses the chasers and



The rotary type of S B tap for automatic machines

contact of the closing sleeve resets the tap. The third class, designated as SB and also illustrated herewith, is of the rotary type with a flange trip, and is also the same as the class S tool except that it has neither the closing handle nor the trip plate. In this tool a flange is fitted over the closing sleeve for collapsing and resetting the tap. The SC tap is of the hand trip type. It has no trip plate and is opened and reset by means of the handle.

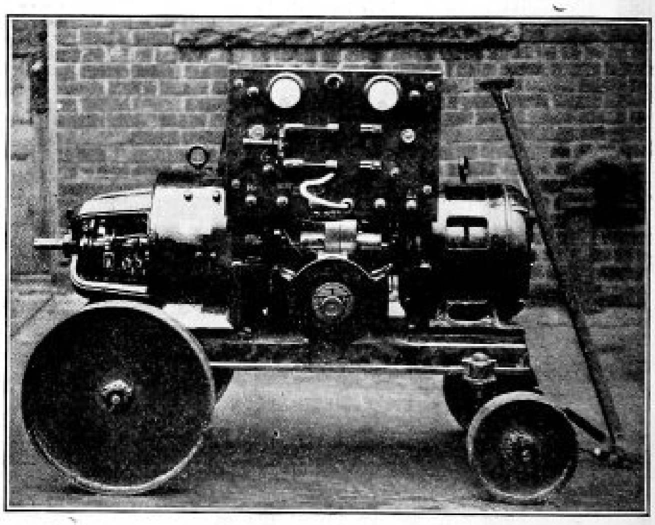
Each of these four classes of collapsing taps is said to be convertible into the other at little or no expense. Thus, one tap with slight changes can be used on hand or automatic machines, and can be changed from plate trip to flange trip or vice versa, as well as to hand trip. The taps are made in sizes ranging from 3/4 inch to 3 1/2 inches inclusive.

The front end of the tap is of large diameter which is claimed to increase the strength and chip clearance. Grooves milled in front of the chasers are intended to prevent the packing of chips and to permit the chasers to cut freely. The tool is of alloy steel, hardened and ground, and is enclosed for protection against dirt and chips. A left-hand skeleton is required for left-hand tapping.

The chasers used in the four classes of S taps are interchangeable but they are not interchangeable with those used in the company's class NL or class H taps. The chasers are of sturdy design and because of their thickness are said to have long grinding life. Short length is a feature stressed as lending strength to the front end of the tool under the torsional stress of tapping. The chasers are of sufficient length, however, for any standard pipe thread. They are supported for their full length, which provides a bearing under the cutting point, and may be removed simply by removing the cap on the front of the tool.

Dual Current Welding Generator

A GENERATOR designed to develop both alternating and direct current for arc welding purposes has recently been developed by the Electric Arc Cutting and Welding Company, Newark, N. J. This machine is being marketed under the name of "Dualarc" generator, and it is built by the designers to meet the demand



Combination a. c. and d. c. welding generator equipped with motor drive and mounted on truck for portability

for a single machine which will embody all of the advantages which have been attributed to both a.c. and d.c. arc welding. The entire apparatus has but one involving unit which is ball bearing and may be driven by any form of power motor, or by any available line shaft delivering 5 to 7 1/2 horsepower.

The entire set is guaranteed to operate continuously for all arc welding without vibration. It is possible to short circuit the generator without injury, as the voltage simply falls to a low value holding the maximum current constant. It can be left in this short circuited condition indefinitely without injury. The field coils are so arranged that they may be connected either as series compound or series differential so that both carbon arc and metallic arc requirements are provided for. The machine is not separately excited. The field windings are wound on steel bobbins and baked solid in enamel before being mounted rigidly on the poles. The poles are then mounted rigidly in the frame and disassembly can be made in the same manner.

The armature is one complete baked unit with d. c. com-

(*Continued on page* 82)

Laying out a throat sheet

Standardizing and Centralizing the Fabrication of Locomotive Boiler Repair Parts

Methods of laying out and fabricating boiler sheets and developing standard repair patches

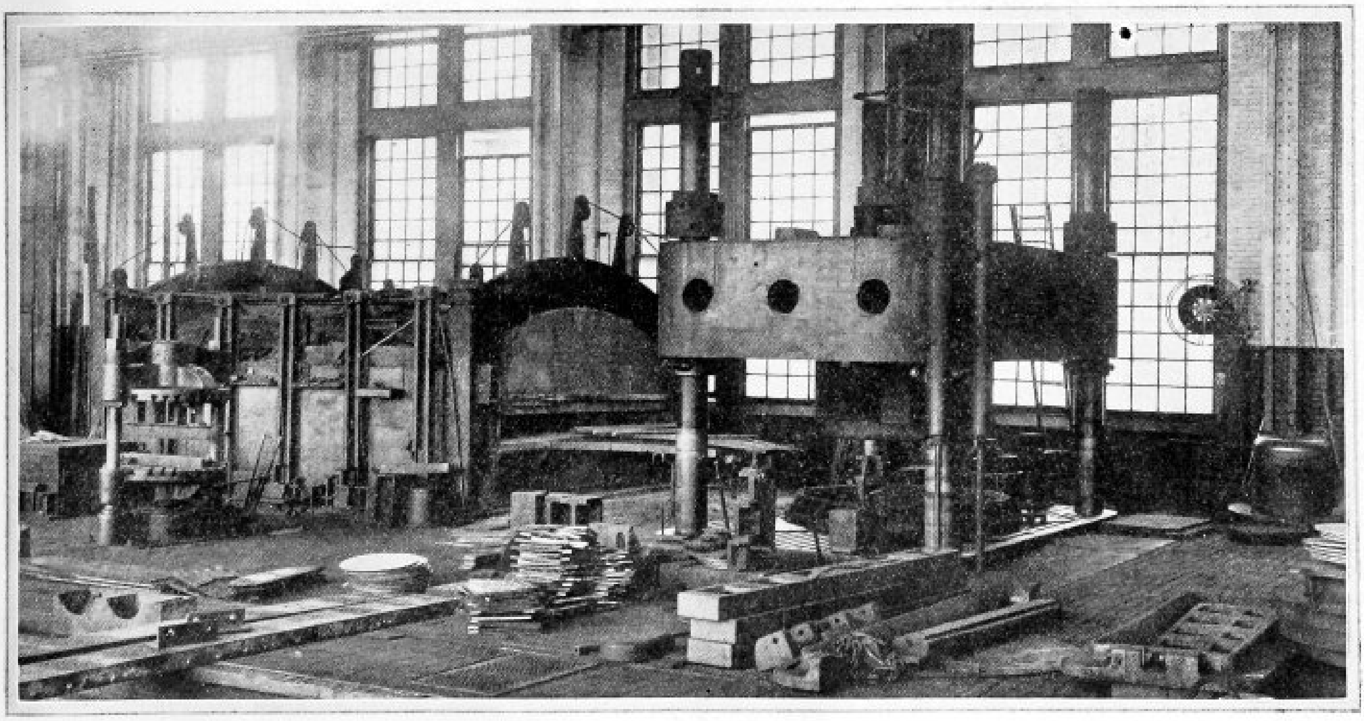
As noted in the article describing the Juniata boiler shop of the Pennsylvania Railroad System, which appeared on page 35 of the February issue, the feature of greatest interest at this point is the method developed for standardizing and centralizing boiler repair work. In this respect the Altoona Works is unique in the railroad field of this country. In effect the entire plant is a fabricating center not only for the boiler but for practically every piece of equipment and part that is used on a locomotive or car insofar as it is susceptible to standardization.

The problem in the case of locomotive and car fittings in general is comparatively simple since standards have been developed covering the entire range of requirements. Boiler parts on the other hand offer many difficulties in their treatment. The first step towards standardization undertaken by the Pennsylvania has been the selection of standard types of locomotives which are especially designed to meet given service requirements. Although this railroad, as in the case of all other roads in the United States, has a great many types in service at present, the Pennsylvania has adopted the policy of retiring many of them as rapidly as their condition warrants.

Standard Types Selected

The standard Pennsylvania types for passenger service are the 10-wheel 4-6-0 designated as the G-5-S and the heavy Pacific type designated as K-4-S. Two types are in general standard for freight service, the Decapod I-1-S and the Mikado L-1-S. A new type for Pennsylvania passenger and express freight service is now undergoing development, the Mountain type, designated as M-1. The standard switching engine, an 0-8-0 type, is designated as C-1.

With this basis of standards on which to work, the boiler maintenance and repair problem for the entire system has been made comparatively simple. In the case of any new type the design is worked out and a single locomotive is



View showing furnace and light presses in flanging department built at Juniata for test purposes. Every piece of equipment, every boiler part that goes into the new locomotive, is made to conform to Pennsylvania standards. After the locomotive has been given exhaustive service tests and all the difficulties ironed out, the design drawings are corrected and plans made to put an order through the shop. If the work is to be carried out by the locomotive builders, complete sets of working drawings are supplied and no deviation from them is permitted.

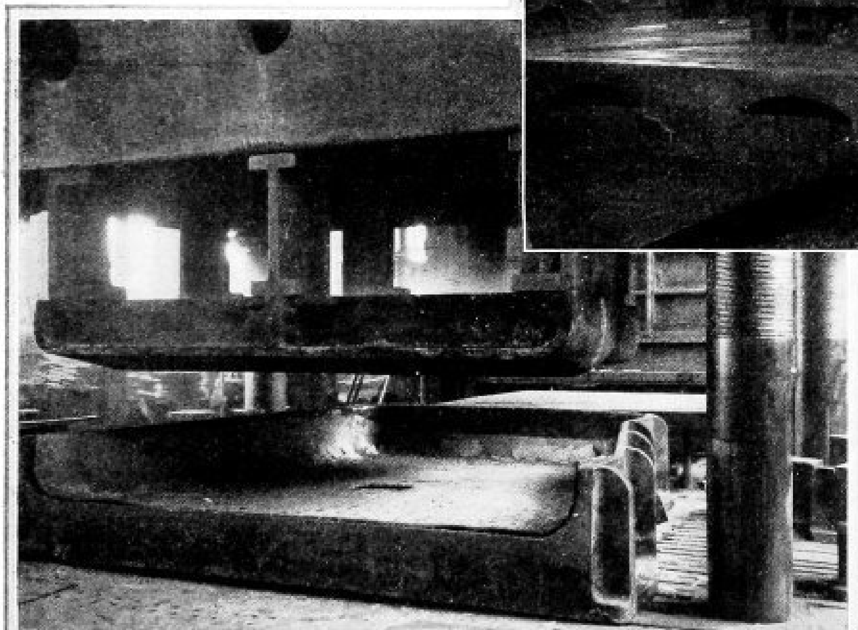
Boiler Production at Juniata

At Juniata the boiler work is arranged on a production scale so that the entire order may be handled with a minimum of effort and so that every boiler part in the entire lot is interchangeable with similar parts. Dies are made for all flanged sheets, for forgings and pressed parts; in fact dies for sheets for many different types of locomotives used by the system are kept in storage at Juniata and are not discarded until the particular type of locomotive for which they were made has become obsolete. In addition to locomotive boiler dies, dies are kept in storage for all stationary boiler types used throughout the entire system. The storage yard for dies at this point presents one of the most interesting sights of any plant in the country from the standpoint of the high development possible in boiler work. The use of these dies for repair work will be discussed in a later section of this article.

Fabrication of Parts

In the process of fabrication, sheets are brought from the storage yard to the laying out floor where they are marked. On an order for 10 engines, for example, whether the sheets are to be flanged or are to be finished in the flat or rolled, one sheet is laid out as a template and used to mark up the complete order. Flanged sheets after being marked are cut to shape and taken to the flanging department where they are heated and put through the flanging process. The general layout of the boiler shop at Juniata with details of equipment, furnaces, presses, and the like, appeared in the first article describing this shop in the February issue. This article should be used as a reference in order to follow through the fabricating process described in the present one.

This press is used for light flanging work, such as sand boxes, dome casings and running boards



Four hundred ton press after completing operation on firebox door sheet

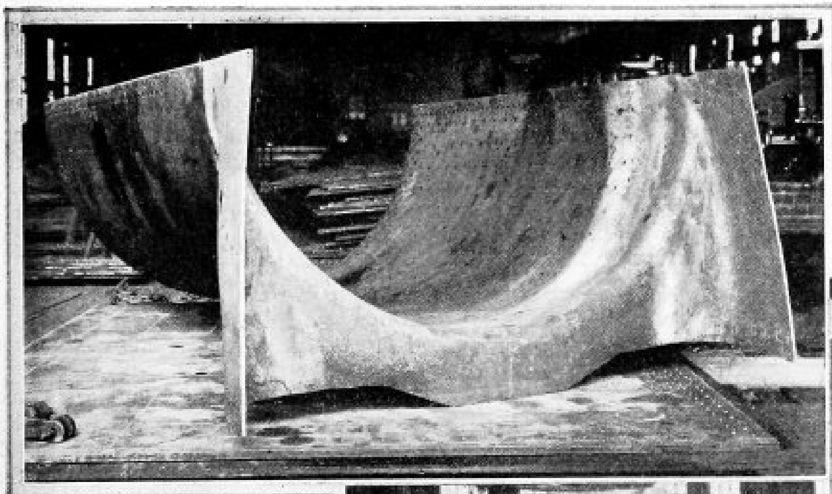
Details of Flanging Operations

A two-piece die is used for flanging the inside throat sheet. This operation is carried out in a single heat. The outside throat sheet is rolled to the proper curvature and then the flange is turned in one operation. Because of the great depth of the throat in this case a three-piece die is used and three heats are generally required to complete the flange. In this instance too, the process is one of drawing rather than pressing and dies of varying curvatures down to the finished shape are used. The same female die is used throughout but the male die is varied.

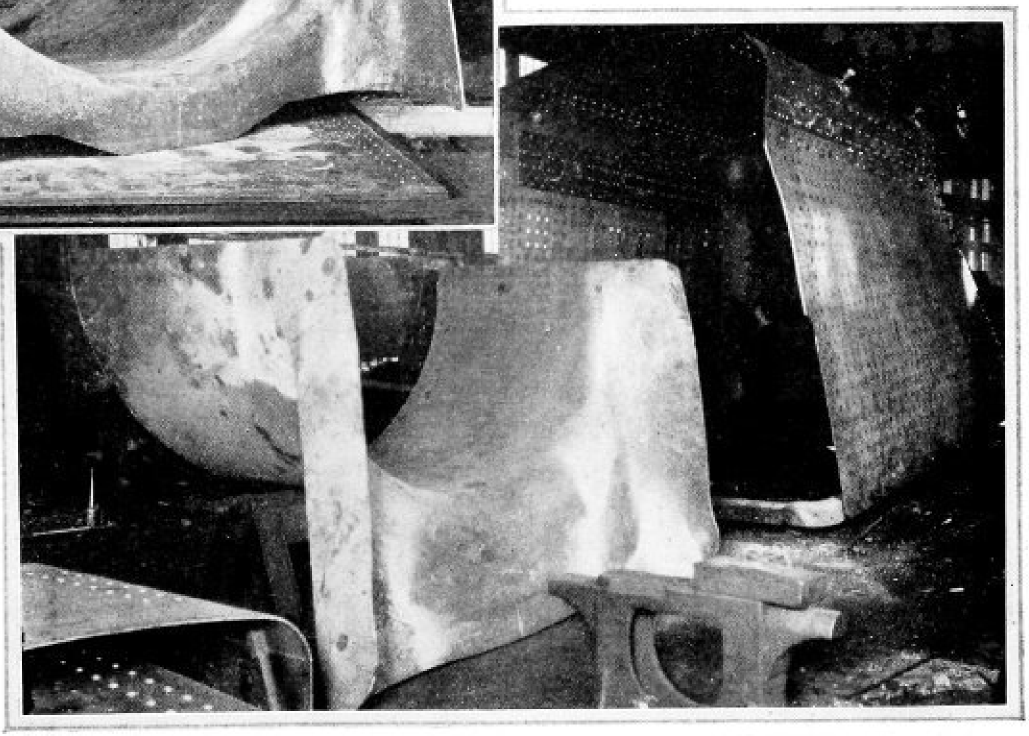
The facilities of the shop will accommodate the entire range of pressed and flanged parts used in Pennsylvania locomotives from light sheet work, such as sand boxes, ashpans, steps, running boards and the like to one-piece domes, flue sheets, door sheets, throat sheets, etc.

One-piece domes are drawn to shape in three or four heats and then given a finishing heat; the number of heats of course being governed by the size of the dome. As in the case of outside throats, a series of male dies of different curvatures are used during the drawing process.

Where sheets are to be finished in the flat or those that are to be flanged, such as tube sheets, or rolled as one-piece crown and side sheets, the first sheet of the order is laid out throat sheet comes from the flanging department it is placed on a special table which consists of a steel plate embedded in a concrete base. The surface of this floor plate is exactly parallel to the surface of a raised steel table about 33 inches in height which is shown in the accompanying photographs. The base of the throat sheet is blocked in place and, by means of jacks, mounted on the upper table, the throat is adjusted to the exact position it will occupy when installed in the boiler. From the layout and the boiler assembly drawings, it is then possible by the use of a square to mark and punch the location of all rivet staybolt holes. This method saves about eight hours in laying out a sheet as compared with the usual practice of bolting it in place, laying it out



Inside combustion chamber throat sheet



Outside throat sheet on assembly floor ready for installation

and used as a template as previously noted. The entire order is then fabricated from this sheet. Finally the sheet used as the template is installed in the last boiler of the order. Six drill presses are arranged to work on large sized sheets at one time. For smaller sheets two drill presses are used. It has been found more economical to drill sheets in multiple than to punch the required holes. As many as ten ½-inch sheets can be drilled at once; in fact the upper limit of thickness that can be drilled is about 6 inches.

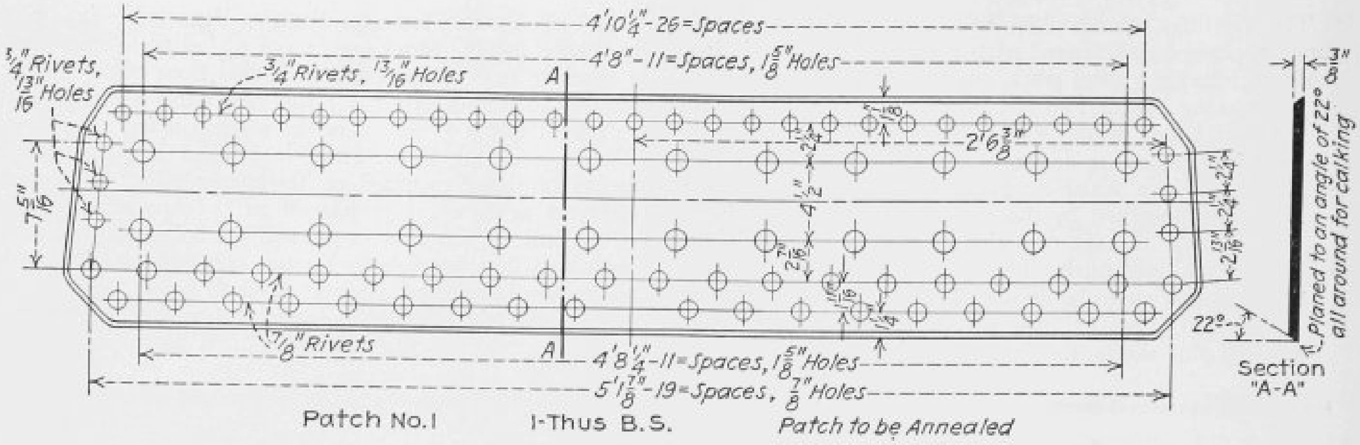
Method of Laying Out Throat Sheets

To speed up the layout of inside and outside throat sheets, the foreman of the department has developed a method which not only saves time and labor, but also insures absolute accuracy in fitting up the sheets on the assembly floor. When a

and then taking it down for drilling. The method has a great deal to recommend from the standpoint of accuracy.

Centralizing Production of Boiler Repair Parts

The above discussion deals entirely with the production of new boilers which have been standardized. Because any sheet that is made in this way can be used in any boiler of the same type, the possibility of carrying the same principle into the field of maintenance and repair has been taken advantage of by the railroad. By utilizing this system, centralization of the production of boiler replacement parts, as well as other standard parts, is possible. Boiler sheets for locomotives on all parts of the Pennsylvania Railroad are made at Juniata. Templates of all the main sheets in the standard locomotives are kept and a stock of standard sheets



Roof sheet patch for installation over two front rows of expansion bolts

of all kinds, such as tube sheets, inside and outside throat sheets, door sheets, and the like, are maintained. This method of course is only possible where a railroad is absolutely sure of its standards and of the interchangeability of sheets.

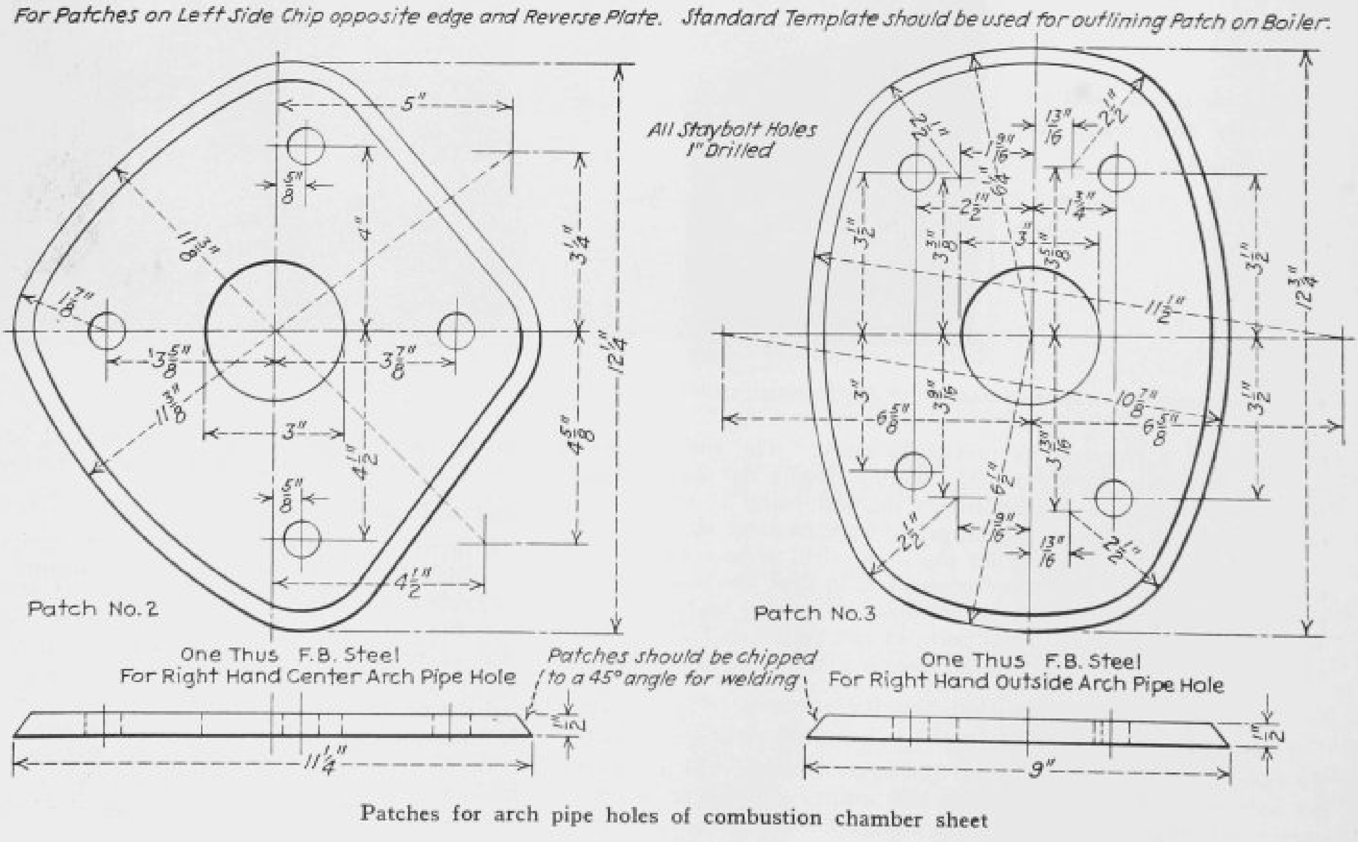
In the case of locomotives built by outside firms, the sheets are cut to size and shop rolled and flanged but are not drilled. They are left blank and bolted up ready for marking out from the old sheet and otherwise handled in the customary manner.

Standard Repair Patches

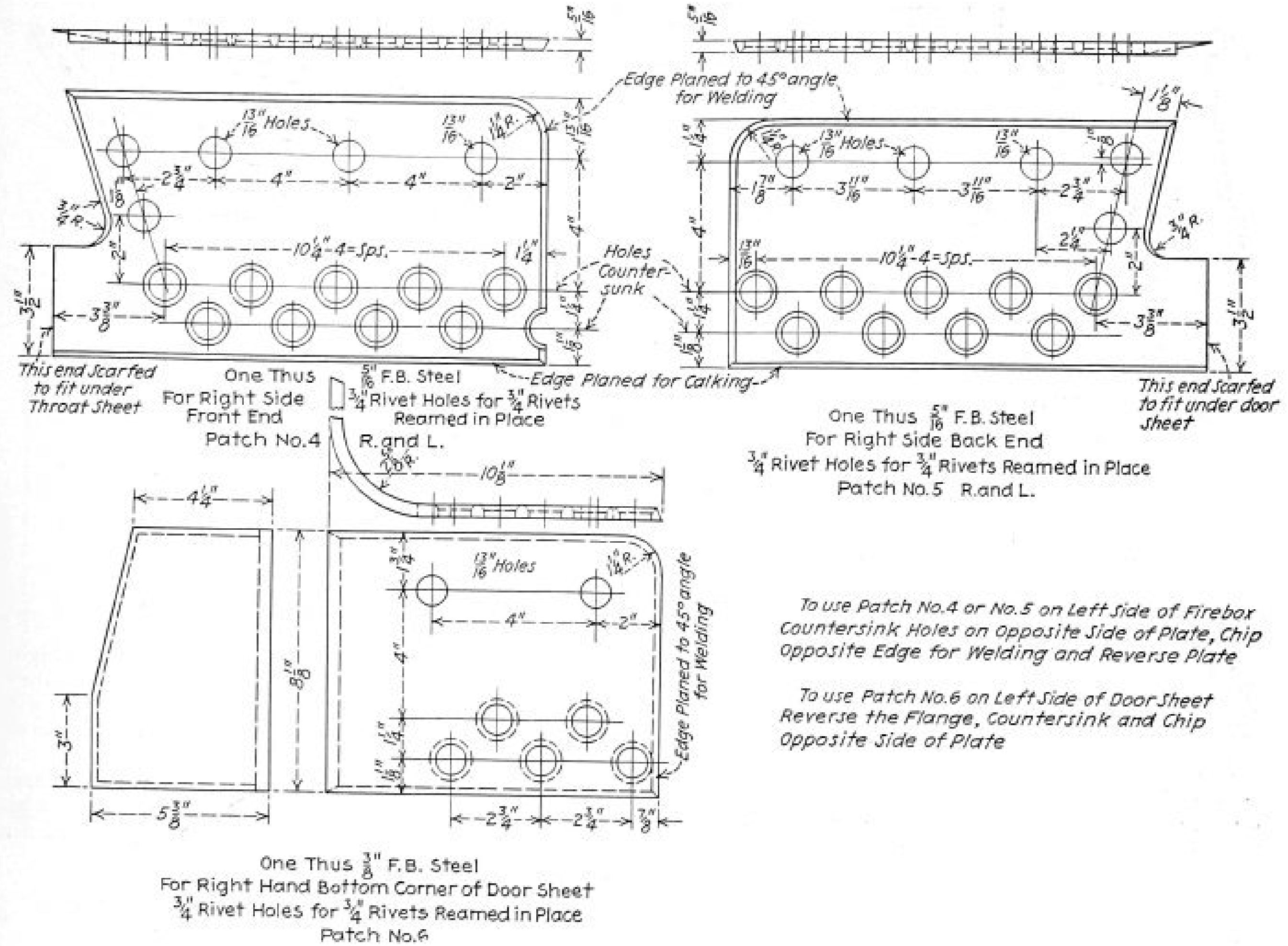
So close are the limits within which this work is carried out and so accurate is the result that it has been found possible to standardize the fabrication of patch repairs. Certain places in a boiler under given operating conditions show evidences of deterioration before other portions of the same boiler. When it is found that repairs to a given sheet in a number of boilers are made necessary by such conditions, a standard patch is developed to be used for replacement. Twelve of these standard patches are shown in the accompanying illustrations. They include patches for the roof sheet over the two front rows of expansion bolts; for arch pipe holes of the combustion chamber sheet; for the bottom corners of the firebox; for the firebox at the bottom of the side sheet and at the bottom of the door hole; complete firebox side sheet; for the back head; for firebox shell side sheets; for half, three-quarters up to full side sheets, mud ring patches, etc.

After developing a standard patch, a template is made from which a stock of such parts is fabricated and kept available to meet requirements from all over the system. By using these patches, a great deal of labor is avoided in their installation. Another advantage is that economy is gained by handling them on a production scale.

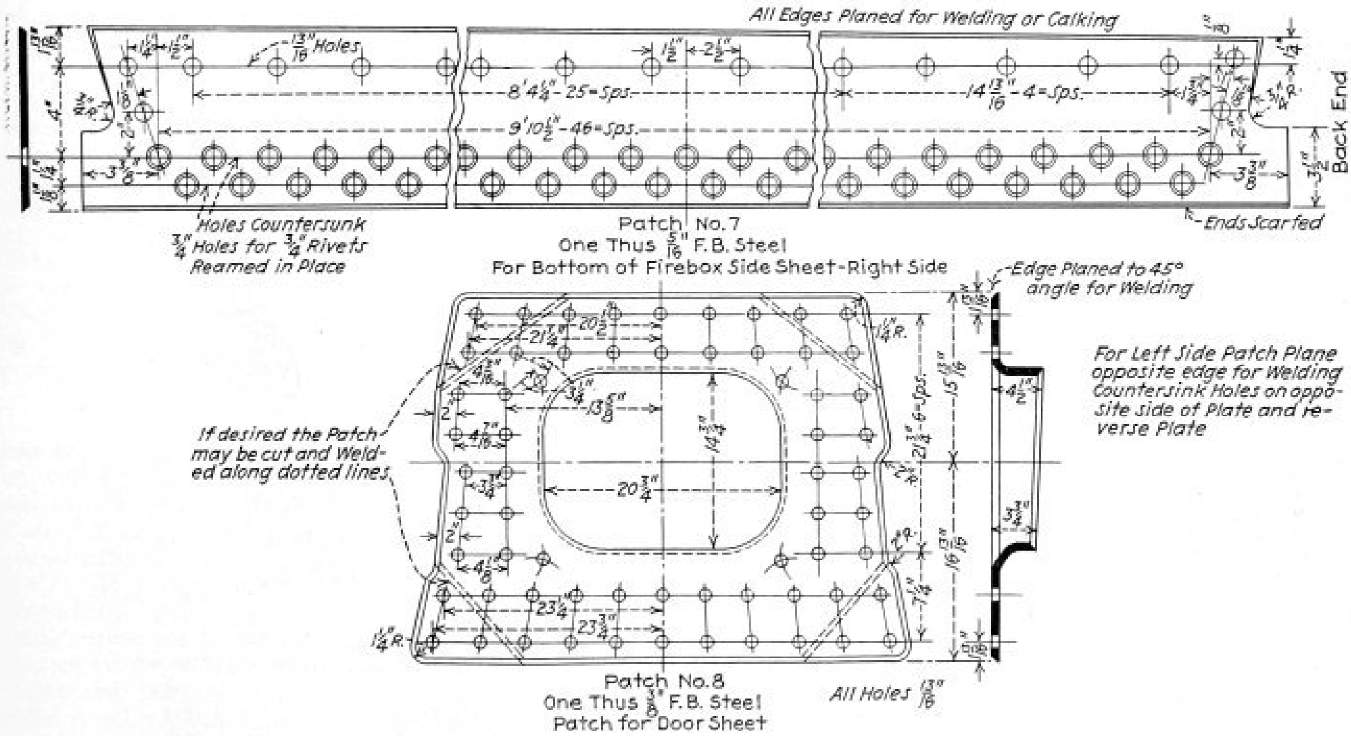
In installing such patches the usual method of cutting out



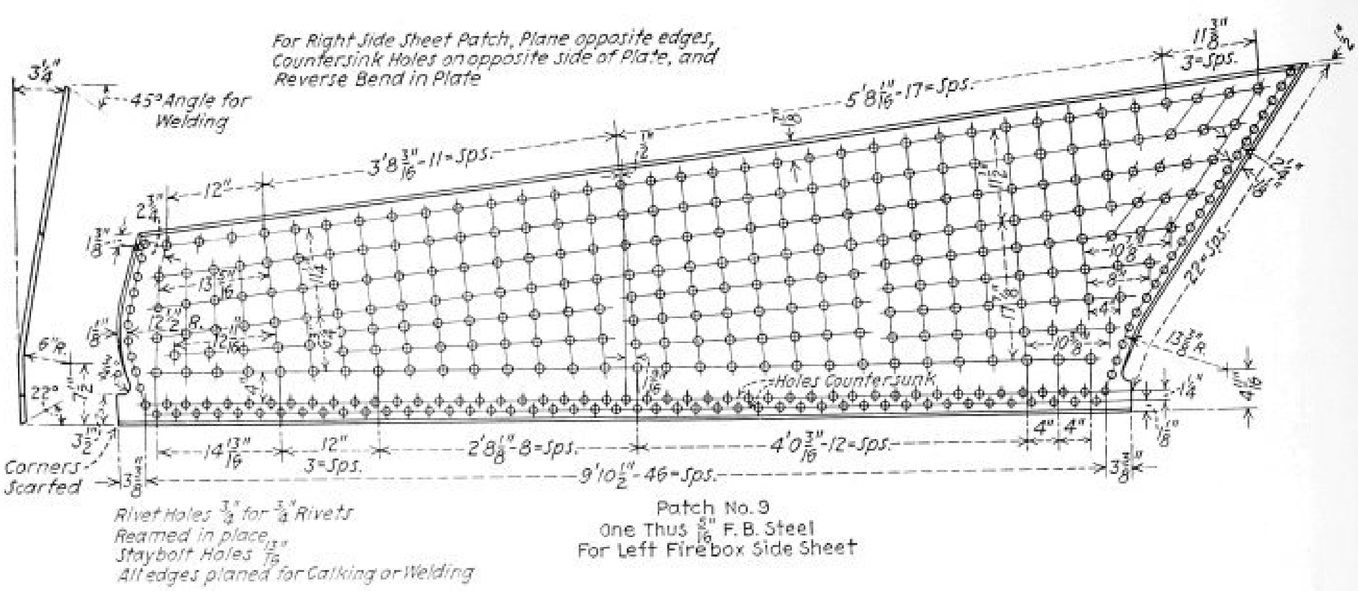
Patches for arch pipe holes of combustion chamber sheet



Standard patches for bottom corners of firebox



Patches for the firebox at the bottom of the side sheet and of the door hole



Patch for application to the side sheet of the firebox

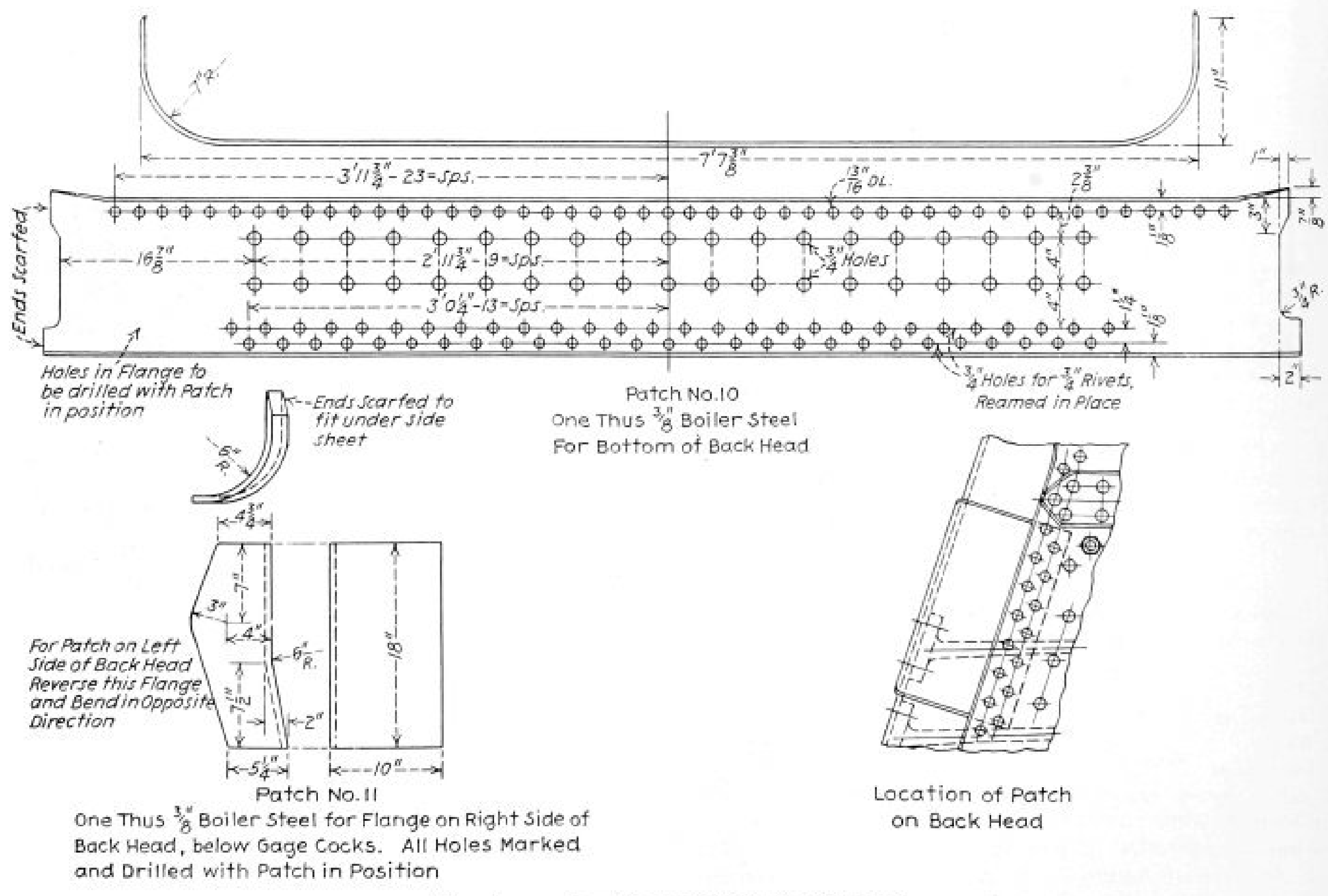
a defective sheet and marking out a new one from it and then bolting it in place for fitting can be dispensed with. The standard patch is taken to the boiler and used as a template for cutting out the defective part. The new patch is fitted into place and welded or riveted without further loss of time for adjusting, cutting or drilling.

A further article on the production of staybolts, crown bolts, and the like will appear in an early issue. In addition a complete outline of work as it is conducted at the Twelfth street shop will also be published.

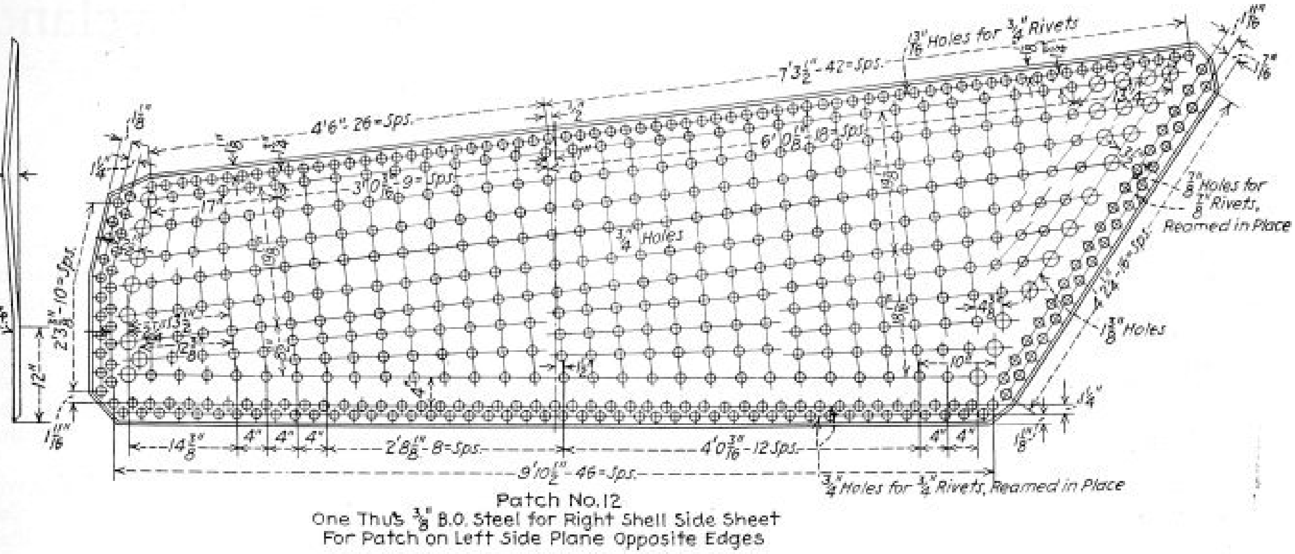
Welding Light Tubing

Broken steel and brass tubing is frequently brought to the welding table for repair, and sometimes gives the oxwelder a little trouble. The walls of such tubing are very light and melt quickly under the heat of the flame. An ever-enlarging hole often results.

An easy way to repair such breaks is as follows: Assuming that the tubing is of ½-inch inside diameter, a short length of 15/32-inch outside diameter tubing is fitted across



Two types of patches used on the backhead



Firebox shell, side sheet patch

the break as an inside sleeve. This tube provides backing for the welding. The break is then bronze-welded without difficulty, using a 1/8-inch rod and a small flame. But very little heat should be used, as the metal is thin. If the tubing is brass, a 1/8-inch brass welding rod is recommended.—*Oxy-Acetylene Tips.*

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

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

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

Below are given interpretations of the Committee in Cases Nos. 498 (Annulled) and 512 as formulated at the meeting of November 20, 1925, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

Case No. 498 (Annulled)

Inquiry: Case No. 512. Is it permissible to locate safety valves for unfired pressure vessels on the piping connected thereto, provided they conform to the requirements of Par. U-2, or is it the intent of the Code that they must be connected directly to the vessel?

Reply: It is the opinion of the Committee that the requirements of Pars. U-2 and U-6, regarding the location of safety valves, can be considered as fully met if the valves are located on the piping to the vessel, provided only there is no intervening valve or shut-off to isolate the safety valve from the vessel. Additional decisions on cases by the Boiler Code Committee will appear next month.

Marking the Contents Upon Cylinders

Considerable discussion of this subject has taken place in the past few years and many suggestions have been made as to the best method for indicating plainly upon the outside of cylinders what the content is.

One of these suggestions was to indicate the contents of the cylinder by its color. This, however, was given up as impractical for a number of very good reasons, one of these being that after a cylinder has been in use for a period of time it becomes difficult to distinguish its color. A second reason is the fact that various manufacturers have established colors for their own cylinders. It has, therefore, become general practice to mark the contents of cylinders upon the outside and this practice has been endorsed by many of the organizations of the industry.

The marks are placed upon the cylinders with a rubber stamp using indelible ink, which does not rub or wear off. The marking is renewed from time to time as the cylinder is returned to be recharged so that it is clear and legible.

The practice of marking cylinders is a distinct step toward greater convenience and safety for the user of these gases. There need be no doubt about the contents of a cylinder when so marked and not only the consumer but the shipper and handler in transit are benefited thereby.—*Acetylene Journal.*

The organization of Lee and Clark has recently been incorporated to take over the business conducted as a partnership under the name of The James T. Lee Company. James T. Lee is president and John O. Clark is vice president. Offices are maintained at 549 West Washington Boulevard, Chicago. The company specializes in hydraulic equipment, plate working tools, metal working machinery, pumps, car wheel borers, pipe benders, flexible steam joints, etc. Mr. Lee was formerly vice president of Hanna Engineering Works, Chicago, and for the past five years was western manager of Southwark Foundry and Machine Company. Mr. Clark, for a number of years, was sales manager of Hanna Engineering Works, Chicago.

The United States Welding Company, Inc., Minneapolis, Minn., have recently issued a chart showing the hose and regulator connections for various makes of equipment, as manufactured prior to January 1, 1926.

A. B. M. A. Holds Mid-Winter Meeting in Cleveland

President Bach makes constructive suggestions for improving business in the boiler making industry—Trade extension bureau, statistics and national advertising discussed

THAT a trade extension bureau would prove useful in creating new markets for the boiler making industry, was suggested by George W. Bach of the Union Iron Works, Erie, Pa., president of the American Boiler Manufacturers' Association, in his opening remarks at the mid-winter meeting of the association, held at the Mid-Day Club, Cleveland, Ohio, on February 12. The year 1926 starts out with better prospects for business in the boiler making industry than was the case a year ago, he said, although the past year has been fairly good as a whole. Business picked up considerably during the last six months of 1925 and there is every prospect that business will be more active during the next six months.

In reviewing the activities of the past year, Mr. Bach pointed out that profits in the boiler making industry were consistent with a table published in the *Literary Digest* six months ago, showing that profits for steel products were the lowest in the list.

In connection with this, Mr. Bach issued a word of warning against firetube boiler manufacturers going into the watertube field without carefully investigating the prospects. He cited the fact that two manufacturers of firetube boilers were contemplating increasing their plants to go into the watertube boiler field whereas probably a careful analysis would show that other lines of business would prove more attractive, such as the heating boiler field.

Mr. Bach also emphasized the attractive possibilities for boiler manufacturers existing in the field of isolated or independent power plants.

As a means for creating new markets and broadening existing markets for the boiler manufacturer, Mr. Bach suggested the usefulness of a trade extension bureau citing the excellent results obtained by this application in other industries. He thought helpful results could be obtained through the activities of a Trade Extension Bureau for boiler manufacturers.

Report of Secretary and Treasurer

President Bach formally introduced to the association its new secretary and treasurer, Mr. D. W. Glanzer of Cleveland, who was recently appointed to this office upon the resignation of Mr. H. N. Covell, formerly with the Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Mr. Glanzer reported that one new member had joined the association since its last meeting. His financial report showed a satisfactory balance in the treasury.

It was voted to send a resolution of thanks to Mr. Covell for his long-continued and effective work for the association.

Report of Stoker Committee

Owing to the fact that A. G. Pratt of the Babcock & Wilcox Company, chairman of the Stoker Committee, had not returned from a European trip, William H. Jacobi of the Springfield Boiler Company, Springfield, Ohio, presented the report of the Stoker Committee.

Mr. Jacobi pointed out that boiler guarantees are more technical than otherwise as they have to do with the absorption of heat by the boiler rather than with the burning of fuel. To make any guarantees usable it is necessary to rely on the measurement of quantities bearing no relation to boiler construction.

The committee recommended that the company furnishing the combustion apparatus be responsible for the amount of air and CO_2 produced and for the complete combustion of the fuel and that the boiler manufacturer be responsible for the absorption of the available heat by the boiler.

Mr. Jacobi reviewed his paper on "Guarantees on Boiler Performance" presented at the last annual meeting of the association pointing out that in many cases the boiler and superheater are penalized for faults not their own.

Mr. Bach reminded the association that Mr. Jacobi's previous paper had aroused a lot of interest among the boiler and stoker manufacturers and that Mr. Pratt's committee had carefully analyzed the paper. He agreed that the stoker manufacturer should be responsible for everything up to the boiler and the boiler manufacturer responsible for the rest.

Mr. Jacobi referred to the difference in efficiency and capacity. The capacity of the stoker is determined by the complete combustion of a certain amount of fuel in a given space whereas the capacity of the boiler depends upon the amount of heat absorbed. The efficiency of a stoker on the other hand is measured by the amount of fuel that can be burned completely whereas the efficiency of the boiler is the ratio of the heat used to the heat liberated.

Mr. Jacobi did not believe that efficiency should be demanded because so many things enter into the problem such as the variation in different fuels and the variations in operating conditions and the quality of firing. In other words, the efficiency of the plant does not depend entirely upon the performance of the boiler itself.

Mr. Bach declared that uniform guarantees should be used otherwise the buyer might be misled.

E. R. Fish of the Heine Boiler Company, St. Louis, Mo., stated that the question of efficiency is exceedingly complicated. The Power Test Code of the American Society of Mechanical Engineers includes both the boiler and stoker. The separation of the boiler and stoker has been discussed but present methods make it impossible to separate them, therefore the Code combines them. He believes that the principle is right but that it cannot be fairly accomplished with present methods. He pointed out that the definition of efficiency is not a matter for this association although an opinion might be given to the American Society of Mechanical Engineers.

Starr H. Barnum of the Bigelow Company, New Haven, Conn., stated that the committee intended to get an opinion from the American Boiler Manufacturers' Association and from the stoker manufacturers for fair guarantees and then to refer them to the mechanical engineers' society.

Mr. Jacobi pointed out that in many cases the boiler buyer gets the boiler and uses his own judgment as to the combustion equipment and then the boiler manufacturer is blamed if the results are not satisfactory.

H. E. Aldrich of the Wickes Boiler Company, Saginaw, Mich., suggested that the stoker manufacturers and boiler manufacturers make an agreement that each would be responsible for his end of the contract and then, if it was desired, they could make a combined guarantee.

It was voted that the report of the committee be prepared and distributed to the members so that it could be discussed at the annual meeting in June.

STANDARDIZATION OF RETURN TUBULAR BOILERS

H. E. Aldrich of the Wickes Boiler Company stated that the committee on Standardization of Return Tubular Boilers had no formal report to make. A standard design for a 72-inch by 18-foot boiler had been adopted and drawings of this would be prepared and sent to the members who are manufacturers of horizontal return tubular boilers. The setting and fixtures, he stated, were ready for the committee. He pointed out that the A. S. M. E. Code Committee will at some future time find it necessary to consider the matter of boiler supporting structures from the viewpoint of safety. In many cases weaker structures are now being installed than the building codes permit. Another matter that will also require attention is the strength of supporting bolts. He pointed out that the work of the committee covers a wide range and that at present they could offer only a progress report.

President Bach stated that the committee had done more work than most of the members realized and that it was their object to standardize size and fittings first. He explained that this standardization will be no obstacle to progress but that it will be a great benefit to the buyer. He agreed that a minimum fiber stress should be determined for the supporting structure.

Owsley Brown of the Springfield Boiler Company suggested that the A. E. M. E. Code Committee should cover the material in valves.

E. R. Fish of the Heine Boiler Company moved that a committee be appointed to frame a report to be submitted to the A. S. M. E. Code Committee covering the quality of valves and pressure fittings. The motion was carried and the president appointed as this committee Messrs. Gates, Cox and Middleton.

A. B. M. A. AND A. S. M. E. CODE REPORT

E. R. Fish, in reporting for this committee, stated that the Unfired Pressure Vessel Code is receiving most attention at present as regards welding. The Code, he stated, permits very little fusion welding. Higher unit pressures are under consideration, if they conform to the special requirements for welding, although he stated that no welding is likely to be permitted in the seams of boilers. Every communication that is sent in to the Code Committee, he said, receives careful attention.

STEEL HEATING BOILERS

W. A. Drake of the Brownell Company, Dayton, Ohio, presented a report for the Steel Heating Boilers Committee urging the necessity for broadening the field for steel heating boilers. One direction, he said, is to limit the field for cast iron boilers which are now installed for powers as high as 200 horsepower. That the results obtained by the use of cast iron boilers had been unsatisfactory was shown in the reports presented at the annual meetings of the association in 1922, 1923 and 1924. Cast iron boilers should be installed only where they can be used.

Two or three new phases of the question were brought out in the report covering such matters as the insurance losses in connection with cast iron boilers, the relative corrosion of steel and cast iron boilers, and the lack of licensed firemen for cast iron boilers irrespective of size. Mr. Drake pointed out that some architects are now being won over to steel boilers and predicted more rapid progress in the next few years. Why do architects and engineers, he asked, give so little attention to boiler rooms as regard light, space, accessibility and such matters? Boiler manufacturers should use their influence to make the architects make boiler rooms what they should be.

C. W. Edgerton of the Coatesville Boiler Works, Coatesville, Pa., pointed out that many high pressure watertube boilers are being installed for heating purposes. In Philadelphia, cast iron boilers are being used for all heating jobs and he believed that this was due largely to the effect of good advertising on the part of the cast iron boiler manufacturers which makes their clients believe that cast iron boilers are the best. He suggested that ratings be taken up by the committee in its next report.

C. E. Bronson of the Kewanee Boiler Company, Kewanee, Ill., stated that the question of fuel consumption is educating users to take steel boilers. The rating of heating boilers he thought will be taken care of without any action on the part of the boiler manufacturers' association. The insurance companies he pointed out have raised their rates on account of the cracking of cast iron boilers.

At the close of the morning's session the association went into executive session to consider the report of the Commercial Committee when standard data sheet for horizontal return tubular boilers was adopted.

A proposed data sheet for watertube boilers was also prepared but this is subject to further revision before adoption.

These data sheets have been compiled so that every bidder may submit a copy with his proposal so that the buyer can make a general comparison upon some of the vital points to see that all bidders are bidding upon the same thing.

Following the executive session the members adjourned for luncheon which was held in the dining room of the Mid-Day Club where an address on budgeting was delivered by H. I. Shepherd, vice president of the Guardian Trust Company of Cleveland.

Afternoon Session

At the opening of the afternoon session President Bach announced that Mr. Speller of the National Tube Company had been prevented from attending the meeting to deliver an address on boiler corrosion but that arrangements would be made for hearing this address at the annual meeting in June.

After brief discussion, the question of a standard bond for boiler manufacturers was referred to the annual meeting.

BOLT, NUT AND RIVET PROPORTIONS

President Bach asked if boiler manufacturers wanted to go into the standardization of bolts, nuts and rivets.

D. J. Champion, president of the Champion Rivet Company, Cleveland, Ohio, stated that the Navy Department has been looking into this matter for two years and that boiler manufacturers should keep in contact with progress being made in this direction. It is only a question, he said, of a good standard article in the least number of sizes and shapes to eliminate waste. He believed that it is better to let the Government settle it.

Mr. Champion then referred to the requirements for rivets for high pressure boiler work, stating that the time is coming when more will be expected of boiler manufacturers in substantial workmanship. Hasty work in large volume will not stand, he declared; for high pressures today the ordinary rivet is a failure. For a pressure of 600 pounds per square inch the best designers insist on closer tolerances in rivets. More work on the rivets is required and no calking of the rivets is allowed at this pressure. Therefore the boiler manufacturers must give a good hole so that the rivets will fit.

Efforts have been made to see how many horsepower can be turned out. On the other hand manufacturers should try to get out the best work. Excellence in workmanship is the keynote of success in getting business, he declared. The big power users are ready to pay a little more for better rivets and for making better holes.

President Bach reminded the association that the recollection of quality remains long after the price is forgotten.

Boiler Sales Reports

President Bach stated that the compilation of boiler sales reports was started by the association with enthusiasm to determine the annual output of the industry. At first all reported their sales but recently there has been some opposition and some of the big manufacturers say that they will discontinue the reports.

Mr. Bach pointed out that statistics are useful only if they are complete. He stated that the statistics compiled by the association were not for publication and were available only to those interested.

F. G. Cox of the Edge Moor Iron Company, Edge Moor, Del., suggested that separate reports be compiled for each type of boiler and the results be circulated only among those manufacturing their own type.

C. W. Edgerton stated that the horizontal return tubular report would be more valuable if made sectionally.

Owsley Brown suggested that the president send letters to each member explaining the proposition and asking for changes and revisions or objections.

Keynote Advertising

W. A. Drake explained the effective results obtained by the use of keynote advertising in other industries and suggested that it would be beneficial if the boiler manufacturers adopted some such scheme so that properly selected keynote ideas may be incorporated in individual advertising.

E. R. Fish suggested that the boiler making field can be broadened or the present field can be kept from slipping away only by means of a central organization including manufacturers of various types of boilers, manufacturers of safety valves, etc., through propaganda. A small committee cannot do much, he stated, it is far better to get the cooperation of other organizations supplying the different items of equipment.

It was suggested that Mr. Drake's committee report further on this subject at the June meeting.

New York State Boiler Code

H. E. Aldrich said that he had checked the new Code and found no differences from the A. S. M. E. Code. Possibly some changes may be required, he stated, for existing installations.

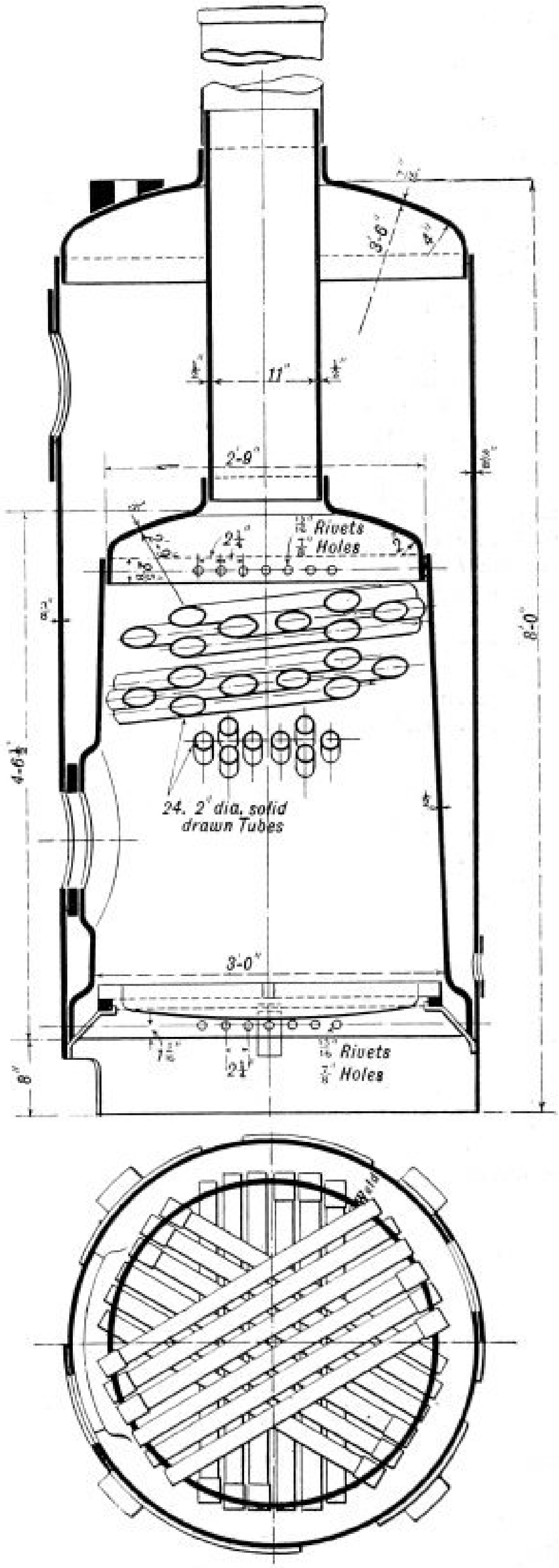
In closing the meeting President Bach announced that the annual meeting of the association would be held May 31, June 1 and 2 at The Homestead, Hot Springs, Va.

"Thermax" Cross-Tube Type Boiler

Among other exhibits at the recent Shipping, Engineering and Machinery Exhibition, held at Olympia, London, England, *The Engineer*, describes the "Thermax" boiler built by Ruston and Hornsby, Ltd., of Lincoln, England.

This boiler which is a Ruston patent was designed with the object of producing a boiler which, while retaining the reliability of the vertical cross-tube boiler, has the advantage of a decidedly higher efficiency. Prior to placing this new boiler on the market, a Thermax boiler was thoroughly tested in the works over a period of nine months, during which time, with the exception of week-ends, it ran at an overload rating of 30 percent. After examination at the end of this period it was found to be in good condition.

From the elevation and plan drawing shown it will be seen that, instead of large-diameter tubes, tube nests are arranged in a series of tiers, and are so placed that the furnace gases are broken up and circulated round the tubes on their way to the uptake. The inclination of the tubes is stated to facilitate circulation and promote easy steaming, which is further assisted by the large firebox heating surface. Accessibility has been kept in mind, and in the particular example we illustrate, which is designed for a working pressure of 120 pounds per square inch, twenty-four solid drawn steel tubes of 2-inch external diameter are employed. They are expanded into the furnace shell, and opposite each nest are placed handhole doors, which permit the tubes to be in-



Cross-tube type boiler

spected and cleaned, and at the same time give access to the firebox shell. Thermax boilers are built in eleven sizes, varying from 6 feet 9 inches high and 2 feet 9 inches in diameter to 14 feet high and 5 feet 7 inches in diameter.

Bulges and Patches in Boiler Plates*

Hard and soft boiler patches and how and where to use for repairs

BOILER patches are of two kinds, which are respectively known as "hard" and "soft." A patch is "hard" when it is solidly riveted to the boiler shell, and "soft" when it is attached to the shell by means of patch bolts. The "hard" patch is greatly to be preferred and should be adopted whenever the conditions will permit. Sometimes, however, it is impossible to get at the inner surface of the patch, so as to be able to support the rivet solidly enough to allow the formation of a good head on the outer end, and in a case of that kind the "soft" patch must be used. "Soft" patches are commonly applied, for example, on the waterlegs of vertical tubular and locomotive firebox boilers, because in such cases the inner surfaces are practically inaccessible when the patches are in place. If a "hard" patch can be put on, a "soft" one should not be used, except for temporary repairs or in emergencies when a stronger construction is to be substituted at the earliest opportunity.

A patch should always be applied to the *inner* surface of the boiler shell, when this is practicable. This is advisable for two reasons: (1) because when the patch is on the inside of an externally fired boiler, the pressure forces it up against the boiler shell, and this tends to keep it tight and to relieve the tension on the rivets; and (2) the pocket that is formed when the patch is on the outside of such a boiler may, under some conditions, collect sediment and scale and thereby lead to trouble. It is hard to make a good, strong, satisfactory job on a "soft" patch, however, if it is placed on the inside. Moreover, the conditions that make it necessary to apply a "soft" patch instead of a "hard" one may also render it difficult to introduce the patch plate into the interior of the boiler. It is an almost universal rule, therefore, to apply a "hard" patch to the inside of the shell, and a "soft" patch to the outside surface; and in what is said in the present article it is assumed that this practice is followed.

Some engineers maintain that a patch plate should always be a trifle thinner than the boiler plate itself, the difference in thickness being about 1/16 of an inch. In certain states, however, the law requires that the patch shall be of the full thickness of the boiler plate. The advice of the boiler inspector should be taken on this point also; for he will not only understand the technical points involved, but will know the legal requirements also.

"Hard" Patches

As already stated, a "hard" patch is applied to the *inner* surface of the boiler and this fact carries with it certain implications in connection with the shape of the patch. The patch plate must necessarily be larger than the hole, and this means that the hole cannot be *circular* in shape, for example, because it would then be impossible to get the patch plate into the boiler, unless it were small enough to be introduced through the manhole. The opening that is cut must be designed with due reference to the possibility of introducing the patch plate through it, and of then getting the plate into correct position for the final riveting. Sometimes the conditions are such that this calls for quite a bit of skill and experience. On this point we cannot give detailed advice, because every case is almost a "law unto itself."

When a "hard" patch is applied to the inside course of a boiler adjacent to a girth seam, as in Fig. 3, the inside plate of the boiler shell must be thinned down at the parts *AA*. For the same reason, when applying a "hard" patch to the outside course, as shown in Fig. 4, the patch itself is scarfed down at *BB* by heating and hammering, and is fitted snugly in between the two shell plates.

In most cases the holes for the rivets are first punched or drilled in the patch plate, which is then used as a templet

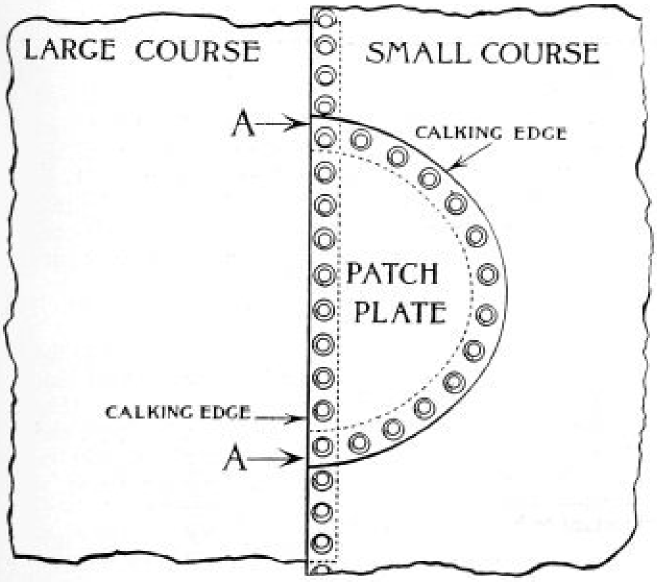


Fig. 3.—Showing a hard patch applied to inside course of horizontal boiler

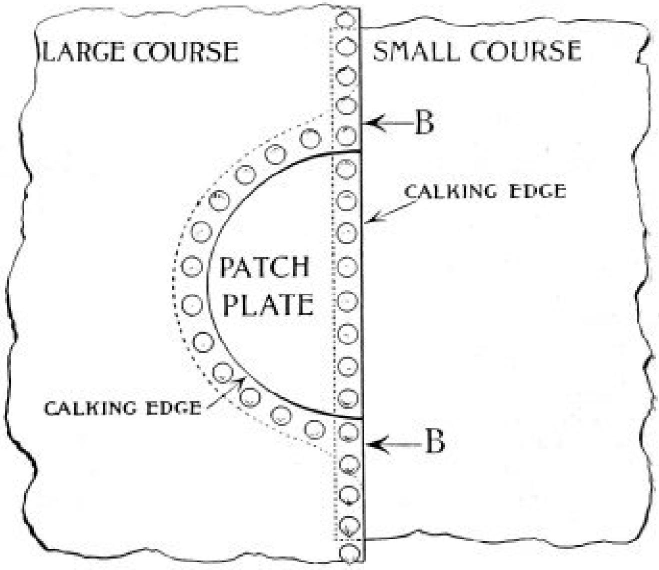


Fig. 4.—Showing a hard patch applied to outside course of horizontal boiler

* This article is reprinted through the courtesy of *The Travelers Standard*, published by the Travelers Indemnity Company, Hartford, Conn. The first installment of this article appeared on page 53 of the February issue.

(as previously suggested) to mark off the places where the rivet holes are to be drilled in the shell. This is done, of course, with the patch held against the *outside* of the boiler. Due allowance should be made, in drilling the holes, for the fact that the patch, when completed, will be on the inside; because this difference will involve a slight change in the positions of the holes. In any event it is advisable to drill the holes a little smaller than the finished size (both in the patch plate and in the boiler plate), and to true them up and make them "fair" with one another by reaming.

Sometimes, when the patch is quite large, a different procedure is adopted. For example, if there were 15 rivet holes to be provided in a straight line, the position of the two end holes might be marked and the intervening holes spaced and drilled without reference to the patch,—a reamer being finally run through the patch and the shell plate to bring all the holes "fair."

When the holes have been drilled and reamed, all remaining burrs should be carefully removed, and the job is then ready for riveting. For this purpose it is advisable to use an air gun with an air pressure of from 90 to 110 pounds per square inch, if this is feasible. The holder-on is an exceedingly important man in the riveting of a patch, because he can easily spoil the whole job. In fact, the holder-on is so big a factor that the riveting should not be attempted at all until the right man for this part of the work is available.

When the rivets have been driven, the plate is to be carefully calked to make the patch tight. In the case of a "hard" patch, with the plate on the inside of the boiler, the calking will naturally be done along the edges of the *boiler plate;* but if it is practicable to do so, the edges of the patch plate should be calked, in addition. (The rivet holes should not be countersunk when applying "hard" patches, because of the difficulty in keeping the rivets tight.)

"Soft" Patches

As already stated, "soft" patches should be applied only when the conditions to be met make it impracticable to do any riveting, on account of the difficulty of holding the rivets on the inside. They are usually made of mild steel boilerplate which can be hammered to the desired form while the metal is cold.

In making the bolt holes for securing a "soft" patch in place, three or four holes may be drilled first, and brought

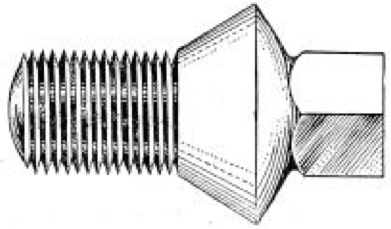


Fig. 5.—Type of patch bolt used

fair with one another on patch and boiler plate, by reaming. The patch plate may then be bolted in place against the boiler, and the remaining rivet holes drilled through patch plate and boiler plate in one operation, thus insuring the "fairness" of the holes. The patch is then to be taken off, and the holes in the boiler tapped to fit the patch bolts that are to be used.

For securing a "soft" patch on a boiler, the bolts that are used should always be the regular boiler patch bolts, which are made for this special purpose and are provided with square shanks projecting outward from the head to receive the wrench that is used in screwing the bolts into place. Patch bolts are not square shouldered under the head, but are cone shaped there, with a standard taper. The holes in the patch are countersunk to receive the patch bolts, and if the bolt is of the right size the countersink should just extend through the full thickness of the patch plate. Boiler makers occasionally fail to attend to this point, and do not countersink the holes deeply enough; and in consequence they not only thread the hole in the shell plate, but also thread some small part of the hole in the patch. This is a grave error because a patch made in this way can never be brought up tight against the shell.

After making sure that no burrs remain in either the patch plate or the boiler shell, the patch is put in position again and securely bolted in place.

When the patch bolts have been screwed up as solidly as possible, the square heads with which they are provided to enable the boiler maker to apply his wrench are sawed off with a hack saw, or else nicked with a cold chisel and then knocked off. The flat end of each bolt is then well hammered on the outside, to drive it into tight contact with the patch plate,—the bolt being meanwhile backed up on the inside, if it is possible to get at it so that this can be done. Patch bolts should be at least long enough to engage the thread through the whole thickness of the boiler plate, and it is usual to make them from an eighth of an inch to a quarter of an inch too long, so that they project inside the boiler by that amount.

The edges of the patch plate must be well calked; and the patch bolts should also be calked, if there is the least doubt about their being perfectly tight after the hammering to which they have been subjected.

A gasket is sometimes placed between a "soft" patch and the boiler shell, but this is seldom necessary. Lead has been recommended for this purpose, but it should not be used because it will almost certainly melt out or blow out while in service. A thin gasket of soft copper may be used if desired, but it should not be necessary unless the boiler plate is corroded so that it is slightly rough or uneven on the outer surface.

In General

From the fact that so much space has been devoted to the consideration of boiler patches, it must not be inferred that we are unduly in favor of making repairs in this way. The boiler patch is a well known and useful thing, however, and it has its legitimate place. The point we wish to make is, that if a patch is the right thing to use in any given case, it is important to have it applied in the right way.

There are many factors to be taken into consideration when deciding whether or not a patch should be used, or a patched boiler be continued in service. If oil or powdered coal is used as a fuel or if a stoker or forced draft apparatus is employed, there would be a greater possibility of trouble than there would be in the case of a hand fired boiler operated under a moderate load. Every case should be considered separately and all the operating conditions should be taken into account.

McClellon Locomotive Boiler

(*Continued from page* 70)

The results of service and the tests have been so satisfactory and so conclusively demonstrated the advantage of the McClellon boiler that, when ten new engines were recently purchased for the road, there was no question or discussion as to the type of boiler to be used. The McClellon watertube boiler was ordered to be placed in all of them.

Dual Current Welding Generator

(*Continued from page* 70)

mutator and a. c. collector rings interval, each ball bearing and frame is demountable separably. There is a shaft extension on both ends of the generator so that air compressors or other power take-off can be utilized. The generator will operate in either direction and the voltage and current are adjustable independently.

The Development of Watertube Locomotive Boilers

A discussion of the problems confronting the designer of watertube locomotive boilers and suggestions of the possible trend in design

By Louis A. Rehfuss

WATERTUBE boilers will undoubtedly play a considerable part in the locomotive boiler design of the future. In the stationary field, their advantages as well as their improved circulation, greater safety and other factors have already made them supreme. The actual design of a satisfactory watertube locomotive boiler is fraught with many difficulties and this has hindered their adoption heretofore.

Assuming that our watertube boiler is to consist of water and steam drums and watertubes, the placing of these to the best advantage immediately becomes a problem. Suppose we place the watertubes horizontally running lengthwise to the boiler axis as shown in Fig. 1.

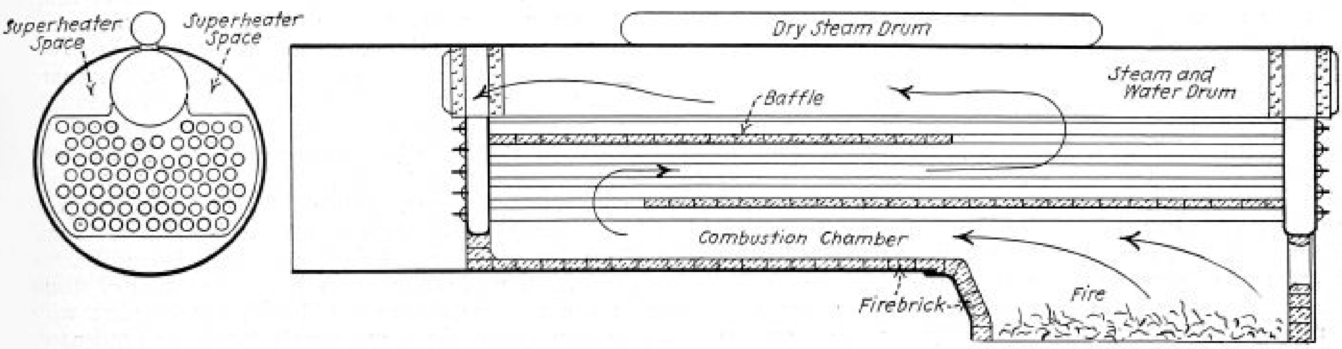


Fig. 1.—Watertube locomotive boiler with tubes disposed horizontally

This method has the advantage of simplicity, low first cost and ease of repair. Unfortunately, however, such a boiler cannot be forced to the high rates of firing common in railroad practice. When forced above nominal overloads, the steam forming in the middle of the tubes tends to become locked temporarily, holding the water back, so that burning of the tubes may easily ensue. When the steam does finally force its way out it tends to blow out both ends. Wherever such boilers are used in stationary practice they are never subjected to overloads of more than 100 or 200 percent above their rating without considerable trouble from burnt-out tubes.

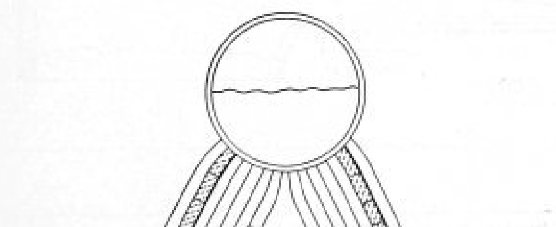


Fig. 2.—Watertubes arranged vertically

For high rates of forcing it is customary in watertube boiler practice to arrange the tubes as nearly vertical as possible, as shown in Fig. 2. The weight of the column of water then forces the steam to flow naturally in only one way no matter how fast it may be generated. Thus the forced draft watertube boilers developed for torpedo boats, which must be capable of extremely rapid steaming, adhere to this general principle. In Fig. 3 is shown an adaptation of this principle within the compass of a locomotive boiler.

When confined within these space limitations, however, other serious difficulties arise. The tubes must be made so very short, from 3 to 5 feet in length, that an excess number of joints is created, unduly complicating the whole structure if an adequate amount of evaporating surface is to be provided. At the same time, with bent tubes placed so thickly in nests 8 or 10 deep, the problem of removing or replacing worn-out tubes from the interior of such a nest would be difficult to say the least.

Between these two extremes lie many alternatives, two of which are shown in Fig. 4 (*a* and *b*). The arrangement shown in *a* is an improvement over the horizontal tube arrangement given in Fig. 1, in several ways. It is doubtful, however, whether the rise of about 1 to 10 that can be given the tubes would be sufficient to force the fires to the degree of overload rating really necessary. Other arrangements would seem to offer greater advantages.

Watertube Arrangements

The arrangement of watertubes shown in *b*, suggested by William A. Newman, in an article which appeared on page 337 of the December, 1925, issue of The Boiler Maker, is somewhat similar to the steam pipes of a Schmidt superheater. The Schmidt superheater is successful, because it keeps all the joints in the comparatively cool smokebox area and yet extends its tubes into the higher heat near the firebox. In the case of the steam superheater, the steam flows

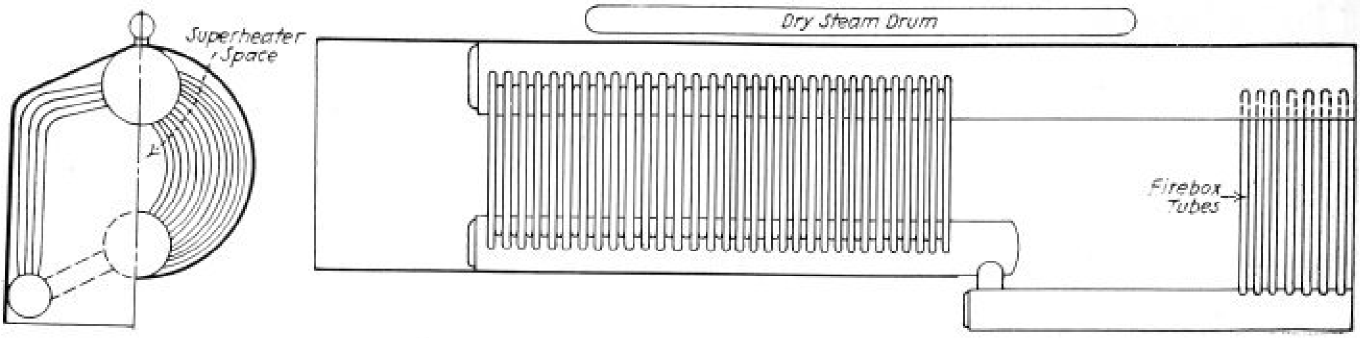


Fig. 3.—Watertube locomotive with vertical tubes

freely through, unblocked in its progress by water columns. As watertubes they would suffer from the same drawbacks as the tubes in Figs. 1 and 4 (*a*), aggravated by the additional length of tube provided. Straight tubes, if they can be used, seem more satisfactory than bent tubes, both from the standpoint of inspection and cleaning, as well as of replacement within the space limitations provided.

A compromise between the extreme forms is suggested in Figs. 5, 6 and 7. Here straight inclined tubes are used, placed at an angle of 30 degrees or any angle found most suitable. The tubes become long enough to reduce the number of joints considerably and yet are pitched sufficiently to withstand high rates of forcing. By making the top cover plates removable, the tubes can be inspected or removed when desired directly through the handholes in the headers. Sufficient rigidity to withstand the jars of railroad service is a question of proper bracing and support to the outside shell, which acts as a supporting framework for the whole system, in addition to being an insulation for the prevention could be supported by the forward wall of the combustion chamber. The skill with which such details were designed would determine the success of the arrangement proposed.

Preventing Radiation

As a lining for the shell to prevent the radiation of heat, we must depend largely on either or both of two mediums: firebrick or preheating water. Where the heating is to be done in two pressure stages, as suggested by Mr. Newman, preheating water walls would be employed. To operate a two-pressure system successfully it would be necessary to pump the water into the high pressure system as fast as it reached the desired pressure in the low pressure system and before it burst into steam. When it is considered that one pound of steam at 100 pounds pressure will occupy a volume 200 times that of an equal weight of water, it is readily seen that the formation of a comparatively small amount of steam in this low pressure system would seriously interfere with its operation unless the steam were removed or condensed.

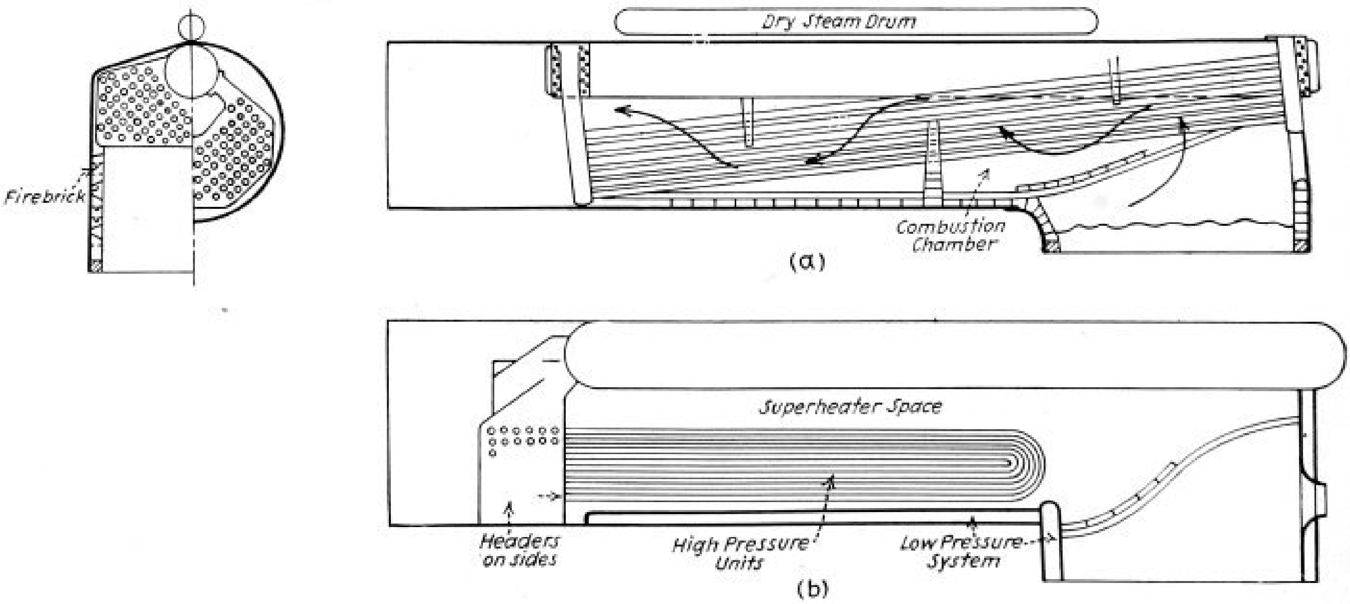


Fig. 4 (a).—Boiler with horizontal watertubes slightly inclined
Fig. 4 (b).—Watertube boiler suggested by Newman. (The Boiler Maker, December, 1925)

of radiation to the outside air. The headers in particular would have to be carefully supported and braced. Fig. 7, a detail of these headers, shows how each one is partially supported by the tubes of the header immediately adjacent and to the rear. The last row, nearest the firebox, would then require to be especially supported. Above, this may be accomplished by special braces extending from drum to shell wall. Since such braces would lie just above the firebox tube walls, they would be out of the direct heat of the fire and therefore free from burning. Below, the last row of tubes

To remove it by using it for locomotive operation would defeat the purpose of the system. To condense one pound of such steam at 100 pounds pressure would require the absorption of 880 heat units. Pumping in cold feedwater for such a purpose would mean introducing at least three pounds of water for every pound of steam to be condensed, without taking care of the heat being steadily received meanwhile from the fire.

To prevent the excessive formation of such steam, it seems advisable to keep any low pressure system employed out of

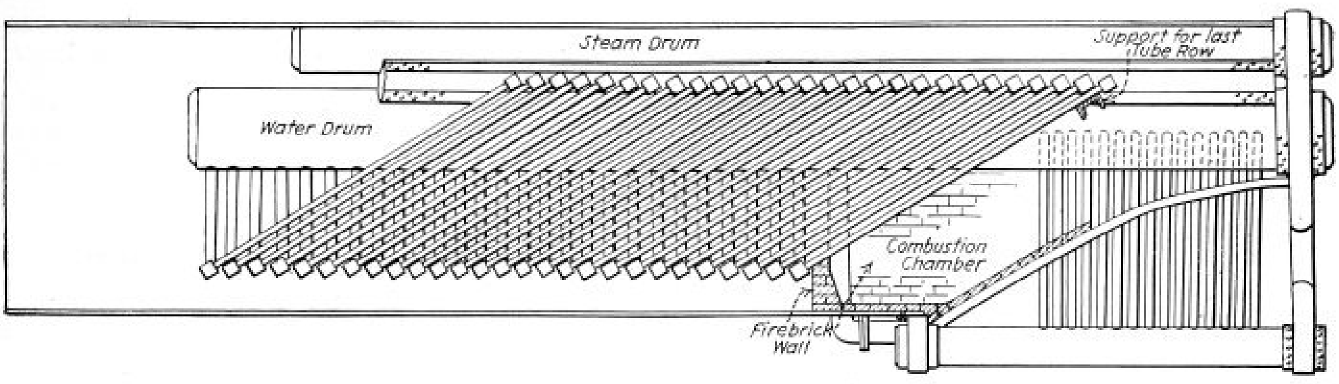


Fig. 5.—Watertube locomotive boiler with straight tubes inclined 30 degrees

the firebox as well as out of all high temperature areas, which should be reserved for the high pressure system entirely. To prevent radiation from these areas, firebrick would then be preferably employed as shown in Figs. 5 and 6. Should a preheating or low pressure system then be desired, because of its ability to extract scale-forming materials and heat feedwater, its use should be restricted to the smokebox and forward portions of the barrel, where temperatures are lower. It would then be used in place of firebrick to line the plate of the barrel in these sections.

One of the big problems in the design of all locomotive boilers is the provision of sufficient combustion space. Particularly at the higher rates of firing, the efficiency of combustion is lower than the boiler's efficiency in absorbing the heat that is given off by the fire.

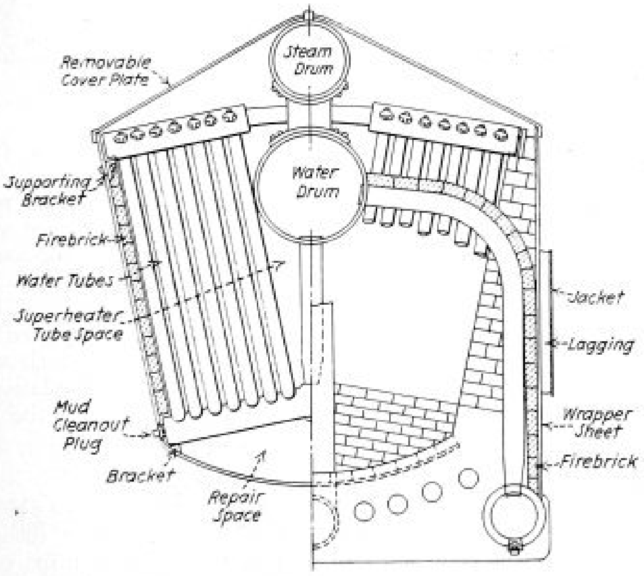


Fig. 6.—Cross section of inclined watertube boiler

The more open arrangement of flame and gas pathway possible with watertube boilers actually extends the combustion space as compared with firetube boilers, but would also result in higher smokebox temperatures. The lessened resistance to the path of the gases, however, makes it possible to operate with a lower pressure on the exhaust. This gain in efficiency at the lower end of the pressure scale through reduced cylinder back pressure offsets any loss occasioned by higher smokebox temperatures.

Use of Superheat

In the use of high pressures, correspondingly higher temperatures result. Modern steam machinery is limited in its capacity to stand excessive temperatures. Even so it is the practice to use high superheats, so that final temperatures of 600 or 700 degrees are not uncommon, while 725 is recommended in some stationary practice. Were no superheat used these temperatures would correspond to pressures of 1,500 to 2,000 pounds. In place of using a high initial superheat, the correct policy with high pressures would seem to be to expand in two stages, using a moderate superheat for the first stage and superheating intermediately as well. In

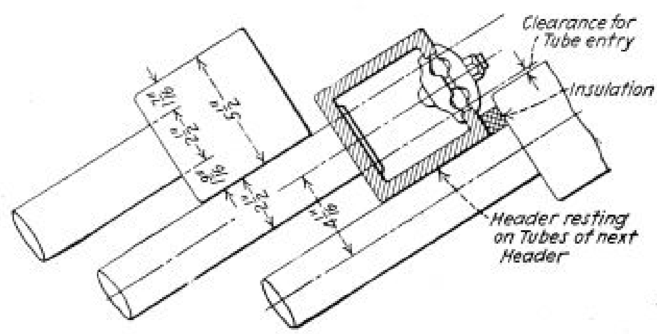


Fig. 7.—Detail of headers (inclined tube boiler)

this way an excellent efficiency ought to be derivable from the use of high pressure compound locomotives.

An objection to the use of watertube locomotive boilers might be urged in the lessened steam and water capacity available. The area outside the tubes of a firetube boiler is greater than the area inside the tubes of a watertube boiler of the same overall dimensions, so that the latter would have less steam and water capacity. This very fact, however, enables the watertube boiler to raise steam much more quickly and to respond more quickly to forcing. The high pressures possible with the watertube designs would also obviate the necessity for large steam capacity, since one pound of steam at 500 pounds pressure occupies but 42 percent of the space it would occupy at 200 pounds pressure.

Crown Sheet Failures

From the standpoint of safety, the great bane of the firetube boilers, which is crown sheet failures, is avoided; so that where failures may occur, they are more local in their action and possess less serious consequences as a whole. An increase in the number of joints from what is required in firetube practice is, however, scarcely avoidable and as we have said previously, the success or failure of the watertube locomotive boiler would depend to a considerable degree upon the skill with which such joints were designed and braced to permit expansion and withstand shocks.

Aside from the possibility of using high pressures, as well as the other benefits recited, one of the greatest benefits to be derived from the use of a watertube locomotive boiler would be the superior water circulation possible with it. Not only does this ensure a high evaporative efficiency, but greater dryness of steam, lessened scale deposition, and the maintenance of more even temperatures throughout the system also result.

While many difficulties lie in the way, the production of a successful watertube locomotive boiler will not be the work of a moment or a year. Once the need or demand for such a boiler becomes sufficiently apparent, means will be found to overcome or circumvent those difficulties and the necessary investigations will be carried out.

Milburn Oil Burner and Preheater

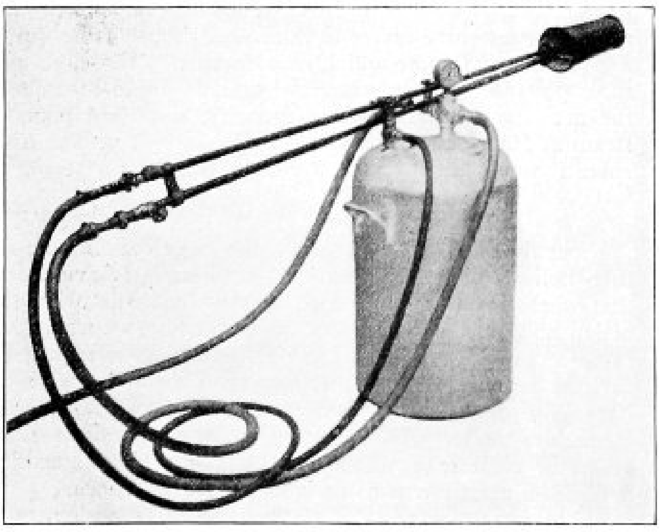
IN welding many castings, preheating is necessary to neutralize expansions and contraction strains or to effect economy of gases. Without preheating, complicated castings are liable to develop new breaks at points remote from the weld after the weld itself has been successfully completed. Large castings will absorb a large amount of heat from the welding flame before a local melting heat is attained, so a great gas saving can be made by first preheating the entire piece.

An oil burner and preheater recently placed on the market by the Alexander Milburn Company, 1418 West Baltimore Street, Baltimore, Md., is primarily designed for this work and to give maximum combustion and greatest heat in the quickest possible time, thereby resulting in greater output from men and machinery.

The burner is of the atomizing type utilizing economically the cheapest grade of crude, fuel, kerosene oil or distillate and compressed air under pressure varying from 50 to 100 pounds.

The air supply line serves two purposes. While furnishing a direct flow to the burner, the air also maintains a similar pressure in the oil storage tank, creating a greater velocity in the oil feed line thus insuring a positive and uniform flow of both oil and air.

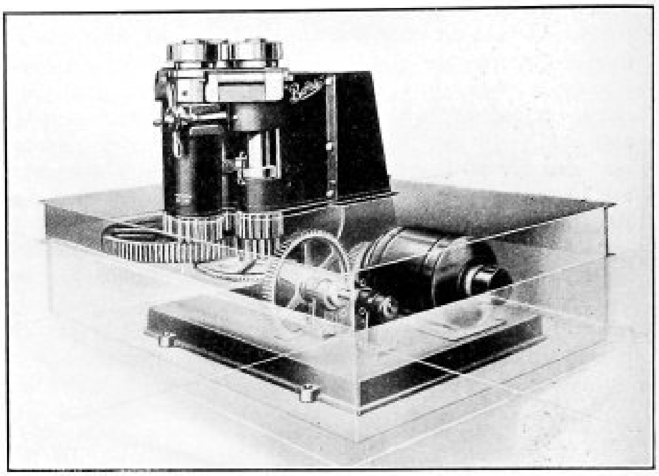
The flow of both air and oil are through straight-line orifices, unhindered by coils or staggered passages. The oil, under pressure, enters the atomizing chamber at right angles to its axis and in an annular form, while the compressed air flows directly through the center striking the filament of oil and completely atomizing it, then expanding it in a venturi-shaped outlet. A thorough mixing vortex is thus set up, producing an intimate and perfect mixture of both oil and air which insures complete consumption and maximum heating value at the flames. No particles of fuel are blown through the flame unconsumed. There is no siphoning effect of either oil or air. Immediately upon opening the valves the gas at the burner can be ignited and the work at hand can be started. It is claimed that carbonization and oxidation are eliminated.



Oil burner and preheater which can be used for many purposes

New Buffalo Bending Roll

A NEW type of bending roll has been built by the Buffalo Forge Company, Buffalo, New York, to meet the special requirements of the General Electric Company, which has three other Buffalo bending rolls of the vertical type in various plants. While the General Electric Company plans to use the machine on one job only, bending flat bars on edge, in various diameters, the same rolls that are used on other Buffalo benders can be furnished for this machine.



Bending roll adaptable to many uses

The rolls on the Buffalo No. 1 horizontal bending roll, as the new machine has been designated, are arranged vertically, so that the material worked on is in a horizontal plane. The entire machine is mounted on a cast iron base plate at the bottom of a pit 16½ inches deep by 73 inches long by 64 inches wide. Ten-inch channel irons placed on the floor support a ⅜-inch checkered steel plate which surrounds the machine. This makes the checkered plate, or machine platform, 10 inches above the floor line, while the rolls proper are 36 inches above the floor line.

Additional Rolls

By using additional rolls, it is possible to bend angles, leg in or out; tees, leg out, squares, across flats or corners, round or twisted bars, flats across or edgewise, rails, copper tubes, 12 or 16 gage; extra heavy steel pipe, heavy steel pipe, standard steel pipe, I-beams on web or flanges, and channels, flange in or out.

Among other changes made possible by the vertical arrangement of rolls, all gearing is now concealed and out of the way. The drive is by a 10 horsepower General Electric reversing motor, having a pinion keyed to the motor shaft and driving a gear on the main drive shaft of the machine. The reversing motor eliminates pulleys and does away with slipping of the clutch. The heavy counterweight used on the vertical rolls has been removed and a coil spring used instead.

Some idea of the flexibility and simplicity of this machine may be gained from the fact that in testing at the factory 2-inch by ⅝-inch flats were bent into circles, edgewise, in which the inside diameter was 13½ inches.

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Elbow Question

Q.—Please enlighten me regarding Fig. 431 in the problem on a ninety-degree elbow, illustrated in your fourth edition of "Laying Out for Boiler Makers." The semi-circle in Fig. 2 is supposed to be divided into eight equal parts, but is equally divided into only six parts. In Fig. 3 the layout of the template, the centers of the radius of the arcs *G-J* and *A-I* do not coincide to *B* and *H* as centers. I am very much in need of your advice on this problem and am hoping for an early reply.—O. N. B.

A.—The text states that the arcs for the large and small ends of the elbow pattern are to be divided into 16 equal parts, or two times the number shown in Fig. 2. It is immaterial as to the number so long as the pattern is laid off as shown in Fig. 3. In this case Fig. 2 is laid off with six divisions and the pattern in twelve divisions or two times the number shown in Fig. 2.

I fail to find the error in Fig. 3 regarding the centers from which the arcs *G-J* and *A-I* are drawn.

Allowable Pressure on Corroded Plate

Q.—I note with considerable interest your formula on page 300 of the October, 1925, issue of The Boiler Maker. In this formula I am satisfied you are seriously at error, and the pressure may not have to be reduced, depending on certain other factors. I believe you should show all of the interdependent factors leading up to the establishment of the pressure of 150 pounds per square inch, which you state is the original pressure.

It would then be a simple matter to establish the safe pressure of the wasted sheet, which you say has wasted away along the seam. What part of the seam? Adjacent to the rivets or along the seams between the rivets? Your magazine is read each month with great interest as it appears in the office of our inspection department. Would appreciate further exchange of views on this subject.—W. R. O.

A.—The formula referred to for shell plates that have become thinner due to corrosion covers the points in question, except for stayed flat plate.

The following example, using the United States Board of Supervising Inspector's rule in which

$$\text{Working pressure} = \frac{Ct^2}{p^2}$$

C = constant value for different plate thicknesses.

t = plate thickness expressed in sixteenths of an inch

p = greatest pitch of stays, inches.

Example.—A stayed flat plate was originally ½-inch thick, what is the maximum allowable pressure if the plate has wasted in some parts to 7/16 inch in thickness? Original pressure was 170 pounds per square inch.

Solution.—Original plate thickness of ½ inch expressed in sixteenths of an inch = 8; then

$$\text{Working pressure} = \frac{170 \times 7^2}{8^2} = 130 \text{ pounds per}$$

square inch.

This calculation shows that the strength of stayed flat plate varies as the square of the plate thickness, whereas, in shell plate the strength varies directly as the thickness of the shell, the strength of stay rods, staybolts and braces directly as the least sectional area.

We would appreciate other views on this important subject.

Self-Supporting Steel Stocks

Q.—Referring to your book, "Laying Out for Boiler Makers," we are preparing to build a self supporting steel stack, 30 inches in diameter, 75 feet high.

We have figured the base diameter as 66 inches, tapering in 12 feet to 30 inches, using two rings of 7/16-inch plate and one ring of ⅜-inch plate in the taper section and making the remaining portion of one 5-foot ring ⅜-inch, two 5-foot rings of 5/16-inch, six 5-foot rings of ½-inch and four 5-foot rings of 3/16 inch plate. This gives a total weight of 9,700 pounds. In chapter IX, page 186, of "Laying Out for Boiler Makers," you give formula for "distance from middle of foundation to the resultant force" and say that "this force should act in the middle third of the width of the base."

Our calculation makes the distance 21¾ feet, using 30 pounds as the wind pressure. Our base is but 66 inches in diameter.

We shall appreciate your giving us information as to whether we have made an error, or misunderstood the article, and as to what plan is used for calculating the strain on anchor rods, needed to make such a stack stable.

In the August, 1925 issue of The Boiler Maker, pages 241 and 242, there is a discussion on similar stacks, by which we make the above distance 36¼ feet, using y equals P multiplied by x, and the product divided by W.

In the same article, you give formula W equal to h squared multiplied or divided by b. Then you transform to get value of b. Is not this transformation inverted?

By inverting the formula, we get b equal to 35¼ feet. But using it as given, b equals 0.02 of a foot. In these latter two calculations, we made force of wind 50 pounds, instead of 30 pounds, as in the first. This explains the different results of 21¾ feet and 36 feet.

We plan to use a cast iron foundation ring 78 inches outer diameter, and to make a concrete base 8 feet diameter by 5 feet deep, though this may have to be altered when the foundation pit is prepared. Do you suggest any change in this? Your courtesy will be appreciated, and explanations, suggestions, etc., welcomed.—M. I. W.

A.—For stacks of small diameter the following formulas will give good results, offsetting also the necessity of a number of lengthy calculations.

The plate thickness you have figured is too great for the bottom and the next 10-foot section. The following formula may be used in calculating the plate thickness at any height:

$$t = \frac{191 \times D \times L}{d^2 \times TS \times FS \times E}$$

in which,

t = thickness of plate, inches
D = diameter of stack, feet
L = length of stack, feet
d = diameter of stack, inches
TS = tensile strength of plate, pounds per square inch = 55,000
FS = factor of safety = 4
E = efficiency of circumferential seam in percentage = 0.50 for single riveted lap = 0.70 for double riveted lap jowl.

The thickness of the shell should be figured for sections 10 feet above the bell section, having the top section not less than 3/16 inch in thickness for stacks 5 feet and less in diameter, and ¼ inch for stacks greater than 5 feet in diameter. Stacks of the latter size should be reinforced with an angle ring at the center of each course to prevent buckling.

The following formulas may be used in determining the diameter of bolts, having 12, 18 and 24 bolts in the bolt circle.

$$\text{For 12 bolts, diameter of bolt} = 0.0257\, H \sqrt{\frac{D}{D_1}}$$

$$\text{For 18 bolts, diameter of bolt} = 0.0222\, H \sqrt{\frac{D}{D_1}}$$

$$\text{For 24 bolts, diameter of bolt} = 0.0182\, H \sqrt{\frac{D}{D_1}}$$

in which,

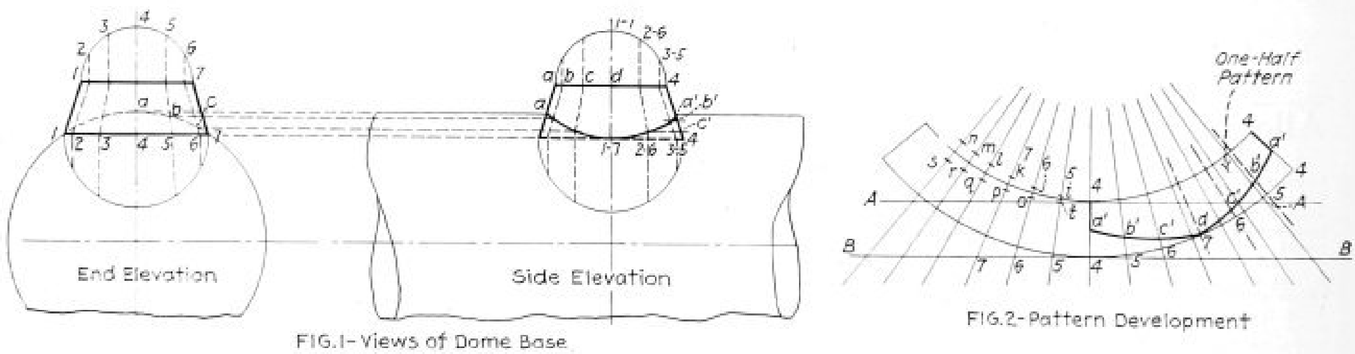
H = height of stack in feet.
D = diameter of stack in feet
D_1 = diameter of foundation ring, in feet.

If you will send in your calculations we will check the work.

Dome Jacket

Q.—I want to make a dome jacket of No. 10 iron, and so far I have been unable to get the correct layout for the bottom part. The jacket is made in two sections, three counting the top, but I am not counting it because we are going to use the old cast top. I would like very much for you to send me a correct layout of the bottom part, which is 18 inches high and 41¾ inches diameter at the top. I don't know what the diameter is where it lies on the boiler.—W. W. B.

A.—This problem consists of finding first the intersection line between the conical frustum of the jacket and the boiler. The method is illustrated in Fig. 1 showing an end view and a side elevation. Draw the outline of the base in the two views and divide the profile of the circular ends into a number of equal parts as *1 to 7* inclusive. Connect the points on these base lines with radial lines. Where the radials in the end view intersect the curvature of the boiler shell as at *a-b-c* and *d*, establishes points on the miter line. These points are projected to the side view as indicated and the the miter is drawn in. The true lengths of the radial line are then determined by projecting their foreshortened length to the outer edge or element of the frustum, as shown at *b'-c'-d'* of the side view.



Layout and pattern development of dome base

As the taper of the frustum is small, the camber lines may be drawn in by the method shown in Fig. 2. The frustum *A-A*, *B-B* is laid off by making the height *4-4* equal to the slant height *4-4* of the side view. Lines *A-A* and *B-B* are parallel. The length *A-A* equals the stretchout of the upper base of the frustum and *B-B* of the lower or larger base. Both are divided into equal parts and radial lines drawn in. With the use of a square the camber line may be drawn as follows: Place the blade of the square on line *5-5* so that the tongue passes through point *4* on line *4-4*, and mark the point *i*. With the blade of the square on line *6-6* and the tongue on point *i* mark the point *j* on line *6-6*. Continue in this manner locating points *k*, *l*, *m* and *n*. With the blade on line *5-5* and the corner of the tongue at *t* mark point *o* on line *6-6*. With the blade on line *6-6* and the corner on point *o* mark point *p* on line *7-7*. Continue in this way for locating the points *q*, *r* and *s*. Midway between the points of the two lines is the camber line. The arc for the large base may now be drawn by setting off the slant height *1-1* of the frustum on the radial lines in the pattern. Set off on the arcs of the pattern their required stretchouts with the use of a graduated wheel. Space the stretchouts into the same number of equal parts as in the frustum Fig. 2. On the radial lines set off the lengths as *4-a'*, *4-b'*, *4-c'* and *4-d'* as shown for the half pattern. Allow for laps.

BUSINESS NOTES

T. Holland Nelson has become associated with The Ludlum Steel Company general offices and works, Watervliet, N. Y. He is in a consulting capacity in connection with the production of rust and corrosion resisting iron and steel. Mr. Nelson is also vice president of the Wm. T. Bate and Sons Company of Conshohocken, Pa. He is well known as a lecturer on rust and corrosion problems and has been intimately connected with the development of rustless steel both in this country and in England.

The American Hoist and Derrick Company, which has its works and main offices at St. Paul, Minn., has recently opened another branch office at 1943 Railway Exchange Building, St. Louis, Mo., with Ward B. Maurer in charge. Mr. Maurer has a wide acquaintanceship among railroad men and users of hoisting machinery in general. Before joining the sales force of the American Hoist and Derrick Company, several years ago, Mr. Maurer was a member of the engineering staff of the Baltimore and Ohio Railroad.

The Chicago Pneumatic Tool Company recently announced the acquisition of the George Oldham and Sons Company of Baltimore, Md. The manufacture of the Oldham products which are continued will be conducted at the Detroit plant, 6201 Second Boulevard. The sales will be combined and handled from the Chicago Pneumatic Tool Company's branches now operating in the principal cities as well as through their domestic and foreign agency connections. The Oldham products requiring repairs should be sent to branch located nearest the customer or forwarded to Detroit.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—D. N. Hover, Jr., Washington, D. C.

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—C. D. Thomas, Salem, Oregon.
Statistician—E. W. Farmer, Rhode Island.

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

J. A. Franklin, International President, suite 522, Brotherhood Block, Kansas City, Kansas.
William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.
Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.
James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.
H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.
International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Ave., Columbus, Ohio.

Master Boiler Makers' Association

President—Thomas F. Powers, system general foreman, boiler department, Chicago & Northwestern.
First Vice President—J. F. Raps, general boiler inspector, Illinois Central.
Second Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.
Third Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.
Fourth Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.
Fifth Vice President—George B. Usherwood, supervisor of boilers, New York Central.
Secretary—Harry D. Vought, 26 Cortlandt street, New York.
Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.
Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—F. H. McCabe, McCabe Manufacturing Company, Lawrence, Mass.
Vice President—J. W. Kelly, National Tube Company, Pittsburgh, Pa.
Treasurer—George R. Boyce, A. M. Castle and Company, Chicago, Ill.
Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie, Pa.
Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.
Secretary-Treasurer—D. W. Glanzer, 840 Rockefeller Building, Cleveland, Ohio.
Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; W. A. Drake, The Brownell Company, Dayton, O.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Works, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

Chicago, Ill. (will accept)	Memphis, Tenn. (will accept)	Philadelphia, Pa.
		St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Los Angeles, Cal.		Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	New Jersey	Pennsylvania
California	New York	Rhode Island
Indiana	Ohio	Utah
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

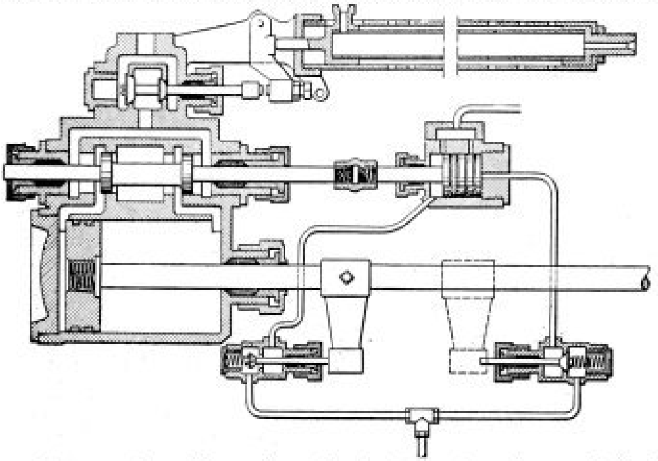
SELECTED BOILER PATENTS

Compiled by
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building
Washington, D. C.

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

1,568,503. BOILER-SUPPLY SYSTEM. ROBERT LUCIEN D'ESFUJOLS, OF LA VARENNE, ST.-HILAIRE, FRANCE.

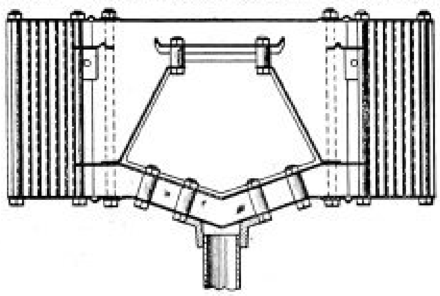
Claim 1. In a system for controlling the supply of liquid to a boiler feed pump a fluid operated prime mover therefor and a device for automatically controlling said fluid comprising an expansible container and a



conduit connecting said container with the boiler above the normal liquid level therein and a second conduit comprising a heat radiating portion connecting said container with the boiler below the normal liquid level therein. 4 claims.

1,570,985. STEAM PURIFIER. ROGER W. ANDREWS, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO ANDREWS-BRADSHAW COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

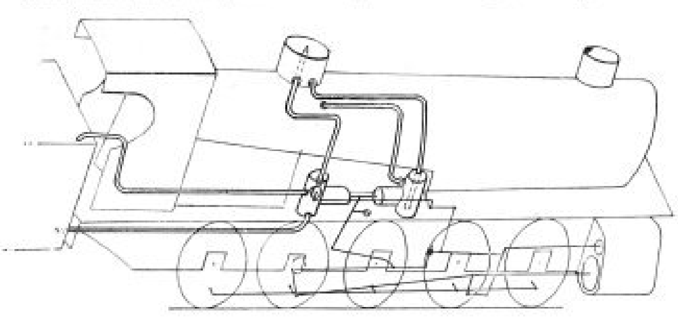
Claim 1. A steam separator comprising a hollow casing having openings in its walls, steam separating baffles mounted in said openings, a steam



outlet connected to one end of said casing, an inner conduit in said casing, with its wall spaced from the walls of said casing, said conduit opening into said outlet, and said conduit having a narrow longitudinal opening through its wall extending substantially the entire length of the wall. 13 claims.

1,559,730. BOILER FEED-WATER APPARATUS. JOSEF MUCHKA, OF VIENNA, AUSTRIA, ASSIGNOR TO THE FIRM SOCIÉTÉ D'EXPLOITATION DES POMPES DABEG, OF PARIS, FRANCE.

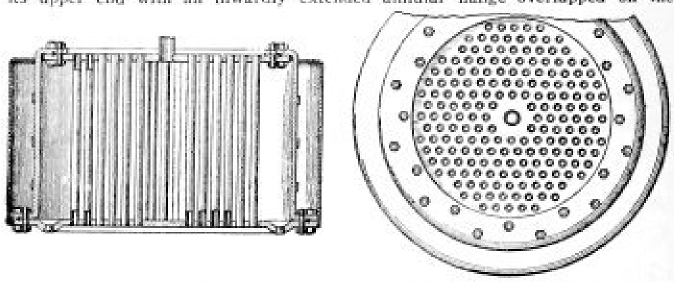
Claim 1. The combination with a steam-engine operating with a variable cut-off, an engine boiler, and a valve gear for the engine, of apparatus for



supplying feed water to the engine-boiler, comprising a feed-water forcing device and means, controlled by the valve gear of the engine, for varying the quantity of water delivered by the feed-water forcing device to the boiler in accordance with the cut-off of the engine. 7 claims.

1,569,588. STEAM BOILER. JAMES M. SPRINKEL, OF AURORA, ILLINOIS.

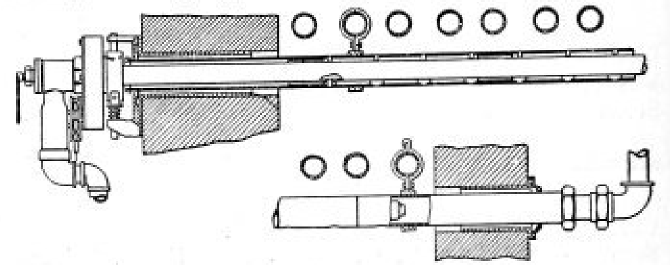
Claim 1. In a device of the class described, a lower head, an upper head of less diameter than the lower head, tubes having their ends mounted in the heads, an inner shell surrounding the upper head and provided at its upper end with an inwardly extended annular flange overlapped on the



outer surface of the upper head, the shell being provided at its lower end with an outstanding annular flange resting on the lower head, the periphery of the said flange being spaced from the periphery of the lower head to form a shoulder, securing devices connecting the first specified flange of the shell with the upper head, securing devices connecting the last specified flange of the shell.

1,571,938. SOOT BLOWER. LEO JOHN BAYER, OF ST. LOUIS, MISSOURI.

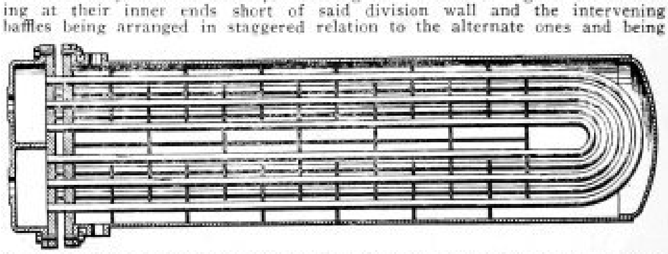
Claim 1. In a soot blower for boilers, the combination with a steam supply pipe terminating at one end in a head, of a peripherally ported blower pipe revolubly supported at one end in the head, a valve in said



head for controlling the steam flow from the steam pipe to the blower pipe, a gear wheel fixed on the blower pipe, a drive shaft, a pinion on one end of the drive shaft and meshing with said gear wheel, a worm on the other end of the drive shaft, a worm wheel meshing with said worm, and a cam fixed to the worm wheel for actuating the aforesaid valve on revolving the drive shaft. 2 claims.

1,571,889. HEAT-EXCHANGE APPARATUS. WILLIAM H. RIPLEY, OF HARTFORD, CONNECTICUT, ASSIGNOR TO THE WHITLOCK COIL PIPE COMPANY OF WEST HARTFORD, CONNECTICUT, A CORPORATION OF CONNECTICUT.

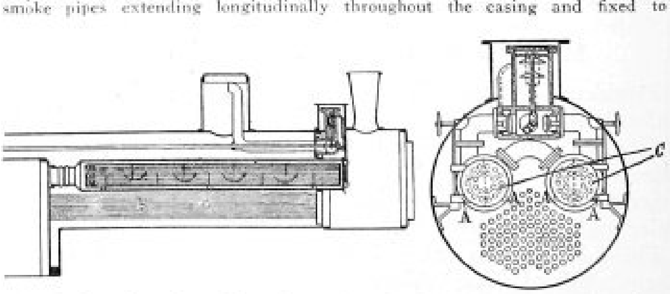
Claim. In a device of the character described, a cylindrical shell, a longitudinally extending wall therein dividing said shell except at its rear end into a pair of semi-cylindrical passes or chambers, a plurality of tubes in each chamber and arranged in series, and a plurality of baffle plates in each chamber, alternate baffle plates being in the form of segments terminating at their inner ends short of said division wall and the intervening baffles being arranged in staggered relation to the alternate ones and being



in the form of truncated semi-circular plates with their inner edges engaging the surfaces of said division wall.

1,558,210. STEAM BOILER. MIECZYSLAW VON POKRZYWNICKI, OF WARSAW, RUSSIA.

Claim 1. In a boiler, the combination with a fire pipe, of a superheater disposed therein and comprising a casing terminating within the fire pipe, smoke pipes extending longitudinally throughout the casing and fixed to



the ends thereof, and an independent casing fixed to the front end of the first mentioned casing and constructed to offer greater resistance to disintegration under the action of heat than do the walls of the first mentioned casing, the two casings having means of intercommunication and the second mentioned casing having openings leading from the fire tube to the front ends of the smoke tubes. 2 claims.

The Boiler Maker

Volume XXVI April, 1926 Number 4

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Edward A. Simmons, *Pres.*
L. B. Sherman, *Vice-Pres.*
C. R. Mills, *Vice-Pres.*
Roy V. Wright, *Secretary*
Henry Lee, *Vice-Pres. and Treas.*
Samuel O. Dunn, *Vice-Pres.*
F. H. Thompson, *Vice-Pres.*
George Slate, *Business Manager*

Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ave.
Mandeville, La.
Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St.
Westminster, S. W. 1.
Cable address: Urasigmec, London

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d; single copies 1s 2d.

Request for change of address should reach us two weeks before the day of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

Inspectors' Convention Date Changed

OWING to the fact that it will be impossible for Mr. E. W. Farmer, statistician of the National Board of Boiler and Pressure Vessel Inspectors, to be in Chicago on May 3, 4 and 5, the dates announced in our last issue for the annual meeting of the National Board, it has been decided to change the dates of the meeting to May 17, 18 and 19. It is the intention to have Mr. Farmer give at the annual meeting a statistical report of all boiler explosions during the past year. As this has a very important bearing upon the work of the members of the National Board it has been deemed advisable to change the date of the meeting, further details of which can be obtained from Mr. C. O. Myers, secretary-treasurer, 14 Commercial National Bank Building, Columbus, Ohio.

Master Boiler Makers' Convention

MEMBERS of the Master Boiler Makers' Association, who have regularly attended the annual conventions of the association fully realize the benefits to be obtained from active participation in these meetings. Those who have failed to take advantage of this opportunity to meet and compare notes with other leaders in this line of work and to participate in a constructive program covering the latest developments in boiler work will have an opportunity to make amends during the last week in May by attending the annual convention of the association which will be held at the Hotel Statler in Buffalo, N. Y., from May 25 to 28 inclusive. In addition to the regular committee reports which have been prepared during the year and which will form the basis of the greater part of the discussion at the convention, the program will include an imposing list of speakers from outside the membership of the association.

According to advance information from the office of the secretary, the association will be welcomed to the convention city by Honorable Frank X. Schwab, mayor of Buffalo. Following the routine business of the opening session, the convention will be addressed by F. M. Barker, superintendent, Buffalo Division, of the Lehigh Valley Railroad and first vice-president of the Central Railway Club. Other speakers will include Walter H. Flynn, superintendent of motive power of the New York Central Railroad; A. R. Ayers, assistant general manager of the Nickel Plate Road; R. B. McColl, manager of the Schenectady plant of the American Locomotive Company; A. G. Pack, chief inspector, Bureau of Locomotive Inspection of the Interstate Commerce Commission; R. E. Woodruff, superintendent of the Erie Railroad at Buffalo and also vice-president and chairman of the Welfare Committee of the Central Railway Club; E. V. Williams, superintendent of motive power of the Buffalo, Rochester & Pittsburgh Railway, Du Bois, Pa., and Frank C. Pickard, manager of the Standard Stoker Company's works at Erie, Pa. A program of entertainment of the members and guests is being arranged by the Boiler Makers' Supply Men's Association which will include a trip to Niagara Falls on Wednesday, May 26, and a dinner on Thursday evening, May 27. Communications so far received at the office of the secretary indicate that the attendance at the forthcoming convention will be a record breaker and everything points to the most successful and enjoyable convention that the association has ever held.

High Pressure Watertube Boilers

AT the annual meeting of the Institution of Naval Architects held in London last month, Harold E. Yarrow of Yarrow and Company, Ltd., Scotstoun, Glasgow, described the high pressure watertube boilers which his firm is building for the 4,000-horsepower turbine steamer now under construction by William Denny and Brothers of Dumbarton, England, in conjunction with Sir Charles Parsons to demonstrate the thermal efficiency of high pressure steam for ship propulsion. Two coal burning boilers are to be installed, each with a total heating surface of 3,420 square feet, of which the superheating surface is 870 square feet. In addition there are 2,200 square feet of air-heating surface for preheating the air prior to its admission to the closed ashpit. The safety valves will be set to 575 pounds per square inch pressure and the final temperature will be from 700 to 750 degrees F. The test pressure is 913 pounds per square inch.

The boilers consist of a forged steam drum, 3 feet 6 inches inside diameter, connected to 3 forged water drums, each 18 inches inside diameter, by means of straight tubes forming 3 steam generating elements, two on one side of the boiler and one on the other. Between the two water drums on the right-hand side is a superheater which consists of a forged drum with a number of U-tubes and which is placed between the two generating elements. The gases of combustion all pass up the side of the boiler containing the two generating elements and the superheater and continue through the air heater above the boiler to the funnel. The single generating element on the left-hand side of the boiler absorbs a considerable portion of the heat from the furnace by direct radiation. In fact, an unusually large proportion of the total heating surface of the boiler is subject to direct radiation, which not only increases the output and efficiency of the boiler but also provides a large amount of comparatively cool surface adjacent to the combustion chamber, which lengthens the life of the brick work. The forged steam drum has no riveted joints. In the water and superheater drums there are no longitudinal seams, but there is one circumferential riveted joint securing the front end plate in which a manhole is placed, the other end of the drum being solid.

It is estimated that these high pressure boilers will cost approximately 15 to 20 percent more than similar boilers having the same total heating surface but working under a pressure of only 250 pounds square inch. The saving due to the reduced heating surface required in the case of the high pressure boilers nearly compensates for the additional cost of the forged drums and certain other more expensive fittings. The fact that the quality of the steam from the high pressure boiler is of higher value than in the case of the low pressure boiler tends to compensate for the slightly higher cost of the high pressure boiler.

Although the actual trial results of the vessel for which these boilers are being constructed will not be available for some time, the boilers mark a definite step in marine boiler practice, the results of which may be far reaching.

Boiler installations having steam pressures of 500 to 600 pounds per square inch pressure and superheats of 700 to 750 degrees F. are in commercial use in power stations on shore. For such purposes, high pressures and temperatures have passed the experimental stage. As the question of materials and workmanship is exactly the same for marine boilers, it is reasonable to suppose that the same success should be obtained with marine installations as has been experienced in the case of power station boilers.

LETTERS TO THE EDITOR

Allowable Pressures

TO THE EDITOR:

In the March, 1926, issue on page 87 appears a stayed plate problem. Mr. Lindstrom expresses a desire to hear views from your readers on this subject.

I am located at the Kewanee shops as a boiler inspector and as this falls in my line I am submitting a brief summary of this problem with figures. You have my permission to use this article as you will and I will watch your magazine for further discussion.

Using the A. S. M. E. Code such as is customary by leading boiler insurance companies; if a stayed plate was originally ½-inch thick, and the maximum allowable working pressure was 170 pounds, it becomes necessary to find the pitch which would be,

C = constant 120 for plate over 7/16-inch thick
t = thickness of plate in 1/16 of an inch
p = pitch of stay in inches.

Therefore,

$$\sqrt{\frac{120 \times 64}{170}} = p \text{ which is}$$

$$\sqrt{\frac{120 \times 64}{170}} = 6.72 \text{ which we find was the pitch used}$$

to obtain pressures as given above. Now if the sheet is wasted down to 7/16-inch we know the pitch has not been changed so we figure again only this time we use as a constant 112 (A. S. M. E.) for plates up to and including 7/16-inch thick. (See problem)

$$\frac{C \times t^2}{p^2} = P$$

$$\frac{112 \times 49}{45.15} = 121 \text{ pounds}$$

which would then be the safe working pressure.

This is as used in all A. S. M. E. states and I think covers this case.

Kewanee, Ill. LEONARD R. AGNELL.

Tank Construction

TO THE EDITOR:

For the benefit of those who are interested in the Question and Answer Department of THE BOILER MAKER, I would like to go a little further with the matter of tank construction, referring to the inquiry of "S. C. D." as noted in the December issue, page 157, and the answers as derived from the various formulas employed by the author.

In the first place I note that while Mr. D. MacC. has checked up on the result of the original formula for determining the working pressure to be allowed on the tank in question, he has failed to analyze the formula employed. The result obtained from the formula as it now stands is O. K., but the radius employed is incorrect. Now before stating the correct formula I would call attention to the result; or what we would have if we used the formula directly below the tank sketch at the top right hand of page 357, this formula gives us a radius of 38.515 inches. Incorporating this in the formula for arriving at the working pressure we lower the same to 129.8 pounds, the original formula referred to above gives us a radius of 36.515 inches and the working pressure corresponding to this radius is 136.9 pounds. The correct radius to employ in the formula for the working pressure is 35.515 inches, derived from the following formula:

$$R = \frac{(\frac{1}{2} \times 23\frac{1}{2})^2 + h^2}{2h} = 35.515$$

$$P = \frac{(\frac{3}{8} - \frac{1}{8}) \times 2 \times 55{,}000}{5.5 \times 35.515} = 140.7 \text{ pounds.}$$

This change of one inch in the radius of the dish in the head will also make a slight difference in the thickness of the material in the head, while the original formula gives us 0.3299 say, 33, the correct formula gives us 0.374 as the thickness, which is 3/8 inch.

$$t = \frac{5.5 \times 140.7 \times 35.515}{2 \times 55{,}000} = .374 \text{ inch.}$$

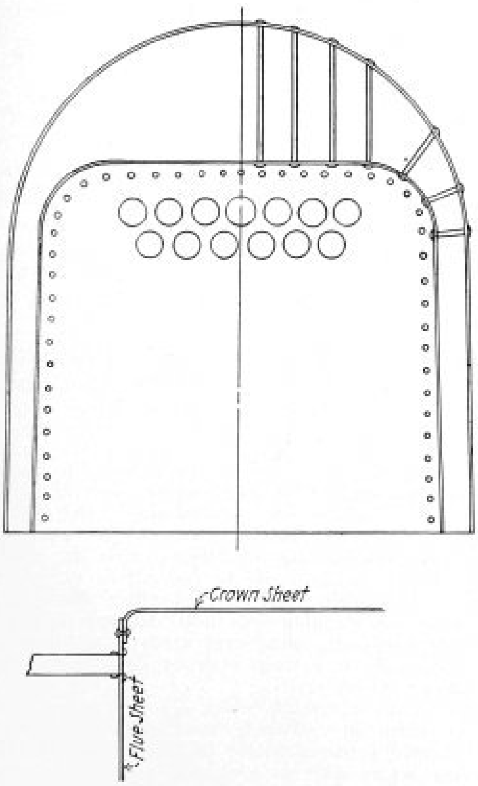
I trust that some of the new beginners and apprentices will be interested enough in the solution of the problems referred to as to verify them to their own satisfaction.

Norfolk, Va. D. W. PHILLIPS.

Eliminating Flue Sheet Cracks

TO THE EDITOR:

My attention has been called to an article in the November issue of THE BOILER MAKER in reference to the cracking of the flue sheet around the knuckle from the flue hole and,



Straight sided flue sheet to eliminate cracks

being a pioneer in this line of business and I believe the first to apply the radial stay crown sheet to the locomotive boiler, I certainly have had some experience with it. This was some years ago, however, in 1881 and I continued making it for 10 years, owing to the fact that we made all our own engines.

The sketch will show you one way I tried out on a small switching engine which made quite an improvement. You will observe that all the staybolts are at right angles to the crown sheet. Keeping the top of the flue sheet straight has a tendency to cut down the expansion. Flanging the crown sheet in place of the flue sheet leaves the flue sheet free to expand, which I proved years ago.

I have heard about applying sling stays and a lot of stuff all to no account; the principle always appears to me as simply expansion; if we take a straight bar of steel it expands in a linear direction; bend it to a circle and we have a movement which acts just the same on the flange around the top of the flue sheet; obviate that by doing away with the flange which this sketch shows. I believe the principle is worthy of a trial by somebody interested.

Chicago, Ill. PETER MCGREGOR.

Rewards of Labor in Boiler Shops

TO THE EDITOR:

Under the above heading appeared a letter in the March issue of THE BOILER MAKER by Walter Wilson of Leeds, England. The writer quite agrees with Mr. Wilson that there are many varieties of bonus systems in this country, and that they were abused during the war and are still abused today both by the employer, trying to get something for nothing, and by the employee trying to beat him at his game.

Some years ago this piece work question was quite thoroughly threshed out in the columns of this magazine and, if I remember rightly, you said that you never thought that the subject would create so much comment. The exact words I do not recall and, as my files are packed away just now, I cannot remember the details, but there was a hot old time, believe me—letters from all over this great country against the piece work system in any form being received.

Since that time, piece work has been introduced into our railway shops all over the country and *some men* are making big wages, but at the expense of good work; certainly they make the job good enough to pass inspection and pass out of the back shop into road service, but then the trouble begins for the roundhouse men.

As far back as 1886, boiler makers were paid 8 cents per tube for installing a set of tubes, the boiler maker getting 5/8 and the helper 3/8. Then the wages of a first class all-around boiler maker were $2.50 a day and the boiler maker was allowed to make about double time and, if his set of tubes passed the shop test, he was paid; but if, during test, there were any defective tubes he had to remove them and replace them with good ones. Today, the average price paid for installing a set of tubes is 9 cents per tube.

Now, after a lapse of 40 years, wages have risen from 25 cents per hour to 73 7/10 cents per hour but the piece work price of tubes is just 1 cent more. Again, in 1914 the piece work price of patching work, such as corner patches or fire door patches, was 75 cents per hole for patches with about 12 holes (rivets) and graded to 50 cents per hole in patches with 30 holes; above that, all patches, including one-half side sheets, flue sheets, door sheet, were 40 cents per hole. Today, 12 years later, the piece work price is practically the same but during that 12 years you all know what changes have taken place; living costs have gone sky high, rents are out of reach of the common wage earner, yet piece work prices are still the same.

Tank work (locomotive) pays, for removing material, marking off new sheets, fitting up (plating) riveting and testing, 7 cents per rivet up to 600 rivets; all over 600 rivets 6 cents per rivet. This means boiler maker helper and heater boy and they have to work hard to make good. Superheater tubes are 47 cents per tube subject to the same condition as small tubes.

Some years ago the writer, then living in Wales, and working for a very large steel company, worked piece work on blast tubes; riveting, the day's work, called for two hundred ⅝-inch rivets for 9 hours' work and we were allowed to put in three hundred per day; we were also allowed to put in extra rivets to make up for Monday and Saturday, those days being 8 hours and 5 hours respectively; the fitting up (plating) was done as day work. There is one thing to be said about riveting piece work—it can be done as good, if not better, by piece work; for it is well known that all kinds of riveting work closes better while being worked hot than it does if allowed to cool off.

Regarding the (plating) fitting up of boilers in American shops, none but the best all-around boiler makers are put on work of this kind and usually they are paid 5 cents per hour more than the ordinary boiler maker and they are worth all they get; but as a rule the fitting up of boilers, putting in fireboxes, etc., is a lump sum job or what is known as a "pool" job; so that the first class man responsible for the job does not derive the true amount of compensation due him.

In my time in Great Britain it was a difficult matter for any but a first class boiler maker, riveter or plater to get a job in a contract shop or railway shop but since the war it may have changed. In fact it has in this country for all of our railway shops are overrun with "McAdoo" mechanics and 90 percent of them are huskies, strong men able to use a go-gun all day without tiring, but outside of that they are not worth the room they take up in the shop, yet they are men who draw down the big checks on pay day.

In conclusion, I cannot help referring to what I said before when the piece work controversy appeared in these pages, and that is—that piece work, whether it be bonus, individual merit, premium or the straight piece work system, has been the means of creating more strikes and ill-feeling between employer and employee than any other known cause.

Wilkinsburg, Pa. FLEX IBLE.

Welding in Pressure Vessels

TO THE EDITOR:

As one of the three mentioned by Mr. Kirkland as a critic of his design of a welded patch on barrel of a locomotive boiler the writer desires to give his reasons for being opposed to welding on parts of boilers that are subject to bursting pressure.

Mr. Kirkland bases his opinion on the results of some tests of welded joints, where results of tests showed that the weld would test higher than solid plate in vicinity of weld, but has nothing to offer relative to what develops in welded joints under service conditions.

The writer's opinion is based on the result of observation for many years while engaged in the repair and inspection of boilers that have been subject to service conditions, also while making investigation of boiler and pressure vessel accidents. Welding is done quite extensively where it is permitted in America and the writer has seen many welded joints that have fractured under service conditions. Had these welds been in the longitudinal joint the result would no doubt have been fatal. It has also been observed that cracks and fractures develop in the immediate vicinity of a welded joint which leads one to believe that welding has some effect on the sheet near the weld.

The fact that welded joints have failed in the past under service conditions is a very good reason why the safety of a boiler should not be depended upon in a country where *safety first* is the idea.

Mr. Kirkland issues a challenge to prove that a riveted joint of 84 percent efficiency is as strong as solid plate. Any American grammar school boy would know that a joint 16 percent weaker than solid plate would fail at some point in the joint. The American mechanic knows this and makes due allowance for same, therefore guesswork is taboo.

Mr. Kirkland suggests that we conduct four tests of joints. The writer has seen all of the tests suggested and others made years ago and they do not mean as much as results observed due to service where plates have been subject to stresses of expansion and contraction as well as products of combustion.

The following is an instance of where a welded joint would not hold, but a patch secured with patch bolts did. The upper corner of the throat sheet in a locomotive boiler cracked near the joint of barrel, throat and wrapper sheets in a place where stresses are very severe. This crack was V'd out and welded and after the engine had made a couple of trips the weld cracked and began to leak and the crack was again welded with same result. After welding had been done three or four times with the same result, a patch was applied with patch bolts which eliminated the trouble.

It seems to the writer that parts mentioned by Mr. Kirkland in his article may not be subject to bursting pressure like the barrel of locomotive boiler.

Olean, N. Y. J. H. FLAHERTY.

Prevention of Boiler Scale*

IN direct contrast to the numerous methods of preventing boiler scale by the chemical treatment of the feedwater, Messrs. K. Kasper, Berlin, Germany, have recently put into practise the Hauptvogel system which is, in principal, entirely different from any other electrical method of preventing boiler scale. Whereas the action of existing electrical processes is based on partial electrolysis obtained by the introduction of anodes into the boiler and requiring leads through the walls of the boiler, the new process works with quite a weak protecting current applied to the boiler externally.

The necessary installation consists of a direct current source at about 6-8 volts (accumulator or A.C. rectifier) from which the positive pole is connected to the front and the negative to the back of the boiler, metallic connections being made on the outside. Voltage and current are adjusted by means of a small rheostat or lamps, the average working conditions being 0.1-0.5 volt and 0.5-1.5 amperes. The consumption of current including losses is about 10 watts, i.e., 1 unit for 100 working hours.

The *Archiv fuer Waermewirtschaft*, published by the Society of German Engineers, in its latest issue gives, among others, the following favorable reports on experiences obtained with the process:

1. A watertube boiler at one of the Berlin Electricity Works having a heating surface of 3,220 square feet and an average working pressure of 375 pounds showed after 2,400 working hours only a very thin scale deposit which could be removed without trouble by light breaking and washing, so that the previous time of cleaning of four weeks could be reduced to two days.

2. With 3 Lancashire boilers in another Municipal Works the time taken for cleaning was also reduced to one sixth of that previously necessary, since large areas of the heating surface remained completely free from scale or deposit and the film at the other places fell off easily.

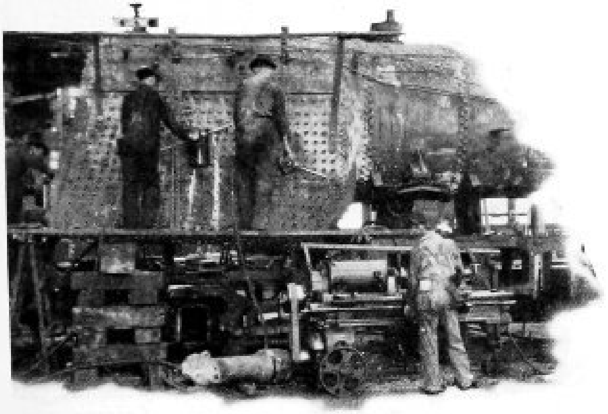
3. Another large watertube boiler, fed with water of 9 degrees hardness, in which an extremely hard scale deposit had formed in the two months previous to the installation of the process had the following result after two months use of the process: the very hard scale deposit had become spongy and loose so that it could be removed by scrubbing in pieces about the size of one's hand.

4. Finally after fitting the process to a locomotive boiler, the boiler only required its sludge washing out every 4 weeks, whereas previously the tubes had to be mechanically cleaned every fortnight.

*Translated from an article in the *Wochenschrift fuer Brauerei*, No. 45, page 285, issue of 7th November, 1925.

(*Continued on page* 101)

Pitting—A Myth or a Menace?



Detailed survey reveals progress being made in eliminating corrosion of boiler steel—One of the pressing needs of the present time is a solution of this problem

By D. A. Steel

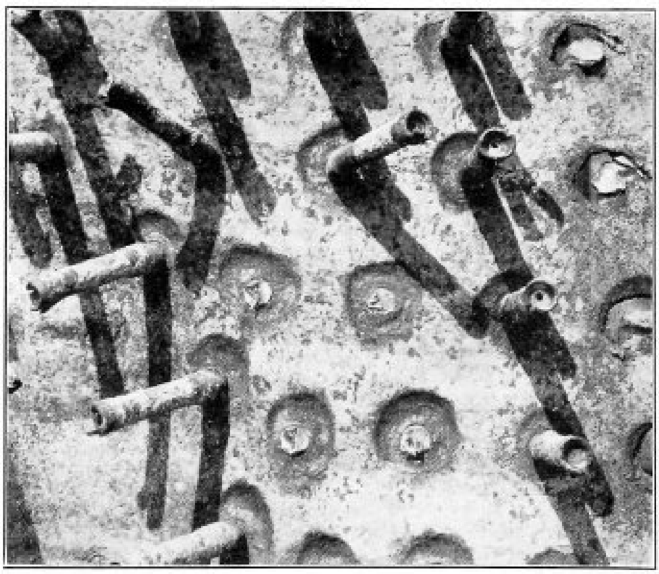
IT is not known whether pitting was encountered in the locomotives whose introduction signalled the birth of steam transportation in this country, but it is probable from the present knowledge of the causes that it was discovered shortly after rails were laid west of the Allegheny mountains. While the tendency of early investigators not to draw fine distinctions between the several boiler troubles attributed to water noticeably limited the instances where corrosion is referred to specifically in their discussions, it is certain that pitting and grooving were known in the '60s and became an increasing source of trouble with railway expansion.

Pitting Is Not a New Trouble

The old American Railway Master Mechanics' Association was organized in 1867. During the following year, in the first technical report of any kind ever presented to that association (a report on boiler explosions), the committee said: "A singular phenomenon presents itself. Recesses are found varying in size from ½ inch to ¾ inch in diameter and extending nearly through the sheet, singly and sometimes in groups. These are generally found on the bottom and lower sides of the boiler shells in places covered with sediment." This was 56 years ago, only two years after the first rail was laid west of the Mississippi river. Three years later, in a symposium before the same association on the experiences of railroads with impure water (of which there was plenty, from indications) we find, for example, the Lake Shore & Michigan Southern reporting that "in some sections impurities destroy the bottom of the boiler after three years' service"; also the statement of the Western Pennsylvania Division Railway that "on removing scale from tubes that have been running less than three years places are found where the iron has been entirely eaten through, varying from a needle point to ¼ inch along the entire length of the flue." It was only two years after this, 54 years ago, when another committee of that association observed that "in some sections of the country the water is impregnated with lime and minerals that attack the iron along seams around rivet and bolt holes and wherever the grain of the iron has been disturbed in the process of manufacture, frequently making it necessary to renew portions of the boiler in two or three years and flues in a year or eighteen months." This committee also reported a case where a boiler "was pitted all over although the scale on the flues seemed to be hugging perfectly tight with not a spot but what was covered." Thus is it evident from reports of one convention after another not only that pitting is not new to the railways of this country, but that it has received the attention of railway men from the time of things which in the progress of transportation are now merely historical.

Millions in Pitting Elimination

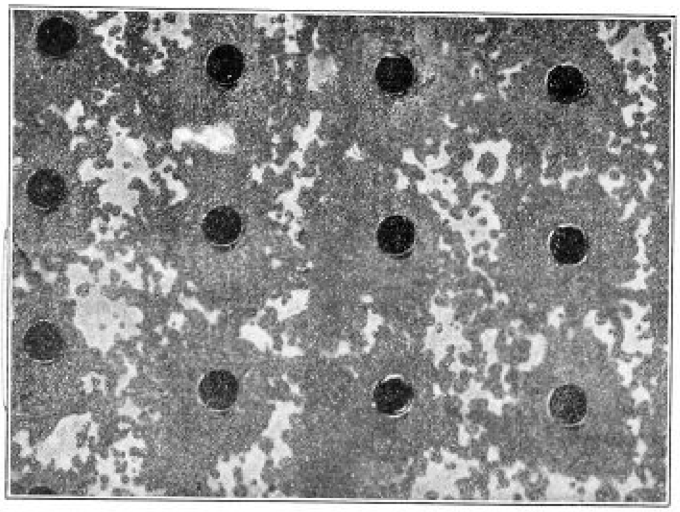
Within the last few weeks, however, the mechanical department head of one of the largest railroads of the country publicly declared that one of the pressing needs of the present is a solution of the problem of pitting and corrosion. Several months before, an executive of an equally large road wrote that the eradication of pitting would save the railroads millions of dollars. The inferences from these expressions are that pitting and corrosion have not been eliminated. The fact is that a great deal of pitting is to be found. The prevalent opinion, indeed, is that pitting is on the increase. Under these circumstances it is not surprising that some



A close view of firebox pitting which also extends to staybolts

disquietude should be felt, especially in the light of showings that some roads can save $100,000 a year, as a conservative estimate, through the extermination of this difficulty. It is appropriate, therefore, that something should be done.

It would be a mistake, however, to conclude from the knowledge of flourishing cases of pitting that nothing has been accomplished towards its eradication or to find cause



A section of a steel plate after drilling but before application, which illustrates how corrosion can get its start outside of the boiler—Note the localized character of the rusted areas, all of which are centered around the holes

for undue alarm in the amount of it. Unfortunately, such conceptions are current. The one presupposes that the past has proved a failure, the other that boiler conditions were never worse. Both are as inimical to progress in pitting control as they are unsound. They are scarcely less in need of correction than the attitude toward the pitting problem that was expressed recently by a railway officer of position that if there were not pitting to bother there would be something else in its place.

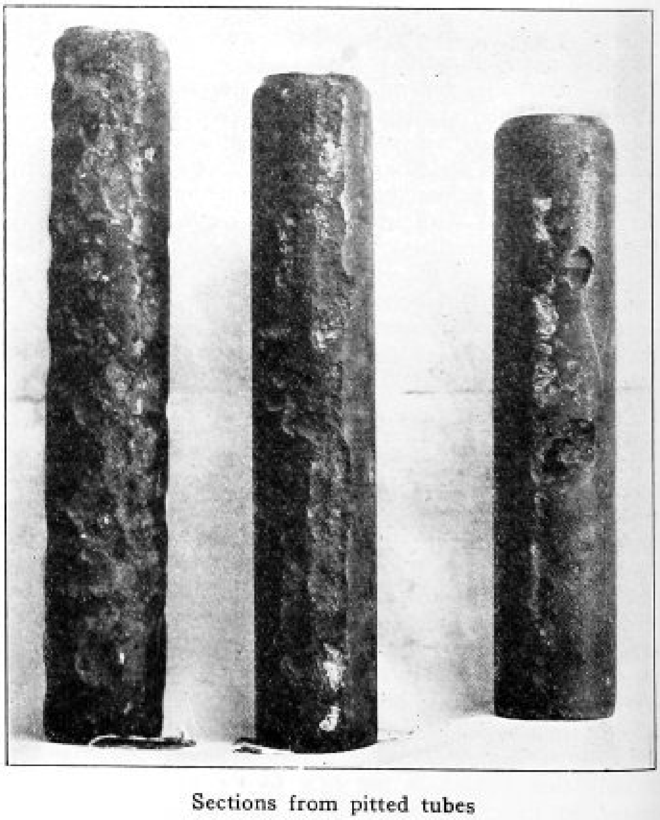
Conditions Are Misunderstood

The fact is that in many instances pitting is not as bad as it is thought to be. It was only recently that an executive officer found to his surprise, but equally to his pleasure, that the pitting on his road was confined to a relatively small area instead of to the entire property as he had come to believe from the reports reaching his attention. The probabilities are that the water inspector has not been hired who cannot recall instances of alarm surrounding reported troubles which were found to be uncalled for by the actual facts. In the recollection of these facts and the ease with which officers who, not being immediately or continuously in touch with pitting disturbances, can acquire distorted impressions of conditions, it may well be repeated that there are many instances where pitting is not as bad as it is thought to be, a fact which plainly enough emphasizes the importance of investigating conditions before steps are taken to correct them.

Again it is found that in many instances pitting is no more prevalent now than before, but only appears so in contrast with the periods when more aggravated boiler troubles kept it in the background. Pitting and grooving are peculiar to regions of bad water. Actually they are properly attributed to bad water insofar as a favorably disposed water is essential to the process. But pitting is only one of many boiler troubles that have at least been peculiar to regions of poor feedwater. Generally it has caused the least expense and aggravation. Certainly this is true in sections of especially bad water. The other troubles are those from incrustation and foaming. Failure of locomotives to steam, clogged feed pipes and injectors, stuck boiler checks, collapsed tubes, burned sheets, leaking, dry cylinders and empty water glasses are among their effects. These troubles are experienced today but in nowise compare with their intensity in the past.

Much Pitting Has Been Eliminated

Indeed much of the corrosion which has troubled in the past has been entirely eliminated. It is not essential at this point to indicate how this happened, but it is proper to emphasize that such is the case. While the imperfect knowledge of the past concerning the relationship between pitting and incrustation, the usual prevalence of one where the other was found, and the primitive character of statistical compilations, etc., quite naturally discouraged any attempt at distinguishing between the precise nature of improvements in conditions as they were brought about, no close student of the subject can fail to recognize that corrosion was a contributing factor in much of the early troubles, and that this corrosion was among the disturbances which, in many instances, have been suppressed. There is every reason to believe, for instance, that corrosion was involved in the trouble on the old Flint & Pere Marquette 55 years ago, when this road "sometimes found it necessary to renew its fireboxes in less than a year." But even with the general lack of differentiation as to the causes of improvements, conjecture is unnecessary. The Illinois Central specifically reports the reduction of corrosion as a contributing factor in securing the present mileage of its tubes; the El Paso & Southwestern furnishes a classic example of pitting eradication; the Southern Pacific reported cases of pitting elimination as long ago as 1899; the Missouri Pacific, prior to the disturbances of the shop strike, had witnessed the practical elimination of firebox pitting in 1919 and now finds that tube pitting per engine is much less than formerly, while striking instances of the suppression of pitting have been produced on the very road whose mechanical head has so recently urged the search of a cure for the evil. It is a well known fact that the last 20 years at least have seen boiler troubles removed from railway operation which if encountered at the present time in the intensity experienced heretofore, not only would constitute a serious drain on financial resources but would make many of the present locomotive and train performances impossible. Such being the case, it is highly important to a proper perspective of



Sections from pitted tubes

the pitting situation to know that in many instances corrosion was among those factors, the elimination or reduction of which affords the explanation for the disappearance of these troubles.

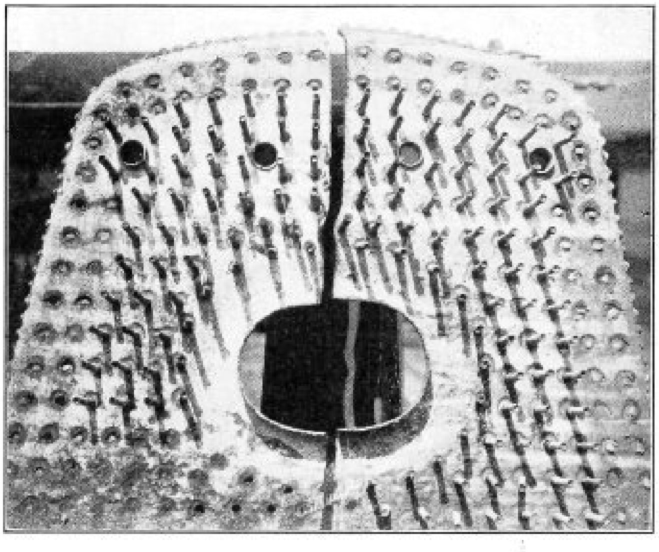
Pitting Has Increased in Some Treated Water Regions

It is true, however, that with all due consideration to the misapprehensions entertained concerning the status of boiler corrosion and the knowledge that much corrosion has been eliminated, there is pitting at the present time. It is the feeling in some quarters, moreover, that the situation is somewhat menacing from the fact that the pitting not only continues in many instances where water treatment has been attempted, but has increased in at least some of these territories. From the lines of the Chicago, Milwaukee & St. Paul, for instance, prominent for its contributions to recent literature on water conditioning work, comes the statement that "we are experiencing 50 percent more pitting today on our flues than we did years ago," while it is also significant that both roads mentioned at the outset of this discussion by reason of the comment of certain of their officers on pitting conditions are pioneers in water conditioning work. Although information from authentic sources to the effect that pitting is prevalent and generally more noticeable in regions of bad water which have not yet been subjected to water treatment, clearly discounts the idea entertained in some quarters that water treatment is necessarily *the* agent responsible for this increase, it does appear on good authority that water treatment—whether by removing protective scale or other action—has been a stimulant to it in some localities. However that may be, it is certain that there are instances where railroads are still getting only 12 to 15 months' life from tubes which, but for pitting and grooving, would give from 10 to 15 years' service (by successive safe ending) while fireboxes and boilers are being prematurely patched because of this trouble. In this connection, though with a note of caution, attention is directed to the following comparisons among the values of flues carried in stock on a few roads selected at random which differ in that two are favored with ideal water while the waters on the others are bad in places, but which are alike in efforts made during recent years to eliminate surplus stock.

	Typical flue stocks carried		
Kind of Territory	Road	Total value	Value per engine
Good water	A	$12,382	$34
	B	27,075	56
Bad water	C	297,424	155
	D	260,227	200
	E	372,699	195

The comparison of the average flue stock of $45 per engine on the first roads with the average of $180 per engine on the others is not rendered less significant by the knowledge that the bad water roads furnished engines with better water than was formerly the case.

In recognition of these facts and the further facts (1) that material and labor costs are high, (2) that the requirements of power are increasingly exacting, (3) that the trend of natural waters, particularly surface waters, is certainly not toward improvement but in the more thickly populated sections noticeably toward becoming less acceptable for boiler use, and finally, in recognition of the increasingly less choice in the selection of supplies as a consequence of increased demands for water, particularly in those sections where the available supplies have been none too good or plentiful in the first place, it is quite obviously in the interests of economy and efficiency that the problem should receive attention. The force of this assertion is not lessened when it is recognized (1) that in all efforts toward increasing the efficiency of the present day locomotive the boiler is the principal point of weakness, (2) that except in the field of electrical transmission, the importance of eliminating pitting and its associated ills is emphasized rather than diminished in the case of those innovations in locomotive design now in prospect, among which is the turbine engine and (3) that success in the elimination of pitting will also reflect to the benefit of the railroads in the aid it will provide in the reduction of corrosion elsewhere, notably in connection with underground piping, heating plant conduit, etc., where corrosion is constantly making large and in some instances surprising demands on maintenance expenditures. The relationship between the origin of this waste and that in boilers gives the latter suggestion a large significance.



A recent case of firebox pitting—Note the location and extent of the corrosion

However, at this moment unmistakable progress is being made in the solution of existing and prospective pitting problems. Fifty-four years ago it was said of water troubles generally that "the subject has baffled the skill of the leading scientific and practical minds at home and abroad." That was a period of nostrums when all kinds of remedies were tried in an effort to overcome the troubles encountered. On the Santa Fe, for instance, a dozen or more methods of purification had been employed up to 1900, among which were petroleum oil, tallow, malt, starch, ship stuff, zinc and prairie soil. Potatoes, peas, wheat and moss were also among the remedies which various roads had tried. That was the period generally when the whole question of boiler ills was in somewhat of a jumble, when cures (giving due consideration to notable exceptions) were applied without rule or reason and the results left appreciably to chance. This situation has been radically changed for the better with reference to corrosion as well as to other boiler ills.

(To be continued)

At the annual meeting of the stockholders of the Northern Engineering Works, manufacturers of electric traveling cranes, electric hoists and foundry equipment, Detroit, Michigan, the following officers and directors were elected for the ensuing year: Henry W. Standart, president and treasurer; Harry C. Bulkley, vice-president; Louis H. Olfs, secretary. The above, with W. Robertson, chief engineer of the company, and Joel H. Prescott constitute the board of directors.

Charles E. Koch, who has served for some time in the Reading Iron Company's mills at Reading, Pa., will, in future, call on pipe buyers in the Reading territory of the Reading Iron Company, confining his efforts to eastern Pennsylvania in the interests of Reading pipe. His headquarters will be the general office of the company, Reading.

British Boiler Firm Fabricates Variety of Plate Products

Welding plays important part in production of tanks, pipe work, stills and boilers — Samples of the work turned out

By John Gordon Kirkland

VERSATILITY of thought and action is dear to the heart of an American. By his clean cut designs, rapidity of construction, ingenuity and adaptability he has gained the admiration of the whole world.

Something of this spirit exists in the works of A. J. Riley and Son, the leading firm of boiler makers in Yorkshire, England. The business was founded in 1888 by Mr. Riley who is a practical boiler maker. Through his determination, shrewdness and energy the business was firmly established. Nowadays the son is the driving force, with all his father's characteristics plus his own.

The shop consists of 3 huge bays each 280 feet by 60 feet span. In each bay a 20-ton overhead crane runs from end to end.

The yard is 280 feet by 180 feet and a private siding runs parallel to the back of the works, where material is picked out of the cars with a 50-foot 5-ton jib and placed in the yard. If for stock, the material is placed in racks and if for immediate use passed into the shops.

Plant and Equipment

No. 1 bay contains the punch and shears, two 6-foot drills, 10-foot vertical rolls, 6-foot 6-inch horizontal rolls, an angle bending machine, a furnace and power press. No. 2 bay has the electric welding plant, hydraulic riveter planing machine, compressor and acetylene outfit. No. 3 bay contains only 2 drills and a turning lathe. No. 1 is laid out for preparing the various parts, No. 2 for assembly and welding or riveting, No. 3 for completion and test. There is a 20-foot sliding door at each end of No. 3 bay, one for goods for transport by road, the other for goods by rail.

The objective in design is economy combined with efficiency; this can generally be obtained by a little cooperation between the practical and technical men. The maximum amount of information is given on detailed drawings, and the finished plan goes through the shops as a law to be strictly adhered to. Riveting is avoided where possible and is practically a thing of the past.

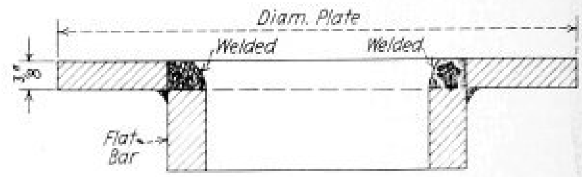
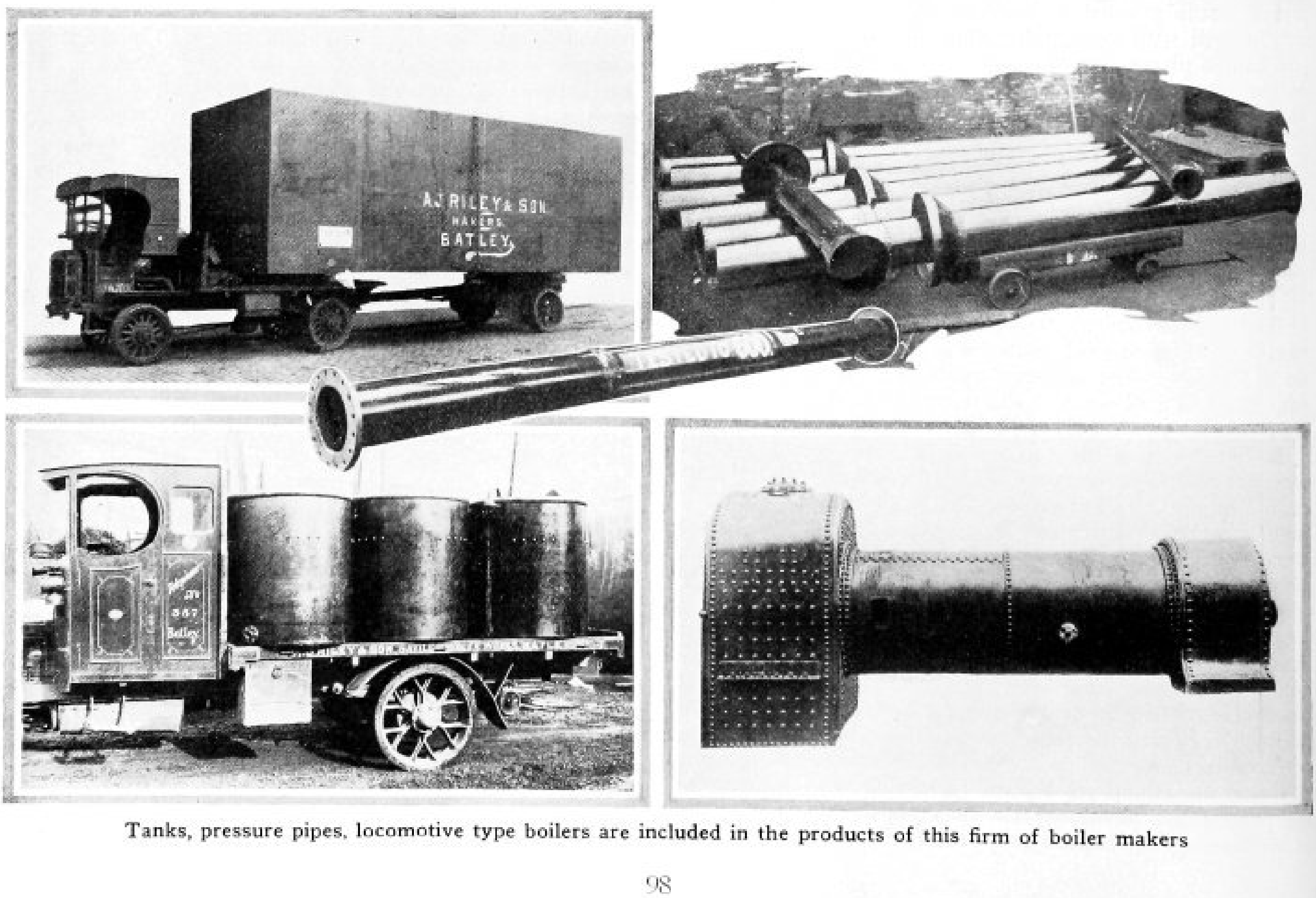


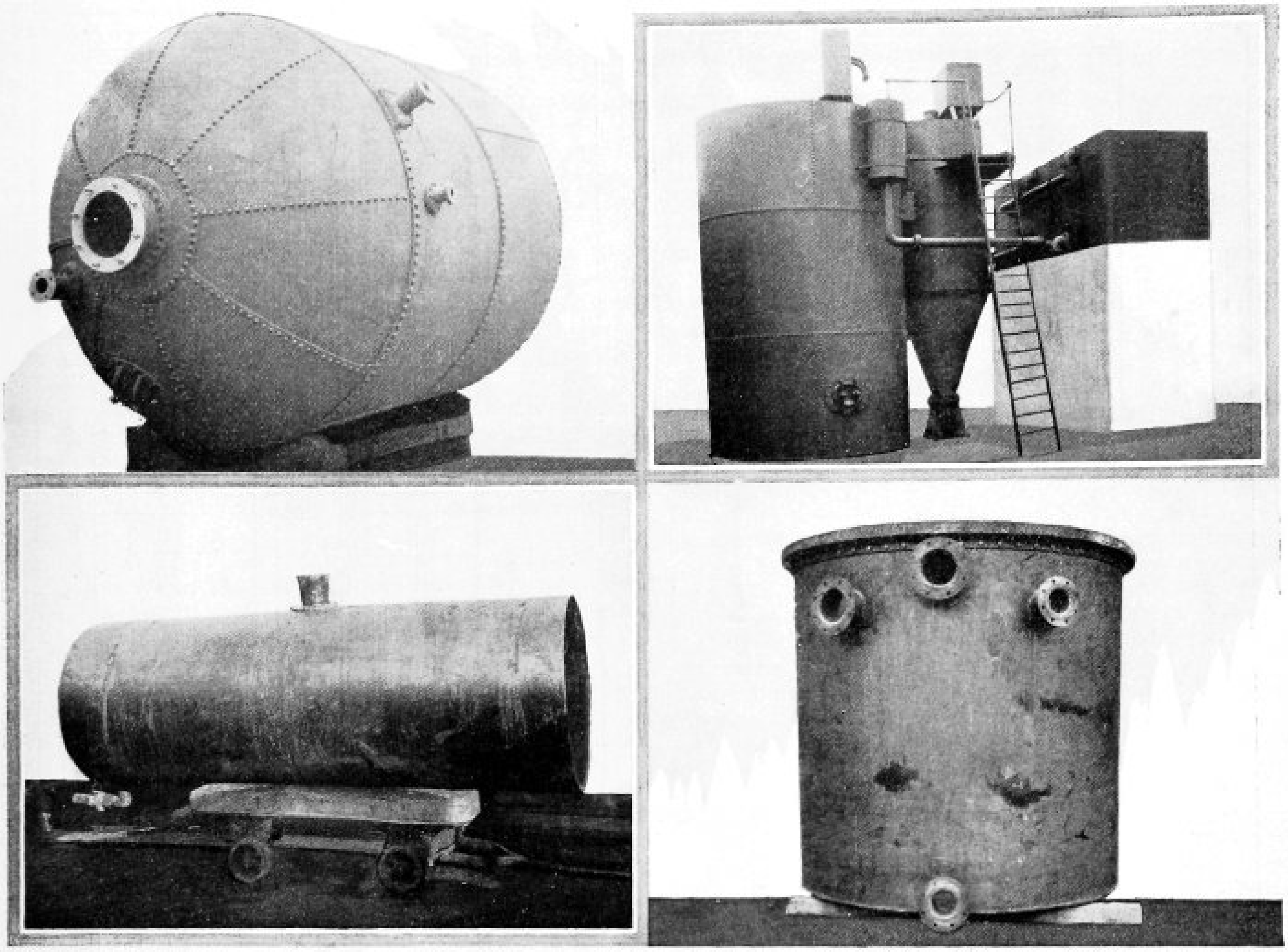
Fig. 1.—Detail of welded pipe flange

Fabricating Pipe Work

Electrically welded pipe is one of the main lines of this firm. These are much cheaper than solid drawn, lap welded



Tanks, pressure pipes, locomotive type boilers are included in the products of this firm of boiler makers



A few examples of large size tank and pressure vessel work of A. J. Riley and Sons

or riveted pipes, if not equally as good. The plates to form the pipes are ordered cut dead to size, this saves marking off, handling and shearing in the works. Therefore when 200 plates arrive for one hundred 15-foot lengths the whole batch goes to the planing machine for edge beveling.

The next process is rolling, after which the tubes are laid in channels and joined together. The plate flanges go to the lathe where they are faced, turned and the center hole cut out, they are then drilled from templates or jigs and ready for fitting. Pipe flanges in Britain are generally made to B. S. T. 1 or B. S. T. 2 which means British Standard Table 1 or 2. For given pressures and diameters all particulars of holes for bolts and thickness are given. The flanges are now fitted to the tubes at right angles to the center and holes in line with each other, and the exact length.

A fillet weld is run around the back of the flange and the heel of the flange is also welded to the tube. The next process is the grinding off, of all rough parts, after which the pipe goes to the test shop, where it is subjected to three times the working pressure and struck with a hammer while under pressure.

The pipe shown on the photograph was tested to 600 pounds and works at 180 pounds steam pressure. Another illustration shows a set of pipes for 250 pounds test. In this case the flanges are made of steel plate pressed to form an angle for riveting on to the tubes.

The processes of this method of pipe making are few, viz.: Planing, bending and welding tubes, turning drilling and welding flanges, grinding, testing and painting.

Pit cages which are made here are all special work. All the parts are forged out from the solid, machined and riveted together. Care is necessary in making these and the cage when finished must be true and plumb from all corners so as to hang properly in the shaft ways.

TAR STILLS

The shells of tar stills are simply cylinders with the vertical seams lap jointed and riveted. The top and bottom being hemispherical are made in 8 segments and a crown.

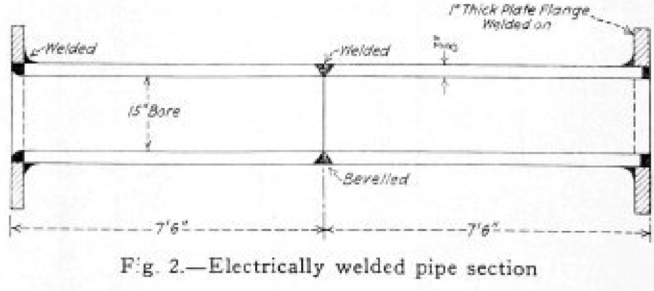
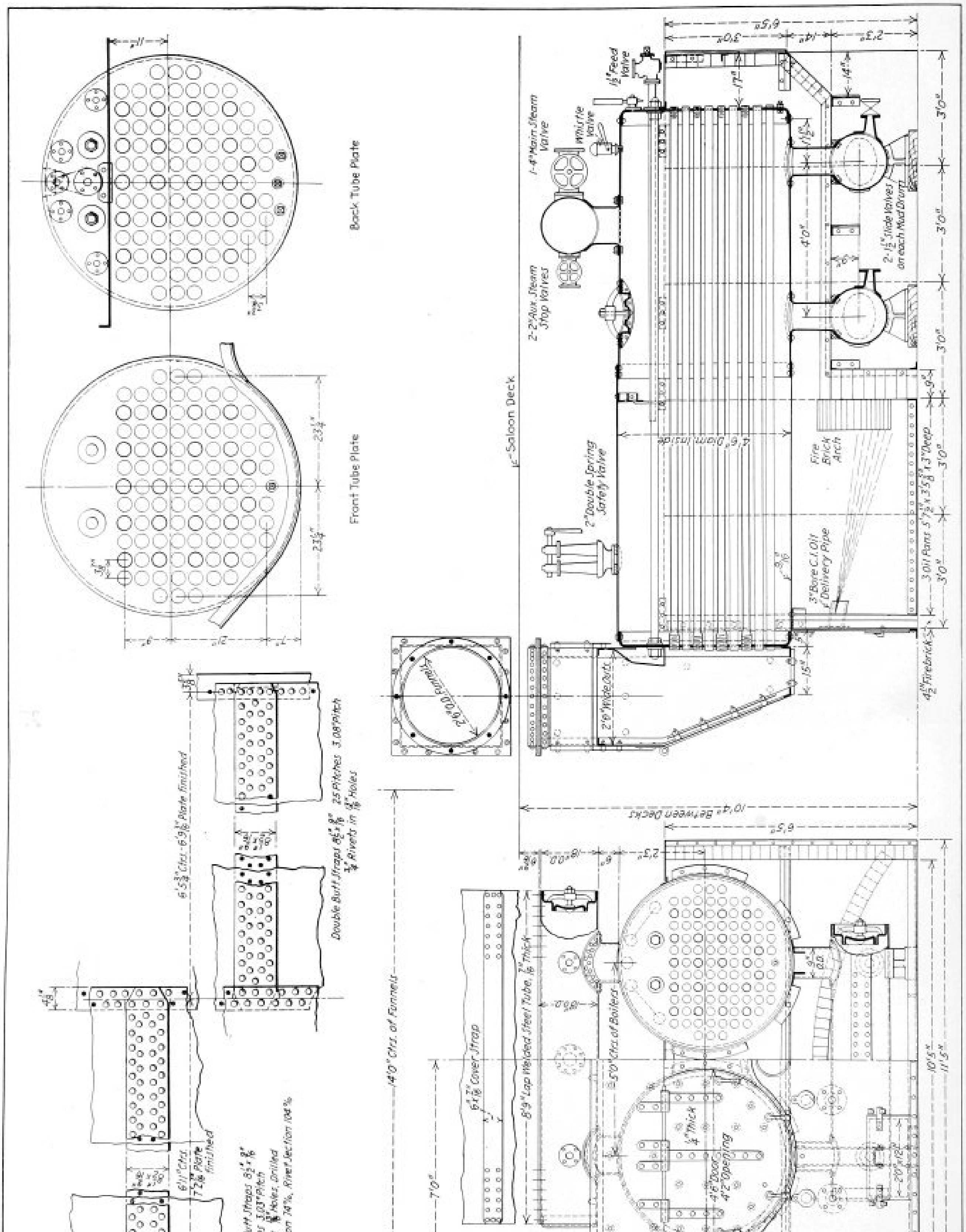


Fig. 2.—Electrically welded pipe section

Some shops, however, press these from one plate. After the template has been developed for the segments, the plates are cut to shape, pressed and punched. The whole job is then assembled and riveted up in the usual way.

TANK WORK A SPECIALTY

The large water tank in the accompanying illustrations measures about 30 feet by 9 feet by 9 feet and is electrically



Details of multitubular marine boilers designed for shallow draft steamers

welded throughout. The method of staying is by triangular gussets. These brace the sides and bottom in a most effective way, the greatest sectional area of plate being where the pressure due to the head is greatest. This gusset comes from the plate mill exactly as shown in Fig. 3. It is simply fixed in position and welded to the bottom. Marking off, punching and shearing are dispensed with, which would be necessary if the staying arrangement consisted of angles, flats and tie rods. The drafting and fabrication is simple and the efficiency beyond question.

The gas coolers shown measure 30 feet by 20 feet by 5 feet built of ¼ M. S. plate and fitted with two hundred and thirty-eight 4-inch diameter tubes 25 feet long. As these are too bulky to send out in a piece, the maximum amount of work possible is done in the works and the erecting and riveting done in the field. It will be observed that all the side sheets are the same and can be drilled from a template. Additional holes are necessary but these are put in each particular sheet. The ends are formed by a radius which takes a part of the side. This is much stronger, neater and cheaper than square corners. Each cooler weighs about 35 tons.

The 30-foot by 7-foot 6-inch diameter type tank is a good example of the application of arc welding. The longitudinal seams are butt jointed, vee'd and welded and the circular

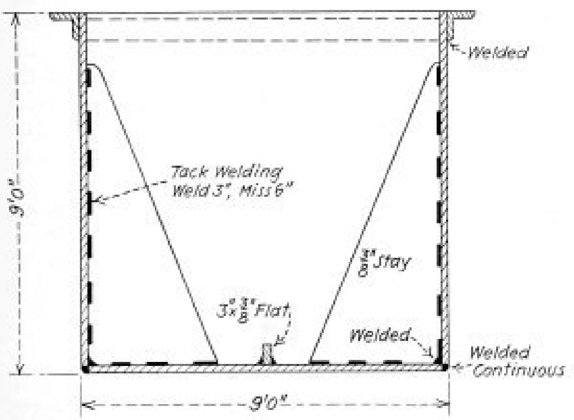


Fig. 3.—Small tank with flanged heads

seams lap jointed and welded in an out. The plates to form the shell are marked on the floor and 4 holes cut by acetylene near the edges. When the plates are bent these holes are handy for assembling the whole cylinder. The flat ends are fixed to the shell by 4 angle cleats. With the job assembled there are about 600 feet ready for the welder. It will be noted that there are no bottom flanges for the branches. These consist of a piece of tube welded to the shell and top flanges welded on for pipe connections.

Another example of tank work is that of a small tank with flanged heads. The manhole body projects into the tank, the depth of section efficiently staying the top. The bottom is stayed by 6-inch by ⅜-inch flats on edge. Compare the cost of this tank with a riveted one of the old days.

Boiler Construction

In addition to other classes of boilers and vessels, this firm handles some 30 or 40 locomotive boilers per annum. As a rule the work consists of renewing the firebox and tubes, but oftentimes when the box is removed and a closer examination is possible a complete new boiler is required.

The marine multitubular boilers built here are designed for shallow draft steamers and generally occupy a space between decks of about 10 feet. The method of manufacture is concentration. The uptakes, funnels, side, back and front casings—oil pans, boilers, steam drums, mud drums—are built at the same time by separate squads. The components are then assembled for inspection and test, after which the whole is shipped abroad.

Boiler Repairs

Mines, mills, quarries and factories of all descriptions, most of which run by steam power abound in Yorkshire. Boilers of all classes are in use and repairs of all descriptions are necessary. Electric welding plays a prominent part in building up wasted areas of plates, pitting, grooving and fractures. Plate patches are of course common and in some cases necessary. The field repairs are expedited by the use of portable electric and acetylene equipment and compressor plants are conveyed with the workmen to the sets by motor wagons.

Boiler Scaling

Boiler scaling and cleaning is not a theory with this firm but an accomplished and established fact. Some 300 boilers per year are scaled by pneumatic tools, and there is no comparison between hand-scaled boilers and this method. Every nook and cranny is cleaned to the bare plate and the saving in fuel effected varies from 10 to 20 percent. Oftentimes scaling reveals a fracture, or pitting and grooving and the same firm steps in with the suitable repair, such is the advantage of being versatile in the boiler making industry.

Some 200 men and boys are engaged at the works, about 120 on the day shift and the remainder on the night shift. The day shift is controlled by one foreman and one under foreman, and the night shift by one foreman.

On each contract the allowable wage bill is fixed and given to the day foreman, who rate-fixes each process and allocates a proportion of the whole to that process. The workmen draw their time wage plus any bonus made on the job completed at a price. Every encouragement is given to good men some of whom draw £8-0-0 per week which is equal to about $40. A certain amount may be overtime but the opportunity to earn it is there through the efforts of the principals of the firm.

Prevention of Boiler Scale

(*Continued from page* 94)

After such experience under actual working conditions the process may be valued as follows, viz.: That it does not absolutely prevent the formation of scale and incrustation, but that it decreases considerably the deposit of hard scale, or makes it of a loose nature so that it breaks off without any harmful secondary action. Although the total costs for the various cleaning processes are not eliminated by it, a saving has been obtained in this special case by lengthening the period for working the boiler from 3 months to 4-5 months.

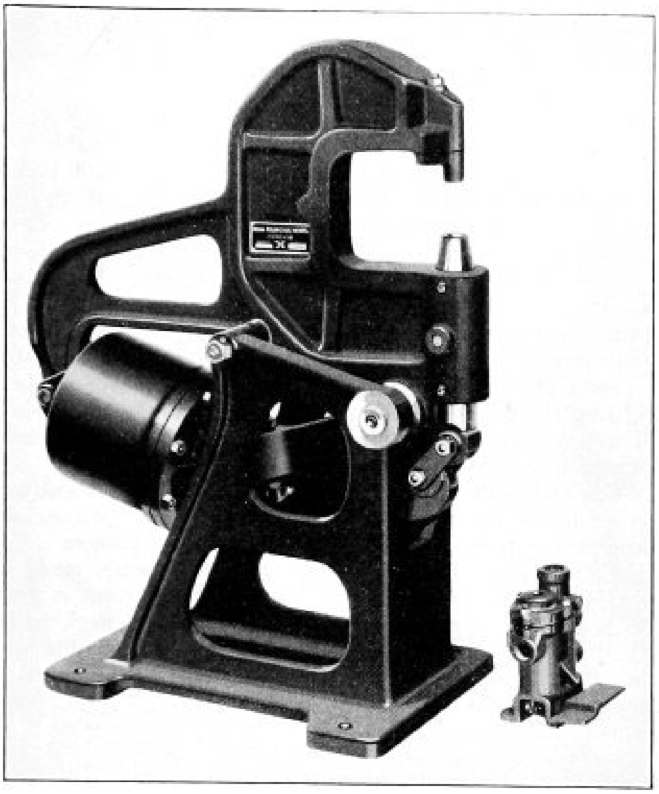
Further experiments with the "Paralyzing" current process are greatly to be desired, since it is cheaper than any other method used in Germany and since there is no possibility of the steam absorbing any matter which would render it liable to taste or smell, a fact which is always present when using chemicals in the feedwater. The initial costs for the apparatus are comparatively small, the consumption of energy a minimum and no supervision is necessary.

Owing to the increasing demand for Agathon Alloy Steels, and to render better service throughout the oil fields of the Southwest, the Central Steel Company of Massillon, Ohio, has opened a district sales office at 404 West First Street, Tulsa, Oklahoma. This office will be in charge of L. S. Allen.

Hanna Rapid Riveter

THE new Hanna rapid riveter, manufactured by the Hanna Engineering Works, Chicago, Ill., which permits inserting rivets from above and driving from below is shown in the accompanying illustration. This feature and a speed of fifty strokes per minute has made possible some unusual riveting records with this equipment.

The mechanism is a combination of simple lever and toggle which combines a long die stroke with a wide range of uniform pressure, thus eliminating the necessity of screw adjustment on the die. The die travel is very rapid as the die approaches the work. The die or plunger speed gradually decreases until it enters the uniform pressure area of the stroke—hence the pressure is uniform. The advantage of this die stroke is, where the work is lightest the speed is greatest; as the rivet head forms, the pressure increases, reaches a maximum and maintains it for several inches of piston travel. Ordinary variations in rivet lengths and plate thicknesses are automatically taken care of by the wide range of uniform pressure.



Rivets are inserted from above on this Hanna machine and driven from below

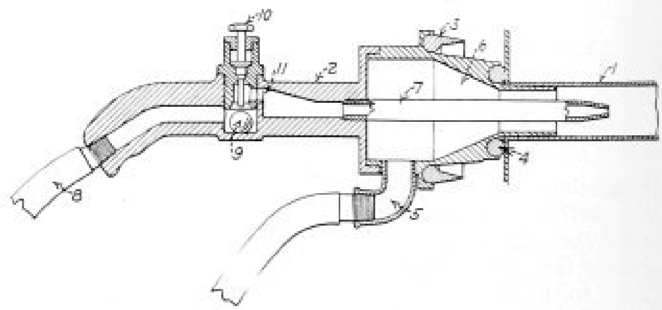
The machine is made in sizes capable of driving 1/4 inch to 1/2 inch rivets hot, 3/16 inch to 3/8 inch rivets cold and can also be used for punching.

Locomotive Boiler Tube Cleaner

A DEVICE for cleaning the flues of locomotive boilers has recently been patented by Robert D. Kilcrease, enginehouse foreman, Atlantic Coast Line, Albany, Ga. The method of cleaning with this device, a longitudinal section of which is shown in the drawing, is by forcing a cleaning fluid into the flue with compressed air from the shop air line. The principal object of the inventor was to provide a flue cleaner that would force the dirt and cinders out of the opposite end of the flues in case it was not entirely closed, and if closed, to prevent the cleaning compound and dirt from flowing back on the man doing the cleaning.

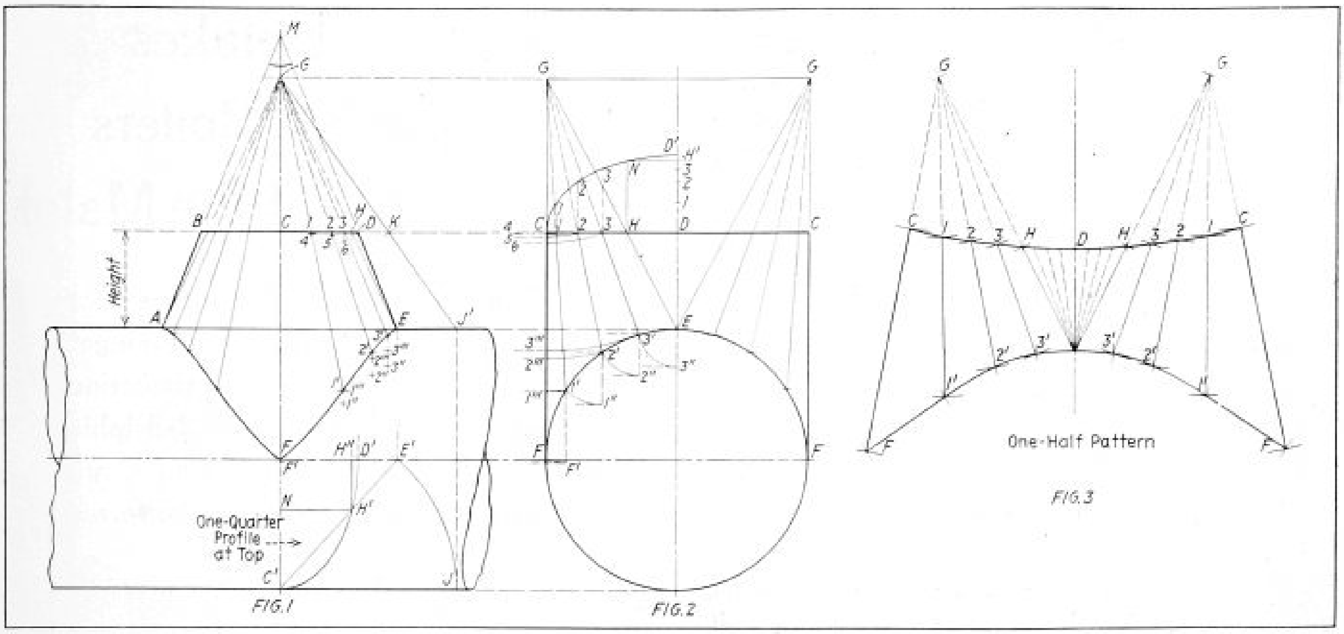
Referring to the reference numbers on the drawing, 1 is a portion of the boiler flue next to the flue sheet. The flue cleaner comprises a tubular body 2, one end of which is turned down for a hose or flexible coupling 8, to be coupled to the body. The body is expanded as shown in the drawing and the head of the cleaner is screwed into it. The forward part of the head forms a nozzle which fits into the flue. The head is provided with a shoulder in which is seated a rubber gasket 4, which bears against the flue sheet and forms a closed joint which prevents leakage of the cleaning compound. The device is also provided with a second rubber gasket 3, which performs a function similar to gasket 4 when cleaning flues or tubes of larger diameters than that shown in the drawing. The elbow joint 5 to which a hose or flexible coupling can be attached is the outlet through which the cleaning compound, scale and dirt can escape from the enlarged chamber in the head when backed up on account of the flue being choked.

The flow of cleaning compound which is forced through the hose 8 is controlled by the valve 10. It will be noted that the inlet and outlet parts of this valve are not in alinement. The inlet part leads into a chamber in which is a ball 9. The stem of the valve 10 rests on a plunger which seats by its own weight. The ball 9, of course, can also drop to the floor of its chamber by its own weight. When the cleaning compound under pressure is admitted to the ball chamber, it lifts the ball against its seat and at the same time raises the plunger. The ball is thus held by the pressure of the fluid until the device is ready for operation. When ready, the operator presses down on the handle of the valve 10 which depresses the plunger and forces the ball 9 from its seat, allowing the cleaning compound to flow through the port 11 and escaping with considerable velocity through the nozzle 7. If the flue is not completely closed by the accumulation of cinders and other particles, the force of the cleaning compound will carry the accumulations out through the opposite end of the flue. If the flue should be completely choked or nearly closed, the pressure of the fluid should be sufficient to dislodge the particles. Any back pressure created carries the loose particles through the outlet 5. This arrangement prevents the dirt and fluid from flowing back on to the operator which relieves him of considerable annoyance.



Longitudinal section of a device for cleaning the flues of locomotive boilers

The body of the flue cleaner is shaped so that it forms a convenient handle which may be comfortably gripped by the operator. The design of the valve 10 is such that it is easy to operate, only a slight pressure on the handle being required to permit the cleaning compound to enter the flue with considerable force. The operator may also stop the flow of the cleaning compound by removing the pressure on the valve handle in case he desires to observe the progress of the work or to move to the next flue. This flue cleaner is designed to operate most effectively with from 70 pound to 130 pound pressure.



Development of transition piece and pattern layout

Transition Piece Intersecting Pipe

One method of laying out and developing the patterns for a sheet metal job frequently required in the shop

By I. J. Haddon

THE problem of laying out transition pieces although so often met with in the sheet metal shop, is one that requires different treatment in nearly every case that presents itself. The writer in this instance presents a clear and concise method that should be of some value to readers who are required to handle work of this character.

In Fig. 1 is shown one view of the transition piece completed *A B C D E F*, and *F C D C F* shows another view. In this case the top, *B C D* is an ellipse but it will be seen that *F E* in Fig. 1 is *not* (as some would presume it to be) a straight line, therefore *not* an ellipse. To construct: Draw center lines and lines representing the pipe; draw the line *B D*, Fig. 1 and *C C*, Fig. 2 at the height required; make *B D*, Fig. 1, equal to the minor axis of the ellipse; draw *A M*, *E M* *at the angle required*, passing through *B* and *D* as shown. Draw a quarter profile of the top as shown; draw *C' E'* cutting the ellipse in *H'*; project *H'* to the line *B D* in *H*, draw *E H* and project to *G*. From *G*, Fig. 2, draw any number of lines intersecting the circle in *F*, *1'*, *2'*, *3'*, and *E*, also cutting the line *C-D*, Fig. 2 in *C*, *1*, *2*, *3*, *H*; draw the quarter ellipse, Fig. 2 and project perpendiculars to *1*, *2*, *3*, *H* *in* *1*, *2*, *3*, *N* as shown, then project them horizontally to *1*, *2*, *3*, *H'*. Now make *C 1*, *2*, *3*, *H D*, Fig. 1 equal to *D*, *1*, *2*, *3*, *H'*, *D'*, Fig. 2. Draw lines *G-1*, *G-2*, *G-3*, and produce them well into the pipe as shown in Figs. 1 and 2.

From *3'*, *2'* and *1'*, Fig. 2, draw lines parallel to *A-E*, so as to cut the lines drawn from *G*, Fig. 1, in *3'*, *2'* and *1'*. Draw the *curve* through these points, as *F*, *1'*, *2'*, *3'*, *E* and this will be the line of inter-penetration.

To Develop

Draw the line *E-D*, Fig. 3 equal to *E-D*, Fig. 1. From *C'* as a center, Fig. 1 and radius *C' E'* describe the arc *E'*, *J*; project *J* to *J'*; draw *J'-G*, cutting the line B-D produced in *K*; then *J'-K* will be the true length of *E-H* and *J'-G* will be the true length of *E-G*. Therefore, from *E* as a center, Fig. 3, and radius *J'-K*, Fig. 1, draw an arc as shown. Also from *E* as center, Fig. 3, and radius *J'-G*, Fig. 1, draw an arc as shown. From *D* as center, Fig. 3 and radius *D'-H'*, Fig. 1, draw an arc cutting the arc drawn from *E* as center. In *H* draw *E-H* and produce to cut the other arc drawn from *E* as center, in *G*.

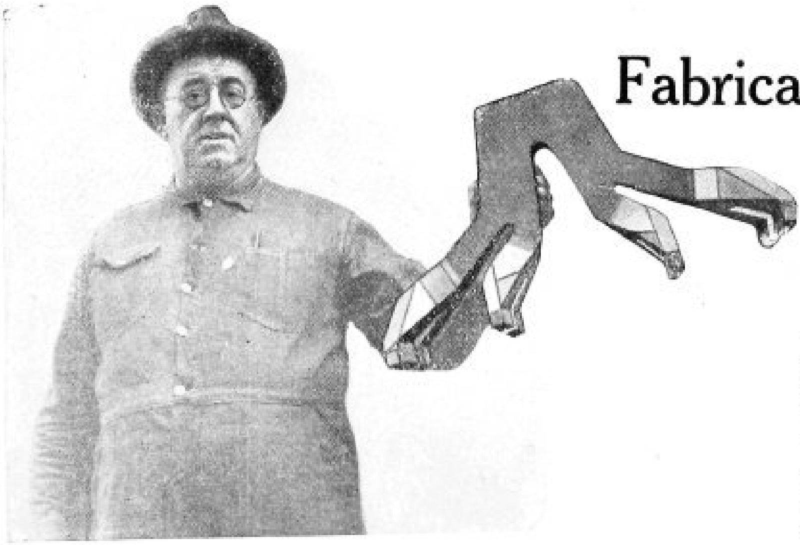
To obtain the true lengths of *3-3'*, *2-2'*, and *1-1'*; from *G* as center, Fig. 2, and radius *G-3*, *G-3'*, etc., draw arcs cutting the line *G-F* in *4*, *5*, *6* and *3'''*, *2'''* and *1'''*; project these horizontally to cut lines dropped from *1*, *2*, *3* and *3'*, *2'* and *1'*, Fig. 1, in *4*, *5*, *6* and *3'''*, *2'''* and *1'''*; then *G-3'''*, Fig. 1, will be the true length of *G-3'*, and *G-2'''*, Fig. 1, will be the true length of *G-2'* and so on as shown. Therefore, with *G* as a center, Fig. 3, and the true lengths of *G-3*, *G-3'*, etc., as radius draw arcs as shown. Now it is necessary to know the true lengths of *3'-2'*, *2'-1'* and *1'-F*, shown in Figs. 1 and 2. Therefore, from *E* as center, Fig. 2, and radius *E-3'* draw the arc *3'-3''*. Project *3''*, Fig. 2, to cut a perpendicular dropped from *3'*, Fig. 1 in *3''*. Then *3''-E*, Fig. 1, will be the true length of *3'-E*. Obtain the true lengths of *2'-3'*, *1'-2'* and *F-1'* in a similar manner as shown.

With these true lengths cut the arcs drawn from *G* as center, Fig. 3, in *3'*, *2'*, *1'* and *F*. Draw lines from *3'*, *2'*, *1'* and *F* to *G* cutting the other arcs in *C*, *1*, *2* and *3*. Draw a fair curve through these points as shown to complete the figure.

The lines shown in the half pattern are rolling lines and are straight at all times. The lines *F C*, Fig. 3, represent the center line of the holes if the plates have to lap. Now

(*Continued on page* 106)

Fabricating the Uptakes for the Boilers of the Malolo



Wooden model of Malolo uptakes

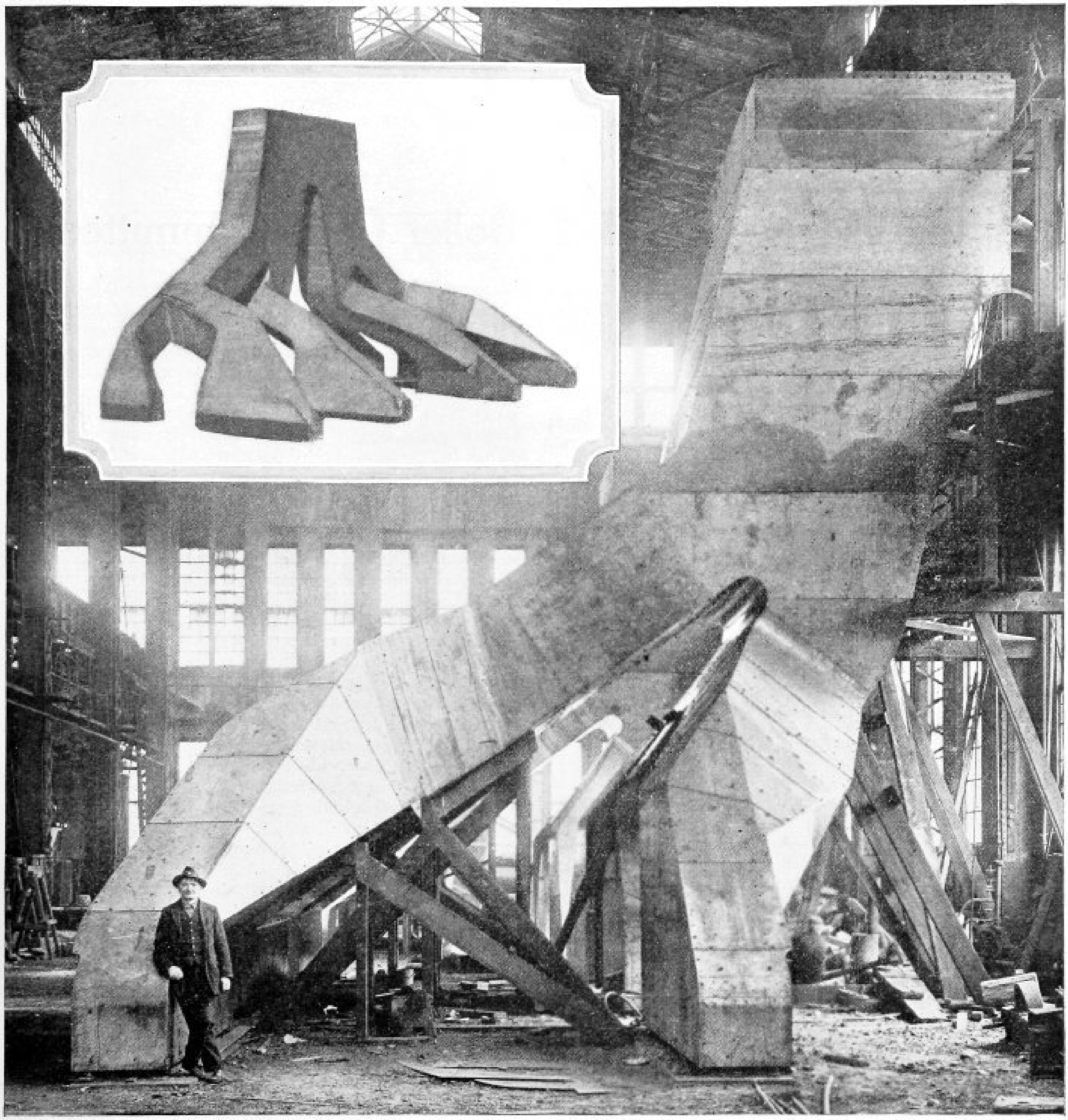
Description of the development of the uptakes of the fast passenger steamship now under construction at Cramp's shipyard in Philadelphia for the Matson Navigation Company of San Francisco, California

AMONG other special features involved in the building of the celebrated steamship *Malolo* is the method employed for the construction of the uptakes from the boilers to the stacks. The *Malolo,* which has the distinction of being the largest high powered and swiftest passenger ship so far built in the United States, is equipped with two batteries of Babcock and Wilcox marine type watertube boilers, six in each boiler room. These boilers are equipped for burning oil and operate at a working pressure of 280 pounds per square inch, delivered at the turbines. This is the highest working pressure, according to the Babcock and Wilcox Company of New York, that has ever been generated in the boilers of any passenger steamship.

It is believed that the uptakes in this ship constitute one of the largest sheet metal working jobs that has ever been attempted in any boiler or sheet metal working shop in this country.

The only plan from the designers of the vessel, Gibbs Bros., Inc., of New York, that the shipyard had to work from in laying out the uptakes was the usual inboard profile of the ship with the side of the uptake leg between the boilers and the stack indicated. In starting the preliminary layouts, it was found that the space provided in the hull was in-

View of completed uptakes in the boiler shop of William Cramp and Sons' shipyard



End view of one set of uptakes for the steamship Malolo—Insert shows detail of wooden model

sufficient for the uptakes and for the large ventilating air trunks passing to the fireroom. A wooden model of the uptakes was made to show the designers that the bulkheads in wake of these uptakes would have to be changed; subsequently a second model was made to show an alternate method of shaping the uptake legs suggested by the boiler department at the shipyard to obtain a better layout of plate work. Where very crooked plate structures are involved, the engineers at Cramps find it best to make a scale model which serves much better than a drawing in discussing the various practical questions involved in building the structure. The work, however, is actually built from the usual detail drawings made up after the conferences with the shop regarding the model are concluded.

A space of approximately 50 feet by 60 feet in the layout department was required to lay down the patterns for the uptakes to full size. Wooden templates were made from the patterns and these used in laying out the sheets for fabrication.

Since a great deal of special fitting was required before the uptakes could be assembled in the ship, they were first erected in the boiler shop. Special preparations were required for handling the work due to the extreme size and weight which amounts to between 35 and 40 tons. To simplify the problem of erection, cribbing was erected along the south wall of the boiler shop to a height of about 36 feet and upon this cribbing the upper members of the uptakes were fastened. Two trenches were dug in the floor approximately 15 feet apart each of these being 125 feet long and 3 feet wide. Cinders, stone and concrete were used as a foundation to simulate conditions that would be found in the ship when the final erection of the uptakes was attempted.

The complete job of laying out, fabricating and assembling the uptakes was accomplished in three months' time. After the assembly of the uptakes was completed, the lower sections were riveted up complete in the shop. They will be installed in the completely assembled condition. The large upper section, however, was dismantled for assembly and final refitting of joints on the ship.

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

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

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

Below are given interpretations of the Committee in Cases Nos. 515 to 518, inclusive, as formulated at the meeting of January 8, 1926, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

Case No. 515. *Inquiry:* Will a composition of steel boiler plate having a copper content not exceeding 0.35 percent, be acceptable for use in boilers built under the requirements of the Power Boiler Code? In other words, is it to be understood that in the absence in the present specifications for steel boiler plate of any requirements or limits for copper, there is no objection to the presence in such steel boiler plate of a copper content up to 0.35 percent?

Reply: There are no requirements in the Boiler Code specifications for steel boiler plate that pertain to copper content. It is the opinion of the Committee that if the chemical and physical characteristics of such steel comply with the specifications in the Code for steel boiler plate, it may be considered to meet the requirements of the Code.

Case No. 516. *Inquiry:* Will a nozzle mounted on a shell or drum formed of pipe which embraces a neck or liner extruded from the metal in one side of the pipe, over which is fitted a forged or cast steel nozzle block, having grooves into which the extruded neck is expanded, be permissible under the Code? The space surrounding the top of the liner is acetylene welded and machined, and also the junction between the bottom of the forged or cast steel saddle is welded to the pipe, but it is pointed out that the welding is for finish and appearance only and is not required for either strength or tightness. In a test of an 8-inch nozzle of this construction, but without the welding, it required 1,000 pounds to produce a slight leak, and when the nozzle was re-rolled, it withstood 2,000 pounds.

Reply: It is the opinion of the Committee that if the nozzle construction referred to has a factor of safety of 5 under test at the working pressure intended, without taking the holding power of the welds into account, and if the other portions of the construction conform fully to the requirements of the Code, the construction described will meet the requirements of the Code. For example, the test reported would indicate that the nozzle is suitable for use at 400 pounds working pressure as the maximum, provided the materials and construction conform to the Code requirements for this pressure.

Case No. 517. *Inquiry:* Is it the intent of Par. P-297 that the term "maximum allowable working pressure" shall apply to the maximum design pressure of a boiler where a boiler designed for a high working pressure is operated at a much lower working pressure? It is found impracticable in operation to work with steam gages graduated to conform to the maximum design pressure, but it is much more convenient in operation to have the steam gage graduated to conform to the pressure at which the safety valves are set to relieve.

Reply: The first part of Par. P-297 refers to "the pressure at which the boiler will operate," and it is therefore the opinion of the Committee that the term "maximum allowable working pressure of the boiler" was in this instance intended to apply to the maximum pressure at which the safety valves on the boiler are set to relieve.

Case No. 518. *Inquiry:* Is it not permissible in applying the formula in Par. P-199 for braced and stayed surfaces in boilers where the staybolts are not symmetrically spaced, to consider the load carried by each staybolt as the area determined by taking the distance from the center of the spacing on one side of the staybolt to the center of the spacing on the other side? Attention is called to the fact that the term p in the formula specifies the maximum pitch measured between straight lines passing through the center of the staybolts in the different rows, but that the formula is presented with a definite implication that the staybolts are symmetrically spaced.

Reply: In cases where the staybolting of boiler plates is unsymmetrical for reason of interference with butt straps or other construction, it is the opinion of the Committee that in addition to the special provisions of Pars. P-205 to P-207, it is permissible to consider the load carried by each staybolt as the area calculated by taking the distance from the center of the spacing on one side of the bolt to the center of the spacing on the other side.

Transition Piece

(Continued from page 103)

supposing the transition piece had to be flanged and riveted to the pipe, then material should be allowed for flanging and the line *F*, *1'*, *2'*, *3'*, *E*, *3'*, *2'*, *1'*, *F* would represent the root of the flange. After punching and setting to shape and flanging the flange should then be marked as required and punched. Then the transition piece should be put on the pipe and marked through the holes in the flange. Then allow the proper lap on these hole marks, cut the hole in the pipe and afterwards punch or drill the holes. This is the quickest method these days especially with the oxy-acetylene torch as now in use and is the most practical method. I have given the solution to this problem to the minutest detail but to anyone conversant with layout details it will easily be seen that could have dispensed with a lot of lines and made the explanation much simpler.

Inspecting Boilers in England

Advisability of adopting a definite procedure when inspecting boilers of different types—Suggested procedure to follow

By A. Wrench

MOST boilers in Great Britain are periodically inspected by inspectors of the various boiler insurance companies. The system employed by the inspector varies according to the amount of detail required by the company he represents, but the main object is to ascertain the exact condition of boilers and the safe working load they may be permitted to carry.

To efficiently carry out this work the inspector must adopt a method for each type of boiler which will reduce the liability of any part being overlooked and defects passed unobserved. Of course, if only one type of boiler had to be dealt with it would be simple to follow a standard method, but when a system adopted for a flue boiler of the Lancashire type is applied to a boiler of the watertube type or a locomotive boiler, it does not work.

Inspecting a Firetube Boiler

A boiler of the former type can be inspected first internally then externally and afterwards in the tubes and flues, but with a boiler of the watertube type it is perhaps the best plan to start at the top drums and proceed downward until the bottom drums are reached thus mixing the internal inspections with the external and flue inspections. It would seem that the point to be aimed at when possible is to examine one part at a time such as the shell internally and externally, tubes fire side and water side, and so on, but this method would entail a great deal of time and would be confusing. One can readily see that if a defect is noted on the water side of a boiler and another defect on the fire side it is possible that the fact that these two defects coincide may be overlooked by the inspector. For example, supposing corrosion was noted on the bottom of the shell of a marine return tube boiler and on examination of the boiler externally, wasting perhaps due to leakage, was noted in the same part of the shell, it may be overlooked that although both defects are not serious in themselves the two together constitute a serious defect. Combined defects of this description will not be overlooked so readily in small boilers but when inspecting large units care should be taken to avoid errors of this description.

Inspectors are apt to consider the condition of a boiler internally, apart from the condition externally and perhaps only find that defects internally coincide with defects externally when looking over his notes prior to making out his official report.

A method to adopt to avoid errors mentioned in the foregoing is to record the position of defects found internally and leave a space for the external condition of the same part. For example, supposing the water side of a furnace tube 7/16-inch thick was found to be confluently pitted 1/8 inch deep at the sides, inspector would write in his book:

Internally—Furnace tubes confluently pitted 1/8-inch deep at sides.
Externally—

On examination of tubes on the fire side (after the internal parts of the complete boiler had been inspected) inspector would note the condition of the furnace plates especially at the sides. If there were no defects inspector would write "in order" after the word "externally." If, however, wasting was found on the sides of the furnace tubes say 3/32-inch deep it would readily be seen that the plate was becoming somewhat thin and that a test hole should be drilled to ascertain the remaining thickness of the plate.

The following methods are suggested for inspecting various types of boilers to ensure that all parts are seen.

Procedure to Follow

Internally fired boilers with furnace and flue tubes set in brickwork similar to Lancashire type boilers:

Examine water gages, pressure gage, back pressure valve; blow out tap and elbow, front end plate; pass to boiler top, examine safety valves, junction valve, high steam and low water valve, if boiler bare examine plates, if covered note covering for dampness. Examine manhole mouthpiece, cover and bolts. Enter boiler, gage thickness of shell and tubes, pass along right tube noting condition of tube and shell. On arriving at front end examine top part of front end plate and gusset stays, note if pressure gage and water gage openings are clear, examine internal feed pipe and fusible plugs if fitted. Pass to left tube and proceed towards back end plate. At back end examine top part of back end plate and gusset stays. Pass between tubes to bottom of boiler, examine lower part of back end plate and gusset stays. Pass along bottom of shell and examine shell and lower parts of tubes. On arriving at front end plate, examine lower part of this and gusset stays and also mud hole mouthpiece. Pass out of mud hole and examine mud hole door. This completes the internal inspection and that of fittings and front end plate. Pass down right tube and out into the bottom flue to examine shell in flues; pass down right side flue, then left side flue. Pass again to back end of boiler by the bottom flue and then down the left tube to the front end. This completes the inspection.

Watertube Boiler Inspection

When inspecting a boiler of the watertube type examine the blow out tap. Proceed to top of boiler and examine the other fittings; examine top and ends of drums, enter drums and examine internally. Pass through flues to examine drums externally and also generating tubes and, if fitted, the superheater. Enter furnaces. If headers are fitted examine them. Enter bottom drums and this completes the inspection. It will be seen that internal and external inspections are not completed separately as in the internally fired boiler as this is impracticable, more especially in very large units.

Inspecting boilers of the marine return tube type (Scotch boiler). Examine front end plate, tubes and fittings. Proceed to top of boiler. Examine top and fittings. Enter manhole, examine right wing set of tubes, shell and right furnace crown. Examine front end plate. Examine middle set of tubes and center furnace tube and lastly left wing set of tubes, furnace tube and shell. Examine longitudinal stays. Pass to combustion chambers and examine right wing combustion chamber girders and staybolts, also back end plate; pass to center combustion chamber and lastly left combustion chamber. Pass out of manhole and enter mud hole at front end, first right and then left to inspect lower parts of shell, furnace tubes, front end plate and combustion chambers. Enter the right wing furnace tube and combustion chamber, then center and last the left wing furnace and combustion chamber. After completing inspection of the furnaces and combustion chambers, examine bottom of boiler in the bilge and other parts of shell and back end plates as far as possible. This completes the inspection of the boiler.

Other boilers may be examined by adopting a similar method. An inspector may have several locomotive type boilers to examine and after inspecting and when writing up his reports may find that although he has examined every part accessible of each boiler, he has omitted to record the position of a defect or the type of a fitting in his book. If his procedure with all the inspections has been the same, he will be able to remember the details required by mentally going over the routine of his inspection. It will also be found that there is less liability to omit recording details when adopting a special method for each type of boilers.

Generally speaking the procedure, with slight modifications, should be as follows:

1st. Inspect fittings and make necessary inquiries regarding working conditions, pressure, etc.
2nd. Examine boiler internally.
3rd. Examine boiler fireside.
4th. Consider defects and repairs necessary.
5th. Make necessary observations to boiler owner.
6th. Record what done.

There is another important point to be remembered in connection with boiler inspecting and that is to decide whether one is satisfied with the observations one has been able to make. Further scaling may be necessary or test holes required to be drilled. If these further preparations are in the inspector's opinion necessary, he should inform some responsible person and not be turned from his decision. When he leaves the boiler his mind should be quite made up and he should promptly forget that there are such things as boilers until he arrives at the next one to be inspected.

If this article (written by an inspector of many years' experience) assists the younger members of the boiler inspecting staffs in a slight degree it will have accomplished its object.

Shop Test for Weldability of Steel Sheet

THE welding quality of the sheet has much to do with the success of sheet metal welds. This quality has little to do with the chemical composition of the sheet, but rather with the impurities in it, and how it was made. In good sheet any good welder can make a good weld, but even the best operator will have trouble in welding poor sheets. Thus it is often desirable to test sheet steel in the welding shop, and this simple method can be used.

Fit the blowpipe with a small welding head or tip (smaller than the one correct for sheet of the thickness being tested) and apply the neutral flame to a smaller piece. Move the blowpipe along slowly enough to heat the sheet to the point of fusion almost through its entire thickness but fast enough to prevent it from "burning through." After a section about 3 inches long has been heated thus, hold the blowpipe still and vertical until a hole is burned in the sheet.

In good welding material the path followed by the blowpipe will be free from an excess of oxide and regular and smooth on the upper side. In sheet of inferior quality there will be an oxide deposit, part of which will be porous or flaky. It will also be marked by a succession of irregular ripples, higher in the center than on the edges.

On the under side of good welding metal will be a slight sag of smooth metal, free from oxide, where it has been heated most. This sag will be covered with oxide in poorer material. There may even be small holes blown through by the sparking action of the impurities.

Poor welding sheet which will cause difficulty in welding will throw off sparks under the blowpipe, the more sparks the less desirable the sheet, while good sheet will spark hardly at all. In good sheet the metal will become fluid before the hole is punctured. In poor sheet the metal will be burned through very soon after the blowpipe stops, in much less time than is necessary to put a hole in good sheet.

In good welding sheet the hole will be round and will have smooth, rounded edges. In poor sheet it will be of more irregular shape, with rather ragged edges. When the poor sheet has cooled there will be porous, spongy looking globules of oxide adhering to the edges of the hole.

Sheet shown to be of good welding quality by this test will be relatively free of impurities; therefore, thorough fusion and a sound weld will be easier to obtain. When a shop has found sheet which under test and in actual work has proved to be of good welding quality it is worth while to put aside a generous sample for comparison in future test.

By purchasing sheet which meets with these requirements, and that will, therefore, give best results under the blowpipe, a finished product of most satisfactory quality will be made possible. This factor, selection of proper material, is one of the important fundamentals of good welding.—*Oxy-Acetylene Tips.*

All-Welded Tender Tanks

ELECTRIC arc welding as a method of constructing locomotive tender tanks, instead of the customary riveting process, offers a prospect of a better product and reduced cost, according to results obtained by the Boston & Albany Railroad. In January, 1921, this road built at its West Springfield, Mass., shops a locomotive tender tank constructed throughout with General Electric arc welding equipment, with the exception of the safety appliances (grab handles). This tank was mounted on a Commonwealth Steel frame, arch bar trucks, on Pacific locomotive, No. 513, and placed in service February 6, 1921. Since that time it has covered a distance of 201,563 miles with no defects having developed in the welding.

With the arc welding method of construction practically all laying out, punching and drilling of sheets, angles and T-braces, together with reaming, riveting and calking, are eliminated. The Boston & Albany tank was made of 1/4-inch plate with the following dimensions: 26 feet long, 10 feet wide and 5 feet 2 inches high.

In the average tank of this capacity there are approximately 7,000 rivets with a total weight of 800 pounds and the number of holes punched in sheets, angles and T-braces would total approximately 15,800. In the Boston & Albany tank there is a total of 1,185 feet of welding, the welding rod consumed totalled approximately 398 pounds.

In order to eliminate the water scoring and rusting, prevalent in the riveted type of tank, the welding of T-braces to the bottom and top of the tank was continuous in its entire width.

A New Use for Old Boiler

WHILE workmen were digging a well for the Metropolitan Laundry in San Francisco a strata of quicksand was struck at a depth of 30 feet. This strata proved to be 50 feet deep. Fortunately the contractor succeeded in obtaining an 18 foot boiler 6 feet in diameter from one of the shipyards which was sunk into this strata of quicksand which enabled the workmen to work safely through the quicksand strata. The lower end of the boiler was landed in a strata of clay. The well was dug a total depth of 225 feet and lined with heavily reinforced concrete 8 inches thick.

Use of the Sectional Flanger in Boiler Shops

A handy piece of equipment for special jobs—Details of dies for variety of work

By C. E. Lester

THE sectional flanging machine is a valuable adjunct to any boiler shop equipment. Its utility is many times enhanced by the addition of odd-shaped formers whereby jobs heretofore done by hand at considerable expense for labor or on the four column press with expensive formers can be done on the sectional flanger at little expense. This may apply to work in quantities, but applies particularly to an odd sheet or two.

The accompanying illustration shows a back flue sheet for a locomotive with a 6-inch offset that may be all done on the sectional press except the offset, or completely done as was the sheet in the photograph.

In the former manner, before the sheet is bent, the sides are completely flanged on the press with an anvil block of the proper radius and a shearing type former except for about 8 inches where the bend comes. The top is flanged and the corners are then turned down on blocks of the proper radius for both dimensions. The sheet is then either placed in the power rolls and squeezed to the proper angle for the offset or it may be done with V blocks under the sectional press or with three bars of iron pyramided top and bottom of the sheet under the four column press.

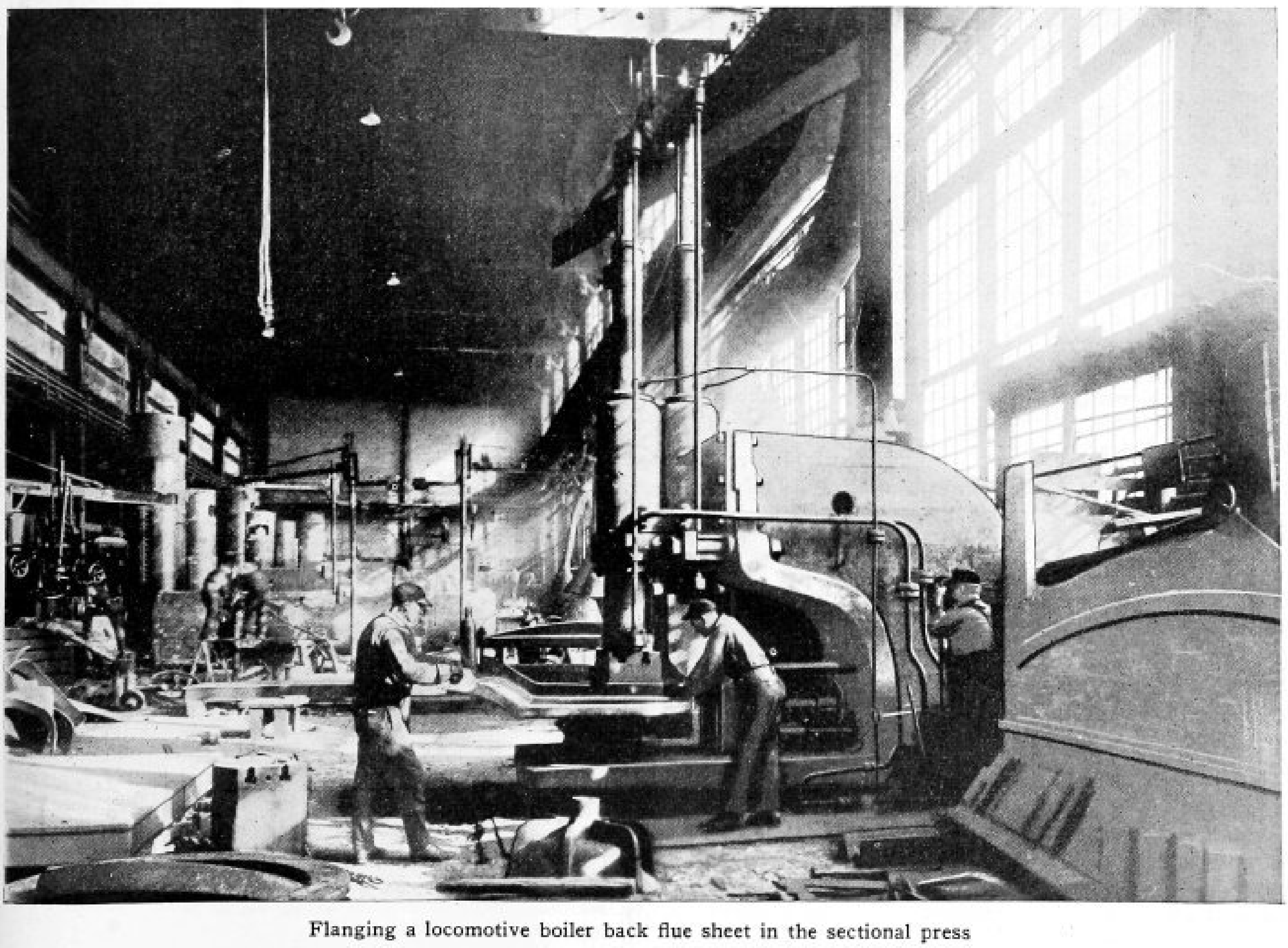
The sheet is then heated locally and the unflanged section laid down. The sheet is then placed in the furnace for annealing and by a proper blocking, the straight section at the mudring is placed in the sheet while making the small final adjustments on the annealing heat.

The quicker way, however, is to bend the sheet to the proper angles before flanging, and with the aid of combination side and corner formers, top and bottom, of the right contours, press the sides and corners above the bend and, with flat blocks as a rest, flange the entire sheet on the sectional press.

Exclusive of the time for the heating and annealing operation, an offset sheet of this kind of ½ or 9/16-inch plate may be flanged at any time in nine heats and generally in seven by a flanger and two helpers in from three and one-half to four and one-half hours. This entails no change in the back vertical ram former, two changes for the vise plate and five changes for the anvil block.

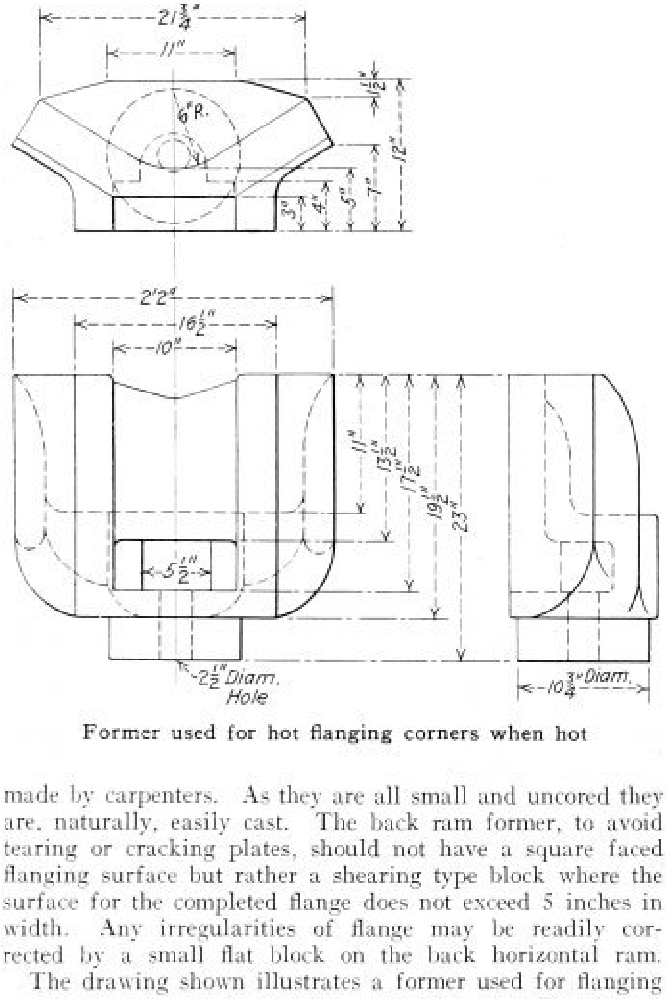
Used for Cold Flanging

The sectional flanger is also exceptionally valuable in cold flanging. With proper sized and types of formers many



Flanging a locomotive boiler back flue sheet in the sectional press varied shapes can be formed. In cold flanging with properly prepared work the machine will readily do straight side and top back flue and door sheets (corners excepted) and circular heads of plate not exceeding 5/8-inch in thickness with 3/4-inch or greater radius and large diameters.

Work may be facilitated and expensive large die blocks eliminated by the use of a master anvil block as illustrated in the April, 1925, issue of THE BOILER MAKER. The inserts of various size and shapes for innumerable jobs may all be of simple design and contours with the patterns readily



Former used for hot flanging corners when hot

made by carpenters. As they are all small and uncored they are, naturally, easily cast. The back ram former, to avoid tearing or cracking plates, should not have a square faced flanging surface but rather a shearing type block where the surface for the completed flange does not exceed 5 inches in width. Any irregularities of flange may be readily corrected by a small flat block on the back horizontal ram.

The drawing shown illustrates a former used for flanging one type of corner hot on the sectional press. The dimensions may be modified to suit varying conditions. A number of inserts may be observed in the right foreground of the photograph.

A Scientific Attack on Scale and Corrosion

No one who has attempted to follow the complexities of the feedwater problem or reconcile the divergent opinions expressed by various experts in this tantalizing field can fail to appreciate the importance of the research carried on for the last four years by the Bureau of Mines under the guidance of R. E. Hall.

It is not that Dr. Hall's many papers on this work leave nothing to be desired in the method of presentation. His earlier papers, in particular, while well calculated to meet the needs of physical chemists, left the average engineer feeling that here at last was some really important information on boiler water, if he could only grasp what it was all about. This may perhaps be excused on the basis that the established practice of scientists calls only for completeness and accuracy in the publication of research results. But popular treatment must follow if the principles discovered are to be widely applied, and some of Dr. Hall's later expositions seem aimed in that direction with a fair degree of success. This applies particularly to the excellent paper delivered before the recent Midwest Power Conference in Chicago.

Stripped of the language of physical chemistry, the fundamentals of boiler water conditioning, as developed by Dr. Hall, are seen to be relatively few and easy to apply under practical operating conditions.

The first principle is that it is possible to maintain the various constituents of the boiler water (in the boiler) in such proportions that precipitation will form as a loose sludge, easily removed by blowing down or continuous filtration, rather than as adherent scale.

In the application of this principle tests are made directly on the boiler water with simplified apparatus adapted to boiler room use. The first test is for sulphate concentration. This concentration depends on the amount of sulphate in the boiler water and on the percentage of blowdown. For any given boiler pressure and concentration of sulphate Dr. Hall's formulas and constants show the minimum concentration of carbonate that must be maintained (ordinarily, by the addition of soda ash) to prevent the formation of adherent scale. The actual carbonate concentration in the boiler water is measured by an apparatus of simple construction.

Steam pressures above two hundred and fifty pounds add certain complications due to the breaking down of sodium carbonate (soda ash) into sodium hydroxide. This breaking down, which is more rapid at higher pressures and also at higher ratings, has two undesirable effects—it increases the amount of soda ash required and also leads, at high pressures, to an objectionable concentration of sodium hydroxide. All trouble of this sort in high-pressure boilers may be eliminated, according to Dr. Hall, by the simple expedient of substituting sodium phosphate for soda ash. Unfortunately, sodium phosphate costs several times as much as soda ash, but this objection is generally less important with high-pressure boilers because they are ordinarily fed with relatively pure water requiring but a small amount of treating chemical.

The foregoing is not by any means the whole story—the complete solution for any particular installation requires a study of the best method of removing precipitation from the boiler, of removing impure water entrained in the steam, of avoiding undue amounts of air, CO_2 and other non-condensable gases in the steam and of preventing corrosion in feed lines, economizers, etc. All these matters have been considered in this research with apparent solutions for most cases that occur in practice.

This is a fine example of the service rendered to industry by intensive scientific research. Many other matters of vital interest to those who design and operate power plants would benefit from an equally exhaustive study.—*Power.*

NEW RESISTANCE WELDERS.—The latest extension in General Electric welding activities is the entry into the resistance welding field. That company is now marketing two automatic resistance welding machines, one for straight seam work and the other for circular seams. The General Electric automatic resistance welders consist of a framework for holding the work, a transformer for supplying current to the electrodes, movable electrode wheels and necessary control.

The welding speed obtained with these equipments varies from approximately 20 inches per minute to 100 inches per minute, depending on the nature and thickness of the material to be welded. Material up to a total thickness of 1/4 inch may be accommodated.

British Boiler Shop Practice

Board of Trade requirements for riveted joints and the calculation of their efficiencies

By Engineer Captain F. J. Drover, R. N.

IN discussing riveted joints the pitch is the distance between the centers of two rivets in the same row. The margin is the distance from the edge of the rivet hole to the edge of the plate. The lap is the distance between two edges of plates which overlap.

LAP JOINT

When one plate is made to overlap the other and one or more lines of rivets put through the two plates the joint is a lap joint. All internal joints in cylindrical boilers are generally single riveted lap joints.

BUTT JOINTS

When plates are kept in the same plane and a cover plate or butt strap is put over the joint and riveted to each, the joint is a butt joint. In the shell plates of cylindrical boilers

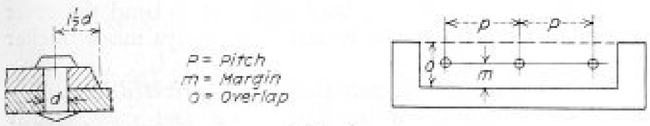


Fig. 1

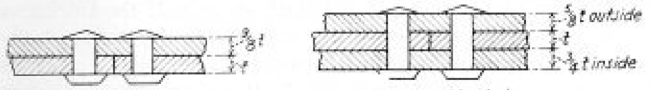


Fig. 2

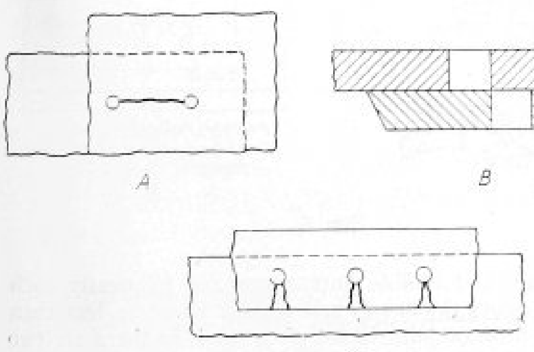


Fig. 3

the butt joint has a strap on each side, and is called a double butt joint, and for high and moderate pressure boilers is triple riveted. In a butt strap joint with a single covering strip, the thickness of strip $= 9/8t$, and this gives a good calking edge. In a double-butt strap joint outside cover $= 5/8t$, and inside cover $3/4t$. Lap edges are planed to 75 degrees for calking. Fig. 2 shows butt joints.

STRENGTH AND EFFICIENCY OF RIVETED JOINTS

Taking a joint in single shear it can plainly be seen that it is possible for the joint to give out in four different ways:

1. By tearing away of the plate between the rivets as shown at *A*, Fig. 3.

2. By shearing of the rivets between the plates as shown at *B*, Fig. 3.

3. By breaking of the plate between its edges and the rivet holes at *C*, Fig. 3.

4. By the crushing of the plate or rivet.

In calculating the strength of a joint it is sufficient to consider one pitch only and, as the plates and rivets each take up their share of the stress, the strength of the plate in one pitch should be equal to the strength of the rivets. Therefore two efficiencies have to be found, that of the plate and that of the rivets.

Let P = pitch of rivets in inches.
D = diameter of finished rivet in inches.
t = thickness of plate in inches.
ft = tensile stress or resistance of plate to tension in tons per square inch.
fs = shearing stress of rivets in tons per square inch.

Consider a width of joint = to pitch, then the stress in this portion $= (P - D) \times t \times ft$, and strength of rivet to resist shearing $= \frac{\pi}{4} D^2 \times fs$. Therefore to obtain equal strength of plate and rivet

$$(P - D) \times t \times ft = \frac{\pi}{4} D^2 \times fs.$$

This assumes one rivet to a pitch length. With double or treble riveted joints there will be more than one rivet in a pitch length and therefore the strength of the rivets would be increased. The plate, having been weakened by rivet holes, has an efficiency which is measured by the ratio of the distance between the rivets to the distance between the centers.

Therefore the efficiency of the plate becomes:

$$\frac{\text{Strength of pierced plate}}{\text{Strength of Solid plate}}, \text{ i. e. } \frac{P - D}{P},$$

which is given as a percentage.

With reference to the rivet efficiency, N is taken as the number of rivets in a pitch length. One, and one-and-three-quarters depends upon whether joint is a joint in single shear, as, for example, a lap joint when one is taken as a constant; or whether the joint is in double shear, as, for example, a butt strap joint, then one-and-three-quarters is used as a constant. In the latter case there are two areas in shear, and the area to resist shearing is double; and it has been found by experiment that the strength is not increased in the same proportion; therefore the Board of Trade allows only one-and-three-quarters.

Concerning the values of fs and ft, the Board of Trade allows a stress of about 47,000 pounds along the fiber and 40,000 pounds per square inch across the fiber, and for steel plates 28 tons or 62,720 pounds per square inch. For fs in the case of wrought iron the shearing resistance of the rivet is about equal to the tenacity of wrought iron plates, so that $\frac{fs}{ft} = 1$. The shearing resistance of steel rivets is about 4/5 of the tenacity of steel plates, and by the Board of Trade is assumed to be 23 tons per square inch.

Therefore $\frac{fs}{ft}$ for steel plates or rivets $= \frac{23}{28}$. Hence the efficiency of the rivets becomes:

$$\frac{\frac{\pi}{4} D^2 \times N \times (1 \text{ or } 1\tfrac{3}{4}) \times fs}{P \times t \times ft}$$

and the joint efficiency is the lesser of the two efficiences, that of the plate and that of the rivet.

Types of Joints

Single-riveted lap joint, Fig. 4A.—This form of joint is only used for the longitudinal seams of boilers when the plate is thicker than that required for strength, so that 50 percent of it is sufficient to withstand pressure safely, e.g. longitudinal joint of a steam cutter's boiler, and steam receivers where the diameter is comparatively small, or with low pressures where the thickness of plate which is sufficient to withstand the pressure would not admit of calking nor of due

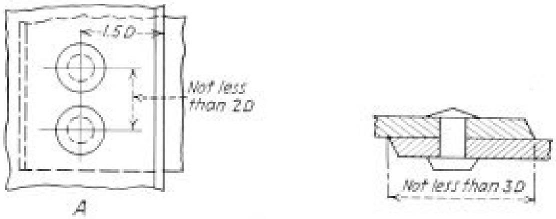


Fig. 4

allowance for deterioration. The internal joints of all boilers are generally single-riveted lap joints. The objection to a lap joint is that the straining force in one plate is not directly opposed to the force in the other, and therefore tends to bend the joint each time pressure is applied, making it in consequence weaker. The grooving in boiler plates, especially in wrapper plates of *D*-shape barrels, is sometimes due to this bending at the joint.

Double-riveted lap joints, Fig. 5.—In shipbuilding the rivets of one row are generally in line with those of another, and this is called chain-riveting. It is not often used in boiler work; more often for this work there is one row in line with the middle spaces of the other row, called zig-zag riveting (see Fig. 5). This latter plan requires less lap and makes tighter work. This class of joint is generally used for the circumferential seams of cylindrical boilers. The mini-

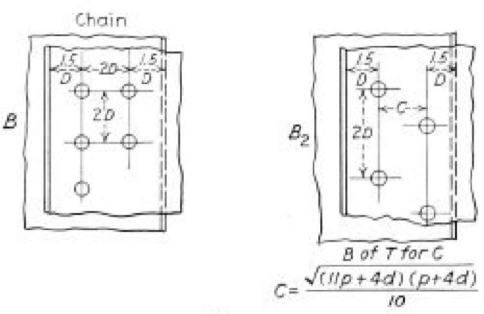


Fig. 5

mum diagonal pitch to ensure safety against cracking is 2 *D* which makes the minimum distance between the rows = 1.7 D. For strength a greater distance is preferable, and it has been proved that the next section of metal on the plate measured zig-zag should be from 30 to 35 percent in excess of the metal measured across. Generally rivet metal is softer than boiler plate and its resistance to shearing is less than that of the plate in tension and for this reason the area of the rivet should be greater than that of the plate remaining between the rivet holes.

Treble-riveted lap joints, Fig. 6.—To obtain a sufficient area of rivets with a lap joint, when plates are thick it is necessary to have three rows of rivets. Rivets in this case are generally arranged zig-zag as sketch *C*2, but sometimes like sketch *C*, chain fashion. A strength of joint of 72 percent can be obtained with a rivet area equal to that of the plate between the holes. The chief difficulty with all lap joints is in working the corners where the next stroke of plating covers the lap.

Single butt strap joint single-riveted, Fig. 7.—The Board of Trade states that single butt straps should be at least 9/8

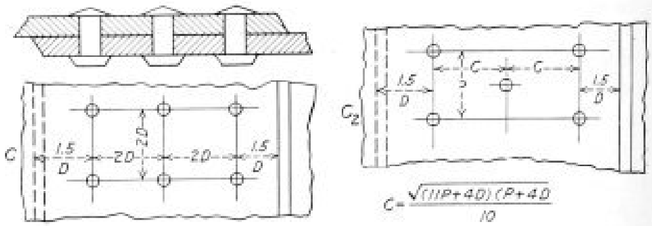


Fig. 6

times the thickness of shell plate they cover. When a butt joint has a cover plate on one side only it is merely composed of two lap joints, and made in proportion to rules already given for lap joints. It is clear that with this form of joint the tension on the plates will tend to bend the cover plate (see D), and for this reason it is always made thicker than the plate it covers.

Butt joint with double butt strap, single-riveted, Fig. 7.—This joint is free from bending action and consequently much stronger than joint *D*. It would at first sight appear sufficient to make a single cover plate or butt strap equal in thickness to plates and a double butt strap half the thickness of the plate. Some experiments with joints thus made indicated that the butt strap was weaker than the plate; hence as mentioned previously, single butt straps are made thicker

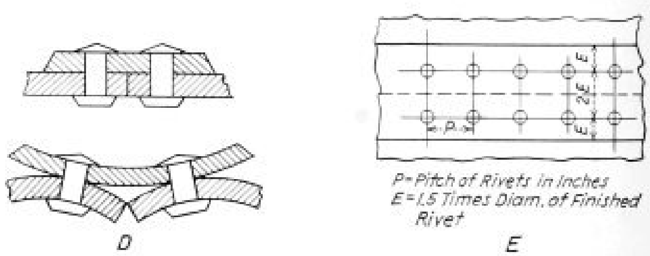


Fig. 7

than the plate and double butt straps are frequently each equal to the plate thickness, and should never be less than $5/8t$. This form of joint is not often used, as there are two rows of rivets, and a shear area of twice that of one row of rivets; besides, there is the expense of double straps, which entails the calking of four seams. The only advantage it possesses over the double-riveted lap is the absence of smithed corners, therefore the plates lie wholly in a circle without deformations. The strength of this joint is seldom more than 65 percent of the solid plate, as more cannot be obtained without placing the rivets so far apart as to prevent the straps being calked tight.

Double butt strap double-riveted, Fig. 8.—

$$C = \frac{\sqrt{(11P + 4D)\ (P + 4D)}}{10}$$

Thickness of butt strap = 5/8 thickness of plate.

(n for calculating = 2)

$$C = \sqrt{(11/20\ P + D)\quad (1/20\ P + D)}$$

$$\text{Butt strap thickness} = 5/8t \left(\frac{P - D}{P - 2D}\right)$$

(n for calculating = 3)

This joint is frequently used for boilers up to 90 pounds pressure for longitudinal seams. Its special advantages are due to the following reasons. There is no necessity for machining or smithing the plates, nor for joggling the cover plates of the next strake of plating.

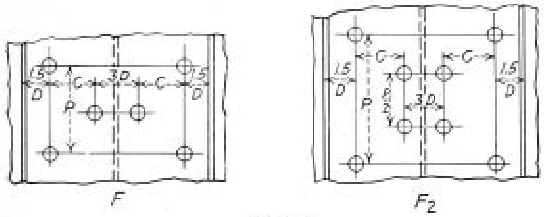


Fig. 8

These joints may be arranged in either form F or $F2$; the strength of the latter, provided sufficient area of rivet is allowed, is the greater.

Double butt straps, treble-riveted, Fig. 9.—

G

Butt strap thickness = $5/8t$

$$C = \frac{\sqrt{(11P + 4D)\ (P + 4D)}}{10}$$

(n = number of rivets in a pitch length = 3)

$G1$

$$\text{Butt strap} = 5/8t \left(\frac{P - D}{P - 2D}\right)$$

$$\text{Diagonal pitch, outer row} = \frac{3P}{10} + D$$

$$\text{Diagonal pitch, inner row} = \frac{3P + 4D}{10}$$

C_1, or distance between outer row =

$$\sqrt{(11/20\ P + D)\quad (1/20\ P + D)}$$

C, or distance between inner rows =

$$\frac{\sqrt{(11P + 8D)\quad (P + 8D)}}{20}$$

(n, or number of rivets = 5)

$G2$

Butt strap = $5/8\ t$

$$C = \sqrt{(11/20\ P + D)\quad \left(\frac{P}{20} + D\right)}$$

(n = 4)

$G3$

C_1, or distance between outer rows =

$$\frac{\sqrt{(11P + 4D)\quad (P + 4D)}}{10}$$

$$\text{C, or distance between inner rows} = \frac{4D + 1}{2}$$

(n = 5)

Butt joints with double butt straps and treble-riveted.—This form of joint has become a necessity for the longitudinal joints of cylindrical boilers of high pressures, since very thick plates have been used for the shells. There are four special arrangements of riveting for this class of work, viz:—

1. Zig-zag riveting, pitch of rivets same in each row.
2. Zig-zag riveting, pitch in outside row being twice that of inner rows.
3. Zig-zag riveting, pitch of middle row being half that of outside rows and inside rows.
4. Chain riveting, pitch of outer rows twice that of inside rows.

POINTS TO NOTE

1. *Diameter of rivets.* If the holes are drilled they can be of very small diameter. If punched, the ordinary steel punch cannot punch a hole less in diameter than the thickness of the plate. The rivet, however, must not be made too large in diameter, or the plate will crush in front of it.

2. *Pitch.* The maximum pitch allowable for a given thickness of plate depends upon consideration of water-tightness.

$$\text{A good formula for pitch of rivets is: } \frac{100 \times D}{100 - e}$$

where D = diameter of rivet in inches
e = joint strength.

Design of joint with a known thickness of plate.—First select efficiency for type of joint in question (see following table). Secondly, find diameter of rivet, i. e. $D = 1.2\sqrt{t}$ for multiple-riveted joint, and $D = 1.4\sqrt{t}$ for single riveted joints. Thirdly, find pitch by one of the following:

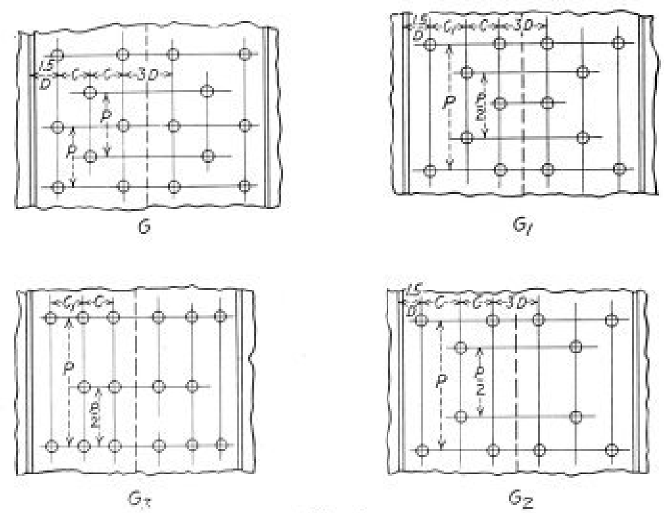


Fig. 9

$$e = \frac{P - D}{P}, \text{ or } P = \frac{100 \times D}{100 - e}$$

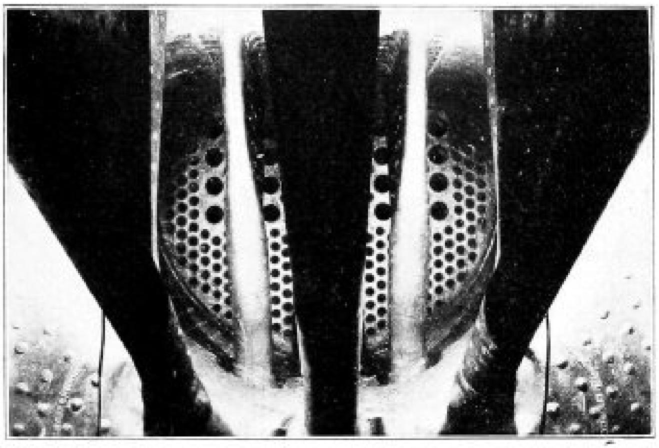
With these three values, the efficiency equation should be ratified according to the type of joint in use. For a joint of maximum strength, the rivet efficiency should equal plate efficiency so far as possible. As rivet holes are generally multiples of 1/16 inch, the nearest 1/16 inch above calculated size should be used for plates under 1 inch and the nearest 1/16 inch below for plates over 1-inch thick.

In boiler work, with Board of Trade rules, the following efficiencies are arrived at for various joints:

Lap joint single riveted	56 percent
Lap joint double riveted	66 percent
Lap joint treble riveted	72 percent
Butt joints double straps single riveted	66 percent
Butt joints double straps double riveted	75 percent
Butt joints double straps treble riveted	80-82 percent
With half number of rivets in outer rows	84-88 percent

Thermic Syphons Used in Combustion Chambers

THE trend in locomotive boiler design has for years been towards proportionately larger grates and fireboxes in order to obtain greater capacity and more efficient transfer of heat from combustion gases to boiler water. One factor which, in addition to other important advantages, has contributed materially to enlarged firebox heating surfaces while taking but a small proportion of the total firebox volume above the arch, is the Nicholson Thermic Syphon and, to date, the Locomotive Firebox Company, Chicago, has placed in service syphon equipment on 1906 locomotives for 78 railroads in this country and abroad.



Syphon installation with two units in a combustion chamber

One or two units of Thermic Syphons are now being installed in the combustion chamber, thus adding to the heating surface in a location of great advantage but, more particularly, serving as a feature of additional protection in the event of low water.

Thermic Syphons have prevented boiler explosions in several cases of low water, there being six definitely reported with water down from 3½ to 6 inches below the high point of the crown sheet. The pumping action of the syphons in such cases causes the water to continue flowing from the syphon opening over the crown sheet. This overflow serves to prevent general overheating of the sheet, which is further protected by the girder-like support rendered by the syphon. A small portion of the sheet ahead of the syphon becomes heated, allowing one or more radials to pull through thus providing a gradual release of the pressure. Five of the above cases were on straight flue sheet boilers with approximately 18 inches of space between the flue sheets and syphons. A recent case of low water occurred on a combustion chamber boiler, Syphon-equipped, with a space of 43 inches between the flue sheets and the syphons. Due to a larger exposed area of the crown sheet, 28 radials pulled through the sheet but no rupture occurred.

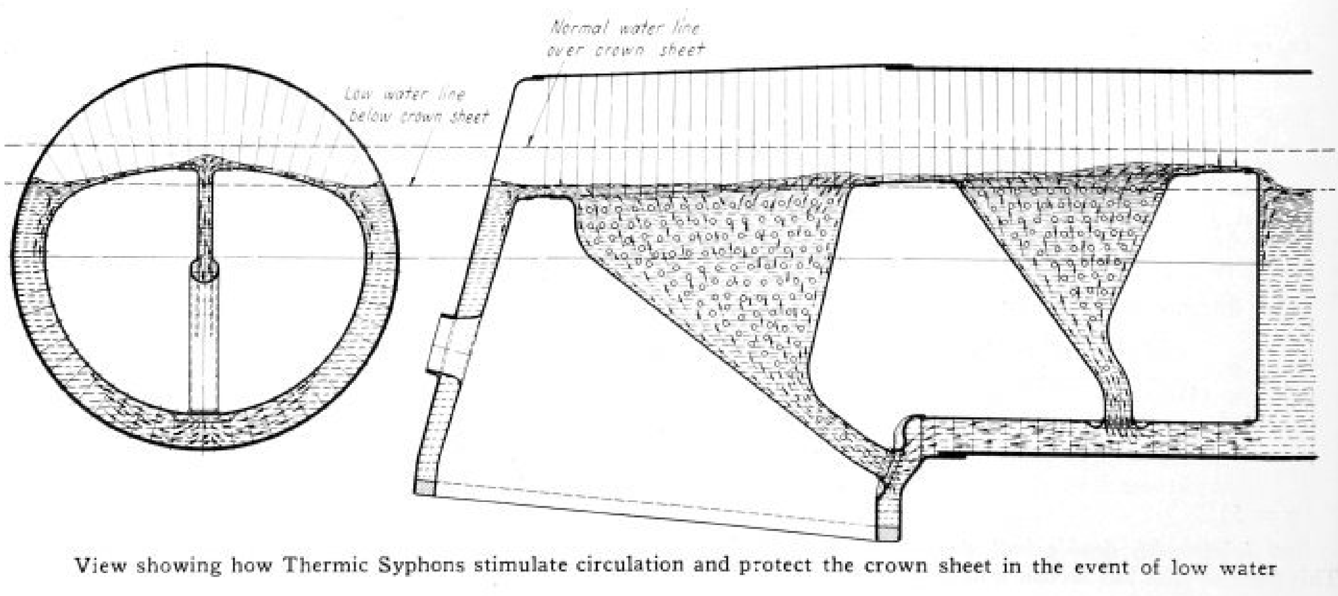
With the continued rise of the crown sheet, as in a combustion chamber design, it is a question of how long a chamber may be protected by a firebox syphon. In the above case, the chamber was short, only about three feet, but many boilers have chamber lengths up to seven feet or more. By the addition of syphons to the combustion chamber, an overflow effect, to protect the crown sheet in event of low water, is furnished in the same relation to location of flue sheet as on straight flue sheet boilers.

A combustion chamber application, in combination with the usual firebox syphon, is shown in the drawing. Locomotives having this design modified to include two syphons in the combustion chamber as shown in the photograph, are giving excellent performance.

It will be noted that the same design as the firebox syphon is used in combustion chambers, being generally triangular in shape; made of firebox steel, with a 3-inch width of water space; staybolted in the usual manner. It is welded to the crown sheet in a similar fashion and the lower attachment employs a standard diaphragm welded to the bottom of the chamber. The structure, therefore, becomes a strut or column between the top and bottom sheets.

It is a known fact that some difficulty in the maintenance of combustion chambers has been experienced since their inception, which may be due to slow circulation of the boiler water. One purpose of locating syphons in the combustion chamber is to draw water from around the chamber and discharge it above the crown sheet, facilitating the general circulation.

Another advantage lies in the addition of heating surface. In the installation shown, the heating surface of firebox and combustion chamber is 329 square feet. The firebox syphon heating surface has 90 square feet, an addition of 27 percent. The syphon located in the combustion chamber has 20 square feet, or 6 percent more, a total addition to the firebox and combustion chamber of 110 square feet, or 33 percent of heating surface. When desirable, two syphons can be applied to the combustion chamber, making a total of 39 percent.



View showing how Thermic Syphons stimulate circulation and protect the crown sheet in the event of low water

Questions and Answers for Boiler Makers

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

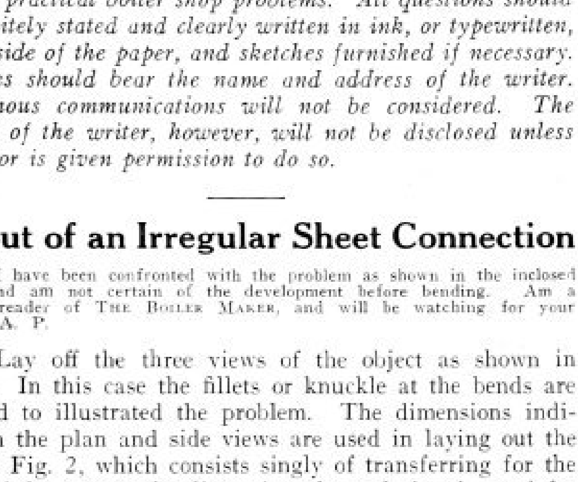
Conducted by C. B. Lindstrom

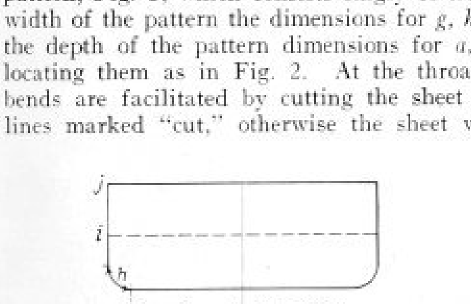
This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries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

Layout of an Irregular Sheet Connection

Q.—I have been confronted with the problem as shown in the inclosed sketch, and am not certain of the development before bending. Am a constant reader of THE BOILER MAKER, and will be watching for your answer.—A. P.

A.—Lay off the three views of the object as shown in Fig. 1. In this case the fillets or knuckle at the bends are enlarged to illustrated the problem. The dimensions indicated in the plan and side views are used in laying out the pattern, Fig. 2, which consists singly of transferring for the width of the pattern the dimensions for g, h, i and y and for the depth of the pattern dimensions for a, b, c, d, e and f locating them as in Fig. 2. At the throat and bottom the bends are facilitated by cutting the sheet as shown by the lines marked "cut," otherwise the sheet would have to be formed by the use of a former necessitating also heating of the plate.





Cut-out pattern for an irregular sheet

Fire Line and Staybolt Stress

Q.—What should be the height of the fire line of an externally fired boiler? (This question was asked in the last State Boiler Inspectors' examination.)

(2) We have a boiler internally fired having the staybolts spaced 4 inches apart each way, and carrying 200 pounds steam pressure. What is the stress of each staybolt per square inch whose diameter is 1 inch at the bottom of the thread "P," having a $\frac{3}{16}$-inch telltale hole in the outer end of each bolt?—L. M. C.

A. (1) It is general practice in boiler construction and settings that under no circumstances should the fire line extend above the waterline.

(2) First determine the total stress on the stay, which equals $4 \times 4 \times 200 = 3{,}200$ pounds.

Find the least cross-sectional area of the stay, measured at the root of the thread, equals $1^2 \times 0.7854 = 0.7854$ square inch.

The following formula is then used in determining the stress on the stay in pounds per square inch.

$$S = \frac{p^2 \times P}{a}$$

in which,

S = stress on stay, pounds per square inch.
p = maximum pitch of stays, inches.
P = pressure in pounds per square inch.
a = least cross-sectional area of stay, square inches.

Substitute the given values, in the formula, then

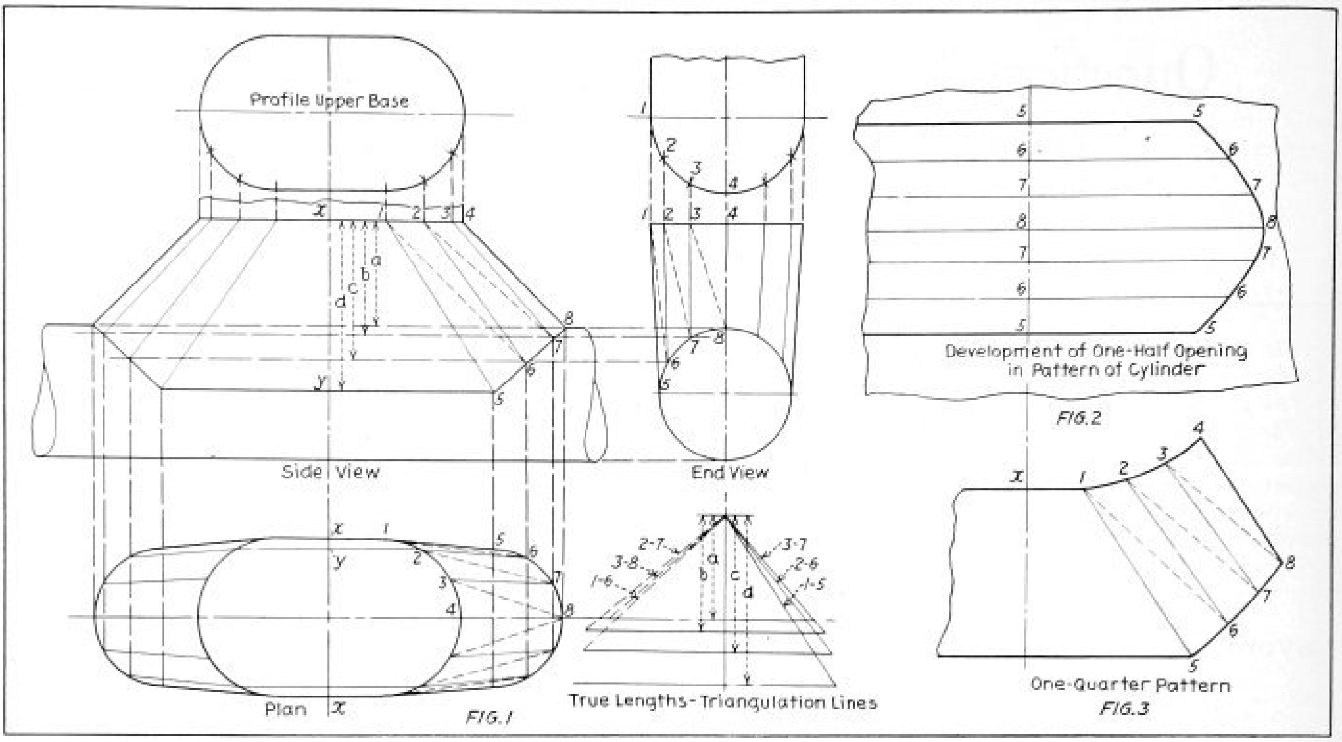
$$S = \frac{4 \times 4 \times 200}{0.7854} = 4{,}074.4 \text{ pounds per square inch.}$$

Down-Take Hot Air Pipe

Q.—Will you please give me the layout for a down-take hot air pipe?—W. E. G.

A.—The complete solution of this problem is given in Figs. 1 to 3. In Fig. 1 a projection of the three views is made indicating the shape and intersection of the connecting pieces. Then by the triangulation method the pattern is produced. In the elevation it will be noted that where the curved section of the transition piece miters with the cylinder the line of intersection is a straight line for the reason that the transition piece is carried to a taper at the center of the pipe. This miter must be produced and if a curved section is required simply round off the lap in accordance with the radius shown in the elevation of your drawing. As all of the construction lines are numbered in the three views, the steps in the development can be readily followed.

Before the pattern can be laid out, it is required to find the true lengths of these construction lines as indicated to the right of the plan, Fig. 1, and also the development of the opening in the pattern of the cylinder as indicated in Fig. 2. The heights of the triangles are taken from the elevation, Fig. 1, as a, b, c and d; the corresponding bases from the plan,



Solution of layout problem involving down-take pipes

measured between the points *1—5*, *2—6*, *3—7*, etc. In Fig. 2 lay off on the line *5—5* the arc lengths between points *5—6*, *6—7* and *7—8* of the end view Fig. 1 and through these points on line *5—5* draw the lines *6—6*, *7—7* and *8—8* perpendicular to the line *5—5*. The lengths *6—6*, *7—7*, etc., are set off equal to the corresponding distances measured at right angles to line *x—x* and the points *5*, *6*, *7* and *8* of the plan, Fig. 1.

With these data the pattern, Fig. 3, is obtained, using the true lengths which are the hypotenuse of the right angled triangles, Fig. 1 and the arc lengths between points *5—6*, *6—7* and *7—8*, Fig. 2.

In the construction of transition pieces of this kind, bring the rivet line either on the lines *x—y* or *4—8*. No allowances for lap are shown in Fig. 3, this must also be made.

Angle Ring Calculation

Q.—Please advise me the proper manner to calculate the "hoop stress" in an angle band used as a reinforcement on a circular shell. Assume a 96-inch diameter shell, $\frac{3}{8}$-inch plate, 40-pound W. P., 5-inch by 3-inch by $\frac{3}{8}$-inch angle on outside, 5-inch leg outstanding, the 3-inch leg tack welded to the outside of the shell. How is the joint of such a reinforcing angle calculated?—G. H. A.

A.—Calculate the stress according to the rules applied for finding the hoop stress in cylindrical shells. For each

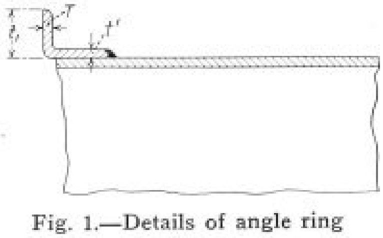


Fig. 1.—Details of angle ring

leg of the angle calculate the stress, using the values of t and t_1 measured as indicated in Fig. 1 and substitute in the following formulas:

$$S = \frac{P \times d}{t \times 2},$$

for the leg of the angle lying in the plane of the shell.

$$S = \frac{P \times d}{t_1 \times 2 \times T},$$

for the leg of the angle perpendicular to the horizontal axes of the shell, in which,

S = hoop stress, pounds per square inch.
P = pressure, pounds per square inch.
d = internal diameter of ring, inches.
$t - t_1 - T$ = measurements of angle ring legs, Fig. 1, inches.

For tank shells made of light plate and large diameter, angle rings are used to prevent buckling. The tack welds are not figured as joints in this case since the shell plate is figured to carry the load or pressure.

BUSINESS NOTES

The main offices and sales department of the Watson-Stillman Company will be located in the Evening Post Building, 75 West street, New York, on and after May 1.

M. Maximillian, aged 55, special railroad representative of the Chicago Pneumatic Tool Company, 6 East 44th Street, New York City, died suddenly from heart failure at his hotel, Richmond, Virginia, March 9th.

William A. Edwards, the branch manager of the Chicago territory for the Ludlum Steel Company, general offices and works, Watervliet, N. Y., has been transferred to take charge of the Southwestern territory with headquarters at Houston, Texas.

H. C. Osman, sales manager of the Nugent Steel Castings Company, Chicago, Ill., has been elected secretary of the company. He will continue to have charge of the sales for the company. C. A. MacDonald, formerly secretary, has been elected treasurer.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

Steamboat Inspection Service of the Department of Commerce

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

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—C. D. Thomas, Salem, Oregon.
Statistician—E. W. Farmer, Rhode Island.

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

J. A. Franklin, International President, suite 522, Brotherhood Block, Kansas City, Kansas.
William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.
Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.
James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.
H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.
International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C. Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Avenue, Columbus, Ohio.

Master Boiler Makers' Association

President—Thomas F. Powers, system general foreman, boiler department, Chicago & Northwestern.
First Vice President—J. F. Raps, general boiler inspector, Illinois Central.
Second Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.
Third Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.
Fourth Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.
Fifth Vice President—George B. Usherwood, supervisor of boilers, New York Central.
Secretary—Harry D. Vought, 26 Cortlandt Street, New York.
Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.
Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—F. H. McCabe, McCabe Manufacturing Company, Lawrence, Mass.
Vice President—J. W. Kelly, National Tube Company, Pittsburgh, Pa.
Treasurer—George R. Boyce, A. M. Castle and Company, Chicago, Ill.
Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie, Pa.
Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.
Secretary-Treasurer—D. W. Glanzer, 840 Rockefeller Building, Cleveland, Ohio.
Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; W. A. Drake, The Brownell Company, Dayton, O.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Works, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

Chicago, Ill. (will accept)	Memphis, Tenn. (will accept)	Philadelphia, Pa.
		St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Los Angeles, Cal.		Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	New Jersey	Pennsylvania
California	New York	Rhode Island
Indiana	Ohio	Utah
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

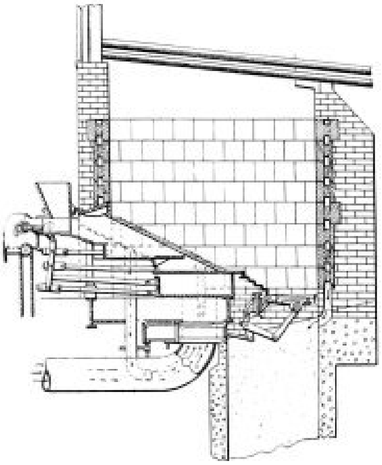
SELECTED BOILER PATENTS

Compiled by
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building
Washington, D. C.

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

1,539,924. FRANK H. WAITE AND GEORGE W. DAVEY, OF LONG ISLAND CITY, NEW YORK. AIR-COOLED FURNACE.

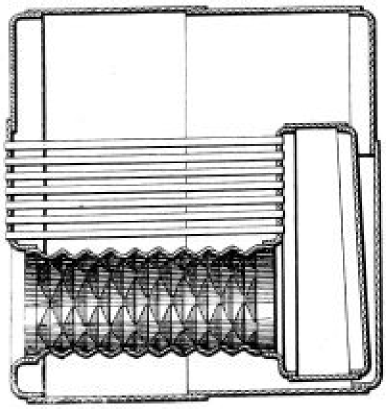
Claim 1. The combination with a furnace including side walls having air channels extending therethrough and an automatic stoker including a main air duct for feeding forced air below the same, of an air supply pipe



for feeding air from the duct to the channels in the walls, and a suction pipe communicating with the duct at a point intermediate its ends and with the channels in the walls at a point spaced from said air supply pipe. 10 claims.

1,540,106. ALFRED COTTON, OF ST. LOUIS, MISSOURI, ASSIGNOR TO HEINE BOILER COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI. FURNACE FOR BOILERS.

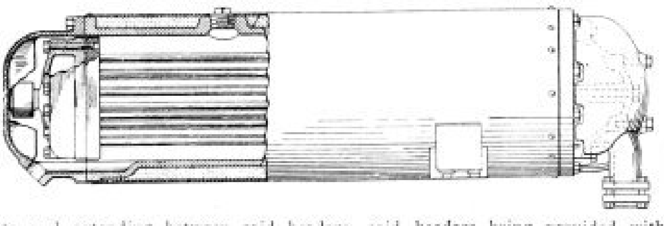
Claim 1. A furnace for boilers consisting of a tubular member provided with a plurality of parallel sections, each of which is composed of a circum-



ferential row of substantially diamond-shaped buckles or pressed portions disposed with their major axes extending circumferentially of said member and their minor axes extending longitudinally of said member. 2 claims.

1,541,519. NEAL T. McKEE, OF MOUNT VERNON, NEW YORK, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE. FEED-WATER HEATER.

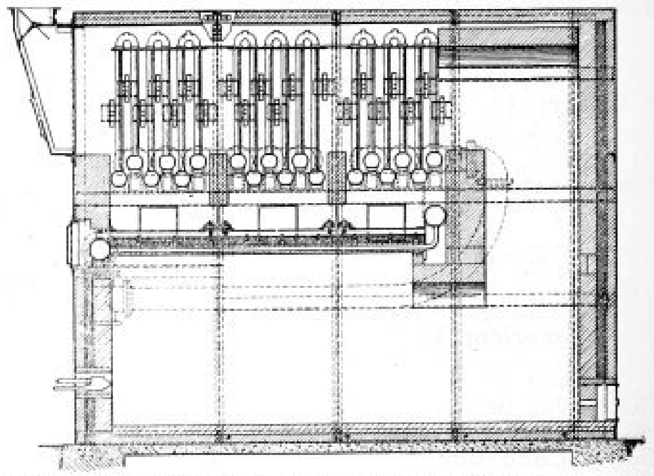
Claim 1. In a feed-water heater having an outer steam casing, a main header and a floating header therein and a plurality of water tubes secured



to and extending between said headers, said headers being provided with water chambers with which said tubes are in communication and means to transmit to said casing outward strains due to unbalanced water pressure within said floating header, whereby tension upon said tubes due to such unbalanced pressure is prevented. 5 claims.

1,541,205. JOHN E. BELL, OF BROOKLYN, NEW YORK, ASSIGNOR TO POWER SPECIALTY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK. SUPERHEATER.

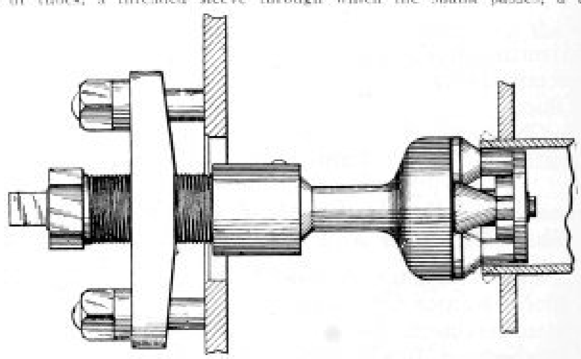
Claim 1. The combination with the furnace of a separately fired superheater divided into two compartments, of a superheater constituting a part of the partition wall between the two compartments and the surface of which is adapted to withstand and absorb radiant heat in the fire chamber, in an



amount to substantially lower the temperature in said chamber, and an ordinary superheater located in the other compartment through which the hot gases pass from the first compartment or fire chamber, and connections between the two superheaters through which the steam passes from one to the other superheater. 2 claims.

1,543,583. RALPH L. MASON, OF TACOMA, WASHINGTON. TOOL.

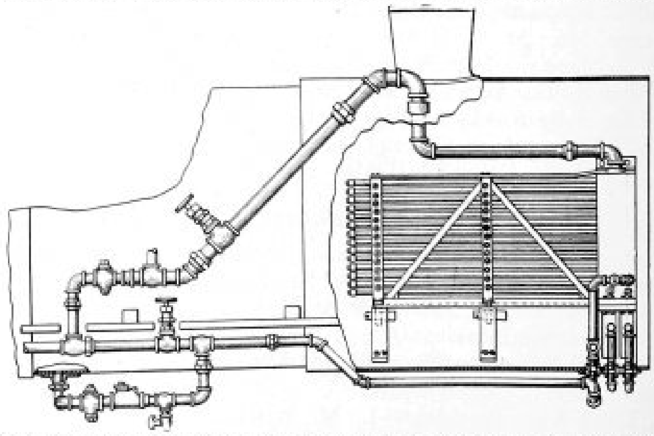
Claim. A tool for belling tubes in boilers and the like comprising a shank, a head, cone-shaped rollers carried by the head for engaging the ends of tubes, a threaded sleeve through which the shank passes, a thrust



member rotatably mounted on the shank and engaged by the sleeve, anti-friction means between the thrust member and the shank and a supporting member having a threaded hole therein for receiving the sleeve with means for fastening the member to a part of the boiler.

1,542,295. GUY T. FOSTER, OF DAYTON, OHIO, ASSIGNOR TO LOCOMOTIVE ECONOMIZER CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE. FEED-WATER HEATER.

Claim 1. A feed-water heater equipment for a locomotive engine including in combination with a horizontally disposed cylindrical smoke-box, a smoke-stack rising vertically from said smoke-box at a point intermediate the length of the smoke-box, and a steam exhaust directed vertically upward



diametrically through the smoke-box and into the smokestack, of twin heater halves provided with sill-plates, seats for said heater halves formed within the smoke-box, each seat including an inwardly opening horizontal slot arranged on either side adjacent the smoke-box wall and adapted to receive the sill-plates of the heater halves when thrust laterally in outward direction away from the medial vertical plane of the smoke-box, and means arranged adjacent the medial vertical plane of the smoke-box for securing to place said heater halves when so thrust outward. 2 claims.

The Boiler Maker

Volume XXVI | May, 1926 | Number 5

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Edward A. Simmons, *Pres.*
L. B. Sherman, *Vice-Pres.*
C. R. Mills, *Vice-Pres.*
Roy V. Wright, *Secretary*
Henry Lee, *Vice-Pres. and Treas.*
Samuel O. Dunn, *Vice-Pres.*
F. H. Thompson, *Vice-Pres.*
George Slate, *Business Manager*

Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ave.
Mandeville, La.
Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St.
Westminster, S. W. 1.
Cable address: Urasigmec, London

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d; single copies 1s 2d.

Request for change of address should reach us two weeks before the day of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

Rivets and Rivet Driving

IN a recent communication D. J. Champion, president of the Champion Rivet Company, confidently predicts that in less than 10 years it will be considered unmechanical and unsafe to drive rivets into punched holes. Mechanical engineers, he says, will specify that all holes and pressure work must be drilled or reamed properly and all rivets must be round with concentric heads, square cut-offs and of the proper length to fill the holes and permit the formation of full-sized heads.

Mr. Champion believes that the days of careless workmanship in riveting are numbered and we heartily agree with him that competent engineers will no longer tolerate it. Life and property are at stake and if careless workmanship is permitted in riveting, the necessary high mechanical efficiency cannot be attained in cases where high pressures are required. Calking should not be necessary and the original cost of the material and workmanship required to give high efficiency is insignificant in view of the results obtained.

Mr. Champion speaks with authority. His views, especially regarding rivets and riveting, are universally respected and we commend what he has to say on this important subject to all thoughtful boiler makers.

Radiation Boilers

THAT the present steam capacity of a boiler can be increased, perhaps 20 percent, by maintaining higher furnace temperatures and by so arranging the heating surfaces that the heat transmitted by radiation may be utilized more completely, is claimed in a pamphlet just issued by the First Engine and Boiler Insurance Company, Ltd., Tokyo, Japan. The pamphlet was prepared by Sohjiroh Haga, chief engineer and managing director of the company, to inform Japanese steam users of the possibilities of greatly improving the efficiency of steam boilers by the more effective use of the heat transmitted from the fuel bed by radiation. The paper contains the results of investigations by the author of the laws governing the transmission of heat from the fuel bed, flames and moving gases through the boiler plate to the water in the boiler and offers suggestions for the practical application of these laws to obtain the highest efficiency.

High boiler efficiency can be obtained, it is shown, by obtaining the highest possible temperature in the fuel bed, a comparatively low temperature of moving gas and the lowest possible temperature of escaping gas. In other words a boiler which absorbs the greatest amount of heat by radiation from the fuel bed will, other conditions being favorable, give the highest efficiency. It is interesting to note that this conclusion is in line with the modern trend in boiler design not only in the stationary field but also in the railway and marine fields. Noteworthy examples of both locomotive and marine boilers, in which the heat transmitted from the fuel bed by radiation is effectively utilized, are published elsewhere in this issue.

Firebox Volume and Steaming Capacity

THERE are two methods of obtaining steaming capacity in a locomotive boiler that in practically every modern boiler design receive the consideration of the development engineers. One of these might be called an artificial means of obtaining high boiler efficiency and consists of adding to a locomotive certain well proven auxiliaries that accomplish a considerable gain in the efficiency of the machine. This method is particularly adaptable in the case of locomotives already in service.

The other method is more fundamental and applies to the original design of the engine—the matter of adequate firebox volume and the relation of the firebox to the remaining sections of the boiler. An example of what can be accomplished in this direction is demonstrated in the design of the Union Pacific type locomotive boiler described elsewhere in this issue. The problem in this instance was to provide sufficient depth between the arch and the grate to allow efficient stoking and proper depth firebox. Because of the wheel arrangement in which one pair of drivers is located back of the throat, the conventional solution would be the straight mud ring above the driving wheel level. This design did not provide the depth of firebox necessary with the result that a Gaines wall was installed and the mud ring dropped to the proper level to meet requirements.

Another problem in design to be solved to insure the efficiency of the firebox is provision for a flow of the gases of either uniform cross section or a flow gradually expanding in cross section from the arch to the back tube sheet. This requirement is met in the present boiler with the exception of a slight pocket between the Gaines wall and the throat. In later locomotives of this type it is believed that the arch will be made continuous to the throat, thus accomplishing a uniform expansion in gas flow up to the combustion chamber, where it becomes constant in cross section.

Great Interest Shown in Master Boiler Makers' Association Convention

IN addition to the regular program of the Master Boiler Makers' Association convention to be held at Buffalo, May 25 to 28 at the Hotel Statler which is published elsewhere in this issue, the meeting should prove to be of exceptional interest because of the recognition being given the activities of the association by outside groups. The value of the subjects to be discussed to the entire railroad industry is amply demonstrated by the cooperation given the Master Boiler Makers' Association by the Water Service Committee of the American Railway Association. A number of representatives of this committee will be in attendance at the convention to enter into the discussion on the subject of water treatment and to outline what is being done by the railroad water services to overcome the difficulties experienced from pitting and corrosion. In connection with the subject of welding which is being given a prominent place in the program of the convention, the American Welding Society has called the attention of members of the Western New York section to the desirability of attending the regular monthly meeting of this section in Buffalo on May 26 and taking advantage of the opportunity of hearing this subject discussed at the Master Boiler Makers' convention.

From every angle the meeting should be one of the most interesting ever held in the history of the association.

In connection with this year's convention the secretary of the association has prepared a historical sketch giving an outline of the organization since its formation in 1907. This sketch will appear in the proceedings and is also published in somewhat amplified form elsewhere in this issue. This retracing of the stages of development through which the association has passed, lends emphasis to the value and standing it has reached in this year of 1926.

LETTERS TO THE EDITOR

Repairs by Electric Welding

TO THE EDITOR:

It was with interest that I read the various opinions on the above subject, including the article by J. G. Kirkland. I note that he states that we in England build up wasted portions of Lancashire boilers, over *large* areas, by this method, but he does not state, however, whether these wasted portions are in tension or compression.

I bring this point forward because no boiler insurance company in this country would pass a boiler repair of this kind if the plate was in tension, unless the welding was reinforced by an external patch.

Repairs by electric welding are very common in this country now, particularly on plates that are in compression, such as furnaces of Lancashire boilers or fireboxes of locomotive boilers, etc. Several makers of new locomotives now fit an entirely welded firebox to their boilers for pressures up to 250 pounds.

Referring to the boilers electrically welded throughout and made by Stevensons of Leith for 80 pounds pressure, I should like to know what class of boiler this is and what form the longitudinal seam of the barrel or shell is? If electrically welded only, I should not like to pass it for 80 pounds, as there is no definite information as to the strength of this seam and it does not come within the requirements of the Board of Trade of this country, which does not sanction welding on plates in tension.

I quite agree that electric welding in many cases is a good repair and cheaper than a patch, but to be reliable the operator must be an experienced man and therefore the *strength* and quality of the job depends very much on the individual that executes the repair.

London, England. P. G. TAMKIN.

Modern Production Methods and Piece Work

TO THE EDITOR:

I read with some interest the letter of "Flex Ible" in the April issue and his cry against piece work.

I can scarcely comprehend, from any one in a supervisory capacity, the objection to an incentive system as a means of stimulating production. It is an admitted fact to increase the amount of labor the average workman will produce, there must be some inducement offered—which is only fair. The average workman, by the amount of work he produces on a day's work basis says, in effect: "The work I do is enough for the pay I get." The employer says, in effect: "You give more work in a day and I will pay you more money." It is done. The problem then is ended—the employee gets more money and the employer gets more production. What could be simpler and fairer? Understand that I do not condone unfairness. There are doubtless employers whose prices paid for piece work are hewed pretty closely just as there are myriads of workmen whose daily ambition is to see how little they can do in a day and get away with it. It takes all sorts of people to make up a world.

The cry of poor work as an arraignment against piecework is but an attempted alibi. To admit that one's gang does poor work, no matter what the system, is an admission of inefficiency in supervision. There may be one or more things, wrong; however, it will not be piece work. The system may not be properly established, or, in its administration there is a lack of understanding or plain opposition.

Sympathetic understanding or the lack of it, by those responsible for its operation, can make or mar any system.

Poor work in a shop is a direct reflection upon the capabilities of its executive. There is but one reason for poor work yet there are lots of excuses. The reason is—poor supervision. The excuses are not worth considering. At the plant where the writer is employed nothing is acceptable but good work, first class work, and we do it as is evidenced on the test block or in the records of satisfied users of boilers we have made or repaired.

We work all piece work and subcontract. The prices paid for jobs are from carefully made time studies and are fair. We have no difficulty in getting good work and plenty of it for a day's work. Our men make good money and are well satisfied as is evidenced by our labor turnover which is very light. We are not a bit diffident in attributing a considerable measure of our success to close supervision.

Piece work lightens a foreman's labors, the loafers keep busy and the conscientious workmen are anxious to have plenty of work ahead of them. This results in the foreman and his assistants having time to spend profitably in watching the quality of the work his men are producing. As a matter of simple attention to duty, no foreman ever has any license to be so busy at something else that he cannot spend some of his time in getting good work.

Reference is made to "Flex Ible's" statement that boiler makers were being paid 8 cents in 1888 for setting a flue; whereas, he gets but 9 cents now. It might be well to consider that 1888 is some years before air tools were introduced into railroad boilershops in this country, for general use. In those days we were rolling flues with a hand feed dudgeon roller expander, prosser expanders and a five-pound hammer. We turned them over with the peen of a hammer and beaded them down right and left handed with a hand beading tool and a two and a half-pound hammer. It's a far cry from those days of all hand work to the present when we have a light weight reversible air motor and self feed rollers, a "sixty" hammer with a "knockout" for expanding and a belling tool and beading tool for the air hammer.

If the piece work prices of 1888 went up with the wages with no consideration for the changes in methods we would now be paying about 23 cents per flue and the boiler makers we work would be pulling down about $2.15 per hour. If such prices were being paid I am inclined to believe that the "kingpin" of workmen, the plasterers, would soon quit their occupation and go to boiler making. Surely the introduction and purchase of labor saving tools and devices should in some way be reflected in the cost of operation and production. Otherwise, why use them?

Hilton Village, Va. C. E. Lester.

Impracticability of Welded Joints in Unstayed Portions of Pressure Vessels

To the Editor:

Inasmuch as modern progress in promoting safety in the manufacture of pressure vessels has been justly considered, the following discussion plays a part in certain decisions made by manufacturers regarding welded and unstayed joints.

It is well to impress upon all readers that the following limitations are imposed by existing laws which are accepted by all modern manufacturers of boilers here in the States. So far as I know these requirements have met with no objection by manufacturers of fusion welding equipment or any other branch of the welding industry.

As Mr. Kirkland admits in the March issue of The Boiler Maker, the arc welding process has met with certain objections in connection with its application to unstayed portions of boilers and other pressure vessels. These objections are now in the form of boiler laws developed through a series of tests made by many if not all of the important boiler manufacturers in the United States. The result of the said tests proved that welded *longitudinal* or *circular* seams of any part of a pressure vessel subject to expansion and contraction stresses, unless thoroughly stayed by some means, were not safe. Needless to say, many examples of these welded tests met with serious failures and none proved perfectly satisfactory.

Personally, I have never seen recorded a failure of a perfect riveted lap or butt joint, unless the allowable pressure on the particular vessel was greatly exceeded. But I have seen and officially known instances of failures in welded joints before half the allowable pressure had been reached and the serious objection regarding the nature of the failure is the fact that when a failure develops it generally goes the limit of the weld, completely tearing away the whole portion. Whereas in a well riveted joint, even when the rivet shears or a portion of the plate tears between rivets, no serious results develop.

Taking up the comparative discussion between a welded joint and its ratio to the surrounding solid plate in terms of tensile strength and efficiency, I am aware of the fact that Mr. Kirkland made an excellent comparison as far as he went. However, to continue the comparison, it is necessary to bear in mind that he mentioned the tensile strength of a weld as applied to the material actually deposited by the weld as a valuable asset. If this is so, why should not all the plate in the boiler conform to the same tensile strength as the actual weld?

Another important consideration in the principle of boiler manufacture is taking care of contractions and expansions or so-called breathing stresses exerted on a boiler under steam or water pressure. A riveted joint reacts under these existing strains in an almost perfect manner, giving at the moment of super pressure and automatically contracting when the pressure subsides.

On the other hand a welded joint has little if any tendency to give under vibrating conditions. As a result the plate is more likely to give under the existing strains thus producing a pulling effect upon the various points of welded joints. This continuous pulling and bending effect will finally weaken and tear the weld which is abnormally hard and brittle because of the slag and impurities in it.

However, it can be readily seen that a *steady* pressure exerted on a welded cylinder might conceivably tear the plate of a low tensile strength rather than the weld which is much harder and which has a much higher tensile strength. But to meet the foregoing irregular and deviating conditions some shock absorber, so to speak, must exist and it is safe to say that the perfect riveted joint will favorably do the work.

Another serious objection to the welding of unstayed portions in a boiler is the fact that the value of the job depends wholly upon the skill of the man doing the work without any method of knowing how good or how poor the job is. Even the hydrostatic test may never disclose inherent weaknesses of the finished weld. In fact nothing will aid as a real test to the completed work except the existing strains while the boiler is in actual working condition for an indefinite length of time.

On the other hand, the efficiency of a riveted joint does not necessarily depend upon the man doing the job but more upon the material and factors of rivet spacing, plate thickness, etc., which can be easily inspected and facts noted.

Under three different heads I have made a summary of why the impracticability of a complete welded vessel, except at portions otherwise stayed?

1. Inability to detect proper application or improper application of weld.
    (a) Perfect weld wholly dependent upon operator.
2. Impracticability of a complete welded and unstayed

surface to withstand existing strains of contraction and expansion without weakening.

3. Resulting welded portions abnormally weak.
   (a) Weak because of too high a tensile strength.
   (b) Weak because of slag deposits and impurities in the weld.
   (c) Weak because of intense heat produced during the process of welding.
   (d) Tendency of a rupture at point of weld to seriously enlarge because of the foregoing weaknesses.

In conclusion, I am sure every manufacturer of steam boilers in the United States as well as Canada would be willing to manufacture them in the cheapest manner providing the efficiency and factor of safety are not lowered.

Franklin, Pa. R. L. HAMILTON.

Program of Annual Meeting of National Board

THE fourth annual meeting of the National Board of Boiler and Pressure Inspectors will be held May 24, 25 and 26, at the Sherman Hotel, Chicago, Ill.

"The National Board of Boiler and Pressure Vessel Inspectors is organized for the purpose of promoting greater safety to life and property by securing concerted action and maintaining uniformity in the construction, installation and inspection of steam boilers and other pressure vessels and their appurtenances, and to secure interchangeability between political subdivisions of the United States."

Monday, May 24th, 1926

Address—Jos. F. Scott, Chairman Engineers' License & Steam Boiler Insp. Bureaus, and Chairman of the National Board.

Report of C. O. Myers, Chief Boiler Inspector State of Ohio, and Secretary-Treasurer of the National Board.

Report of E. W. Farmer, Chief Boiler Inspector State of Rhode Island, and Statistician of the National Board.

General Discussion on officers' reports and any other questions for the good of the National Board.

Afternoon Session

Address—Chas. J. Manney, Chief Clerk Ohio Boiler Inspection Dept. "The Stamping of Boilers, Proper Handling of Data Sheets, and Keeping of Boiler Records."

Address—C. D. Thomas, Chief Boiler Inspector State of Oregon, and Vice-Chairman of the National Board.

Address—M. A. Edgar, Chief Boiler Inspector State of Wisconsin, "What is an Explosion?" and "What is a Major Boiler Accident?"

Opening of Question Box.

Note: A question box will be provided for the purpose of asking questions affecting the work of the National Board. The Executive Committee requests all who are interested to make use of this question box, either by personally depositing questions in the box, or, if not attending the convention, mailing to the secretary. The names of persons asking questions will not be published.

Tuesday, May 25th, 1926

Address—H. Kriegsheim, President, The Permutit Company, New York, N. Y., "Intercrystalline Cracks in Riveted Seams."

Address—T. McLean Jasper, Director of Research, A. O. Smith Corp., Milwaukee, Wisc., "Fatigue of Metals."

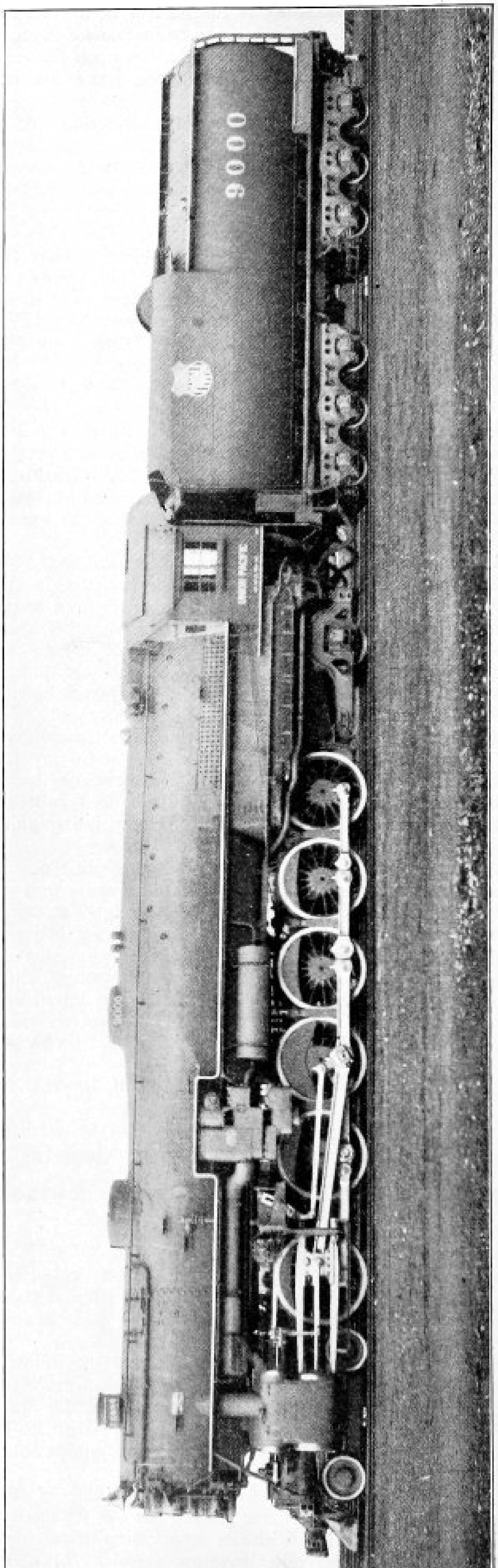
Address—J. P. Morrison, Chief Inspector, Hartford Steam Boiler Insp. & Ins. Co.

Note: The above papers will be illustrated with stereopticon lantern slides.

Wednesday, May 26th, 1926

Executive session for members of the National Board only. The members are requested to be prepared to discuss any problems with which they are confronted in their work in connection with the National Board.

The meeting will be presided over by Joseph F. Scott, representing the State of New Jersey. The secretary-treasurer of the board is C. O. Myers, Columbus, Ohio.



Large firebox volume of Union Pacific type locomotive gives high steaming capacity

Boiler of the Union Pacific Type Locomotive

This boiler designed for 220 pounds working pressure has the largest firebox ever equipped with a Gaines arch

THE American Locomotive Company recently delivered a 4-12-2 type locomotive to the Union Pacific which is believed to be the largest non-articulated steam motive power unit ever constructed. This locomotive, known as the Union Pacific type, was selected as a result of studies and tests made by the railroad management extending over a period of several years. These tests included an investigation of the operating costs of the 2-8-8-0 Mallet type, two-cylinder 2-10-2 type and three-cylinder 4-10-2 type locomotives.

The 2-8-8-0 type locomotives were designed for service on the principal mountain grades of the Union Pacific, but during certain seasons they were placed in road service between Green River, Wyo., and Laramie, where the maximum grade is 0.82 percent. Considerable reductions were obtained in operating costs through the use of the Mallet locomotives but owing to the fact that locomotives of this type are inherently low speed machines, they could not be used in this district during the busiest season.

Since 1917, the standard locomotive for fast freight service in the mountain districts has been the two-cylinder 2-10-2 type which has a rated tractive force of 70,450 pounds. About one year ago, the Union Pacific purchased a three-cylinder 4-10-2 type locomotive for demonstration and comparison with the 2-10-2 type. This locomotive was built as nearly identical to the 2-10-2 type as the three-cylinder design would permit, having nearly the same weight on the drivers, the same grate area and practically the same design of boiler, and 63-inch drivers.

The comparative tests conducted with the three-cylinder 4-10-2 and the two-cylinder 2-10-2, developed that the three-cylinder locomotive could regularly handle 20 percent more tons in regular service with an expenditure of 16 percent less fuel per thousand gross ton-miles. As a result, the Union Pacific requested the builders to design a locomotive for fast freight service capable of hauling the 2-8-8-0 tonnage and also of making the same speeds as made by the 2-10-2 and 4-10-2 type locomotives. In other words, it was desired to have an increase in permissible speed of from 20 miles per hour to 40 miles per hour and an increase in the average speed over the district of from 12 miles per hour to better than 20 miles per hour.

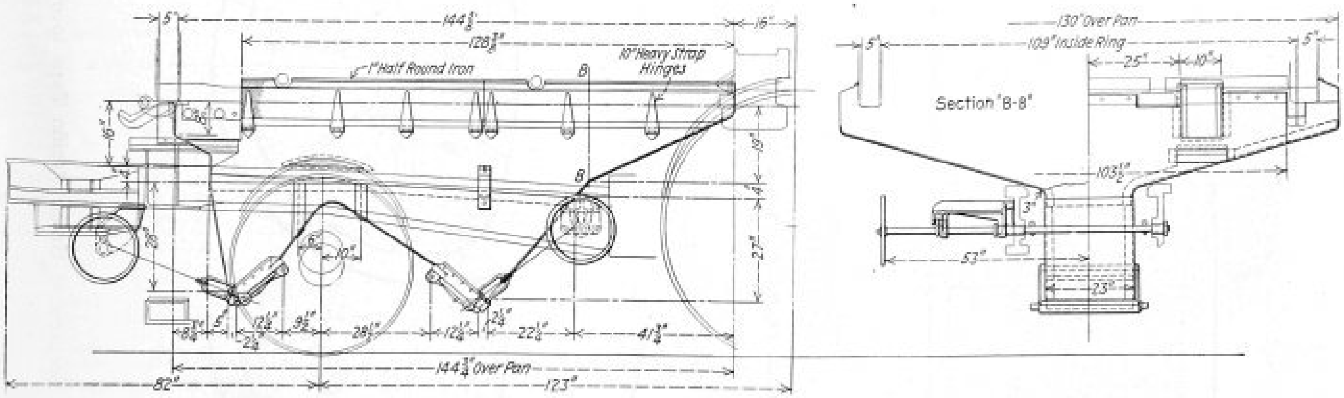
The design of the locomotive as a whole embodies straight engineering throughout, combining a number of accepted features in a manner that has not been used before in order to obtain the characteristics desired within the specified weights and clearance limitation. The locomotive develops a rated tractive force of 96,650 pounds. The boiler steam pressure is 220 pounds per square inch. The diameter and stroke of the outside cylinders is 27 inches by 32 inches and the inside, 27 inches by 31 inches, the main rods for the two outside cylinders being connected to the No. 3 drivers and the main rod from the inside cylinder to the No. 2 drivers.

The total weight of the locomotive is 495,000 pounds, of which 355,000 pounds is carried on the drivers, 80,000 pounds on the engine truck and 60,000 pounds on the trailing truck. The total length of the driving wheel base is 30 feet 8 inches, but by installing lateral motion devices on the No. 1 and No. 6 drivers, the designers were able to reduce the total rigid wheel base to 17 feet 6 inches.

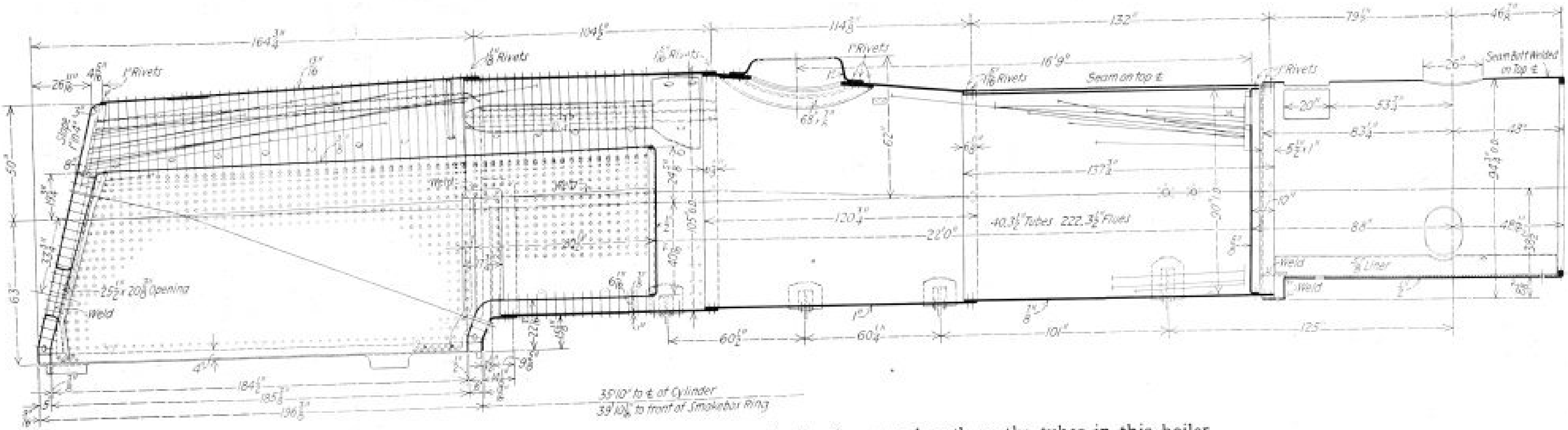
The Boiler

The boiler is of the wagon top type and carries a pressure of 220 pounds per square inch. The firebox total heating surface, including the combustion chamber, is 529 square feet. The heating surface of the five arch tubes is 62 square feet making a total fire heating surface of 591 square feet. The area of the grates is 108.25 square feet. The boiler has 40 tubes, 3½ inches in diameter and 222 flues, also 3½ inches in diameter, with a length over the tube sheets of 22 feet. The total evaporating surface is 5,853 square feet. It is equipped with a Type E superheater which provides a superheating surface of 2,560 square feet, and a Worthington feedwater heater having a capacity of 10,000 gallons per hour.

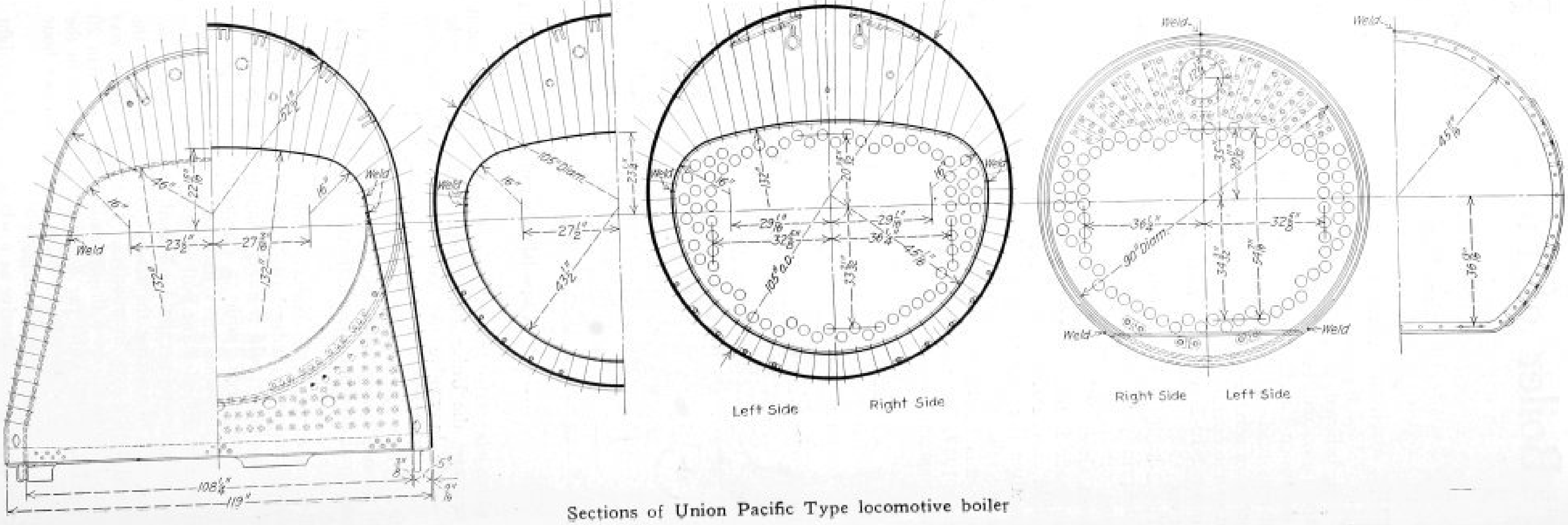
The design of the boiler presented a considerable problem. The builders were limited to an axle load of 60,000 pounds and it was also desired to keep the total weight of the locomotive as low as possible. To secure a firebox to burn semi-bituminous coal it was necessary to have firebox volume combined with ample length of flameway and depth of firebox. Both volume and length of flameway were secured by a combination of the Gaines wall and internal combustion chamber. Previous locomotives equipped with the Gaines wall never had sufficient depth from the crown to the top of the grate, but a satisfactory depth was obtained in this case by allowing the rear driving wheel to extend up



A special ash pan was developed for the Union Pacific locomotive 9000



The firebox and combustion chamber are practically the same length as the tubes in this boiler.



Sections of Union Pacific Type locomotive boiler between the inside of the throat and the front of Gaines wall. It was also desired to retain the same length of tubes, 22 feet, as used on the Union Pacific's other locomotives, but while this seemingly gives a relatively short tube for a boiler of this size, the long distance from the front tube sheet to the cylinder center should in turn improve the draft conditions in the smokebox by equalizing the pull on the upper and lower flues. The dome is the largest ever built by the American Locomotive Company and the firebox is the largest to which a Gaines wall has been applied.

The air compressors are located at the front of the smoke box. This arrangement together with the concealed piping gives the locomotive an unusually smooth appearance. The 67-inch drivers permit the use of a straight axle on the front drivers instead of a bent axle commonly applied to three-cylinder locomotives to clear the inside main rod. Other features in the design are the unusual length of the crown sheet, 241 11/16 inches, and the saving in weight, approximately 5,000 pounds, through the use of cast steel cylinders.

The Tender

The tender is carried on two six-wheel Commonwealth trucks equipped with 6-inch by 11-inch journals and 33-inch rolled steel wheels. It has a cylindrical tank of 15,000 gallons capacity. The capacity of the coal bunker is 42,000 pounds.

UNION PACIFIC TYPE LOCOMOTIVE

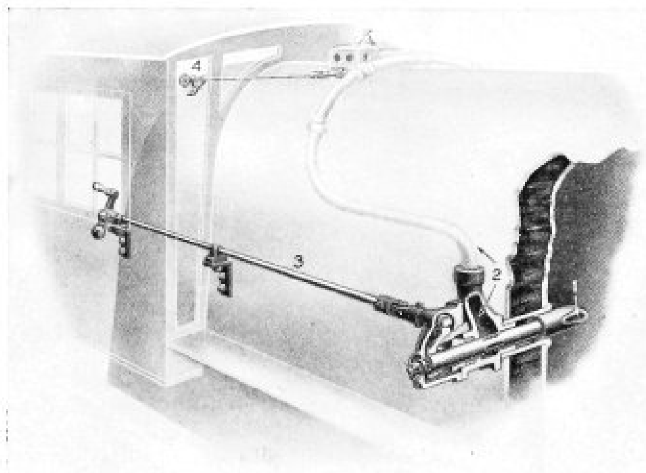
TABLE OF DIMENSIONS, WEIGHTS AND PROPORTIONS OF THE UNION PACIFIC TYPE LOCOMOTIVE

Railroad	Union Pacific
Builder	American Locomotive Co.
Type of locomotive	4-12-2
Service	Fast freight
Cylinders, diameter and stroke	2–27 in. by 32 in. 1–27 in. by 31 in.
Valve gear, type	Walschaert
Valves, piston type, size	14 in.
Maximum travel	7 in.
Outside lap	1¼ in.
Exhaust clearance	$\frac{3}{16}$ in.
Lead in full gear	$\frac{3}{16}$ in.
Weights in working order:	
On drivers	355,000 lb.
On front truck	80,000 lb.
On trailing truck	60,000 lb.
Total engine	495,000 lb.
Tender	287,000 lb.
Wheel bases:	
Driving	30 ft. 8 in.
Rigid	17 ft. 6 in.
Total engine	52 ft. 4 in.
Total engine and tender	91 ft. 6½ in.
Wheels, diameter outside tires:	
Driving	67 in.
Front truck	30 in.
Trailing truck	45 in.
Journals, diameter and length:	
Driving, numbers 2 and 3	12 in. by 13 in.
Driving, others	10 in. by 13 in.
Front truck	7½ in. by 13 in.
Trailing truck	9 in. by 14 in.
Boiler:	
Type	Wagon top
Steam pressure	220 lb.
Fuel	Semi-bituminous
Diameter, first ring, inside	90 in.
Combustion chamber, length	80½ in.
Tubes, number and diameter	40–3½ in.
Flues, number and diameter	222–3½ in.
Length over tube sheets	22 ft.
Grate area	108.25 sq. ft.
Heating surfaces:	
Firebox and comb. chamber	529 sq. ft.
Arch tubes	62 sq. ft.
Tubes and flues	5,262 sq. ft.
Total evaporative	5,853 sq. ft.
Superheating	2,560 sq. ft.
Comb. evaporative and superheating	8,413 sq. ft.
Special equipment:	
Superheater	Type E
Feedwater heater	Worthington
Stoker	Elvin
Tender:	
Water capacity	15,000 gal.
Fuel capacity	42,000 lb.
Journals, diameter and length	6 in. by 11 in.
General data estimated:	
Rated tractive force	96,650 lb.
Cylinder horsepower (Cole)	4,329
Speed at 1,000 ft. piston speed	37.6 m.p.h.
Factor of adhesion	3.66
Curvature	16 deg.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	71.75
Weight on drivers ÷ tractive force	3.68
Total weight engine ÷ cylinder hp.	114.3
Total weight engine ÷ total heating surface	58.8
Boiler proportions:	
Comb. heating surface ÷ cylinder hp.	1.95
Tractive force ÷ combined heat. surface	11.5
Tractive force × diam. drivers ÷ comb. heat. surface	7.69
Cylinder hp. ÷ grate area	39.9
Firebox heat. surface ÷ grate area	5.46
Firebox heat. surface, per cent of evap. heat. surface	6.28
Comb. heat. surface ÷ grate area	77.7

Improved Type Superior Locomotive Flue Blower

DURING the past few months the Superior locomotive flue blower, manufactured by the American Railway Appliances Company, Inc., New York, has been considerably improved especially in the operation and application to a locomotive boiler over former types, while at the same time accomplishing a gain in efficiency.

The application of the new type consists of replacing two waterleg staybolts with two short lengths of 3½-inch tubing, one on each side of the firebox. The blower is made up primarily of two nozzles so mounted on oscillating sleeves that they project into the firebox through these tubes. The nozzles are made of "Q" alloy to withstand the high temperatures existing in the firebox in the zone within which the nozzle is located. The sleeves are carried



Phantom view of Superior flue blower installation

in body castings which are in turn mounted on the outside of the boiler approximately 36 inches back from the flue sheet. From this casting an operating rod connected to an oscillating crank is carried back to a convenient location in the cab.

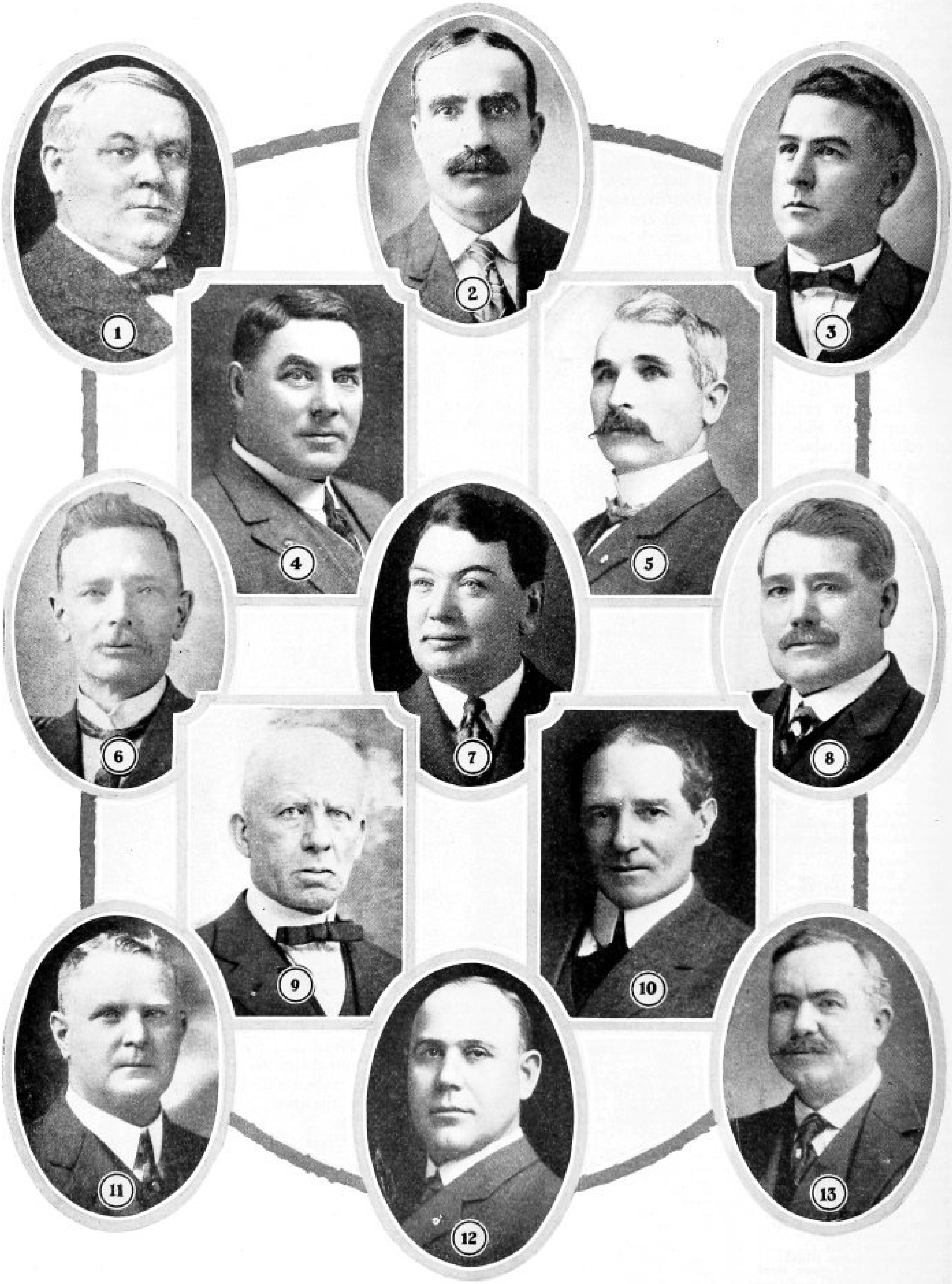
Steam is piped from the steam turret of the boiler to the body castings where it is carried through ports to the oscillating sleeves and thence to the nozzles. The steam supply is controlled by valves with operating handles located within easy reach of the crew and so arranged as to operate one nozzle at a time.

The nozzle directs a flat powerful jet of dry steam with uniform intensity into the flue sheet. This jet is from 8 to 12 inches in height.

Referring to the detail illustration shown herewith, (1) designates the steam outlet in the oscillating nozzle; (2) the steam supply pipe and steam passages through the blower; (3) the operating rod connecting the blower with the oscillating crank in the cab; (4) the cab control for steam supply.

The operation of the blower consists of first, opening the

(Continued on page 132)

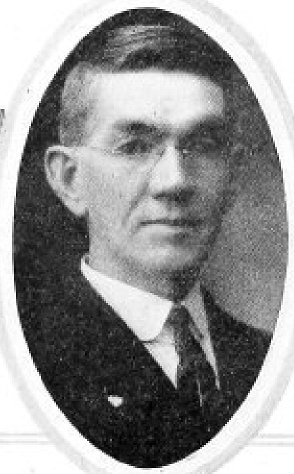


Past Presidents of the Master Boiler Makers' Association Since the Consolidation in 1907

(1) George Wagstaff, 1907-1908; (2) P. J. Conrath, 1908-1909; (3) A. E. Brown, 1909-1910; (4) A. N. Lucas, 1910-1911; (5) M. O'Connor, 1912-1913; (6) T. W. Lowe, 1913-1914; (7) Andrew Greene, 1915-1916; (8) D. A. Lucas, 1916-1919; (9) John B. Tate, 1919-1920; (10) C. P. Patrick, 1920-1922; (11) Thomas Lewis, 1922-1923; (12) E. W. Young, 1923-1924; (13) Frank Gray, 1924-1925

* Photographs of G. W. Bennett, president 1911-1912, and of James T. Johnston, president 1914-1925, were not available for publication.

James T. Goodwin



W. H. Laughridge

C. L. Hempel

J. A. Doarnberger

Four of the Presidents Before the Consolidation in 1907

History of the Master Boiler Makers' Association

Conditions leading to the organization of the association and the men who made its success possible

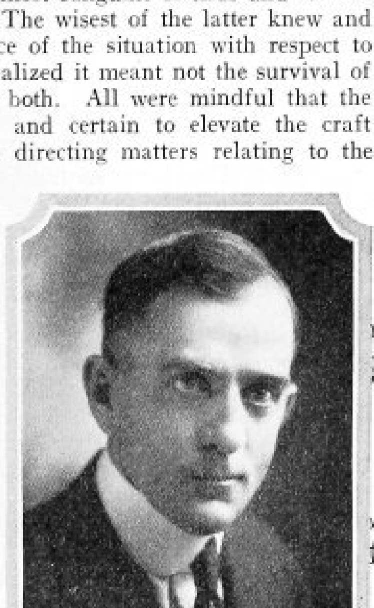
By Harry D. Vought*

THE Master Boiler Makers' Association as now constituted is a consolidation of two rival organizations—the Master Steam Boiler Makers' and the Railway Master Boiler Makers' associations. Both had struggled earnestly for independent existence; neither had done anywhere near as well as its most sanguine friends and leaders had wished or expected. The wisest of the latter knew and appreciated the significance of the situation with respect to each association. They realized it meant not the survival of the fittest but disaster for both. All were mindful that the objects sought were lofty and certain to elevate the craft most deeply concerned in directing matters relating to the foundation of steam, especially in its relation to the operation of the railroads of the country.

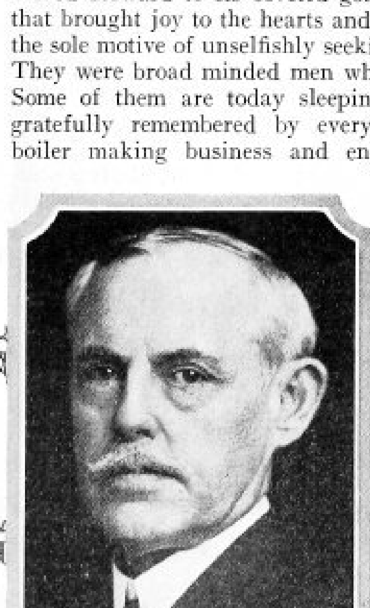
So it was decided to make a strong effort for that unity of organized action which makes for strength, mutual benefit and that measure of success which is always inspirational. Buoyant with hope an appeal was made as with one voice, "come, let us reason together!" It met with such quick response that the hearts of its authors were filled with gladness. The wisdom of men reasoning together was so emphasized at the conferences which followed, such fine leadership was developed and such irresistible impressions made, that the undertaking like an avalanche which sweeps away or buries every obstacle obstructing its pathway, moved forward to its coveted goal. There was a new birth that brought joy to the hearts and minds of those actuated by the sole motive of unselfishly seeking to help their fellow men. They were broad minded men who had nothing else to gain. Some of them are today sleeping their last sleep and are gratefully remembered by every man identified with the boiler making business and enjoying the fruits of their kindly labor.

The final outcome was a joint convention at Cleveland, O., in May, 1907, when the two associations before named were combined and the Master Boiler Makers' Association began a career that has ever since been without blemish. It has been constantly making history in the mechanical world. Its objects as agreed upon and made a part of its Constitution are:

"The mutual improvement of its members by an exchange of ideas in its meetings, the reading and discus-



T. F. Powers
President 1925-1926



H. D. Vought
Secretary 1907-1926

* Secretary of the Master Boiler Makers' Association.

sion of papers, and a general interchange of views, so that all may profit by the experience of others more proficient in our craft."

Active membership is limited to Master Boiler Makers, Assistant Foremen and General Boiler Inspectors who are practical boiler makers and filling such position at the time of applying for admission. There is also a list of associate members made up of men who have served as Master Boiler Makers, or others whose experience will be valuable to the Association. Nearly all have either advanced to higher positions in the railway mechanical departments or have graduated into various manufacturing and industrial branches of boiler manufacture. If active members change their occupation or position their status in the Association is not affected unless they engage in a calling foreign to boiler making. It should be understood that the Association is not identified either directly or indirectly with organized labor, has no desire to be and is eagerly anxious to avoid any such impression.

Among the men instrumental in the achievement of the proud record made and the maintenance of the position and attitude as well as the fine governing policy of the past 23 years, are the following:

George Wagstaff of New York City, formerly supervisor of boilers on the New York Central Lines, now an expert of the American Arch Co. and first President of the Association.

P. J. Conrath of Chicago, Boiler Tube expert of the National Tube Co. of Pittsburgh as is also J. W. Kelly of Oak Park, Ill.

Thomas Lewis of Sayre, Pa., General Boiler Inspector of the Lehigh Valley Railroad.

George W. Bennett, formerly with the New York Central and now District Inspector of the Interstate Commerce Commission, Albany, N. Y.

Charles Hempel of Omaha, Neb., retired General Boiler Inspector of the Union Pacific System.

The late James T. Goodwin of Plainfield, N. J., who was with the American Locomotive Company's plant at Richmond, Va., and later with the National Tube Co. as a Boiler Tube Expert.

John A. Doarnberger of Roanoke, Va., Master Boiler Maker of the Norfolk & Western Railroad.

E. W. Rogers of Schenectady, N. Y., an expert of the American Locomotive Co.

John H. Smythe of Cornwell Heights, Pa., formerly with the American Locomotive Company's plant at Paterson, N. J., and now interested in manufacturing.

Charles P. Patrick of the Central Vermont Railroad at St. Albans, Vt., formerly General Boiler Inspector of the Erie's western end.

James E. Cooke of the Bessemer & Lake Erie, Greenville, Pa.

A. N. Lucas, District Manager of the Oxweld Railroad Service Co., Chicago, formerly with the St. Paul Railroad.

D. A. Lucas of Milwaukee, Works Manager of the Prime Manufacturing Co. and formerly with the Burlington at Havelock, Neb., of which place he was at one time Mayor.

George Austin of Topeka, Kan., General Boiler Inspector of the Santa Fe.

James T. Johnston of Los Angeles, Cal., Assistant General Boiler Inspector of the Santa Fe.

Edward W. Young of Dubuque, Ia., formerly General Boiler Inspector of the St. Paul.

T. P. Madden of St. Louis, General Boiler Inspector of the Frisco System.

Frank Gray of the Alton at Bloomington, Ill.

E. S. Fitzsimmons of Pittsburgh, formerly with the Erie and now General Manager of the Flannery Bolt Co.

John Harthill and John German of the New York Central at Cleveland, O.

William H. Laughridge and W. S. Larason of the Hocking Valley at Columbus, O.

Charles Hurrash of the Three I's, Kankakee, Ill.

Thomas W. Lowe, of Winnipeg, Man., General Boiler Inspector of the Canadian Pacific.

John McKeown of Galion, O. (who died August 17, 1925), for a life time with the Erie, probably the most venerable member of the Association and familiarly known as the "Man with the Whistle," his peculiar capacity in that regard being usefully employed at nearly every convention in summoning members to attend the various sessions of the Association.

Henry J. Raps of the Illinois Central, Chicago, Ill., whose son, John F. Raps of the same city, is General Boiler Inspector of the same road.

John Troy of Ann Arbor, Mich., of the Ann Arbor Railroad.

Andrew S. Greene of Indianapolis, Ind., General Boiler Inspector of the Big Four.

L. M. Stewart of Waycross, Ga., General Boiler Inspector of the Atlantic Coast Line.

T. J. Talbot of the American Locomotive Company's plant at Richmond, Va.

E. E. Stillwell of Mexico.

Henry J. Wandberg of Minneapolis, Traveling Inspector of the St. Paul.

J. J. Davey of St. Paul, General Boiler Inspector of the Northern Pacific.

Thomas F. Powers, System General Foreman of the Chicago & Northwestern Railway, Oak Park, Ill.

J. B. Malley, of the Frisco at Springfield, Mo.

David Champion of Cleveland, President of the Champion Rivet Co.

George N. Riley of the National Tube Co., Pittsburgh.

T. J. McKerihan of the Pennsylvania, Altoona, Pa.

C. H. Aiken of the Bourne-Fuller Co., Cleveland, O.

John Berry of the Grand Trunk, Toronto.

Arthur J. Beland of the Chicago Junction Railroad, Chicago.

John C. Campbell of the Ulster Iron Works, Chicago.

L. E. Borneman of the St. Paul Railroad, St. Paul.

M. S. Courtney of the Great Northern, Minneapolis.

John O. Crites of the Pennsylvania, Williamsport, Pa., now retired.

M. O'Connor of Los Angeles, now engaged in manufacturing interests.

A. C. Dittrich, General Boiler Inspector, Soo Line, Minneapolis.

George E. Dougherty of the Interstate Commerce Commission, Boiler Inspection Department, Washington, D. C.

Thomas Eads, Master Mechanic of the Tampa & Jacksonville Railroad, Gainesville, Ga.

C. E. Elkins of the Missouri Pacific, Little Rock, Ark.

Nicholas Emch of the Emch Machine & Plumbing Co., Toledo, O.

William F. Fantom of the Illinois Central, Chicago.

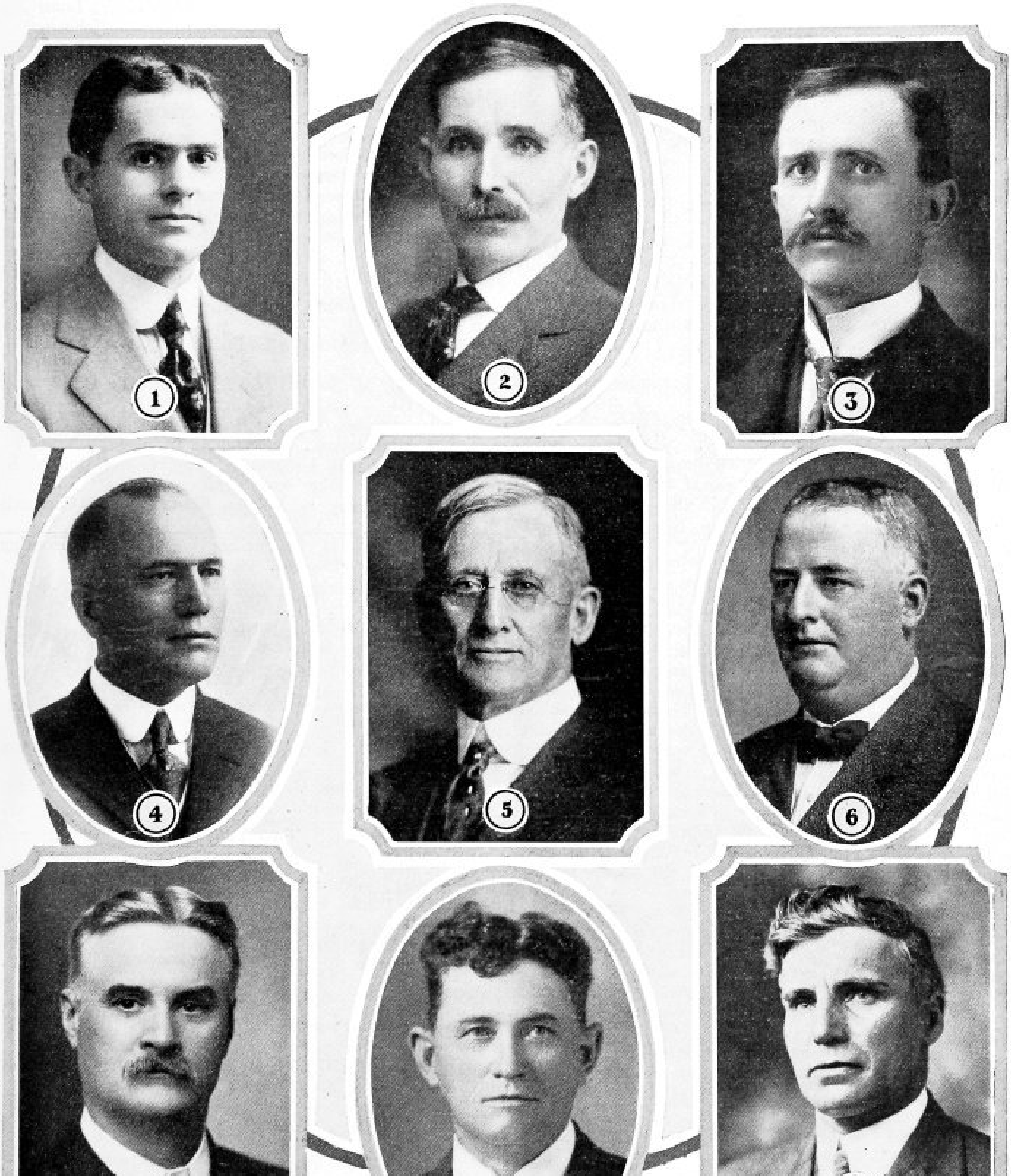
John E. Fernstrum of the Menominee Boiler Works, Menominee, Mich.

Capt. M. J. Guiry of the Great Northern, St. Paul and Capt. B. C. King, Assistant General Inspector of the Northern Pacific, veterans of the World War, who were members of the contingent of American mechanics who went to Russia to help keep the railroad equipment in good condition while that country was allied with other countries in fighting Germany.

H. Louis Hahn, General Manager of the New Mexico Steel Co., Albuquerque, N. M.

Andrew Hedberg, Chicago & Northwestern Railway, Winona, Minn.

E. H. Hohenstein, General Inspector, Rock Island Lines, Rock Island, Ill.



A Few of the Members of the Master Boiler Makers Association Who Have Been Active in Its Affairs

(1) J. F. Raps; (2) H. J. Wandberg; (3) H. J. Raps; (4) T. P. Madden; (5) George Austin; (6) B. F. Sarvcr; (7) E. W. Rogers; (8) L. M. Stewart; (9) John H. Harthill.

Robert S. Kennedy of the Southern Pacific, Portland, Ore.

John Kernohan of the Grand Trunk, Durand, Mich.

Thomas Kilcoyne, Cincinnati, O., Traveling Inspector of the American Arch Co.

O. H. Koebernich, General Inspector of the Nickel Plate, Cleveland.

Charles J. Longacre of the Pennsylvania, Elizabeth, N. J.

M. M. McAllister, American Flexible Bolt Co., Erie, Pa.

John J. Mansfield, Chief Boiler Inspector of the Jersey Central, Jersey City, N. J.

F. A. Mayer, General Master Boiler Inspector of the Southern Railway, Washington, D. C.

C. N. Nau, President and Felix Nau, Vice-President of the United Boiler, Heating & Foundry Co., Hammond, Ind.

C. F. Petzinger of the Central of Georgia, Macon, Ga.

E. J. Reardon of the Locomotive Firebox Co., Chicago.

I. J. Pool of the Baltimore & Ohio Railroad, Baltimore.

E. M. Rearick, General Boiler Inspector of the Buffalo & Susquehanna, Galeton, Pa.

T. J. Reddy of the Chicago & Eastern Illinois, Danville, Ill.

G. P. Robinson, Assistant Engineer of the American Locomotive Co., New York City.

A. E. Schaule of the D. M. & N. Railroad, Proctor, Minn.

W. G. Stallings of the Illinois Central, Memphis, Tenn.

John B. Tate of the Pennsylvania, Altoona, Pa.

A. F. Stiglmeier, G. B. F., of the New York Central Railroad, Albany, N. Y.

Many Original Members Still Active

These are only some of the men who rank as the pioneers of the Association who are part and parcel of its backbone and credited with contributing substantially to its maintenance. The majority of those who are still living and others are expected to attend the convention in Buffalo, and will be seen and heard many times during its deliberations. It will be noticed that some are now identified either with production by being in business for themselves or are connected with various corporations that have learned to know their practical value and induced them to graduate into the manufacturing world. Every mother's son of their number served in the boiler shop from the trying period of an apprenticeship which began with tossing hot rivets to the man doing the skilled work overhead until they qualified and rose to positions of authority.

It should be said in passing that all boiler makers with such a record, and their name is legion, have made the greatest sacrifice for humanity of any other set of men connected with industrial operations for all have impaired hearing and some are positively stone deaf, but as a rule they keep right on with their chosen occupation and give only the best of important service. It is indeed surprising that some one of their number or some other inventive genius has not long since been moved to originate and perfect a device of some kind that would protect their hearing and save it.

The foregoing list of veterans and their location indicates to some extent how widespread is the membership of the Association, making it international, for it covers Australia, Mexico, Cuba, the Philippines and Canada as well as the United States.

Those who have served as Presidents and directed the welfare of the organization are as follows:

Before Consolidation

*Thomas C. Best	W. H. Laughridge
John H. Smythe	*James T. Goodwin
W. M. Wilson	C. L. Hempel
*F. J. Graves	J. A. Doarnberger

*Deceased.

Since Consolidation

George Wagstaff	Thomas W. Lowe
P. J. Conrath	James T. Johnston
Arthur E. Brown	Andrew S. Greene
A. N. Lucas	Daniel A. Lucas
George W. Bennett	John B. Tate
M. O'Connor	Charles P. Patrick
Thomas J. Lewis	E. W. Young
T. F. Powers	Frank Gray

The present officers including members of the Executive Board are as follows:

President: Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 So. Clarence Ave., Oak Park, Ill.

Vice-Presidents

First: John F. Raps, G. B. I., I. C. R. R., 4041 Ellis Ave., Chicago, Ill.

Second: W. J. Murphy, G. F. B. M., Penn. R. R., Olean, N. Y.

Third: L. M. Stewart, G. B. I., Atlantic Coast Line, Waycross, Ga.

Fourth: Stephen M. Carroll, G. M. B. M., C. & O. R. R., 2919 Merrill Ave., Huntington, W. Va.

Fifth: George B. Usherwood, Supervisor of Boilers, N. Y. C. R. R., 302 Baker Ave., Syracuse, N. Y.

Secretary: Harry D. Vought, Room 314, 26 Cortlandt St., New York, N. Y.

Treasurer: W. H. Laughridge, G. F. B. M., Hocking Valley R. R., 537 Linwood Ave., Columbus, O.

Executive Board

Albert F. Stiglmeier, Chairman.
Henry J. Raps, Secretary.

One Year

Edward J. Reardon, Locomotive Firebox Co., 1908 Straus Bldg., Chicago, Ill.

Henry J. Raps, G. B. F., I. C. R. R., 7224 Woodlawn Ave., Chicago, Ill.

Lewis E. Nicholas, Gen. B. F., C. I. & L. R. R., 2220 Ferry St., Lafayette, Ind.

Two Years

C. H. Browning, F. B. M., G. T. Ry., 53 Cherry St., Battle Creek, Mich.

Louis R. Porter, F. B. M., Soo Line, 2723 Ulysses St., Minneapolis, Minn.

Albert F. Stiglmeier, Gen. Boiler Shop F., N. Y. C. R. R., 138 N. Allen St., Albany, N. Y.

Three Years

Charles J. Longacre, F. B. M., Meadow Shops, Penn. R. R., 664 Monroe Ave., Elizabeth, N. J.

R. W. Clark, G. F. B. M., N. C. & St. L. R. R., 720 17th Ave., So., Nashville, Tenn.

Franklin T. Litz, G. B. F., C. M. & St. P. R. R., 21½ 37th St., Milwaukee, Wis.

The Birth of a New Association*

The sixth annual convention of master boiler makers, held in Cleveland last month, marked an epoch in the boiler making industry, as it was not only the culmination of the careers of two vigorous and successful organizations, but it was also the inception of a broader and more vigorous line of activity by a new association which is to be known as the International Master Boiler Makers' Association. Perhaps the most noticeable, as well as the most pleasing, feature of the convention was the perfect harmony and mutual good will which prevailed among the members of

*An editorial published in the June, 1907, issue of The Boiler Maker.

both organizations. In view of the fact that these two bodies have been such sturdy rivals in the past, it was hardly to be expected that perfect agreement would be obtained on all matters pertaining to the consolidation. The result, therefore, is all the more gratifying, and shows very plainly the effect of the many months of hard work accomplished by the retiring officers and others who had the best interests of the organization at heart.

The selection of officers for the new association augurs well for its success. The president, both by reason of his position and the fact that he has been an untiring and zealous worker in the effort to bring about the consolidation, should prove a most able leader, while the selection of a secretary who is already in the business is a move which will do much to strengthen the organization and start the active work of the new association.

Master Boiler Makers' Convention Program

The seventeenth annual convention of the Master Boiler Makers Association will be held at the Hotel Statler, Buffalo, N. Y., May 25-28 inclusive. The following program has been arranged by the officers of the association and in addition, a most interesting series of social events, arranged by the Boiler Makers' Supply Men's Association, will be held between business sessions:

Tuesday, May 25

REGISTRATION OF MEMBERS AND GUESTS—8 A. M.

BUSINESS SESSION

Convention called to order .... 10.00 A. M.

Invocation:
Past President J. H. Smythe, Official Chaplain of the Association.

Addresses:
John J. Love, Acting Mayor of Buffalo.
Frank M. Barker, Vice-President, Buffalo Chamber of Commerce and Superintendent, Lehigh Valley R. R.
Walter H. Flynn of New York City, S. M. P., N. Y. C. R. R.

Responses:
John F. Raps, First Vice-President.
W. J. Murphy, Second Vice-President.
L. M. Stewart, Third Vice-President.

Annual Address:
Thomas F. Powers, President of the Association.

Routine Business:
Annual Report of the Secretary, Harry D. Vought.
Annual Report of the Treasurer, W. H. Laughridge.

Miscellaneous Business:
New Business.
Appointment of Special Committees to Serve During Convention.
Resolutions.
Memorials.
Announcements.
Recess to 2 P. M.

Afternoon Session

Convention called to order .... 2.00 P. M.

Committee Reports on Topical Subjects:

No. 2. "Flue Sheets, Combustion Chambers and Other Types of Boilers." F. J. Jenkins, Chairman; George Austin, John Finucane .... 2.00 to 2.30 P. M.

No. 5. "Best Form and Arrangement of Lagging and Jacketing for Easier Removal and Application for Inspection of Hollow or Rigid Tell-Tale Hole Hammer-Headed Staybolts." Franklin T. Litz, Chairman; M. J. Guiry, Charles C. Butler............ 2.30 to 3.00 P. M.

No. 6. "Shop Kinks." C. J. Baumann, Chairman; C. J. Baumann, Ira J. Pool.... 3.00 to 3.30 P. M.

Announcements.
Adjournment.

Evening

8.00 P. M.: Reception to Officers and Members of the Association.

Wednesday, May 26

Convention called to order .... 9.00 A. M.

Addresses:
A. R. Ayers of Cleveland, Assistant G. M., N. Y. C. & St. L. R. R.
R. B. McColl, Manager, Schenectady Plant, American Locomotive Company.

Responses:
Stephen M. Carroll, Fourth Vice-President.
George B. Usherwood, Fifth Vice-President.

Unfinished Business:

Committee Reports on Topical Subjects:

No. 1. "Recommended Practices and Standards" .... 10.30 A. M. to 12 M.
J. A. Doarnberger, Chairman

Announcements.

Afternoon

Excursion to Niagara Falls.

Thursday, May 27

Convention called to order .... 9.00 A. M.

Addresses:
A. G. Pack, Chief Inspector, I. C. C., Bureau of Locomotive Inspection.
R. E. Woodruff, Superintendent, Erie R. R., Buffalo.

Responses:
A. F. Stiglmeier, Chairman, Executive Board.
Henry J. Raps, Secretary, Executive Board.

Committee Reports on Topical Subjects:

No. 3. "Boiler Corrosion, Pitting and Grooving." Kearn E. Fogerty, Chairman...... 10.00 to 11.00 A. M.

No. 4. "When Staybolts Have Become Enlarged What Is the Best Method of Reducing Hole in Roof and Outside Sheets?" Louis R. Porter, Chairman .... 11.00 to 11.30 A. M.

No. 8. Law. C. E. Elkins, Chairman .... 11.30 to 11.45 A. M.

Announcements.
Adjournment.

Evening

Banquet at 7 P. M. by the M. B. M. Supply Men's Association.

Friday, May 28

Convention called to order .... 9.00 A. M.

Addresses:
E. V. Williams of Du Bois, Pa., S. M. P., B. R. & P. R. R.
F. C. Pickard of Erie, Pa., Works Manager, Standard Stoker Company.

Responses:
Thomas Lewis, Past President.
P. J. Conrath, Past President.

Address on Foreign Shops:
Thomas Lewis, G. B. I., L. V. R. R.

Report of Executive Board, A. F. Stiglmeier, Chairman .... 10.00 to 10.30 A. M.

Report of Special Committee on "Standard Names for Various Parts of Locomotive Boilers." W. H. Laughridge, Chairman .. 10.30 to 10.45 A. M.

Report of Special Committee on Publication of Names of Master Boiler Makers in Official Lists. D. A. Lucas, Chairman.. 10.45 to 11.15 A. M.

Unfinished Business:
Report of Committee on Resolutions .... 11.15 to 11.30 A. M.
Report of Committees on Memorials .... 11.30 to 11.45 A. M.
Report of Committee on Topics for 1927 Convention, A. F. Stiglmeier, Chairman.... 11.45 A. M. to 12 M.

Election of Officers .... 12 M. to 1 P. M.

Adjournment.

F. A. Brandes of the Brandes Machinery Company, Keith Building, Cleveland, Ohio, has been appointed to represent Joseph T. Ryerson and Son of Chicago, Ill., exclusively, on their complete line of metal working machinery and small tools.

Joseph T. Ryerson and Son, Inc., of Chicago, Ill., have taken over the reinforcing bar division of the Penn Metal Company of Boston, Mass. The general sales offices will be located at 677 Concord Avenue, Cambridge, Mass.

Two Methods of Producing Ductile Welds Developed

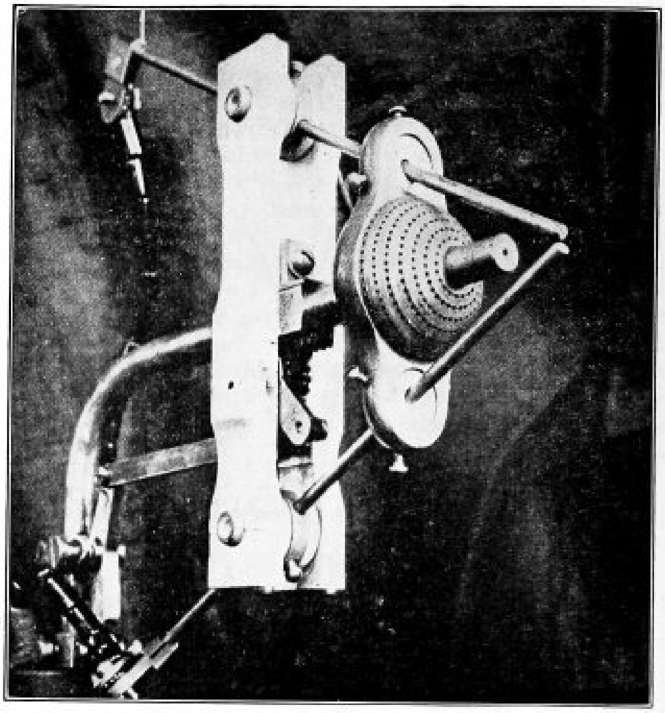
TWO methods for producing ductile welds have been developed by research scientists of the General Electric Company, working in different laboratories hundreds of miles apart. Both of the methods, similar in some respects, mark a decided step in the utilization of the heat of electric arcs in the joining of metal parts or the building of metal structures. The one was developed in the Schenectady research laboratory by Dr. Irving Langmuir; the other was developed in the Thomson research laboratory at Lynn, Mass., by Peter Alexander.

In both processes, air is excluded from the metal by means of a bath of hydrogen or other gas. The formation of oxides and nitrides in the weld metal is thus prevented, and the fused metal is as strong and ductile as the original metal.

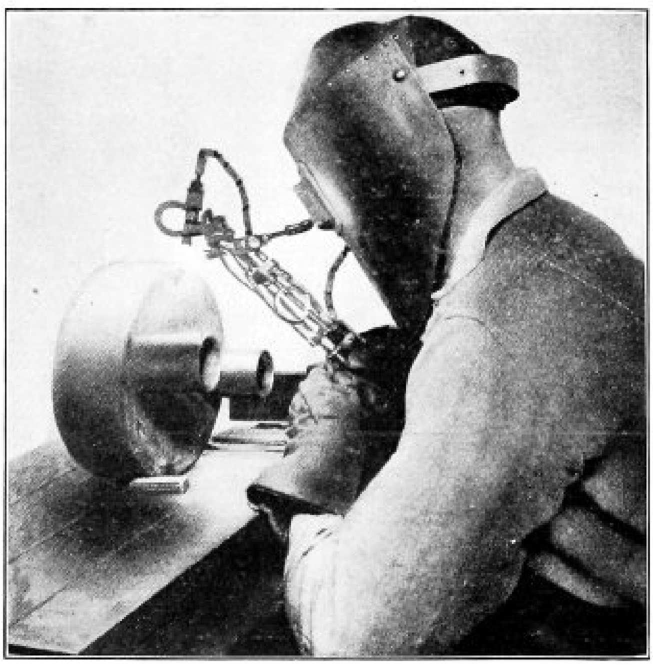
Announcements of these radically new methods of arc welding are made in the March issue of the *General Electric Review*. In brief, the method developed by Dr. Langmuir in Schenectady is to pass a stream of hydrogen between two electrodes. The heat of the arc breaks up the hydrogen molecules into atoms. These combine again a short distance in front of the arc into molecules of the gas, and in so doing liberate an enormous amount of heat, so that much higher temperatures can be obtained with this than with the usual welding methods. Since atomic hydrogen is a powerful reducing agent, it reduces any oxides which might otherwise form on the surface of the metal. Alloys containing chromium, aluminum, silicon or manganese can thus be welded without fluxes and without surface oxidation.

The process developed in the Lynn laboratory by Mr. Alexander is based on the utilization of the chemical and physical properties of hydrogen and other gases in their molecular state. This process aims primarily at the prevention of the formation of the nitrides and oxides in the arc-deposited metal, which limit the ductility of the usual arc welds.

In this process the arc is struck between the metallic wire or carbon used as one electrode and the plate or work to be welded used as another electrode. The crater of the arc is always on the work to be welded. The gaseous atmosphere is supplied in a form of a stream around the arc. Pure hydrogen, water gas, hydrogen-nitrogen mixtures, anhydrous ammonia, methanol vapor and some other suitable gases can be used, according to the nature of the work. The hydrogen-carbon monoxide mixtures were suggested by Professor Elihu Thomson; water gas and methanol are examples of such mixtures.



Atomic hydrogen arc welding torch, Type I



Welding with the atomic hydrogen arc

This process makes the arc welding process more efficient and suitable for the fields which at present are out of its reach. Low carbon steel, alloy steels, and most of the nonferrous metals and alloys can be welded with success by this process in suitable gaseous mixtures.

Superior Locomotive Flue Blower

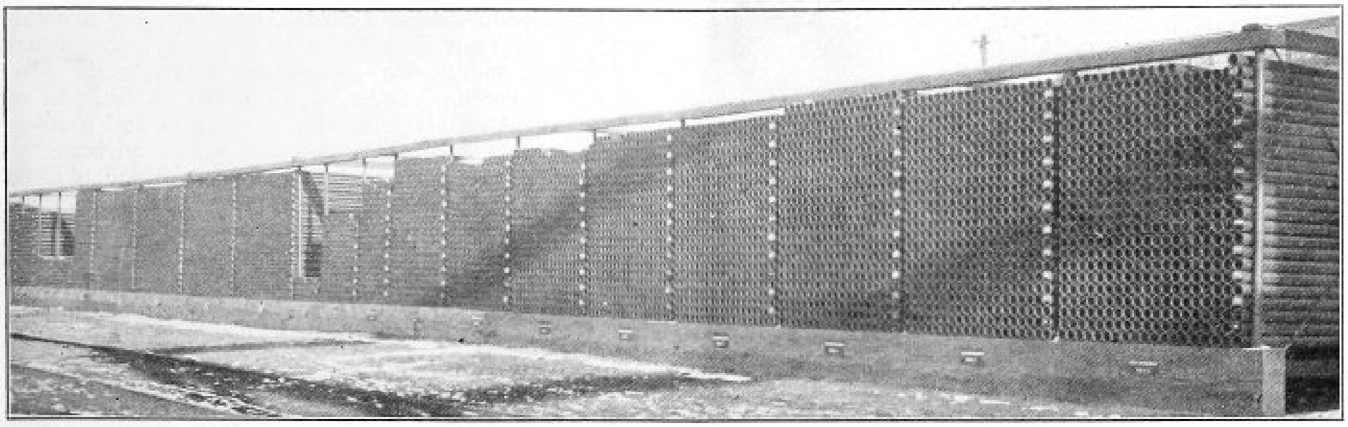
(*Continued from page* 125)

steam control valve; second, slowly turning the nozzle oscillating crank first in one direction as far as it will go and then in the opposite direction to its limit; third, closing the steam control valve. The operation is carried out for one blower at a time. The best results are obtained by using the flue blower on the road as the engine works. The flues should also be blown at the start and at the end of each run. When the blower is first turned on the exhaust is noticeably black as it is loaded with soot blown off the flues. When the exhaust is clear the flues are clean. This gives a visual evidence of the effect of the blower.

A number of railroads which have applied this device have in addition to the usual savings obtained by the use of the flue blower also found considerable savings in the maintenance of the combustion chamber as well as flues, flue sheets and superheating units.

The Robert June Engineering Management Organization of Detroit, Mich., has moved to larger quarters at 2208 West Grand Boulevard where it now occupies the entire building. This is the organization's fourth move in four years to larger quarters.

E. O. Shreve, manager of the San Francisco office of the General Electric Company since 1918, has been named manager of the industrial department of the company with headquarters at Schenectady, filling the vacancy caused by the recent death of A. R. Bush.



More than a two years' supply of flues on an American railroad in 1922—Slow moving stocks of flues that have not been properly sheltered are now considered detrimental by causing incipient corrosion that hastens their destruction in the boiler

Pitting—A Myth or a Menace?

Modern idea of causes of pitting and preventatives developed to combat this evil in the locomotive boiler field

By D. A. Steel

An important step in the suppression of pitting is the attention being directed specifically to pitting and corrosion problems by technical organizations. Prominent among these, because of its immediate interest in the pitting of locomotive boilers, is the American Railway Engineering Association. This association has had the general subject of water treatment under study for many years and by an understanding with the American Railway Association is the recognized research body for the railroads in this field at present. Pitting and corrosion was assigned to the Water Service committee of this association for study in 1920 and has since been continued from year to year as one of its principal subjects. Its constituency of 30 or more water service officers, chemists and engineers of tests from all sections of the country is representative of the talent in water supply and water conditioning work on the railways at present and among them are officers closely in touch with the immediate problems in question as well as with current thought and investigation on the subject, including some meritorious work done or sponsored by supply interests. Its reports show the drift of thought and must be considered as valued factors in the general educational work among railway officers essential to successful results in the control of pitting in a field in which the personal element enters as extensively and vitally as in this—where to some extent every engine crew and roundhouse and boiler foreman, as well as pumphouse man and even those in charge of handling boiler sheets and flue stocks are factors in the problem.

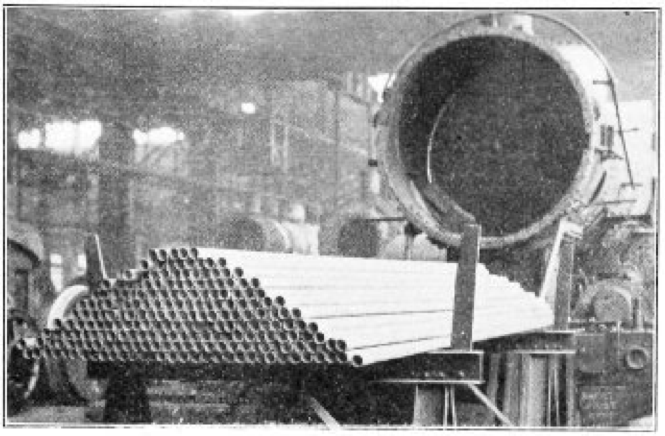
But the American Railway Engineering Association is not alone in its investigation of pitting and corrosion. An indication of the complicated nature of this problem is afforded by the investigation of the American Society for Testing Materials on a related phase of the subject over the past several years in cooperation with the United States Bureau of Standards and by more recently inaugurated work on this specific subject by the American Chemical Society, the American Electro-Chemical Society, the American Institute of Chemical Engineers, the American Society of Mechanical Engineers, the American Society of Refrigerating Engineers, the American Foundrymen's Association, the American Waterworks Association, the Master Boilermakers' Association, and the American Committee on Electrolysis. In addition the National Research Council has a corrosion committee which, while doing no research work itself, endeavors to co-ordinate the work of the committee of other associations.

The Modern Conception of Pitting

It was early established that by far the greatest number of chemical substances, no matter how stable in the dry state, do not retain their original form when dissolved in water but, instead, that a certain percentage of the substance (depending upon the concentration of the solution and the amount of other substances present, etc.,) splits up into particles, each of which carry electric charges. These particles, called ions, are so constituted that half are negatively charged and half are positively charged. Thus, when sulphuric acid (H_2SO_4) is dissolved in water a certain percentage of it splits up or becomes ionized, forming H ions, which carry a positive charge and SO_4 ions, which carry a negative charge.

In this field it was also established at an early period that when two interconnected metals are immersed in this solution, a current of electricity is produced. In the process all of the positive ions of the solution move towards one of the metals and all of the negative ions to the other metal where the charges are surrendered, producing the current. The other characteristic of this process is that eventually one or both metals are eaten away, whereupon the current ceases. It is observed that this entire process can take place without the aid of electric or other energy from the outside—the identical condition of the electric battery. It was not long before this process became established thoroughly in the industries for the generation of electric current, for electroplating work and also for the production of many chemicals. Its applicability to the processes of corrosion was established in 1907 when Cushman, Walker and others, working in large part independently of each other, challenged the long-lived theory that the process of rusting required carbonic or

*This article commenced on page 95 of the April issue of The Boiler Maker.



There are large economies in prolonging tube life

other acid (as ordinarily conceived), and declared that the process of all corrosion of iron is fundamentally electrolytic.

Briefly, this theory as applied to the locomotive boiler presupposes that wherever corrosion occurs a condition exists identical to that of a battery, which comprises two points of difference in the metal and their exposure to a suitable solution, or electrolyte as such solutions are called. The first stage of the process is the solution of iron at the point of highest "potential." The second stage is the removal of this ionic iron as a result of its chemical combination with oxygen or as a result of some other agency or action. The action stops when the electro-motive force created by the difference in the metal surfaces involved is destroyed or when the products of decomposition accumulate in such quantities as to polarize or otherwise to counteract the corrosive process or when the activity of the solution itself is rendered impotent. In the latter connection it is found that some substances, while perfectly good electrolytes, lessen the activity of pitting solutions and that in all cases the activity of the solution appears to bear a close relation to the concentration of ions of hydrogen in the solution, a fact which has led to the adoption of the practice of using the hydrogen-ion concentration as a measure of the corrosive powers of the solution.

Some Preventatives Have Been Found

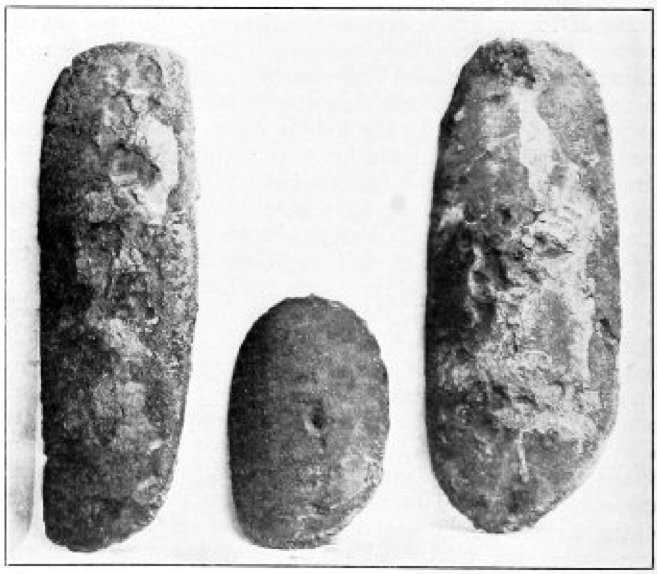
But again progress in pitting control has not been confined alone to acquiring the modern conception of the process. Instead a marked advance appears to have been made in the study and application of cures. Of the events in this field probably the one of most practical importance is the general acceptance of discoveries to the effect that sufficiently concentrated solutions of caustic soda (NaOH) and carbonate of soda (Na_2SO_4) are inhibitors of corrosion. The problem contingent upon the use of these chemicals to the degree said to be necessary to the purpose, is that of avoiding foaming (for both are foaming salts) but the tone of reports of various experiments already carried out in railway service where the foaming trouble has apparently been met, tend so to confirm the earlier investigations of Cushman, Walker and others, and particularly the experiments conducted by the U. S. Navy in 1912, that increased efforts to apply this remedy for pitting in some form or other are certain. The fact is that some of these reports indicate that well directed efforts in this direction have been crowned with success.

While the above events are of the greatest importance in every consideration of pitting at the present time, it is also significant that other studies are now progressing on railroads which invite attention. Most prominent among these, perhaps is the study being made of the effect on pitting of dissolved oxygen, a substance that was mentioned among corrosives considered by some as early as 1904, but which was not given serious thought until after the work of Cushman and others, mentioned above. On the theory that this oxygen is the controlling factor in pitting in some waters by oxidizing and thereby continuously removing the ionic iron as it is produced under the electrolytic action, and on the strength of certain laboratory experiences and observations of pitted flues which are said by its advocates to strengthen the theory (notwithstanding current doubts of its effect in boiling water), various tests are now being made with feedwater heaters in an effort to remove it before the water reaches the boiler. Thus the feedwater heater becomes a more important facility, for the present at least, than merely as a fuel economizer. The Pennsylvania and the Chicago, Milwaukee & St. Paul are among the roads conducting such experiments.

Other experiments being conducted at the present with the hope of correcting pitting, from which its advocates expect much, involve the counter-electrical method of treatment, a treatment which is patterned after a practice claimed to have been applied successfully in certain marine boilers. It provides essentially for the "application of an electrical charge to the boiler sufficient to counteract and neutralize the potential normally in the boiler,"—a treatment whose chief difficulty in winning support, pending the completion of experiments now under way, lies in the possibility of causing damage similar to that which it proposes to prevent, but which is of special interest for the knowledge its study may develop concerning a thermal electric activity suspected of being in the boilers, and which, if established, may assist in explaining certain irregularities about the grooving action.

Rusted Flues Hasten Pitting

Among the most prominent of other experiments being carried on are the better care of new flues and sheets preparatory to installation. This is based on the theory that rusting lowers the resistance to pitting by destroying the protective coating afforded by the surface skin and, in some cases it seems, actually starts the pitting process; the use of alloy steel tubes, notably the copper content flue; the use of coated flues, notably the lead covered flue; the coating of boiler interiors with cement and other products, including the processes of rendering the surfaces resistant by pretreatment with chromic acid, etc., and certain studies in metallurgy having as their object the improvement of the quality of the flues and sheets themselves, and of their proper support in the boiler.



Superheater tubes are not immune from pitting

QUALITY OF BOILER METAL PARAMOUNT

The importance of the last conclusion cited is expressed in the following statement of W. A. Powers, former chief chemist of the Santa Fe, who gave the subject of corrosion special attention for many years:

"I have investigated a large number of pitting epidemics, both on boiler tubes and firebox sheets and have never found a case in which the pitting was not due either to poor material or uneven strains caused by improper staying. The latter cause is much more prevalent than we ordinarily think and is not always readily detected, but a very close examination will show that the pitting is confined to certain areas on the firebox sheets. For instance, there may be pitting on the short radius but none on the crown sheet; again, there may be pitting on the throat sheet and nowhere else. Quite often it is on only one side of the staybolts, all of which is due to local strains which evidently keep the material under a great tension at those particular places. Under these conditions the sheets will pit regardless of how good material is."

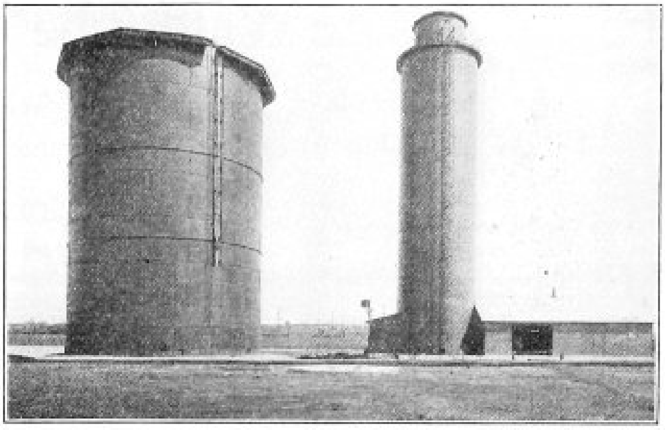
Another remedy is worthy of special attention as an indicator of the progress being made in pitting control. This is the successful resort to law that has been made recently to prevent the pollution of streams, on the ground that such pollution as will tend to impair the service of the railroad to the public through the destruction of its boilers is unlawful on grounds similar to the pollution of a public drinking supply.

PRACTICAL OBSTACLES TO SUCCESS

There is no question but that progress is being made in finding and also in applying remedies for pitting. There are many conditions which make some of the progress in this direction scarcely short of remarkable, even as they help to explain why some roads have not progressed farther in eliminating their pitting troubles. The complicated nature of the problem should be emphasized in this connection. Thus, not only does it present involved questions of chemistry and metallurgy but a situation replete with problems of practice and where changes are constantly taking place in operating conditions, boiler design and materials, etc., to say nothing of the changes in personnel. Thus the engine that is here today is somewhere else tomorrow; boiler sizes, pressures and duties have increased and various modifications made in use, as a result of which one problem is solved very often only to find a new one in its place.

Again, there are few men in the railway field who have had the time or resources at their disposal to carry out investigations essential to the solution of pitting problems. Thus the chemist is often also the engineer of tests, while the water service officers on the few roads that have yet appointed them are constantly required to divide their attention among various water supply activities, including the development of new supplies, superintendence and maintenance, with the result that even the general problems of water softening by one process or another can receive only a portion of their attention. Moreover, the problem has not been simplified by the common failure of the mechanical department to keep such records as will afford the data essential to a correct picture of conditions or, among other things, by a division of responsibility among conflicting interests.

In considering the progress in pitting control the fact cannot be overlooked that the elimination of pitting is largely a question of economics. The probabilities are that pitting would be far less now than it is if railroads were willing to spend the money for it. In this respect, the problem of pitting is identical with other problems confronting railroads, whether of an operating, maintenance or mechanical nature. The investment required is properly measured by the results to be gained. That this principle has actually been applied to the pitting question is well illustrated by the case of a certain railroad that is contenting itself at present with the substantial reduction of pitting in a certain territory that it has been able to secure by internal treatment simply because, from a careful consideration of the damage being done by pitting and the cost of remedial measures, it cannot justify the expense of more complete treatment until traffic increases warrant it.



The water plant can be a potent factor in pitting prevention as it has been in scale removal

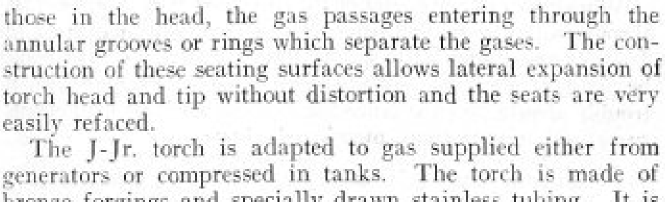
Thus each road must largely determine its own progress in pitting control. Where a road, however, is properly organized and manned, as many are at present, and wants the elimination of pitting badly enough, certainly the solution of pitting does not constitute the formidable nor even the expensive problem that it is often surmised to be.

Milburn Markets New Welding Torch

CONSISTENT with the demand for a small welding torch for work not requiring the usual standard torch, The Alexander Milburn Company, Baltimore, Md., has perfected the Type J-Jr. torch. This is a sturdy, compact torch giving a high degree of efficiency and economy. The torch uses the same tips as are supplied with the standard larger torches and is adaptable to all classes of welding. It uses low and comparatively equal pressures of oxygen and acetylene.

Due to its light weight, it is easy to operate continuously. The quality of its work has been highly satisfactory. Comparison of its use show savings in gas and a speeding up of the work.

The supermixing of the gases through a standardized system of multiple mixing assures a uniform flame. The seats of the tips are flat, with annular grooves coinciding with those in the head, the gas passages entering through the annular grooves or rings which separate the gases. The construction of these seating surfaces allows lateral expansion of torch head and tip without distortion and the seats are very easily refaced.



The J-Jr. torch is a compact model of high efficiency

The J-Jr. torch is adapted to gas supplied either from generators or compressed in tanks. The torch is made of bronze forgings and specially drawn stainless tubing. It is simple in construction, with all parts easily accessible.

An angle of 67½ degrees in the head allows a natural position in operating the torch, utilizes the heat to best advantage and protects the operator's hands. Equally balanced, the torch is easily manipulated and will not tire the operator.

The J-Jr. is 18 inches long, weighs 25 ounces and is furnished with three welding tips adaptable to a wide range of welding.

High Pressure Watertube Boilers for Marine Purposes*

Details of Yarrow boilers designed for turbine passenger vessel using steam at 575 pounds pressure and 700 degrees F.

By Harold E. Yarrow, C.B.E.

THE theoretical advantages of high steam pressures and temperatures in conjunction with turbine installations are well known and fully recognized. Sir Charles Parsons, in his paper on Steam Turbines, given before the First World Power Conference in 1924, dealt with the subject in the following terms:

"By the use of higher steam pressures and temperatures, together with the lowest possible exhaust pressure and by other devices, it is expected in the future to reach an overall efficiency (from fuel to electricity) of 30 percent, which is not inferior to the best results obtained by oil engines, even neglecting the cost of oil for cylinder lubrication."

Similar statements have been made by other responsible authorities, and naval architects and marine engineers are now beginning to consider seriously the application of high steam pressures and temperatures on board ship.

Sir John Biles, in his paper, "Relative Commercial Efficiency of Internal-combustion and Steam Engine for High Speed Passenger Vessels," read before the Institution of Naval Architects a year ago, gives an interesting comparison between the steam turbine and the internal combustion engine, from which it is shown that the former, when high pressures and temperatures are employed, compares favorably in efficiency with the latter method of propulsion.

High Pressure Boilers Already in Use on Shore

The adoption of high pressures and temperatures on land has already made considerable progress. Boiler installations having steam pressures of 500 to 600 pounds per square inch, and superheat temperatures of 700 to 750 degrees F., are in commercial use in a number of power stations, and such pressures and temperatures may be said to have passed the experimental stage.

If, therefore, these pressures and temperatures can be adopted on land, there seems no reason why they should not likewise be adopted at sea. There are certain fundamental factors common to both, among them suitable materials and workmanship. The better and more uniform materials now in use, and the improved metallurgical and manufacturing methods now adopted, remove from the designer's mind any anxiety as to materials. Copper, wrought iron, and cast iron have been discarded in the manufacture of watertube boilers of high pressures. Steel is in common use, and its uniformity leaves little to be desired. Certain of the non-ferrous alloys which are now used also contribute to that security which characterizes modern installations.

Workmanship must obviously be of the very highest class throughout, just in the same way as the manufacture of the Diesel engine requires the greatest skill. It may therefore be accepted that, with good materials and workmanship, no trouble should be experienced in boilers working at the pressures and temperatures mentioned above.

Tight Joints Possible at High Pressures

Fear has been expressed that with high temperatures and increased pressures there will be a difficulty in keeping steam joints tight, and that this will be more serious on board a vessel than in a power station, as the latter generally consists of a large open building and all joints are easily accessible. There does not seem to be any valid reason to fear this difficulty, for if proper materials and high class workmanship are employed, steam joints can be made quite satisfactory. A suitably designed metal-to-metal joint with strong bolts and thick flanges should give no trouble. In one respect the problem is simplified in a marine installation as compared to land boilers, because in the latter case the

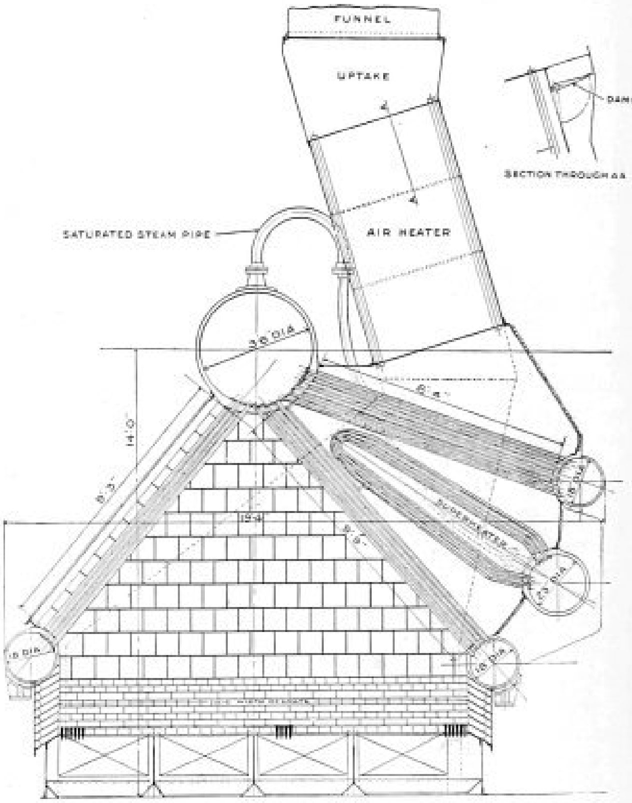


Fig. 1.—Yarrow high pressure watertube boiler (mercantile type) for 575 pounds per square inch pressure

units are usually much larger and the valves and pipes are, in consequence, very much bigger than on board ship. For instance, the steam pipe from each of the Yarrow boilers at the County of London Electric Supply Company's station at Barking, working at 400 pounds per square inch, and 725 degrees F. superheat, has a diameter of 8 inches and joins up to the 12-inch main steam pipe line. In a steamship of 24,000 shaft horsepower having six boilers of 575-pound pressure and 750 degrees F. superheat, the diameter of the main steam pipe from each of the boilers would be only 4 inches, and would connect into two 7-inch steam pipes in the engine room. The valves and boiler fittings would be of smaller size and their design therefore simplified.

Boiler Efficiencies of 85 Percent Expected

In considering the problem of turbine installations with high pressure boilers, it may be assumed that a boiler efficiency of not less than 85 percent will be realized when air heaters are fitted, and in the case of boilers with straight and well inclined tubes the rapid circulation of the water keeps

*Abstract of paper read before the Institution of Naval Architects, London, Eng., March 26, 1926.

the tubes clean, and therefore a high efficiency can be maintained over long periods of service.

It may be of interest to the meeting to give some particulars of two high pressure boilers, coal fired, which will be installed on a passenger vessel now being built by Messrs. William Denny & Brothers, for Turbine Steamers, Ltd., the managing owners of which are Messrs. John Williamson & Company.

In determining the type of boiler for this vessel it was

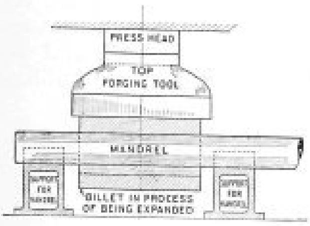


Fig. 2

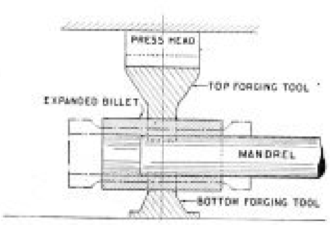


Fig. 3

NOTE.—The chain-dotted line (Fig. 3) shows the form of the forging at the end of the process.

necessary to select a design that would be suitable for general mercantile practice, and one preferably free from as many bolted and riveted joints as possible, due to the high pressure to be adopted. It was also considered important that all the pressure parts should be as far as possible circular in section. After careful investigation it was decided to adopt the Yarrow type, and the order was placed for the two boilers by the main contractors, the Parsons Marine Steam Turbine Company, with Messrs. Yarrow and Company.

The design of the boiler has been passed by the Board of Trade, whose officers have offered many valuable suggestions, and who have given every assistance to facilitate this new development. Each boiler, a general arrangement of which is shown in Fig. 1, has a total heating surface of 3,420 square feet, of which the superheating surface is 870 square feet; in addition, there are 2,200 square feet of air-heating surface for preheating the air prior to its admission to the closed ashpit. The safety valves are set to 575 pounds pressure, and the final temperature will be from 700 to 750 degrees F. The test pressure is 913 pounds. The design generally, while not unlike that used in the Navy, has been based on mercantile practice, and more closely follows the design of the Yarrow land type boiler now in use at several electric power stations.

CONSTRUCTION OF THE BOILER

As will be seen from Fig. 1 and the photographs (Figs. 5 and 6), the boiler consists of a forged steam drum connected to the three forged water drums by means of straight tubes expanded and bell-mouthed in accordance with the usual practice. Between the two water drums on the right-hand side (Fig. 1) is a superheater which consists of a forged drum with a number of U tubes and which is placed between the two generating elements. The gases all pass up one side of the boiler and through the air-heater situated above the boiler and to the funnel. The reason for adopting a single-flow type of boiler where all the gases pass through one side is because this design makes in this particular case a somewhat better arrangement in the ship than the double-flow type where the gases pass equally through each side. The generating element on the left-hand side of the boiler absorbs a considerable portion of the heat from the furnace by direct radiation, and it will be noted that the proportion of the total surface of the boiler subject to direct radiation is considerable, which is an important feature in modern watertube boiler design, not only increasing the output and efficiency of the unit, but also providing a large amount of comparatively cool surface adjacent to the combustion chamber, which lengthens the life of the brickwork.

The admission of air for combustion is arranged in the following way: The cool air in the stokehold enters an opening between the inner and outer casings at the front of the boiler about 6 feet up from the firing-floor, passes up the double casing through the air-heater, down the double casing at the back of the boiler into the closed ashpit, and so through the firebars. The efficiency of the unit is naturally increased by the air-heater, which extracts heat from the flue gases, and in addition the air in its passage to the combustion chamber as above described takes up a certain amount of heat which would otherwise be lost due to radiation, and incidentally keeps the stokehold cool. Also the circulation of air in close proximity to the furnace lining helps to keep the brickwork at a temperature which ensures low cost of upkeep.

For controlling the supply of steam—especially as, unlike an oil-burning boiler, the supply of fuel cannot be quickly cut off—various means of regulation have been provided. If reference is made to Fig. 1 it will be seen that a damper is fitted in the uptake at the side of the top of the air-heater. When this damper is in its horizontal position the air passes through the air-heater to the combustion chamber. When, however, the damper is brought to a vertical position the air from the fan passes straight up to the funnel, thereby short-circuiting the air-heater and entirely stopping the supply of air for combustion. This arrangement would be used when the engines are stopped suddenly, e.g., when the

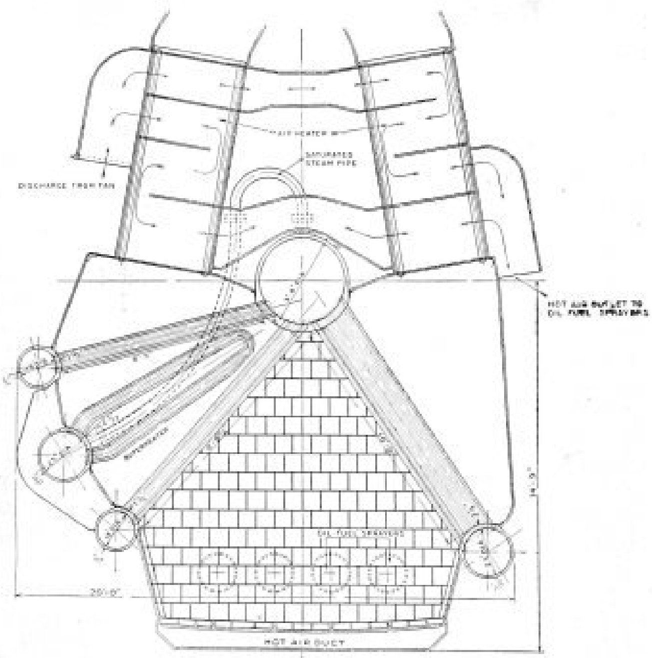


Fig. 4.—Yarrow watertube boiler (mercantile type) for 1,000 pounds per square inch pressure

vessel stops at a pier. Provision is also made for controlling the speed of the forced draft fan, thereby limiting the amount of air for combustion. A still further control is to by-pass the steam direct from the boiler to the condenser by the silent blow-off.

In preparing the design of a high pressure boiler it is advisable to reduce the number of riveted and bolted joints to a minimum, and how this has been accomplished in the present case will be seen from the fact that the steam drum has no riveted joints at all and, apart from the attachment of boiler mountings, the only bolts are those required to secure the two internal manhole doors. In the water drums and superheater drum there are no longitudinal joints, and only one circumferential riveted joint securing the front end-plate in which the manhole is placed. The other end of these drums is solid.

Method of Forging the Drums

All the drums have been manufactured by Messrs. John Brown & Company, of Sheffield, and a short description of the process of manufacture may be of interest. The steel used is ordinary boiler steel 26/30 tons, with 30 percent elongation in 3 inches lengthwise and not less than 20 percent elongation in 3 inches transverse. The large steam drum is made by the following method: A large octagonal ingot is forged under a hydraulic forging press to a round billet; it is then cut to a length which will give the weight necessary for the finished forging, and is carefully examined for any surface defects. The billet is then bored with a hole throughout its entire length large enough to take a mandrel for the second forging operation.

The second forging operation consists in expanding the billet to a larger diameter without increasing the length, the internal diameter after this operation is slightly less than the finished diameter of the steam drum. This operation is shown in Fig. 2. The expanded forging is reheated ready for the third operation, which consists in forging on a mandrel in such a manner as to increase the length without increasing the diameter. A large mandrel is used of a diameter approximately that of the finished drum, and forging is continued until the required length is obtained. This operation is shown in Fig. 3. The thickness of the main body is now that required for the drum, plus machining allowances.

The ends of the forging are left thicker to allow for the final operation, which takes place after the internal diameter of the drum is bored to the finished sizes. This last forging process consists in closing in both ends as nearly as possible to the required shape of the finished drum. The final closing-in is performed on a round bar or mandrel somewhat smaller in diameter than the manholes in the ends. The forging is then thoroughly annealed and sent to the machine shops, where the necessary mechanical tests are taken and the final machining carried out.

The process of forging of the water and superheater drums is much simpler.

Boiler Fittings

The boiler tubes and superheater tubes are solid drawn cold-finished. The problem of boiler fittings such as safety valves, stop valves, joints, etc., is one to which much care must be devoted. The safety valves require special consideration in design and construction for high pressure and temperatures. The ordinary safety valve with its small lift is a trap for grit, etc., when the valve is blowing off. The valve shuts down on this grit and soon indentations extend across the face and the high velocity causes grooves to be cut. The safety valves for the two boilers above referred to are of the high-lift type manufactured by Messrs. Cockburns, Ltd., and either this type or the full-bore safety valve manufactured by the same firm would seem to meet adequately the problem of high pressures and temperatures. The stop valves and other fittings are of the usual design, strongly constructed and of suitable materials. The main stop valve has monel metal spindles, valves, and seats, but other materials have been found to be equally satisfactory. The joints, as already stated, are metal to metal, and the flanges are particularly thick so as to avoid the possibility of any distortion. The feed regulators are being supplied by Messrs. A. G. Mumford, Ltd., and the water gages by Messrs. Dewrance & Company.

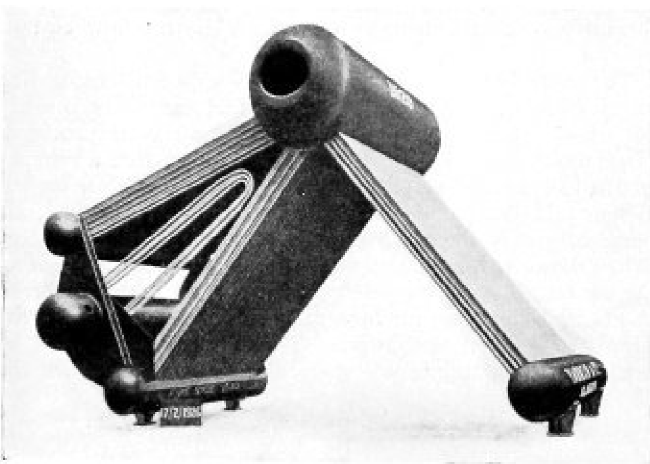


Fig. 5

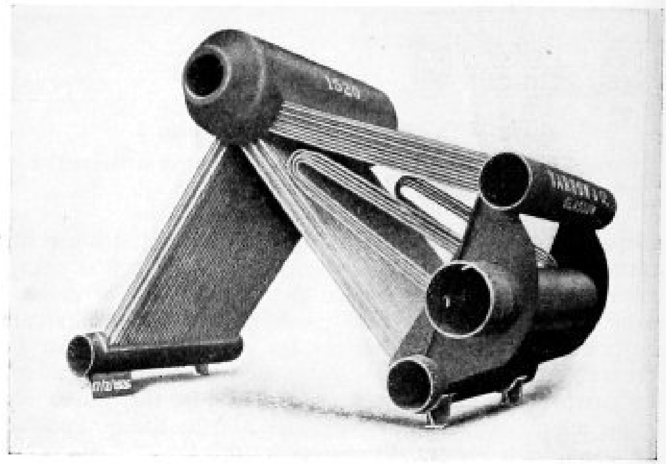


Fig. 6

Cost of High Pressure Boilers

With regard to the initial cost of a high pressure boiler, the price of the solid drums is at present greater than built-up drums, but a number of the fittings are common to boilers whether for high or low pressure, such as furnace fittings, casings, uptakes, air-heaters, brickwork, etc., so that the total increase in cost is not considerable.

It is estimated that the two boilers described above with forged drums for 575 pounds pressure cost approximately 15 to 20 percent more than similar boilers having the same total heating surface, but having a boiler pressure of 250 pounds per square inch. If, however, a comparison is made on a more correct basis, that is to say, taking into account the fact that the quality of the steam from the 575-pound boiler is of a higher value than in the case of a lower pressure, then the cost of the high pressure boiler is very little more than the cost of the other. The saving due to the reduced heating surface required in the case of the high pressure boiler nearly compensates for the additional cost of the forged drums and certain other rather more expensive fittings. The initial cost of high pressure boilers is, therefore, no handicap to their introduction.

The two photographs (Figs. 5 and 6) shown of the boilers in course of construction give a good idea of the general design of the boiler as well as illustrating the solid drums.

Fig. 4 shows a section of a Yarrow boiler suitable for 1,000 pounds pressure, the boiler being of such a size as would produce steam for 4,000 shaft horsepower when being worked at a very moderate rating. This boiler is of the double-flow type, but it can, of course, be designed for single flow depending upon the general layout of the boiler room where it is to be installed.

Fusion-Welded Pressure Vessels*

The Reliability of Present-Day Fusion Welding—Proposed Code for Fusion-Welded Pressure Vessels, Based on Use of the Latest Practices and Methods—Specifications for a 60-Inch Fusion-Welded Tank 20 Feet Long for a Working Pressure of 200 Pounds

By S. W. Miller†

WHILE engineering has been defined in many ways, the fundamental idea involved in the use of the term is that it is concerned with the employing and developing of the materials and forces of nature for the use of mankind, an engineer being one who is occupied with this work.

There is not, and cannot be, a sharp line of division between any two of the many fields of engineering, but in a general way mechanical engineers are concerned with machinery, boilers, engines, and their appurtenances, among the latter being piping and containers of various kinds.

The applications of fusion welding to these structures have been great both in number and size and many of them have been in successful operation for a long enough time to make it almost certain that no trouble will arise in the future in any of these cases, and to warrant an increase in the number, size, and kind of applications of the processes.

An engineer controls the materials and structures he works with by means of specifications. He draws up these specifications from his own experience and that of others, including the results of well-planned and executed tests, so that by using good judgment he is able to obtain the results he desires. It may well be that in some cases he does not have all the information he needs, but that does not deter him, as he always finds ways to get what he wants.

Further, if any design, construction, or process is advantageous, it is the duty of the engineer to learn about it and use it when and where he can. This may require some study, but one of the engineer's most precious privileges is to investigate and learn.

Now with regard to fusion welding in general, it seems to the author very clear that the advantages of the processes make it incumbent on the engineer to study them thoroughly, so that he may use them intelligently, and that he is not fair to himself unless he does so.

It is admitted by all those to whom the author has talked that good welding can be and is being done. To deny this would be to deny facts. If it is being done, some one must know how to do it, and so he would be rash indeed who would say that engineers could not draw up specifications that would insure good welding.

A code differs from a specification in that it governs all specifications, and in that it is written primarily as a safety measure. In other words, the author's conception of a code is that it is a description of the minimum allowable requirements for safety. But a code must not contain requirements that are prohibitive or even unduly restrictive to the industry, if it is a fact that by the use of good material, design, and workmanship a product can be safely made that is safe. Therefore, in the author's view, there is no room nor place in a code for any restrictions based on any assumption that bad workmanship may sometimes be used.

It should be pointed out that the responsibilities of the code committee, the enforcing body, and the engineer are essentially different. They correspond rather closely to those of the legislative, administrative, and judicial departments of our Government. The code committee is the legislative, the enforcing body is the administrative, and the engineer is the judicial factor.

The code committee makes the code, and should produce one that is fair to the producer, the consumer, and the public.

It is theoretically very simple to make a code, but there are many practical difficulties in the way. These are quantitative rather than qualitative, and are usually due to a lack of definite knowledge. Mere opinions are not data, and as a code should be based on sound engineering data, such opinions are of little or no force or value. So the committee should insist on definite evidence, getting it where and how they can.

The author knows of no other code than the A.S.M.E. unfired-pressure-vessel code that contains restrictions based on the assumption of poor workmanship. While it is not denied by any one that there have been some cases of failure of welded pressure vessels due to this cause, there are thousands of welded pressure vessels that have not failed, and it is a fact that good welding does not fail.

It is bad logic to condemn fusion welding as a dangerous *process* because of these failures, unless it be admitted that failures of other types of joints due to the same cause also condemn the *processes* by which they are made. Such reasoning is obviously more harmful to the one using it than it is to the welding industry.

After the code has been made, it must be enforced if it is to be of any value, and this is the duty of the state, through its authorized representatives. It cannot be done by the code committee. Therefore, as local conditions and laws differ, each enforcing body has problems that it must solve in accordance with its own peculiar difficulties.

Further, as the state must do the enforcing, the code should not contain any references to inspection, stamping, or other matters that relate to the duties of the state. Also no attempt should be made to specify methods of doing work, tests for operators, or other similar matters. These are functions primarily of the manufacturer, and secondarily of the inspector employed by the engineer or the constituted authority.

Also, as it is the duty of the state to enforce the code, the state should do so, and not avoid its duty by trying to prohibit or unduly restrict an industry. It is probably true that there are not at the present time enough competent welding inspectors in state employ to enforce thoroughly a good code, but that is not the fault of the code, and certainly a committee should not allow itself to insert restrictions in a code for any such reason as this. Obviously if a good code were completely enforced, there could be no accidents.

The unfired-pressure-vessel code of the A.S.M.E., in the author's judgment, needs revision of the parts relating to fusion welding if it is to command the respect it should from those familiar with welding practices and possibilities. Probably the easiest way to revise would be to rewrite, and so he ventures to present a code for fusion-welded vessels, believing that, while it is doubtless not perfect, it is much more accurate and workable than the one he criticizes. It is only fair to say that changes in the most important items have been presented by the American Welding Society to the

*Presented at a recent meeting of the metropolitan section of the American Society of Mechanical Engineers, New York.

†Union Carbide and Carbon Research Laboratories, Inc. Mem. A.S.M.E.

Boiler Code Committee for their consideration, and that it is expected that some modifications in the present restrictions will be made, because of the engineering evidence that accompanied the presentation, and because of the advances recently made in welding.

But it is the belief of the author that the recommendations referred to are not as liberal as would be perfectly safe, and so he has gone still further with the idea of using the latest practices and methods as a basis for the proposed code.

Experience and observation warrant the statement that at present it is no more difficult to train men to make perfectly satisfactory welds than it is to train them to make any other satisfactory product. Some may find it hard to realize this, but it is true, and it has been proven so many times in the last two or three years that to deny it would be simply to deny the facts. The welding of 140 miles of 8-inch pipe by 44 welders who made 18,000 welds in which the only defects were four pinhole leaks, which were calked, is one instance. This pipe is an oil line operating under a maximum pressure of 750 pounds per square inch, and during a severe storm was in places washed out of the trench 20 feet from its position. It was pulled back into place without stopping the flow of oil and without any leaking.

Another case is three tanks each 7 feet in diameter and 35 feet long, of ¾-inch material in the shell, with heads 1-inch and 1⅛-inch thick, for 125 pounds working pressure, the hydrostatic hammer test at 375 pounds being used, under which the tanks were all perfectly tight. These were the first large welded tanks made by the manufacturer, and the author believes the largest fusion-welded pressure vessels ever made.

Still another instance is the welding of a lime-kiln shell 125 feet long and 8 feet in diameter of ⅝-inch material. It weighed 15 tons less than a riveted one of the same shell thickness, and its alinement was well within the specification limit. It is interesting to know that the apparent fiber stress across the riveted joints was twice the stress across the corresponding welded joints, due to unavoidable movement in the riveted ones. Over two years' service has failed to develop any defects in the welds. Such instances might be multiplied, but as each one was a pioneer job, they prove the contention that good welding, even in unusual jobs, is easily obtained, provided the will to obtain it exists.

There is also submitted a specification for a definite tank, of the maximum diameter that can be made for 200-pounds working pressure with a ¾-inch-thick shell, though, as

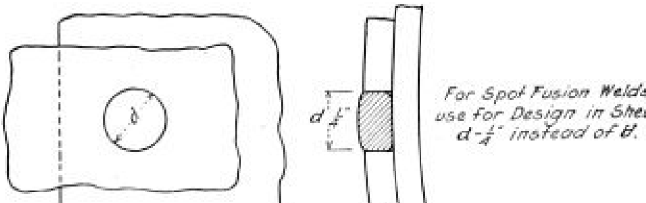


FIG. 1

noted above, larger-diameter tanks, but carrying less pressure, have been successfully made. Of course different conditions would alter the specifications, and the one given is only a guide to the engineer. It will be noticed that the requirements are more rigid in some respects than the proposed code calls for, because they embody the author's opinion of the best possible design and construction, such as might be desired in a special case.

There is also appended a list of published articles that may be of interest to the engineer, as well as to others.

PROPOSED CODE FOR FUSION-WELDED PRESSURE VESSELS

All provisions in the A.S.M.E. pressure-vessel code shall apply to the vessels covered by this code, unless such provisions conflict with those in this code, in which cases this code shall apply.

1. The term "fusion welding" in these rules shall be considered as applying to the oxy-acetylene and metallic-arc welding processes, the work being done by hand, and ordinary welding materials of good quality being used.

2. Longitudinal seams shall be of the double-V type, that is, welded from each side half-way through the sheet. Girth and head seams may be of the single-V type, that is, welded entirely through from the outside. Double-V longitudinal welds shall be reinforced at the center of the weld on each side of the plate by at least 25 percent of the plate thickness. Double-V girth welds shall be reinforced at the center of the weld on each side of the plate by at least 10 percent of the plate thickness. Single-V welds shall extend entirely through the plate and shall be reinforced at the center of the weld by not over 20 percent of the plate thickness. All welds shall be of sound metal, thoroughly fused to the sides of the V for its entire depth. Sheets must not be allowed to lap during welding. In material ¼ inch or less in thickness the longitudinal seams need not be beveled. In material less than ¼-inch thick, beveling the heads will be sufficient, and the shell need not be beveled at the head seams but one side of each girth seam shall be beveled.

There shall be no valley either at the edge or in the center of the joint, and the weld shall be so built up that the welded metal will present a gradual increase in thickness from the surface of the sheet to the center of the weld.

At no point shall the sheet on one side of the joint be offset with the sheet on the other side of the joint in excess of one-quarter of the minimum thickness of the plates.

NOTE: There is little if any additional cost involved in the making of a double-V seam over that of a single-V. The former is also symmetrical and so causes no eccentric loading. Further, when ordinary welding rod is used—and the code is based on its use—there is a strong tendency for defects to occur at the bottom of the V, further increasing eccentric loading.

These conditions affect girth seams very little, and the single-V weld in them and similar places is entirely reliable. It must be borne in mind that the remarks in this discussion apply to pressure vessels only, and, because of the nature of their use, the greatest refinement of design and manufacture must be used to insure safety.

3. The plate or sheet used shall be of suitable quality for welding and shall conform to the requirements of Sections U110 to U125 of the Pressure Vessel Code, or to those in Sections S5 to S17 of the Power Boiler Code, except that the carbon content shall not exceed 0.18 percent and that the limits of ultimate tensile strength shall be from 48,000 to 58,000 pounds per square inch.

NOTE: The materials specified for sheets and plates in Section U71 are, in the author's judgment, satisfactory, except that he would limit the carbon content to a maximum of 0.18 percent in the cases of flange and firebox steels. The reasons are,

1 The lower the carbon in the steel, the less is it injured by heat and mechanical work.

2 The lower the carbon, the better the distribution of welding stresses.

3 The lower the carbon the higher is the relative strength of the weld, and the tendency to break in the plate, until with 0.15 percent carbon plate, low-carbon steel welding wire, and reasonable reinforcement of the weld, the plate will always break.

There is a tendency to speak of the efficiency of a weld in the same way as the efficiency of a riveted joint is referred to, but the only safe way is to make the joint more than 100 percent efficient, and then we need not worry about the efficiency. This is easily done by using the proper materials. We may further consider that while with riveted joints a greater efficiency reduces the weight of the plate, provided the same strength plate be used in all cases, yet even the highest-strength plate will not allow the efficiency to be much increased, as the shearing strength of the rivets is a rather definite quantity.

With welding, the strength of the weld is also a definite quantity in the case of any particular wire, and a 100-percent weld in 50,000-pound plate is just as strong as a 50-percent weld in 100,000-pound plate, so there is no difference in weight, while the 50,000-

pound plate has the advantages spoken of that make it much more desirable material.

4. Maximum allowable fiber stresses on welds due to internal pressure shall be as follows, per square inch of plate section.

	Pounds Per Square Inch
In tension:	
Butt double-V longitudinal welds	8,000
Butt single-V girth or head welds	6,500
Double full fillet girth or head welds	7,000
Spot or intermittent fillet head welds	5,600
In shear	7,000
In compression	15,000

Where spot welds are used, as in Figs. 1 and 6, the calculation for strength shall be based on the diameter of the hole minus ¼ inch.

Where fillet welds are used, as in Figs. 4, 5, 6 and 7, the calculation for strength shall be based on the length of the

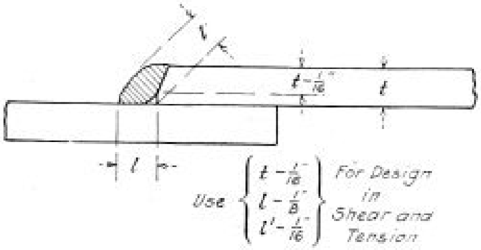


Fig. 2

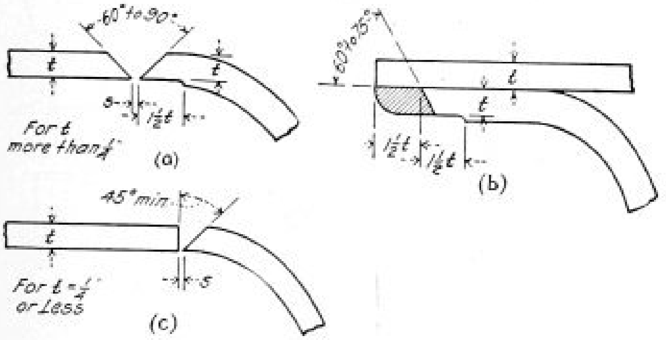


Fig. 4

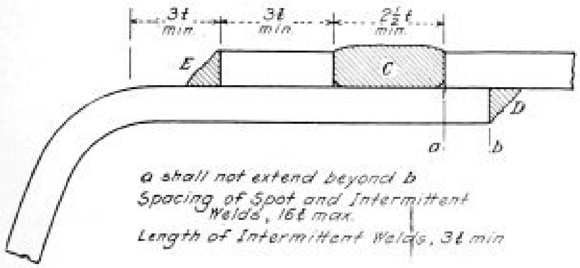


Fig. 6

weld minus ⅛ inch, and on the thickness of the weld minus 1/16 inch, measured perpendicular to its surface.

All vessels shall be so supported as to distribute properly the stresses due to their weight and contacts. In no case shall the working fiber stresses on welds be increased, by any stresses other than those due to internal pressure, more than 500 pounds per square inch of plate above those allowed for that pressure.

Note: Section U68 allows a maximum tensile fiber stress of 5,600 pounds per square inch for both double- and single-V welds. This is taken from test results given in Prof. R. J. Roark's paper before the A. S. M. E. in May, 1922, in the table on page 26 of the preprint, and in the early drafts of the code appeared as 28,000 pounds with a factor of safety of 5. (See also Heating Boiler Code, section H7O.) From the latter it is clear that the stress is per square inch of plate section.

The figure in Roark's table, however, is per square inch of weld section, and when reduced to plate section it becomes 7,000. If it be fair to take it as a sound engineering datum, then 7,000 should be used instead of 5,600. But 35,000 pounds ultimate strength is too low for even a single-V weld made by a competent operator, as any one familiar with weld tests knows, and indicates clearly lack of penetration or fusion, which would readily be seen by even superficial examination. There can be no objection to rating a single-V girth weld at 6,500 pounds the proposed figure. Double-V

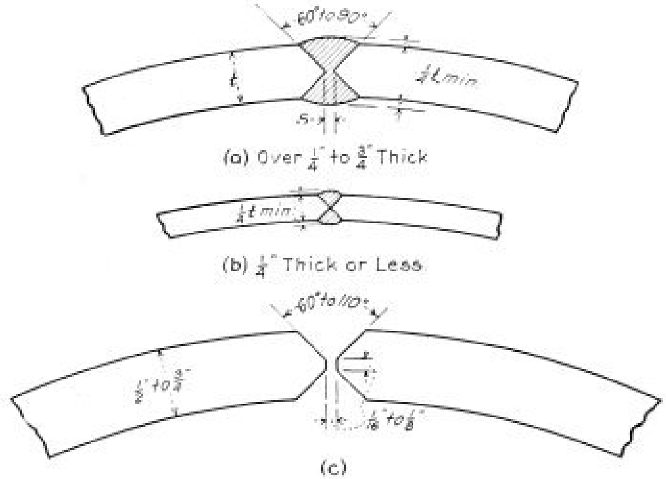


Fig. 3

This figure gives design dimensions and is not to be used in construction.)

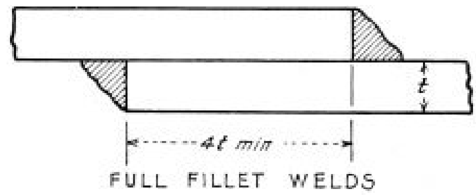


Fig. 5

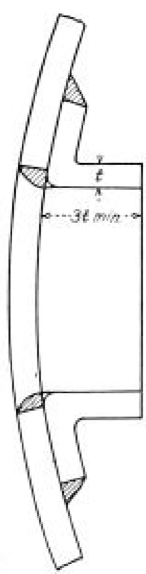


Fig. 7

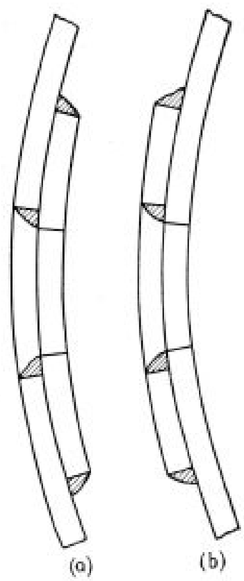


Fig. 8

welds are shown by Bulletin No. 5 of the A. W. S., to be much superior both in consistency and strength to those of the single-V type, and the A. W. S. recommended that a maximum tensile fiber stress of 8,000 pounds per square inch of plate be allowed for double-V welds. Under the test conditions described in that Bulletin, this is equivalent to a factor of safety of about 6.25. The author believes that 8,000 is much too low in the light of present-day knowledge and skill, but it certainly cannot be said to be too high in view of the facts in Bulletin No. 5, and as it has been recommended by the American Welding Society, he has used it in this code.

The ultimate shearing strength of weld metal is about 40,000 pounds per square inch or approximately equal to that of rivet material. It is felt that a factor of nearly 6 gives ample security, especially as allowance is made in this code for possible imperfect fusion in corners of spot and fillet welds.

The lap-weld construction is known by tests made during the war to be perfectly safe, provided welding is done at both edges of the lap, or an equivalent spot weld is used. This latter is feasible with small diameter tanks.

The compressive strength of weld metal is seldom used in tanks. As the weld is usually low-carbon steel, and as it is never the controlling factor in tank design, the figure given is safe and is introduced for completeness.

5. Where vessels are made up of two or more courses with welded longitudinal joints, the joints of adjacent courses shall be not less than 60 degrees apart.

NOTE: This is the same as Sec. U72.

5*a*. The provisions of sections U53, U54, and U62 of the A.S.M.E. code shall govern the application of manholes and handholes.

Manhole openings, if elliptical, shall be not less than 11 x 15 inches or 10 x 16 inches; if circular, not less than 15 inches in diameter.

Handhole openings shall be reinforced as are manholes, when their greatest dimension is over 6 inches.

Manhole frames shall be of wrought steel at least as thick as the plate to which they are welded, but not more than 25 percent thicker, and if welded, shall be applied as in Figs. 7 and 9, the welds being full fillet and extending all the way around inside and outside.

The total section of the frame at any plane passing through its center shall be at least equal to the section of the plate removed along the same plane.

The outside weld shall be so designed that its tensile and shearing strengths shall each be equal to the tensile strength of the material removed from the plate.

NOTE: It has been found by stress-strain measurements that with the method of design given there are no serious stresses around the manhole opening at the working pressure. The provisions are mostly copied from the A. S. M. E. code, with slight changes in the wording to suit welding conditions.

6. The shell shall be substantially circular at any section.

NOTE: This is taken from Section U73, the instructions as to how to obtain the result being omitted as not belonging in a code.

7. Heads shall be dished and flanged, and shall be designed in accordance with Sections U36 to U39 of the A.S.M.E. code, except that when a manhole frame is welded in a head in accordance with this code, no increase in head thickness will be required.

(In this code a "convex head" means one convex to the pressure, and a "concave head" one concave to the pressure.)

They shall be attached to the shell as shown in Figs. U3-J or U3-K of the A.S.M.E. code, or Figs. 4, 5, or 6 of this code.

A head inserted in a shell shall be well fitted and a driving fit therein.

The minimum length of head flanges, either convex or concave, shall be as follows:

Inside Diameter of Tank	Minimum Straight Length of Flange
12 in. and less	1½ in.
Over 12 in. to 24 in.	1¾ in.
Over 24 in. to 36 in.	2¼ in.
Over 36 in. to 48 in.	2¾ in.
Over 48 in. to 60 in.	3½ in.

In any case in which the head is over ¼ inch thick and more than 1¼ times the shell thickness, it shall be reduced to the shell thickness as shown in Fig. U3-J and U3-K. The use of a double-V girth weld will be considered the equivalent of Fig. U3-J.

The calculated strength of the construction in Fig. 6 shall be such that the strength of the outside fillet weld and the sum of the spot or tack welds shall each be equal to at least 3,000 pounds per square inch of cross-section of the shell.

NOTE: The greatest objection to the usual design of welded convex inserted head is that it is not possible to prevent some bending stress on the weld, because of the distortion of the head under pressure and because a perfect fit cannot be had between the head and the shell. The design using spot or tack welds at the end of the flange as shown in this code avoids this bending and so makes a safe construction, which should be allowed.

The calculated strength of each part of the weld is 37½ percent of 8,000 pounds, a total of 75 percent, rather more than the theoretical 50 percent ratio of the strength of a girth section to a longitudinal one.

The design also provides for omission of the theoretical corner strength of a perfect weld, as it is sometimes difficult to get these corners thoroughly fused.

8. Nozzles in heads and shells shall not exceed 12 inches in nominal diameter. They shall be of forged or rolled steel, and shall be welded to the shell or head as shown in Fig.

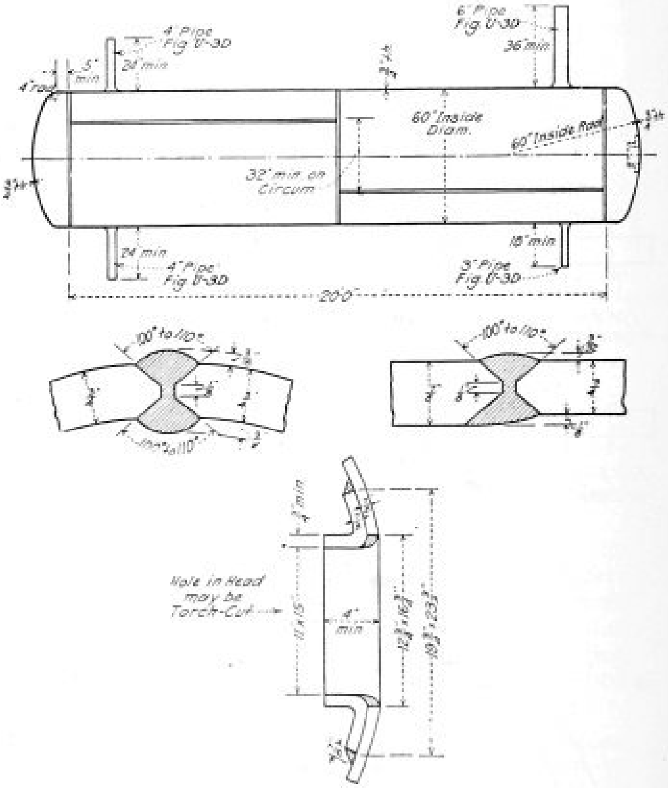


FIG. 9 PRESSURE VESSEL FOR A WORKING PRESSURE OF 200 LB. PER SQ. IN.

U3-A. The nominal diameter of the nozzle shall not exceed one-third of the shell diameter.

NOTE: This has been changed from Section U76 to make the nominal size limit clear. The ratio of diameters of the shell and nozzle should not be less than 3 to 1, in the author's opinion, in a pressure vessel. In piping the fiber stress is much less, and a smaller ratio, even 1 to 1, is permissible in many cases.

9. Threaded connections shall not exceed 12 inches in nominal diameter and shall be made as in Figs. U3-b to U3-i and Table 1. Flanges shall be of forged steel and shall fit closely to the plate before welding. Pipe nipples shall be of extra heavy pipe for a distance from the shell of at least 6 times their nominal diameter.

Where nipples are threaded into the plate without any welding, and the plate is too thin for the number of threads called for in Table U5 of the A.S.M.E. code, a boss may be built up by fusion welding to provide for such threads, if the nominal pipe size does not exceed 2 inches. The nominal diameter of threaded connections shall not exceed one-third the nominal shell diameter.

Table 1—Flange, Nozzle and Pipe Connections

Figure	Shell Thickness	Allowable Working Pressure	Shell Diameter	Maximum Nominal Pipe Size, In.
U3-A	any	any	any	12
U3-B	any	any	any	12
U3-C	any	any	any	3
U3-D	any	any	Any that can be welded inside	8
U3-E	any	250	Any that cannot be welded inside	4
U3-F	any	150	any	2
U3-G	any	any	Any that can be welded inside	8
U3-H	any	100	any	2
U3-I	3/16 in. min.	any	16 in. min.	1
I	1/4 in. min.	any	30 in. min.	1½
I	3/8 in. min.	any	48 in. min.	2½

Note: Forged-steel flanges have been required, and the building up of a boss is copied from Section U59, for completeness, with the 100 pounds pressure limit omitted, as the author believes it to be entirely unnecessary.

Table 1 is copied from Bulletin No. 5. The author believes it to be more rational than the limits in Fig. U3, because it takes account of practical conditions and welding possibilities, as well as giving more scope in the application of nipples in perfectly safe ways.

10. Each tank shall be tested under hydrostatic pressure to 1½ times its maximum allowable working pressure, care being taken to remove all air from the tank and its connections. While under this pressure, it shall be struck swinging blows at intervals of 6 inches along all seams with a hammer of from 2 pounds weight for ⅛-inch shells to 12 pounds for ¾-inch shells, the hammer being allowed to fall freely from full arm length but with only the force of its own weight.

After this test the pressure shall be raised to 3 times the maximum working pressure and be held there 3 minutes.

Note:—The above test is that recommended by the A.W.S. in Bulletin No. 5, and is practically the same wording as U78, the changes being with the idea of making the test more easy of interpretation and execution.

It is impossible to discuss it fully here. Bulletin No. 5 devotes 3 pages in the Bureau of Standards report, and 6 pages in the committee report to it.

In general it was shown that even a permanent distortion of a tank by the hydrostatic test seems to have no detrimental effect on the strength of a properly welded tank, and that the hammer test does detect some defects that otherwise would be missed.

The results do not show that this test will invariably detect a tank that the author thinks should be rejected, and even a test pressure of 4 times the working pressure would not accomplish this.

No one has yet defined a bad weld, and so it is not possible to agree on how far a test should go. But it is sure that a double-V weld is good, and as Bulletin No. 5 shows that it is in all cases thoroughly reliable, and as no double-V weld has ever failed, let us spend our time in making and improving what we know to be good, and then we need not worry about bad welds and how to find them, for there will be none.

(To be Continued)

Duplicate Boiler Explosions

Lightning is said never to strike twice in the same place, and although there is no such popular belief protecting the owners of boilers, the natural effect of a boiler explosion is to impress itself so vividly on the minds of the persons connected with the plant that the standard of safety is raised and the possibility of a repetition becomes more remote. A boiler explosion doesn't just happen, but instead is brought on by a definite cause. If the cause is not definitely determined and removed, a repetition of the accident is to be expected. For instance, stop valves on steam lines are frequently ruptured by water-hammer. The water-hammer is most likely produced by an improperly drained pipe system or by faulty operation of the boilers. Unless the piping is redesigned or the boiler operation improved, further accidents are almost sure to occur.

The Waite Phillips Company of Rainbow Bend near Winfield, Kansas, suffered a boiler explosion in July 2, 1925, and on September 12, 1925 suffered a second explosion from exactly the same cause—low water. The installation consists of four locomotive type boilers that operate at 150 pounds pressure. At the time of the first accident, which occurred about 2:40 a.m., the fireman was about 100 feet away from the boiler house, returning from another building. The water level in boiler No. 1 became low and uncovered the crown sheet with the usual result. The crown sheet overheated and collapsed and ruptured, causing the boiler to be thrown forward about 50 feet from its foundation. About half of the boiler house was wrecked.

A little over two months later boiler No. 4 in this group exploded. As in the previous instance, the cause was low water. The crown sheet dropped and the boiler hurtled out of the house. By a peculiar twist of fate, it came to rest partly on top of the one that had exploded before. Again no one was injured. The property loss amounted to $1,700.

As previously stated, the direct cause of each accident was low water. This was quite apparent from an examination of the boilers after the explosions, but the cause of the low water is not so apparent. The boilers were subject to inspection and the gages and appliances were found to be kept in good condition. The presence of a feedwater regulator suggests the possibility that too much dependence was placed upon it, the operatives thus becoming lax in watching the water level. The fact that no one was killed or injured in either accident indicates that there was no one in the boiler room on either occasion.—*The Locomotive.*

Tool Designed to Drill, Ream and Countersink Flue Sheets

A tool designed to drill, ream and countersink flue sheets has been placed on the market by W. L. Brubaker & Bros. Co. of Millersburg, Pa.

This tool is made so that, if in the course of operation any of the parts wear out, they can be replaced, as all the parts are made up to a master and are interchangeable. This tool

Brubaker combination drill, reamer and countersink

takes the place of three operations that are necessary to cut a hole in the flue sheet and does it all in one operation. It can be furnished in any size desired and in any style shank.

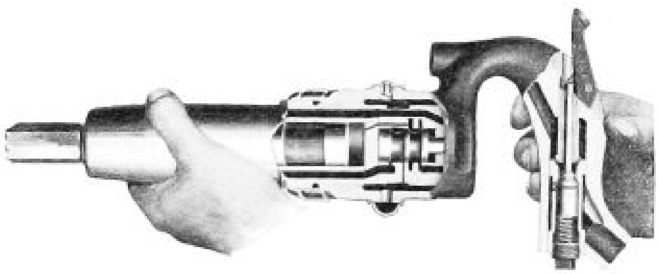
After once getting the complete tool, it is only necessary to replace certain parts, as the shank and parts other than the countersinks, reamer and drill, should last for years.

The advantage claimed for this tool is that it does away with all the laborious work of drilling, reaming and countersinking of flue sheets and makes the operation one which is quite simple.

Spool Valve Chipping Hammer

THE Thor chipping and calking hammers, made by the Independent Pneumatic Tool Company, Chicago, Ill., are now available in the "spool valve" type for use where grit and dirt work into the hammer and must be eliminated to obviate wear and tear in the moving parts. The action of the spool valve is to deflect grit and dirt from the bearing surfaces and this characteristic makes the hammers well adapted to railroad shop use.

The illustration affords a view of one of these hammers with the outside shell cut away to show the internal con-



Thor hammer, designed to reduce wear on moving parts

struction. The hammer handle and throttle are similar to those in the sleeve valve type except that the locking device is said to be the most positive handle and barrel lock ever used. The ratchet teeth on the sliding collar interlock with similar teeth on the handle, and the collar is held stationary by its octagonal inner surface, which fits the large octagon on the barrel. This construction is similar to that of the Thor riveter and an important advantage results from the fact that no matter where the handle seats, the collar may be turned to that octagonal side which puts it in exact mesh with the handle. There is no lost motion.

The spool valve is operated by constant pressure on its back end and intermittent pressure on the front end, caused by the flow of air to the lower end of the piston. The design is intended to prevent the escape of any of the air operating the valve without being used for the piston stroke, consequently resulting in economy in air consumption.

Other features of this hammer are the self-seating throttle, designed to be always air-tight, spiral inlet ports affording accurate regulation, and barrels of special alloy steel, hardened, ground and lapped to size, thus assuring a full bearing to the piston with consequent long barrel life and maximum hammer efficiency.

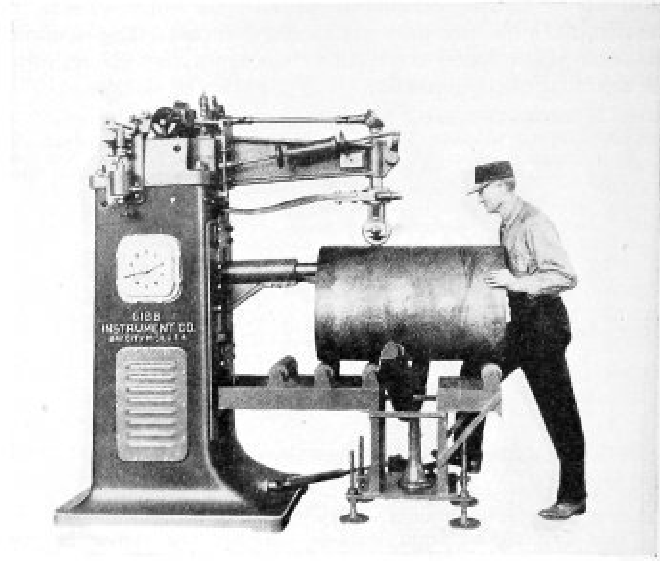
Electric Seam Welding of Sheet Steel *

ELECTRIC seam welding in America is not new; its universally successful application dates back to 1921. Prior to this time there were a few installations of machines built on the principle of the continuous travel of a copper roll with the continuous application of current. This method was not widely successful because the continued application of current accumulated heat, creating a different heat condition at the beginning and at the end of the weld. Leaks and unsound welds were necessarily frequent.

Roll-Step Method of Welding

In 1921 a firm of American engineers spent several months visiting the plants of the various European manufacturers of seam welders. They found that a German manufacturer had progressed beyond the rest of the world in seam welding in the so-called "roll-step method." By this method the work passed between rolls in a step-like

*Data supplied by Gibb Welding Machines Company, Bay City, Michigan.

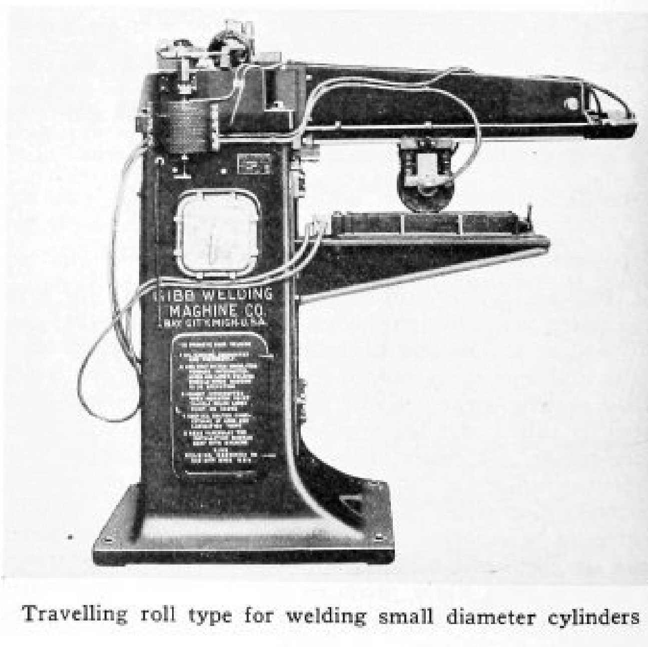


Stationary roll type electric seam welder

manner, and current was applied only at the rest period. This entirely eliminated the accumulation of heat with its attendant leaks and poor welds. While uniformly good welds resulted, production did not exceed three feet per minute, but these were good, strong, leak-proof welds and practically no scrap. This American company imported these machines and their own engineers developed the "dual speed" method. This method provided a slow speed during the welds, and a fast speed between welds. It preserved the quality of welds at a speed increased to $4\frac{1}{2}$ feet per minute.

Experimentation then developed that periodic interruptions of the current without interruptions in travel preserved the uniform conditions necessary to sound and leak-proof welds and a high rate of welding speed was accomplished. The surges of current had the penetrating effect without accumulating heat. The establishment of the correct principle in seam welding was fundamental for best results at the greatest speeds.

Seam welders should be designed for the work. For this reason the manufacture of a standard machine is impossible. The accompanying illustrations indicate two of many types with their application.



Travelling roll type for welding small diameter cylinders

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Calculating Allowable Pressure on Corroded Boiler Materials

Q.—With reference to page 87 of the March issue of THE BOILER MAKER, "Allowable Pressure on Corroded Plates" from which I quote: "*Example.*—A stayed flat plate was originally ½-inch thick, what is the maximum allowable pressure if the plate has wasted in some parts to 7/16-inch in thickness. Original pressure was 170 pounds per square inch." Please advise me why this problem cannot be worked by proportion; that is, ½ = 8/16, 170 pounds; then 7/8 on 7 × 170 ÷ 8 = 148 75/100 pounds pressure instead of 130 pounds, as you have it. It seems to me that a cut of 40 pounds is too much when the plate has only wasted away 1/16 inch.

Refer to the formula for safe working pressure on lap welded tubes; table gives a 6-inch tube 0.165-inch thick, 199 pounds. Suppose we find this same tube to be wasted away to 0.155-inch; is it safe to work this new safe working pressure by rule of proportion or by the formula which reads "where heavier material is used" and says nothing about where thinner material is used, which is the case of this tube? Please criticize or correct me in your next issue. Thanking you for favor shown in this matter.—T. B.

A.—The rule given in the March issue, 1926, on the maximum allowable pressure on stayed flat plate should be used, as the formula shows that the strength varies as the square of the plate thickness.

The maximum allowable working pressure according to the United States Board of Supervising Inspectors formula equals

$$\frac{C\,t^2}{p^2}$$

in which,

C = constant value for different thicknesses of plate.
t = thickness of plate, in sixteenths of an inch.
p = greatest pitch of stays, inches.

Example: (a) A stayed flat plate was originally ½-inch thick, what is the maximum allowable pressure if the plate has wasted in some parts to 7/16 inch? Pitch of stays is 7 inches.

Solution: Use the formula given and substitute for C, 125 for ½-inch plate; then the allowable working pressure on the ½-inch plate equals:

$$\frac{125 \times 8^2}{7^2} = 163.4 \text{ pounds per square inch.}$$

For 7/16-inch plate, substitute 120 for C.
Then,

$$\frac{120 \times 7^2}{7^2} = 120 \text{ pounds per square inch.}$$

The allowable external pressure on tubes that have wasted away, may also be determined by proportion, as explained for shells.

U. S. BOARD OF SUPERVISING INSPECTORS RULES ON TUBES

Lapwelded and seamless tubes, used in boilers whose construction was commenced after June 30, 1910, having a thickness of material according to their respective diameters, shall be allowed a working pressure as prescribed in the following table, provided they are deemed safe by the inspectors. Where heavier material is used, pressures may be allowed as prescribed in first formula under the heading "Flues," for determining the working pressure of lapwelded flues. Any length of tube is allowable.

Outside diameter Inches	Thickness of material Inch	Maximum pressure allowed Pounds
2	0.095	427
2¼	.095	380
2½	.109	392
2¾	.109	356
3	.109	327
3¼	.120	332
3½	.120	308
3¾	.120	282
4	.134	303
4½	.134	238
5	.148	235
6	.165	199

Heat Required to Raise the Temperature of Water

Q.—Will you please say if the following calculation for boiling water, at 52 degrees F., at atmospheric pressure is correct:

Two tanks each 8 feet by 2 feet by 1 foot 4 inches righ. Capacity of each tank, 1,163 pounds of water. Water temperature 52 degrees F. Required temperatures, 212 degrees F. (atmospheric pressure). Boiler pressure, 25 pounds per square inch, normal capacity of boiler, 600 pounds of water per hour.

B. T. U.'s required to raise 1,163 × 2 = 2,326 pounds of water from 52 degrees F. to 212 degrees F. = (212—52) 2.326 = 372,160 B.t.u's.

Latent heat of boiler steam = 1,115 — 0.7T (where T = absolute temperature of boiler steam) = 1,115 — 0.7 × 267.3
= 928 B. T. U.'s.

Total B. T. U.'s of boiler capacity per hour = 928 × 600 = 556,800 B. T. U.'s.

Time required with 556,800 B. T. U.'s (boiler capacity) = 60 minutes.
372,160 B. T. U.'s (tank capacity) = (?) minutes.

Assuming 70 percent efficiency, time required to boil water to atmospheric pressure in both tanks = 60 minutes (approximately).

The question of pipes (in tanks) heat conductivity is not taken into consideration. If this affects the heating process, **please show its effect in calculation.**—T. L.

A.—The capacity of the tank 8 feet by 2 feet by 1 foot 4 inches equals

8 x 2 x 1 1/3 = 21 1/3 cubic feet
62.5 = number of pounds of water in 1 cubic foot
21 1/3 x 62.5 = 1,433 pounds of water in the tank.

Number of heat units required to raise 1 pound of water from 52 degrees to 212 degrees is 212 — 52 = 160 B.t.u.

To raise 1,433 pounds requires
1,433 x 160 = 229,280 B.t.u.
and for 2 tanks, 229,280 x 2 = 458,560 B.t.u.

1 pound of steam at 25 pounds pressure (absolute) gives up in condensing its latent heat, of evaporation, or 951.5 B.t.u. and in addition the heat in falling to 212 degrees. Since the temperature of the steam at 25 pounds pressure is 240 degrees, each pound of steam also gives up 240 — 212 = 28 B.t.u. Therefore, each pound of steam gives up
951.5 + 28 = 979.5 B.t.u.

Capacity of boiler equals 600 pounds of steam per hour, then the total theoretical heat available equals

$979.5 \times 600 = 587{,}700$ B.t.u.

$587{,}700 \div 458{,}560 = 1.28$

$60 \div 1.28 = 46$ minutes approximately

to raise the temperature from 52 to 212 degrees.

Due to heat losses in the boiler and piping, and considering an efficiency of 70 percent the heat available is reduced to $587{,}700 \times 0.70 = 409{,}390$ B.t.u.

Causes of Sheared Rivets and Care of Locomotive Boilers—Patch Bolts

Q.—As one of the readers of THE BOILER MAKER, I shall be very much obliged if you will try and furnish me with the following information:

(1) What are the various causes of rivets (copper or steel) breaking off at the points in locomotive fireboxes in the tube plates and back plates and patches, etc.?

(2) When rivets shear off in firebox tube plates, at what portion of the rivets does the shearing generally occur, and what are the causes of shearing off?

(3) Also what do you consider a safe and reasonable size of head for collar studs or patch bolts, as they are known in America, say 1 inch in diameter?

I sincerely hope that you will give me the latest boiler engineers' opinions on these three subjects; also will you kindly devote a little more space in your valuable book on the upkeep of locomotive boilers in engine sheds, as I am an engine shed boilermaker-in-charge. Hoping for a reply at your earliest convenience.—A. F. C.

A.—(1) The breaking and shearing of rivets are due to the stresses produced from internal pressure, continued expansion and contraction of the boiler parts, to crystallized steel rivets due to overheating before driving; and from too much hammering of rivets in driving by the hand and air gun methods.

(2) At the center of the rivet shank.

(3) Patch bolts are made, any desired diameter and length, threaded, 12 threads to an inch, also blank. The

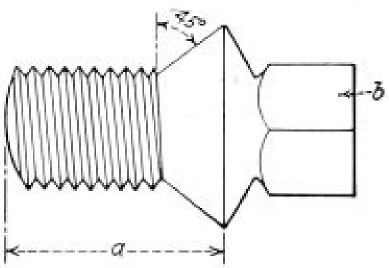


Fig. 1.—Details of patch bolt

length is measured as shown in Fig. 1 at *a* and the heads are countersunk to an angle of 45 degrees. The head *b* is for setting the bolt, which is afterwards cut off.

(4) The efficiency of a locomotive boiler depends to a great extent upon the care it receives in the engine shed or (round house); namely:

(a) In the washing out of the boiler, for the removal of sediment which settles on the tubes and along the bottom of the shell and water legs and on the crown sheet.

(b) In *blowing out*, which should not be done under full steam pressure, as sudden reduction in pressure causes strains in the boiler parts, resulting usually in leaky joints and tubes. Before blowing out, reduce the pressure at least to 20 pounds per square inch. Do not refill the boiler with cold water until it has cooled off, otherwise sudden contraction stresses arise which will cause leaky seams and tubes.

(c) In the removal of scale, if scale is allowed to collect serious results may follow, as the heat will not be transferred through the plate to the water fast enough to prevent overheating, which may result in a rupture and an explosion.

(d) All exterior heating surfaces should be kept free of soot, especially tubes and flues. Plugged tubes and flues affect the steaming of the boiler, as such a condition reduces the effective heating surface and retards the draft.

(e) After the cleaning of a boiler, all accessible parts should be inspected internally and externally, and necessary repairs made.

The foregoing are general requirements, therefore we invite our readers to give more complete details on the care of locomotive boilers followed in their experience.

Tubes

Q.—(1) What is the average life of watertubes in stationary boilers of the B. & W. and Oil City type?

(2) In states that have adopted the A.S.M.E. Code, is there a rule specifying that tubes must be removed from boilers of this type after a certain period of time in service? If so, what is this ruling?

(3) Has the Steamboat Inspection Service of the Department of Commerce a ruling limiting the time on tubes for this type boiler in marine service?—J. T. F.

A.—The life of tubes in any type of boiler depends to a great extent on the care and operation of the boiler and on the nature of the feedwater. It is difficult to approximate the life of boiler tubes which varies from a year to several years.

Periodical boiler inspections are required by the United States Board of Supervising Inspectors and also by the states and cities of the United States. These inspections govern the removal and installation of new tubes.

For locomotive boilers the Interstate Commerce Commission, Division of Locomotive Inspection, requires that all flues of locomotive boilers in service shall be removed at least once every four years. This is done primarily for the inspection of the boiler. However, if the condition of the boiler warrants, the time for the removal of the tubes may be extended upon formal application to the chief inspector.

Marking-off Paint

Q.—Would you kindly tell me either in your magazine or by letter how to mix red lead or yellow ochre so that it marks to the best advantage on iron as used in laying out and marking up black iron where a quick drying paint is needed.—J. A. H.

A.—First mix the red lead with water to a thick consistency then add a small quantity of linseed oil and thin with gasoline.

Information Wanted on a Pilot

Q.—Please furnish me with layout of pilot made from old flues and another made of flat iron.—J. F. D.

A.—Will some of our readers give the information on this subject?

OBITUARY NOTICE

DAVID M. DILLON, president and founder of the D. M. Dillon Steam Boiler Works, Fitchburg, Mass., died in that city, April 27, at the age of 83 years. He had learned the steam boiler business in Worcester when he moved to Fitchburg in 1870 to establish the nucleus of what came to be one of the largest industries of its kind in New England. Mr. Dillon is reported to have been the inventor and builder of the first steel boiler ever manufactured. It was built to exhibit at the Mechanics Fair, Boston, in Quincy Market in 1874, and at the time was severely criticized because steel was substituted for iron. He held a prominent place in the banking and business life of his city, and was a director in various manufacturing corporations other than his own. He is survived by a daughter and four sons, Fred N., D. Frank and Walter S. of Fitchburg, and H. Lowell Dillon of New York.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

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

Steamboat Inspection Service of the Department of Commerce

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

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.

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

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

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.

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

Vice-Chairman—C. D. Thomas, Salem, Oregon.

Statistician—E. W. Farmer, Rhode Island.

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

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

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

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

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

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

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

Master Boiler Makers' Association

President—Thomas F. Powers, system general foreman, boiler department, Chicago & Northwestern.

First Vice President—J. F. Raps, general boiler inspector, Illinois Central.

Second Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.

Third Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.

Fourth Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.

Fifth Vice President—George B. Usherwood, supervisor of boilers, New York Central.

Secretary—Harry D. Vought, 26 Cortlandt Street, New York.

Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.

Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—F. H. McCabe, McCabe Manufacturing Company, Lawrence, Mass.

Vice President—J. W. Kelly, National Tube Company, Pittsburgh, Pa.

Treasurer—George R. Boyce, A. M. Castle and Company, Chicago, Ill.

Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie, Pa.

Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.

Secretary-Treasurer—D. W. Glanzer, 840 Rockefeller Building, Cleveland, Ohio.

Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; W. A. Drake, The Brownell Company, Dayton, O.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Works, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

Cities

Chicago, Ill.	Memphis, Tenn.	St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Los Angeles, Cal.	Philadelphia, Pa.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	New Jersey	Pennsylvania
California	New York	Rhode Island
Indiana	Ohio	Utah
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

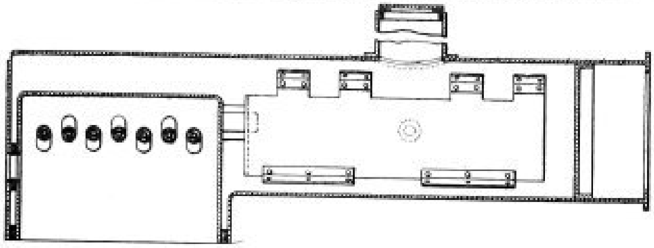
SELECTED BOILER PATENTS

Compiled by
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building
Washington, D. C.

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

1,577,438. STEAM GENERATOR. VITTORIO ANDRIOLI, OF FOGGIA, ITALY.

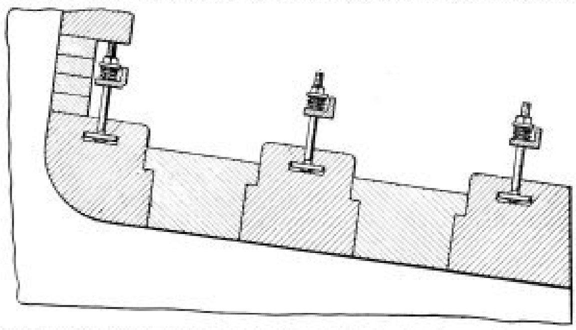
Claim 1. In a horizontal flue boiler having a fire box at one end thereof, a smoke box at the other end and boiler tubes adjacent the fire box, the combination of two vertical longitudinal partitions in the boiler dividing the interior of the boiler into three juxtaposed longitudinal compartment means



for supplying feed water to the lateral compartments within the boiler, means providing intercommunication between the several compartments whereby highly heated boiler water in the central compartment flows longitudinally of the boiler into the lateral compartments to mix with and entrain the feed water therein, and means for directing the water in the lateral compartments longitudinally of the boiler into the boiler tubes. 2 claims.

1,574,946. HANGING-ARCH CONSTRUCTION. ENOCH P. STEVENS OF CHICAGO, ILLINOIS; MARY ANN STEVENS, EXECUTRIX OF SAID ENOCH P. STEVENS, DECEASED.

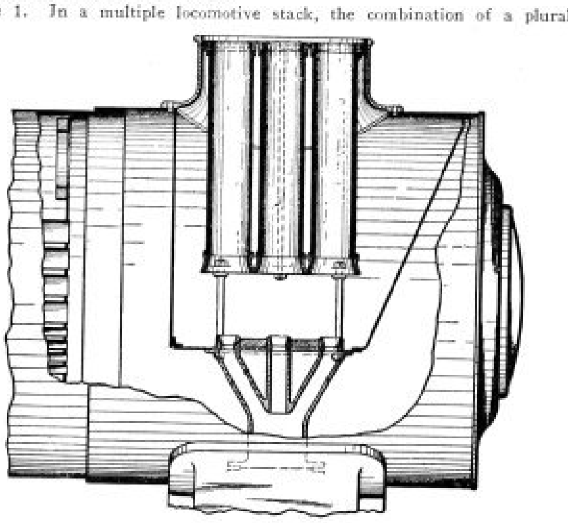
Claim 1. In an arch construction, a series of hangers, a row of bricks extending in the direction of the series of hangers and in substantially balanced suspension beneath the same, said bricks having recesses and said



hangers having engaging heads and the head of each hanger in engagement with a group of the bricks in the row, and an adjacent row of bricks supported on said hanger-supported bricks; a brick in a group supported by a hanger being removable in a direction transverse to its row, into a space left by removal of a brick in said adjacent row. 13 claims.

1,578,776. LOCOMOTIVE STACK. CLEMENT F. STREET, OF GREENWICH, CONNECTICUT.

Claim 1. In a multiple locomotive stack, the combination of a plurality

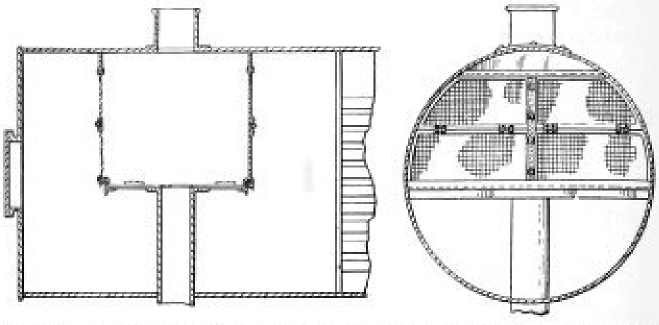


of vertical discharge channels; and head plates, to which said discharge channels are fitted and maintained in normal relative positions.

In a multiple locomotive stack, the combination of a plurality of vertical discharge channels; head plates to which the ends of said passages are fitted; and longitudinal bolts, passing through said head plates and connecting them with the interposed channels. 10 claims.

1,542,257. WILLIAM L. McMAHAN, OF OSKALOOSA, IOWA, ASSIGNOR OF ONE-THIRD TO L. L. JORDON, OF OSKALOOSA, IOWA. DRAFTING SYSTEM FOR LOCOMOTIVES.

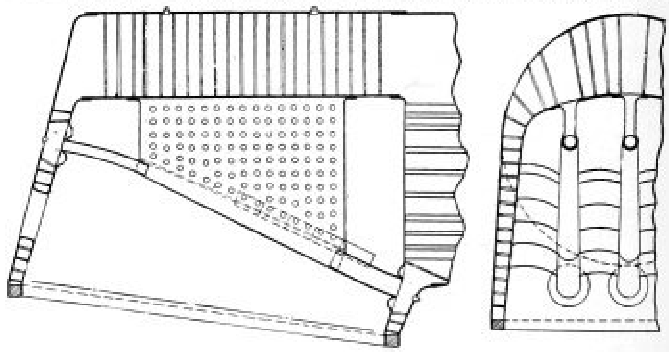
Claim. In a locomotive, a draft system comprising an exhaust nozzle leading into the smoke box, sectional baffle plates hingedly connected together and provided at their edges with clips, flanges located in the smoke box of the locomotive, and adapted to be engaged by said clips, table plates



hingedly connected together and provided at their hinged edges with recesses, said recesses adapted to register with the discharge end of the exhaust nozzle, said table plates adapted to rest upon the flanges in the smoke box, and screen sections hingedly connected together and having at their free edges clips adapted to engage the flanges in the smoke box, the baffle plates being interposed between the flues and exhaust nozzle of the locomotive, and the screen sections being interposed between the exhaust nozzle and the forward end of the smoke box.

1,574,997. LOCOMOTIVE BOILER. JOHN L. NICHOLSON, OF CHICAGO, ILLINOIS, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

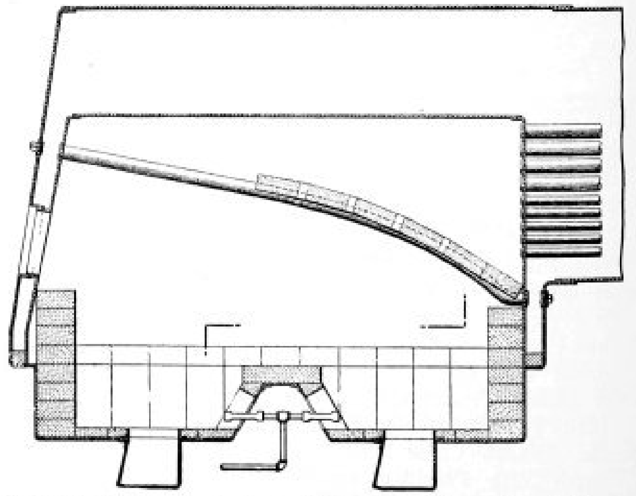
Claim 1. A locomotive boiler and its internal firebox having a fuel door therein in combination with a vertical longitudinally extending water



steaming and circulating element therein, said element having a bottom which is inclined upwardly and rearwardly, and terminal neck portions, one of which extends into the front water space of the boiler and the other into the back water space above the fuel door, and said element at its top opening through the crown sheet of the firebox. 4 claims.

1,578,291. FURNACE. CHESTER A. SIEGEL, OF ARLINGTON, NEW JERSEY, ASSIGNOR TO AMERICAN ARCH COMPANY, A CORPORATION OF DELAWARE.

Claim 1. In a locomotive furnace, the combination of a fire arch extending from one end of the firebox toward the other; a fire pan for said



firebox with a flash wall at either end thereof; and burners in said fire pan directed fore and aft toward said flash walls, so that their fuel streams shall be retroverted by said flash walls and meet in the upper portion of the combustion chamber defined by said fire arch. 7 claims.

The Boiler Maker

Volume XXVI | June, 1926 | Number 6

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ave.
Mandeville, La.
Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St.
Westminster, S. W. 1.
Cable address: Urasigmec, London

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d; single copies 1s 2d.

Request for change of address should reach us two weeks before the day of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

Boiler Manufacturers Get Down to Business

In the past the American Boiler Manufacturers' Association has devoted most of its activities to the technical side of the industry. It has done much constructive work in improving the standards of boiler construction and the efficiency of shop production. Questions relating to the quality of boiler materials, the proportions and design of boilers, methods of shop production, cost accounting, management and inspection have been discussed at length at its regular annual and mid-winter meetings and the results of its deliberations have been of incalculable value to the members of the association and to the boiler making industry at large. Up to the present, however, the association has consistently followed the policy of avoiding any organized action with regard to the development of trade or marketing the products manufactured by its members. As a result little has been known, even among the boiler manufacturers themselves, as to the total volume of production in the boiler making industry as a whole or of the extent of its markets. No collective effort has been made to develop new markets or to standardize commercial practices in the industry, consequently the business has been carried on by the manufacturers individually, each undertaking such business as its own organization could secure and making contracts and quoting prices according to methods of its own. The result has been a highly disorganized industry as far as its commercial activities are concerned with all the attending evils such as destructive competition within the industry itself, unopposed encroachment of competing industries, small profits and loss of business due to negligence.

This unhealthy condition of affairs has made itself keenly felt during the past few years but its causes and the methods by which it might be overcome have not been recognized. At the annual convention of the association early this month George W. Bach, president of the association, urged the members to get down to business, take account of stock and plan a definite campaign for the cultivation of new markets and the standardization of practices in the industry so that boiler manufacturers might not only get more business but also earn a fair profit on the work they are doing. The situation was ably analyzed in an address by Charles F. Abbott, executive director of the American Institute of Steel Construction, who described at length the remarkable results achieved in the structural steel industry in three years by the adoption of modern sales and merchandising methods and by arousing a national consciousness of the value of the industry's products by educational and advertising campaigns. The response to the constructive suggestions and recommendations offered by Mr. Bach and Mr. Abbott was instantaneous and enthusiastic. Plans were immediately made to take a general survey of the situation and find out exactly what the production of the boiler shops in the United States has been in recent years, what their capacity is and to what markets they have been selling their products. With vital statistics of the industry available as a foundation it is believed that definite constructive plans can be made to improve business methods and to widen the markets of the industry.

Master Boiler Makers' Convention

MEASURED by attendance alone the seventeenth annual convention of the Master Boiler Makers' Association, which is reported elsewhere in this issue, was one of the most successful in the annals of the association. Buffalo and the Hotel Statler proved to be an ideal base of activities. Four distinct factors entered into the success of the convention—an excellent list of speakers, well prepared reports and discussions, the best display of boiler shop tools and equipment ever shown at a convention by the supply men and, last but not least, a splendid program of entertainment.

Several thoughts were brought out by various speakers which should bear fruit in the activities of every member of the body in the future. The master boiler maker must put as much thought and study into becoming a leader of men as he did in learning his trade. Two or three mechanical officials who addressed the convention emphasized this point. Consideration and assistance, combined with a well-rounded course of training are absolutely essential if apprentice boys are to be attracted to the trade of boiler making. No more important mechanical department problem than that of training apprentices to be master craftsmen of the future faces the railroads of the country at the present time. Another thought presented to the association is that the master boiler maker should strive to broaden his outlook in his relations with the railroads as a whole and with the community. Finally he should by maintaining the efficiency of his organization, continue to improve the service of the locomotives under his charge and to make further reductions in boiler accidents which, as Mr. A. G. Pack, chief inspector of the Bureau of Locomotive inspection pointed out, have gradually been decreasing in recent years.

The association may feel justly proud that its work is becoming more and more recognized by railroad officials as evidenced by the willingness of prominent mechanical officers to be present at the conventions and to address the organization. In another direction too the association is making progress—that is in its adoption of standard practices. The value of its work on welding has been recognized by national organizations of welding engineers, several representatives of which were present at the convention and took part in the discussion. In the matter of boiler corrosion and pitting, the members because of their knowledge of service conditions have assumed places of importance in the widespread campaign of the railroads to decrease this costly item of maintenance. A further discussion of the part the association can play in this endeavor will be given in a later issue in whch the complete report on ths subject will be published.

At a meeting of the executive board immediately following the last session, it was decided to hold the eighteenth convention at Chicago. The dates and place of meeting will be announced later.

The National Board Meeting

IN this convention issue of THE BOILER MAKER is contained a brief report of the fourth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors which took place at the Hotel Sherman, Chicago, Ill., May 24, 25 and 26. About 75 members and their guests were present. The value of this organization, which represents the legislative phase of the boiler industry, has been increasing in importance since its inception, until now the uniform and thorough enforcement of boiler requirements throughout the localities governed by the Boiler Code of the American Society of Mechanical Engineers is entirely due to its efforts. A complete transcript of the proceedings of this meeting will appear in a later issue.

LETTERS TO THE EDITOR

Piece Work Conditions

TO THE EDITOR:

I prefer to write under the above title rather than "Rewards for Labor" for the very obvious reason that "wages" and "rewards" are the antithesis of each other. A reward is a gift, but a wage is a sum of money that must be paid by agreement.

The card system of piece work conditions, as detailed by Mr. W. Wilson in the March issue of THE BOILER MAKER, has one or two defects that bar it from the boiler making industry as a whole. For example: the workman is expected to follow the instructions on the card, use the tools on the card, and get the job out under the price shown on the card, before he can claim any bonus. Assuming that a workman follows the instructions to the letter; works conscientiously even hastily all the time and makes no bonus; then he has the very reasonable complaint that had he been allowed to do the job his way he would have made a bonus. Alternatively the artisan may find that he has enough time at his disposal to talk and smoke or both and still make a good bonus, and consequently he is not giving of his best, in case the price gets cut next time the same piece of work comes round. The card system commends itself to the training of apprentices and repetition work but would destroy the ingenuity and adaptability of first class boiler makers and that is something that must not be destroyed on any account.

It is immaterial whether workmen are paid time wages, time and a quarter, or time and a bonus, because any system that guarantees a time wage limits the enterprise and capacity of a workman. Invariably where the weekly wage is guaranteed the amount of bonus that a man can make is restricted and this combination of restricted bonus and guaranteed wage keeps the earning capacity of the workman and the productive capacity of a business at a moderate if not a low level.

Wages, irrespective of how they are paid, bear a fixed proportion to the market price of the product, let us say one-fourth, and work out an example.

No. 1: Thomas Smith & Company can make a tank for a wage bill of $90; there is no limit to the amount of wages the workmen are allowed to make, and no guaranteed time wage; every incentive here for the men to work hard, earn plenty of money and be prosperous; and the selling price is $90 \times 4 = \$360$.

No. 2: Henry Clark & Company who guarantee a weekly time wage and give a bonus if the job is done for $100; but the men must not earn more than time and a half; no incentive here for speed, earning capacity of the workmen leveled to time and a half and the productive capacity of the business stinted; selling price of the tank $100 \times 4 = \$400$.

It is not hard to discern that Thomas Smith & Company can get more trade, get better workmen, pay bigger wages and be more prosperous and finally sell 10 percent below Henry Clark & Company.

My idea of piece work conditions is that every job that an employer contracts for at a fixed price should be contracted to the works at a fixed wage bill with no guarantees and no limits on wages. The allowable wage bill would be the estimated wage bill derived from previous data and experience, or both. By this method the employer is joining in contract with the workmen to sell a given article. The employer cannot lose through high wage cost because he has sublet that part; his own costs are reduced by being in a position to pass more jobs through the shops in 12 months than his competitor, and the economic status of the business is sound.

The subject offers a wide field for controversy and will no doubt be to our mutual advantage to have some American ideas for the question of wages and conditions is a national one.

Leeds, England. JOHN GORDON KIRKLAND.

Tendencies in European Boiler Design

By G. P. Blackall

At present the position of boiler design in Europe is certainly in a state of flux. Having regard to the fact that power requirements, including the generation of electricity, are to a great extent dependent on the steam boiler (and in the United Kingdom almost entirely so), its present evolution is a matter of fundamental importance.

In the countries of western Europe the stage has been reached when a steam pressure of 400 pounds to 500 pounds may be said to be a normal commercial pressure. Many modern stations working at this pressure have been built during the last few years, and up to the present there does not appear to be any decided tendency to use very much higher pressures for commercial undertakings. Considerable work is, of course, being carried out with super-high pressures, i.e., pressures 1,500 to over 3,000 pounds per square inch. The various designs developed in this class appear to have achieved results which indicate the possibilities of commercial adoption and exploitation. Their adoption, however, will naturally go through a process of slow evolution, as the very nature of the duties demanded from such boilers calls for caution and exhaustive testing before responsible engineers will accept and adopt the radical changes involved.

The materials available today for the construction of boilers limit the designer to a maximum working steam temperature of about 750 degrees F. However, there is practically no limit to the steam pressure which may be used, and it is on this special phase of the steam generation problem that engineers are concentrating with the idea of increasing the overall thermal efficiency of the turbo-electric generating plant.

Up to the present the trend of development has been to strengthen and modify existing designs of steam boilers to comply with the requirements for an average pressure of approximately 500 pounds. In this work the established British designs have been adopted with results which would be expected from long experience in this field of engineering. The English engineer is frequently criticized as being too conservative, but, so far as boiler design development is concerned, experience goes to show that such criticism is more often than not greatly exaggerated. The most recently constructed super-power stations in Continental Europe are using pressures in line with British practice. In the most modern super-power station in Berlin, for example, a steam pressure of 495 pounds per square inch has been adopted. This figure was settled upon as being the most economical after very careful consideration of all the factors bearing on the final overall efficiency of the power station, and after taking into account the thermal advantages of higher pressures.

The higher furnace temperatures attainable with pulverized fuel have necessitated modifications to overcome difficulties in connection with refractories, and it is becoming general practice to use water-cooled furnace walls. These walls become part of the boiler heating surface, and there appears to be a tendency to create a boiler design round such a combustion chamber. Engineers will want to see that any radical departure from established precedents in design has a long experience under service conditions before it can be said that any particular method is the one to meet the future conditions for efficient steam generation.

Other marked departures from conventional design are chiefly concerned with super-high pressures. The outstanding design in this field is, of course, that evolved by Dr. Benson who actually uses a pressure of 3,200 pounds, at which water is flashed into steam, the change taking place at the critical temperature of approximately 706 degrees F. The design of the Benson boiler makes a great appeal to the practical mind because it is little more than a steel tube heated externally, the water being forced through the coil at 3,200 pounds pressure. Apart from what has already appeared in THE BOILER MAKER, however, little is as yet known about this boiler, beyond the fact that it has actually been under steam at the above pressure.

Another interesting design is that evolved by Professor Loffler, of Charlottenburg. In this case a steam pressure of 100 atmospheres is generated by applying the furnace heat at the superheater. This is a very revolutionary departure, as the boiler has no direct connection with the furnace. Superheated steam from the furnace-fired superheater is fed into the water in the boiler proper and thus provides the primary steam. This arrangement readily lends itself to the adoption of present-day boiler making methods, and it is also very flexible, as the superheater unit and the boiler may be erected entirely independently of one another.

Yet a further development is that of J. V. Blonquist, of Stockholm. He has designed the Atmos boiler which consists essentially of a number of steel tubes mounted above the furnace and carried at each end in special bearings and stuffing boxes, so that they can be rotated at a speed of 330 revolutions per minute. It is claimed that by means of this rotation the interior surface of each tube is completely covered with a solid layer of water due to centrifugal action, and that the steam bubbles are easily separated from the water. A moving boiler tube is naturally regarded with some suspicion, but a number of Atmos boilers are in operation under industrial conditions at 1,500 pounds pressure.

There is also the internal-combustion boiler in which the heating flame burns while in actual contact with the water in the boiler. Although it is not yet in a finished state, this design at least has very interesting possibilities. It is too early, however, to attempt to form any opinion as to its practical future.

Engineering Index

The Engineering Index, 1925. 792 pages, 7 inches by 9½ inches. Bound in cloth. Published by the American Society of Mechanical Engineers, 29 West 39th Street, New York.

The Engineering Index published each year by the American Society of Mechanical Engineers has for years been considered a necessary reference book by those who wish to keep in touch with current engineering literature. It is invaluable in any engineering library, and a great convenience, because of its completeness, to those who have occasion to consult it only occasionally.

The first volume of the Index appeared in 1892 and it has been published annually since 1906. Up to 1918 it was prepared and published by the Engineering Magazine Company, but since that time by the American Society of Mechanical Engineers. This volume, numbering nearly 800 pages, includes some 18,000 items which appear in engineering and other technical publications. More than 3,000 of these items are cross references. Many 1924 publications received too late for inclusion in the 1924 Engineering Index, as well as periodicals appearing in 1925, which were received as late as February 1, 1926, are included in this volume. In the preparation of the index, the staff of the society reviewed more than 1,200 periodicals, reports and other publications regularly received during the year by the Engineering Societies Library, New York. The railway field, both steam and electric, is, if anything, even more completely covered than in former editions.

Multiple Pressure Locomotive Developed in Germany

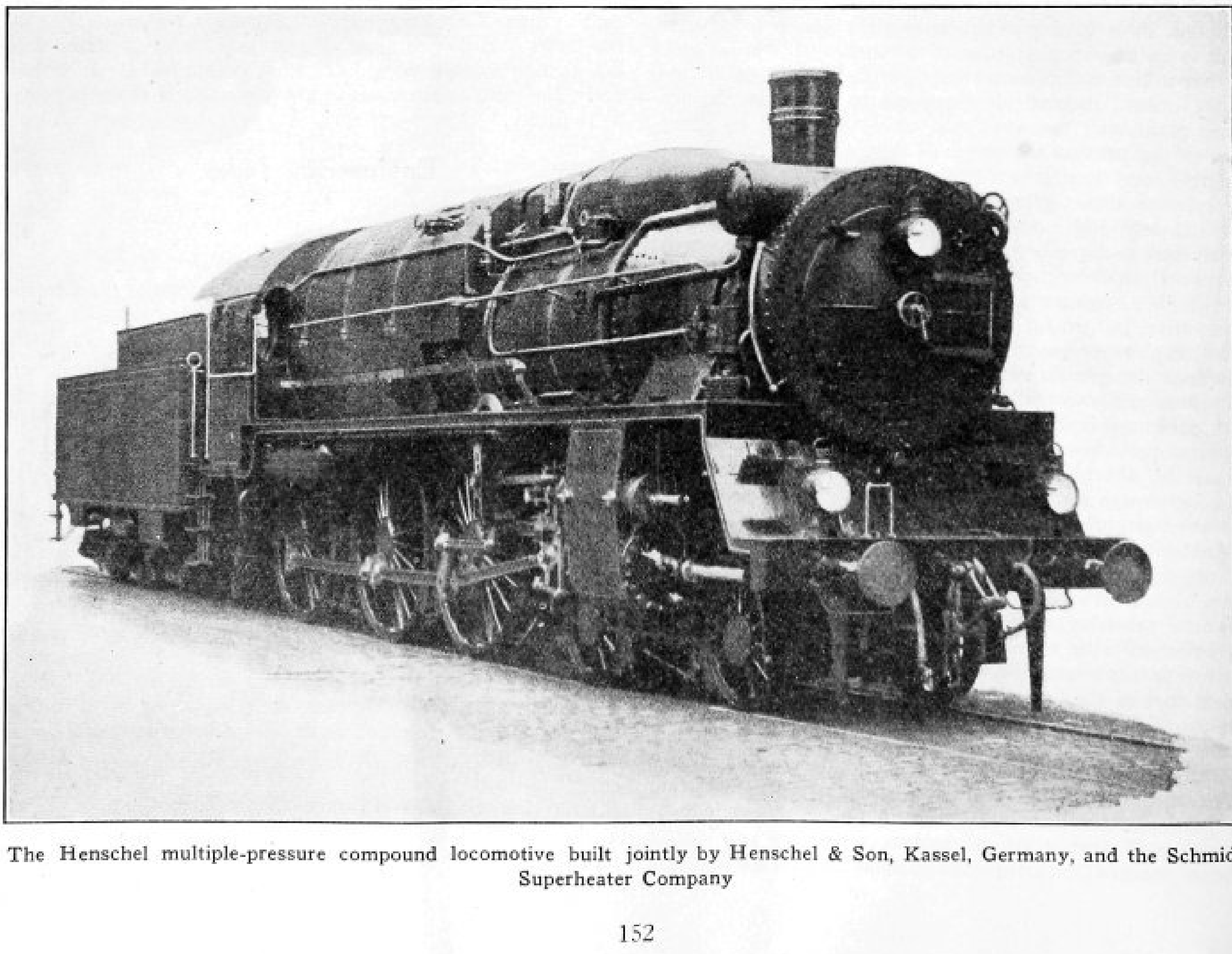
Combined watertube and firetube boiler generates steam at 800 pounds and 200 pounds pressure

An interesting locomotive has recently been built in Germany which generates steam at two pressures. This locomotive, known as the Henschel multiple pressure compound locomotive, is of the 4-6-0 type and has three cylinders. The original design was developed by the late Dr. Wilhelm Schmidt, inventor of the Schmidt superheater, and was built jointly by Henschel and Sohn, Kassel, Germany, and the Schmidt Superheater Company. This locomotive was exhibited at the railway exposition held last year at Munich, Germany, and has been undergoing extensive tests on the German State Railways since that time. It was built primarily for experimental purposes with the object of determining the practical possibilities of what has for a considerable time been considered as theoretically most desirable, namely, the employment of extremely high pressure steam in combination with two-stage expansion and superheat.

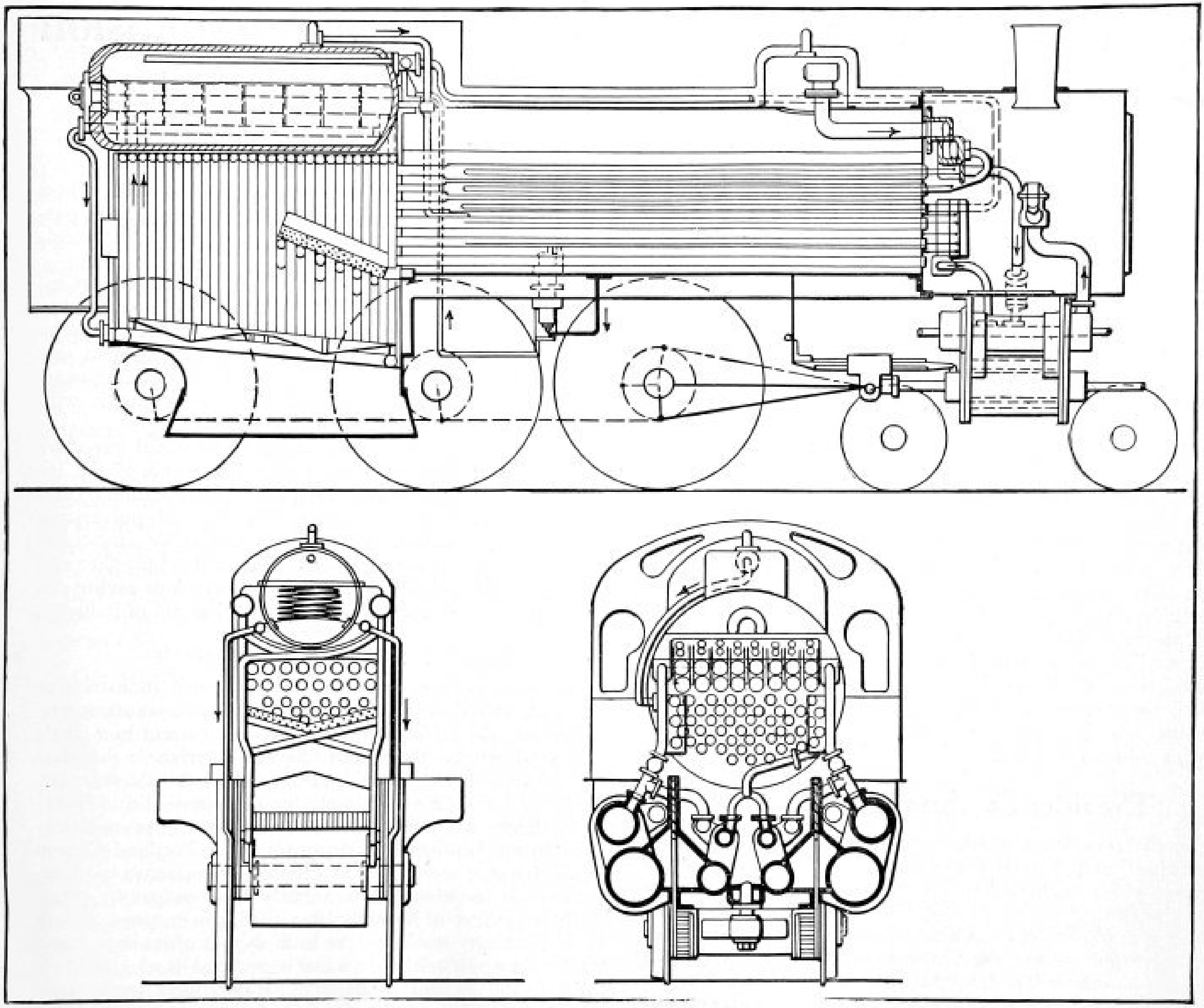
Superheated steam at about 880 pounds pressure per square inch is used in a single high pressure cylinder and the exhaust from this cylinder at about 200 pounds per square inch is combined with superheated steam at the same pressure drawn from the low pressure section of the boiler, to supply the two low pressure cylinders.

The high pressure section is a watertube boiler similar in many respects to the Brotan type. Two-inch tubes set closely together form the sides, end walls and top of the firebox. The lower ends of the tubes, forming the side and end walls, set in a hollow frame which supports the grates. Around the top of the firebox is a second hollow frame in the lower side of which are set the upper ends of the side and end wall tubes and on the inner side the tubes which extend across the top of the firebox. This system of tubes is filled with water about half way to the upper frame. It can withstand the high temperature of the firebox on account of the small diameter of the tubes and the absence of scale. The small tube diameter is permissible on account of the fact that the small bubbles of steam generated from the small amount of water in each tube take about one-sixth of the space of the steam bubbles created in locomotive boilers of the usual design. The comparatively small space taken by the rising bubbles insures a good transmission of heat between the fire and the water.

This system of tubes produces steam at about 1,320 pounds per square inch. The steam from this section is passed into a system of pipes placed inside a large drum which is centrally located above the top of the firebox. This drum is not exposed to the combustion gases, but is heated from the inside by the system of pipes carrying steam at 1,320 pounds pressure. The heat from these pipes is transferred to the water in the drum surrounding the pipes, causing the steam in the piping system to condense. This transfer of



The Henschel multiple-pressure compound locomotive built jointly by Henschel & Son, Kassel, Germany, and the Schmidt Superheater Company



Outline sections of new two pressure German locomotive

heat generates steam in the drum at about 880 pounds pressure.

The lower ends of the piping system to the inside of the drum are connected by outside pipes to the lower frame of the firebox which carries the 2-inch tubes of the side and end walls. By this arrangement the condensate from the heating pipes in the drum is returned to the tubes forming the firebox and is used over again. The high pressure section of the boiler thus forms a closed circuit in which steam is generated from distilled water. The utilization of distilled water, of course, eliminates any possibility of scale being formed. Thus one of the greatest difficulties in the operation of the ordinary locomotive is overcome.

The drum is fed with ordinary feed water from the tank on the tender and trouble may be expected from scale being deposited on the heating coils. For this reason the designers may be required to apply to the locomotive feed water treating equipment or a device for removing scale from the drum. Any scale deposited on the inside wall of the drum will, of course, have an insulating effect.

The steam at 880 pounds pressure generated in the drum is piped through a superheater, the tubes of which are located in the usual manner inside of the tubes of the low pressure cylindrical boiler, to a high pressure cylinder. This cylinder is placed midway between the two outside or low pressure cylinders and drives direct to the front driving axle. The steam is exhausted from the high pressure cylinder at about 200 pounds to the two low pressure cylinders. This exhaust steam, however, is supplemented by steam from the low pressure section of the boiler, superheated in the usual way by a second superheater, the units of which are also located in the tubes of the low pressure boiler. All available space in the smoke box is taken up by two superheaters.

All three cylinders are placed in a horizontal plane and are connected to the front drivers with cranks at 120 degrees. They are equipped with piston valves and extended piston rods which are considered indispensable in Germany. Complete tests are yet to be made, but it is reported that the preliminary tests have shown an unusual economy in steam consumption.

Table of Dimensions and Proportions of the 4-6-0 High Pressure Three-Cylinder Locomotive

Type of locomotive	4-6-0
Cylinders, diameter and stroke	1—11.4 in. by 24.8 in. 2—19.7 in. by 24.8 in.
Valve gear, type	Walschaert
Wheels, diameter outside tires:	
Driving	78 in.
Front truck	39.4 in.
Boiler:	
Steam pressure, high pressure section	880 lb. per sq. in.
Steam pressure, low pressure section	200 lb. per sq. in.
Heating surfaces:	
Firebox (including all fire heated surfaces)	1,000 sq. ft.
Heating coils in drum	1,312 sq. ft.
Tubes and flues, low pressure section	2,061 sq. ft.

American Boiler Manufacturers Seek Trade Expansion

Constructive organization work along modern commercial lines inaugurated at thirty-eighth annual convention at Hot Springs, Va.

IN response to the constructive leadership of George W. Bach of the Union Iron Works, Erie, Pa., president of the association, and a stirring address by Charles F. Abbott, executive director of the American Institute of Steel Construction, the American Boiler Manufacturers' Association at its thirty-eighth annual convention, which was held at the Homestead Hotel, Hot Springs, Va., from May 31 to June 2, enthusiastically entered upon a new era of trade organization work which it is believed will have a far-reaching influence upon the future welfare and prosperity of the boiler making industry.

That the industry is now going through one of the most critical periods in its history was pointed out by Mr. Bach in his address at the opening of the convention. Due to excess manufacturing capacity in the boiler shops, diminished demand for boilers and the encroachment of other industries in the power and heating fields, he urged the members to take active measures for trade extension along the lines successfully adopted in other industries. He recommended first, that the association take a general inventory of the situation by compiling accurate statistics of production in the industry; second, the establishment of a trade extension bureau and, third, the promotion of the sale of steel boilers for steam heating and low pressure power and process work. Mr. Bach's address follows:

President's Annual Address

In the president's judgment the American boiler manufacturing industry is at present going through a very trying period, which might in fact be called the period of elimination, because of the over-production of boilers due to excess boiler manufacturing capacity in this country. In analyzing this condition we find the fundamental cause for this excess capacity is due to the fact that the centralization of power plants, with its consequent use of larger boiler units, operating at a very much higher percentage of rating, as well as very much higher efficiencies, and with the more efficient utilization of steam in prime movers as well as process work has brought with it the use of proportionately fewer numbers of boilers. Also, the development of water power, as well as the progress made by oil and gas engines as prime movers for power, have curtailed the boiler demand to such an extent that there are fewer boilers and very much less horsepower required than formerly. In fact the boiler output has not been proportionate to the growth in population by any means. This condition is a perfectly natural development with the times and in the progress of the engineering art and must be faced as such.

While there are no authentic statistics to show exactly what the actual drop in volume of business is, these facts are obvious and should be verified by having an accurate statistical record of the boiler output in horsepower and for different types of boilers compiled by our association.

Trade Extension Work Needed

We should, however, take heed and follow the example of other trade organizations in the development of our potential markets by organized trade extension work, pushing the development of our markets to where we will get our rightful share of the boiler business. By this I mean that we should follow engineering progress of the times and educate the boiler users to such facts that steel boilers are much more efficient and better in every way than cast iron boilers for heating purposes and low pressure steam generation, where the latter type boiler is generally used. This applies particularly to the larger heating installations for public buildings, institutions, factories, larger homes, etc.

We should also take steps to push the modernizing of industrial power plants in the interest of general fuel conservation, as it is a recognized fact that the efficiency of the boiler plant in fully 75 percent of the boiler installations in this country could be increased up to 30 percent by junking obsolete equipment in the power house and replacing it with modern apparatus.

There is no doubt that the average industrial executive pays too little attention to the power house end of the industry, and the power plant equipment manufacturers (that is, the manufacturers of boilers, stokers, coal pulverizing equipment, superheaters, economizers and other accessories and auxiliaries to boiler installations) should get together and bring before the public the fact that a tremendous saving can be effected in the steam and power production end of industry.

Examples Set by Other Industries

One needs only to study the work of such industries as that represented by the paint and varnish manufacturers' association, which increased its sales by 40 percent in a single year by advertising the slogan "Save the surface"; the plate glass manufacturers' in one year increased the sale of plate glass by 25 million square feet; the California Fruit Growers' Exchange has increased the sale of Sunkist oranges tenfold. In the building industry we find the Portland Cement Association and the National Lumber Manufacturers' Association each increasing tremendously their output by pushing their product in an organized intelligent manner, and in the steel industry several of the leading authorities have stated that at least six million tons of structural steel should be added to the present production by intelligent propaganda and educational work in the use of steel as against other material used for structural purposes. The American Institute of Steel Construction, composed of 99 percent of the structural steel fabricators in this country and Canada, have a four-year program laid out for this purpose, as well as constructive engineering development work in the interest of steel structural material. This covers every form of use for structural steel from the largest structure down to steel dwellings, such as illustrated in a special Model Home Section of the *New York Herald-Tribune*, Sunday, April 25, 1926, featuring a model steel frame house, including in this house also a steel heating boiler which received special mention in that article.

The American Institute of Steel Construction has also reprints from an article in *The Iron Age*, March 4 to April 8, 1926, on "The Dwellings of Tomorrow," featuring the use of steel in the construction of modern dwelling houses.

These are merely examples of what can be done in the development of markets, and practically every major industry today is carrying on extensive trade development work, not only in their own interests but in the interest of the general public, who after all is the greatest beneficiary in movements of this kind.

There never was a time when trade association work was as important in every industry as it is today, and such eminent authorities as Hon. Herbert Hoover and other prominent men in our public life and in industry advocate this movement along the lines of rational and legal procedure.

We are favored at this meeting in having speakers of particular interest on this subject and I believe that after hearing these men you will be very much better informed and receptive to the idea of carrying on trade extension work vigorously and intelligently, as it should be in our industry.

Profits too Low in the Boiler Making Industry

President Fish in his able address a year ago referred to this state of affairs in general, and pointed out particularly the very low percentage of profit, if any, earned by most of the boiler manufacturers. It is deplorable to think that quite a number of manufacturers in this industry have been doing business at a positive loss during the past few years. This state of affairs certainly can not continue. Mr. Fish referred to the possibility of consolidation, with the probable closing up of some of the shops, but, as he also aptly stated, "Who shall it be?" It is questionable whether consolidation is the remedy for the present situation. Certainly I am not qualified, due to inexperience in that direction, to pass judgment on this particular point.

I fully believe that the first and most constructive move we can make is to take a general inventory of the situation and establish a trade extension bureau for the betterment of our interests and that of the public, as is done by practically every other major industry in this country today through its trade association.

If, after having developed our potential markets, we find excess capacity, some other move is necessary leading towards a betterment.

Commercial Practices Should be Standardized

We should also make progress in other commercial practices, such as standardizing methods of bidding on jobs, payments, guarantees and other details of this kind. The question of prices can be left out of the discussion, as I believe that by proper development of the industry and creating a demand for our product that will take care of itself, but there is no reason why we should not all do business in a definite, systematized manner and refuse to do it any other way, particularly at the bidding and request of the individual purchaser who frequently is not familiar with our trade standards and would be perfectly willing to accept them if they were made uniform in the industry, and particularly if they would be of benefit to the purchaser.

The present methods of developing an inquiry of a prospect, whereby we all make a great deal of sales effort in the way of individual visits, preliminary proposal drawings, and a great deal of detail work, which is duplicated by all of us, is an economical waste in the very beginning of a boiler sale, and the changes from our standards in trying to please everybody by building anything they may want practically upsets our engineering and shop standards and really makes for a higher cost of production and frequently a more inefficient and impractical boiler and setting than would be furnished by a standard article, and the consequent troubles invariably fall on the boiler manufacturer to carry, who assumes them in the interest of so-called good business practice to keep a satisfied customer.

The constant changes in design and construction of boilers, particularly with the coming of higher operating pressures, make a great deal of our engineering work and shop equipment obsolete, and the tremendous expense we are all put to in that respect is sufficient without adding to it by trying to make something that is not practical to the whim of somebody who does not understand the situation.

Make One Thing and Make It Cheap

This brings out an angle of standardizing our shops for production along certain lines. By that I mean that we should equip ourselves to make one thing and make it good and cheap, instead of trying to make everything on the market in the way of boilers. It is obvious that the shops equipped for the heavy plate work of modern watertube boilers can not advantageously make boilers of lighter plate construction and compete with the shops especially equipped to handle light plate work expeditiously with lighter and faster tools and by an organization trained in that particular class of work. The history of the boiler industry as well as manufacturing industry in general shows conclusively that success comes with standardization and concentration of a product. This refers particularly to what is now the leading industry in this country and the newest big industry, the automobile, where this practice is carried out properly in every branch of the manufacturing end of it from the purchase of the raw material to the selling of the finished automobile. As boiler manufacturers we can well study and take a lesson from the automobile industry from the purchasing of the material to the sale of the finished product.

In reviewing the past year's business one might say that the business since the last annual meeting has not been what might be called good, nor has it been extremely bad, and the profits earned have been on the whole very small. On the subject of profits it might be well to say that statistics of major industries show that steel and fabricated steel products, including boilers, are at the very foot of the list of earnings in all major industries, showing a net profit of only about 4 percent on the invested capital. This is too low to attract investors and stifles engineering and other development work leading to progress in the art of boiler manufacturing. It is also proving a serious handicap, just as it did to our transportation system and other lines suffering from inadequate earnings on the investments.

Radical Changes Predicted in Future

As to the trend of the future I believe that there will be radical changes in boiler design and installation, leading to necessary changes in all shop equipment, engineering development work, particularly in high pressure boilers for central stations and the larger industrial power plants. The centralization of power is here, and super-power development is more than a pet phrase. Whether this will continue along the lines of public service corporations or the centralization of industrial power plants serving certain industries within a given radius from the power plant for the exclusive use of these industries and possible lighting and heat of same, leaving the street lighting and general public power and lighting requirements to the central station, is a question for the future, and in my opinion a logical development.

I believe that the centralization of industrial power plants is inevitable, tending towards the elimination of the smaller power plant, but developing future possibilities in the industrial power field for steam to be used not only for power but for process work and heating purposes by groups of industries located within a certain radius where it is practical to carry high pressure or low pressure steam and power advantageously. This is probably for the more distant future, and for the present we have a large field in modernizing the existing smaller and larger industrial power plants, which can be done by proper cooperation with industrial and consulting engineers in practically every part of the country.

There is also a tremendous avenue for development of our industry in the heating boiler field, where the development of the steel boiler has a proper place, that has not been exploited or pushed as it should be by our association. Many of the shops now trying to build moderate or high pressure boilers with equipment hardly suited for that purpose could probably develop heating boilers better suited for their equipment, and keep their shops running, if this particular field were cultivated systematically by our association.

I want again to caution all of these shops against entering the field of the higher pressure boilers, particularly the watertube field, where the competition today is even keener than in the firetube field, and the investment necessary to equip these older shops for production of a modern high pressure boiler is not justified by the profits in that particular line.

The work of standardization and simplification carried on by our industry in cooperation with the Department of Commerce is progressing slowly, but surely. While that committee has a big job they are making progress that will lead to betterments in the firetube boiler field, both for the manufacturer and for the public. This committee should be supported in every possible way in carrying on its work. It is more difficult to effect any method of simplification or standardization in the watertube boiler line, because of the fact that these boilers are built to meet more varying conditions, but unquestionably some very useful work could be carried on in the simplification of design and shop practices in that line also.

Many other economies could be effected in engineering standards, sales simplification, advertising in all its forms, and other major items of our industry, and I recommend that all of these problems be given serious consideration and measures be carried out leading to the lowering of the cost of all of the items of our manufacturing expense.

Recommendations

Summing up, I would therefore recommend first of all that accurate statistics be gathered and records be kept of the total production of our output in horsepower, either segregated into the various types of boilers or as a whole, to ascertain what is the total volume of our business and its decline or growth, as compared with the population or other industries.

Second, the establishment of a trade extension bureau that will function in cooperation with the manufacturers of other equipment entering into boiler settings, such as stokers and other major or minor apparatus required for a complete boiler installation, for the proper method of carrying on the work of modernizing industrial power plants in the interest of conservation of natural resources and economy in industry.

Third, the work of pushing steel boilers for steam heating and process work, as aforementioned, with architects and users of this type of boilers.

It is useless to leave these important jobs in the hands of committees composed of men who are too busy and do not have the time to devote to this work to carry it on as it should be. A proper trade extension bureau could analyze every major industry in this country as to the possibilities for boiler installations, and in my opinion that is the most important work our association can do at present.

We have carried on the technical development of our industry for the benefit of the public in general, and we have neglected the commercial side of our business to a point where we are far behind practically every other major industry in this country in that direction.

While this is probably the most critical period in our industry, we should not look at the situation from a pessimistic viewpoint, but should face the facts squarely and by concerted effort along the aforementioned lines carry out the work of improving the industry for ourselves and the public in general.

Report of Standing and Special Committees

In presenting his annual report the new secretary-treasurer, A. C. Baker, 801 Rockefeller Building, Cleveland, Ohio, announced that 4 new members had joined the association during the past year, 3 of which are active members and 1 an associate member. The present membership includes 2 honorary, 69 active and 29 associate members, making a total of 100.

The treasurer's report showed the financial condition of the association to be highly satisfactory.

J. H. Broderick of the Broderick Company, Muncie, Ind., chairman of the entertainment committee, outlined the conditions under which the golf tournaments would be held on Monday and Tuesday afternoons.

E. R. Fish of the Heine Boiler Company, St. Louis, Mo., chairman of the committee to act with the A. S. M. E. Boiler Code Committee, reported briefly regarding the status of the work of the committee, calling attention to the necessity for following out the interpretations of the Code which are being issued by the committee from time to time.

M. H. Broderick of the Broderick Company, Muncie, Ind., called attention to the desire of the oil field boiler interests for representation on the A. S. M. E. Boiler Code Committee.

At the suggestion of Mr. Fish, A. G. Pratt of the Babcock and Wilcox Company, New York, moved that a resolution be drawn up for presentation to the Council of the American Society of Mechanical Engineers requesting the appointment of such a representative on the Boiler Code Committee. The motion was carried.

Report of Stoker Committee

At the annual meeting of this association, June, 1925, Wm. H. Jacobi of the Springfield Boiler Company presented a paper—"Guarantees on Boiler Performance." This paper stressed the fact that regardless of changes in boilers as regards design, construction, pressures, methods of burning fuel, etc., the natural laws governing the conversion of water into steam will not change, but that because of these changes and application of these laws, methods heretofore used in computing and stating results obtained are obsolete. He recommended that these methods be modernized by expressing boiler performance in terms of uniform flow of combustion gases of stated heat value. The specific recommendations made were:

1—That the determining factor of boiler performance be the rate of uniform supply of combustion gases by weight containing definite heat value per pound or per cubic foot corresponding to the best combustion conditions obtainable for all fuels;

2—That in stating boiler performance the ratio:

$$\frac{S \times (H-h)}{G \times (H_1-h_1)}$$

or briefly, pounds of steam produced per pound of combustion of combustion gases supplied—replace the boiler horsepower developed per pound of fuel burned,

where S equals pounds of steam produced
G equals pounds of combustion gases supplied
H equals heat content of steam products in B.t.u. per pound.
h equals heat content of boiler feed water in B.t.u. per pound.
H_1 equals heat content of combustion gases in B.t.u. per pound.
h_1 equals heat content of combustion gases at boiler temperature in B.t.u. per pound.

3—That guarantees on boiler performance be made on the basis of the above ratio with tolerance allowed to cover the variations inherent to the nature of the fuels used.

Under instructions of the association this paper was considered by the Stoker Committee in a report made to the February, 1926, meeting of the association, and it was moved that the report of the Stoker Committee be prepared and circulated among the membership two weeks in advance of the general 1926 meeting. Two of the members of this committee met in New York on April 29 and this present report is the result of that meeting.

(1) It is felt that before submitting this matter to the Joint Committee of the American Boiler Manufacturers' As-

sociation and the Stoker Manufacturers' Association, the American Boiler Manufacturers' Association should take a stand for or against the suggested method of expressing boiler performance.

(2) It is understood that regardless of any action of the American Boiler Manufacturers' Association or the American Boiler Manufacturers' Association and Stoker Manufacturers' Association jointly, before a revised method of expressing boiler performance can become generally used the approval and backing of the Test Code Committee of the American Society of Mechanical Engineers must be secured.

(3) The most complete understanding of the engineering involved in change of method of expressing boiler performance must prevail among boiler manufacturers, fuel burning equipment manufacturers and users of such equipment before such a modified method of expressing performance can be put into operation.

With these points in mind the committee offers the following resolution for acceptance, rejection or modification at this meeting:

RESOLVED, that it is the feeling of the members of the American Boiler Manufacturers' Association that existing methods of computing and stating boiler operating results are obsolete and that this association should work toward the expression of such results in the following form:

(a) In determining performance of a boiler and furnace it is deemed proper that the company furnishing the combustion apparatus shall have ample opportunity to designate the operating conditions of their equipment and be responsible for the amount of air, the draft required in the furnace, the CO_2, CO and loss due to unburned combustible, based on the fuel and ultimate analysis thereof, with relation to the surrounding furnace conditions. By combustion apparatus is meant that portion of any boiler setting within which the combustion of fuels is fully completed and comprises the fuel and air feeding devices and their appurtenances inclusive of the proportions of the necessary furnace space. In other words, responsibility for the fuel actually used shall lie with the manufacturer of the combustion apparatus, and in this connection—

(b) It is to be understood that when complete combustion is satisfied it shall be considered that the entire heat energy made available in the process, as determined by calorimetric tests of the fuel used, resides in the resulting gases—and that the manufacturer of the fuel burning equipment shall not be responsible for any variations thereof, providing combustion has been satisfactorily completed in accordance with his own statement.

(c) The completeness of combustion of the fuel actually used shall be determined by measurement of the resulting gas constituents made at some point in the boiler, say after 20 percent of the heating surface has been passed over, and the average values at this point shall not be less than the stated percentage of CO_2, nor greater than the stated percentage of CO as specified by the manufacturer of the combustion apparatus. The variation in CO_2 measured at different points in cross section shall not vary more than 1.5 points above or below the stated percentage, providing no delayed combustion is present at this or any other point beyond as evidenced by the absence of flame, and that the flow of gases is uniform and free from stratification or laning.

Fulfillment of the above requirements shall be accepted as evidence of complete combustion.

(d) Responsibility for the effective absorption of the heat liberated by the combustion of the fuel used and boiler proper performance will lie entirely with the manufacturer of the boiler and other heat absorbing apparatus.

Respectfully submitted,

A. G. Pratt,
S. H. Barnum,
W. H. Jacobi.

L. E. Connelly of the Connelly Boiler Company, Cleveland, Ohio, moved that the matter of guarantees be referred to the A. S. M. E. Power Test Code Committee. The motion was carried.

Report of Commercial Committee

E. R. Fish submitted standard data sheets for horizontal return tubular and watertube boilers.

After brief discussion, upon motion by James McKeown of the John O'Brien Boiler Works, St. Louis, Mo., it was voted that the standard data sheet for horizontal return tubular boilers be referred to the manufacturers of horizontal return tubular boilers for revision and that action be deferred until later.

The watertube standard data sheet was not adopted.

Monday Evening Session

At the Monday evening session F. N. Speller, director of the Department of Metallurgy of the National Tube Company, delivered an address on "Internal Boiler Corrosion." An abstract of this paper will be published in a later issue. In closing, Mr. Speller referred to the National Joint Committee, which is being organized to study, for the benefit of steam users, the treatment of feed water and the corrosion problem. Upon a motion by E. R. Fish it was voted to adopt a resolution showing the interest of the American Boiler Manufacturers' Association in the work of this committee and also that the executive committee be authorized to appoint a committee to cooperate with the Joint Committee.

Tuesday Morning Session

At the opening of the Tuesday morning session the president appointed M. J. Broderick, J. G. Eury and A. C. Weigle as a nominating committee and J. F. Johnston and P. Champion as the auditing committee. Resolutions were adopted upon the death of David M. Dillon, one of the earliest members of the association, and of Clarence V. Kellogg, past president of the association.

H. N. Covell, former secretary of the association, but no longer connected with the boiler making industry, was unanimously elected an honorary member.

During the remainder of this session the members of the association listened with absorbed attention to an inspired address by Charles F. Abbott, executive director of the American Institute of Steel Construction, outlining the trade extension work of the structural steel fabricators and the remarkable progress which has been made during the past four years in broadening their markets and promoting the sale of their products in new fields. Mr. Abbott's address is published on page 158.

Wednesday Morning Session

At the opening of the meeting on Wednesday morning the association voted to make the following changes in the by-laws:

1. That the secretary and treasurer be appointed by the executive committee, abolishing the clause in Article IV calling for the election of the secretary.
2. Fiscal year changed to May 1 to April 30 inclusive.
3. Dues for associate members changed from $15 to $25 per year.
4. Authority given to print a new edition of the Constitution and By-laws of the association.

Charles E. Gorton, chairman of the Administrative Council of the American Uniform Boiler Law Society, outlined briefly the work of the society during the past year.

(*Continued on page* 161)

Executive Director of American Institute of Steel Construction Suggests Methods for Building Up the Boiler Making Industry*

By Charles F. Abbott†

THE president of your association has asked me to come to your annual convention and talk to you in the belief that, because of the campaign to widen the field of usefulness of structural steel which the American Institute of Steel Construction is now carrying on, I may be able to offer various suggestions which will be of service to you in extending the field of usefulness of your own product—steel boilers.

Let me begin by telling you a story. Not a story starting off, "It seems there were two Irishmen," but one which, based upon a recent personal experience, will illustrate one of the principal points of my address.

A few weeks ago, while traveling from Seattle, Washington, to Boise, Idaho, Lee H. Miller, the chief engineer of the Institute, and myself were standing on the rear platform of our Pullman, talking to the brakeman who in the course of the conversation divulged the fact that he had been traveling over the route for 25 years, and the additional fact that he had accumulated $25,000, all of which was safely invested. He was, you see, a substantial and intelligent citizen.

As the train passed beneath a highway bridge built of a material that competes with steel, Miller turned to the brakeman and commented on the fact that the competing material had been used in the construction of the bridge.

Blind to Steel But Awake to Competing Material

"Oh, yes," the brakeman replied, "all our bridges are built of that. We build the finest bridges in the world out here." Then he went on to say that there was a plant 25 miles down the road that turned out the material used in their construction.

"But why don't you use steel?" Miller asked.

"Because steel crystallizes," was the brakeman's reply.

"What happens when it crystallizes?" asked Miller.

"Why, it falls down," replied the brakeman.

At this point we were passing under a long highway bridge over the railroad. "What's that made of?" said Miller, pointing to the bridge approach. The brakeman named the competing material. "And that," said Miller, pointing to the part of the bridge over the railroad. "Why, steel," said the brakeman in a surprised and slightly aggrieved tone.

During the next half hour we passed under a number of highway bridges over the tracks. Most of the approaches were of the competing material, while most of the sections over the railroad—the sections in which strength and security are particularly essential—were of steel. In each case the series of questions and answers between Miller and the brakeman was run through again.

At about the fourth repetition Miller said to the brakeman, "You've been on this route 25 years, how long have the railroad bridges been here?"

"They were up before I came," was the brakeman's reply.

"Any increase in the weight of the locomotives since you came on the route?" asked Miller.

"Sure, the weight has increased about four times."

*Address delivered before the American Boiler Manufacturers' Association, Hot Springs, Va., June 1.

†Executive Director of American Institute of Steel Construction, New York.

"But," said Miller, "the railroad bridges haven't fallen down and they are all of steel. How do you account for that?"

"Hanged if I know," said the brakeman.

"Well," said Miller, "I'll make you a bet. We'll soon pass the plant that you say turns out this other material. I'll bet the plant is of steel construction."

The brakeman said he didn't believe it was, but that he'd wait and see. A few minutes later we passed the plant—and Miller was right. The plant was of steel construction throughout.

There was a man, who after traveling over steel bridges for 25 years was blind to steel, but awake to the competing material. Why? The answer is to be found in the contrast between the methods of merchandising followed by the steel industry, and those followed by the industry that manufactures the competing product.

Fifty years ago, or, indeed, up until the beginning of the World War, merchandising consisted primarily in competition between members of the same industry. Attention was concentrated largely upon production. Little or no time was consumed in considering whether the market for the product as a whole was expanding or contracting. Ignorance of the causes of business fluctuations, of the facts of supply and demand, of efficient business methods, resulted in intense competition within the industry itself.

Real Competition Now Between Industries

Today the competitors that manufacturers have most to fear are not those in their own industry. There has arisen a new competition for all lines of business. The real competition is not now between concerns in the same industry, but between different industries meeting similar needs, not for the individual concern's share of the money spent in the industry, but for a proper share of the national income for the industry as a whole. It has come to be accepted that if there is enough for the industry as a whole there will be enough to go around among its members.

To meet the new competition there have been evolved new principles of merchandising. Based upon the indisputable fact that the public demands those commodities which it knows and has confidence in, one of the most important of these new principles is that any industry, which would keep competitive commodities from encroaching upon its territory or which would extend the field of its product, must build up in the general public a consciousness of the merits of its product that will create confidence in the service it can render.

Merits of a Product Must Be Impressed Upon General Public

A consciousness of steel was lacking in the brakeman who had travelled over steel bridges for a quarter of a century—but had never known it—because the service that steel renders to humanity, and its advantages as a building material, had never been effectively brought to his attention. He, representing as he does the attitude of the public at large, had been allowed to accept steel as a commonplace, while, through various forms of organized effort, the service of a competing material and its advantages had again and again been impressed upon him.

But again, why? Why has this condition existed in the past? Why does it still exist? Because the steel industry is still, to a great extent, depending upon obsolete theories of merchandising.

The steel industry may be divided roughly into two main divisions, the hot steel industry which produces the steel from the ore, and the cold steel industry which fabricates the steel for the various uses to which it is put by the ultimate purchaser. Reliance, to a greater or less extent, by both of these divisions of the steel industry upon the merchandising principles of a vanished era, while manufacturers of competing products have been alert to take advantage of the merchandising principles of today, is responsible for the unfortunate position in which many branches of the steel industry now find themselves.

With no intention of offering destructive criticisms, with the idea only of painting the background for constructive suggestions, I may say that the hot steel industry is the only large industry existing today in which there is not universal recognition of the fact that the producer should maintain an active interest in his product until it reaches the consumer.

Sales Methods of Hot Steel Industry Antiquated

The hot steel industry has never taken any interest in its product after it has passed into the hands of the cold steel industry. The hot steel industry has always thought, and still thinks, in terms of tonnage output. Concentration upon the greatest number of tons per man per day has brought about neglect of the market and of all that concerns it.

Constructive advertising to build up a public consciousness of steel has never been applied. In altogether too many instances the sales methods of the hot steel industry are antiquated, obsolete. Its varying prices, established to meet local or special conditions, are a throwback to the old customs of trading, long ago consigned to the scrap heap. Its failure to classify its trade, or to recognize those whose responsibility is certified by the capital invested, as compared to those with little or no financial standing, presents a condition that is far from logical.

The hot steel industry has never assumed the initiative in any effort to extend the use of steel. The development of new uses has been left to the consumer. The railroads themselves are responsible for the use of steel in the construction of freight and passenger cars. The automobile manufacturers assumed the initiative in preparing specifications which they submitted to the mills.

Attention Concentrated on Production Rather Than Markets

How has this concentration upon production, to the exclusion of practically everything else, affected the hot steel industry?

An analysis of 27 of the more important iron and steel mills shows earnings of $3.80 in 1924 and $4.51 in 1925 for each $100 of aggregate capitalization. An analysis of 12 other important industries shows average earnings of $12.00 for each $100 of aggregate capitalization. The survey of the iron and steel mills further shows that in spite of the growth in the nation's capacity for consumption, the ability of the steel mills to produce steel exceeds the ability of the nation to absorb it.

Earnings that are so low in proportion to the aggregate capitalization are in great part attributable to this excess plant capacity. Excess plant capacity is frequently referred to as a condition which retards progress in the hot steel industry. Declining markets naturally lead to a condition of excess capacity. If the same importance had been attached to markets as has been devoted to efficient production there would be no excess capacity in the hot steel industry.

Too much of what has been said about the merchandising methods of the hot steel industry applies also to the cold steel industry—those of us who fabricate the steel; and our division has suffered greatly as a consequence.

A few days ago Victor M. Cutter, president of the United Fruit Company, speaking on New England sales methods before the New England Foreign Trade Conference, said, "Our prosperity in the past has been so firmly established that it has led to self-satisfaction, lack of aggressiveness, and to a provincialism which has blinded us to the significance of the development of manufacturing and industry in other parts of the country, and to the need of developing new markets for our products.

Importance of Developing New Markets Recognized in Other Industries

"I believe our manufacturing and production are amply cared for. I also believe our merchandising and sales methods are rotten, and that our knowledge of markets for our products, both domestic and foreign, is infinitesimal. The remedy for the situation lies in a realization of these facts and in aggressive action in merchandising, which includes advertising and publicity, the proper packaging and handling of our products, and the building up of sales forces to balance our splendid manufacturing and production."

Mr. Cutter could scarcely have spoken more to the point had he been addressing a gathering of representatives of the hot and cold steel industries. Although speaking generally of merchandising methods in vogue in New England, Mr. Cutter has summed up, in a few words, the situation that has existed in the steel industry as a whole for many years, and that still, with a few noteworthy exceptions, exists today.

But while we of the cold steel industry may be censured for not having taken more immediate advantage of the principles of modern merchandising, we are still, in this respect, far in advance of the hot steel industry.

You, the fabricators of steel boilers, are awake to the seriousness of the situation. The manufacturers of sheet steel, whose steel roofing a few years ago was being displaced by a competing product at the rate of thousands of tons a year, are checking the invasion of their territory and extending their field. The fabricators of structural steel are laying a firm foundation for the recovery of the market encroached upon during the old days of disorganization.

Structural Steel Fabricators Awake to the Situation

This come-back on the part of two branches of the cold steel industry has been brought about by means of industrial group cooperation which, functioning through trade associations, has made possible the application of those merchandising principles that have proved their worth so conclusively during the last decade.

The American Institute of Steel Construction, the association of the structural steel fabricators, and the Sheet Steel Trade Extension Committee, the association of the sheet steel manufacturers, are not associations based upon the "pay a few dollars a year and forget it" theory, or upon mere attendance at an annual meeting. They are trade associations whose members have shown a willingness to contribute substantial financial support, and the enthusiasm, hard work and ideas which enable them to function along three main lines of endeavor—

1. Standardization to eliminate waste in production and to promote the most efficient use of the product,
2. Research to develop new uses for the product and new markets,
3. Creation of a public consciousness of the advantage of the product.

I am not sufficiently familiar with your industry to suggest specific means and methods which should be resorted to by you to remove the obstacles to its continued progress. I have learned, however, that, aside from the competition of the manufacturers of cast iron boilers and the gradual elimination of the industrial power plant, there are a number of factors within your industry which are handicapping development.

What the Boiler Making Industry Lacks

The code of the American Society of Mechanical Engineers governs the details of steel boiler construction, but not the design. The A. B. M. A. handbook is largely disregarded by the purchaser. This, of course, leaves you at the mercy of the whim of the purchaser, and makes it impossible for you to take advantage of the economies which can be brought about by standardization. I understand, also, that no standard code of practice governs the relations between buyer and seller, that there has been no cooperative study of the potential field, no educational work and no cooperative advertising.

This situation, if I understand it correctly, closely parallels that existing in the structural steel industry before the advent of the American Institute of Steel Construction in 1921. An account of how the structural steel fabricators have met, or are meeting, the various obstacles that had virtually hog-tied the industry, may, therefore, contain suggestions which will prove of value to you.

At the beginning I should like to make it clear that the Institute is not primarily interested in the adoption of any particular working stress as the basis for the erection of structural steel. The Institute is, however, vitally interested in the substitution of recognized engineering practices for the wide variations existing in the past that have resulted in many unjustifiable practices and a lowering of standards.

How the Institute of Steel Construction Is Overcoming Obstacles

One of the first matters to which the Institute turned its attention was the formulation of standard specifications for the design and erection of structural steel which would incorporate recognized engineering practices and combine the factors of safety, durability and the most economic use of steel.

When Bessemer steel came on the market in 1885 a unit stress of 16,000 pounds per square inch was taken—for no particular reason—as the basis for figuring all structural steel stresses, and this stress had held its own despite the practically universal adoption of the open hearth furnace, the product of which possesses a reliability and uniformity never achieved by the Bessemer process.

The Institute recognized that, if steel was to do the work of which it was capable, its use in building construction must be based upon a stress that would take advantage of the better quality of the product turned out by the open hearth.

Enlisting the aid of the country's ablest engineering talent, men outside of the structural steel industry, the Institute developed standard specifications for the design and erection of structural steel which take 18,000 pounds per square inch as the unit of working stress.

Standard Specifications Developed

Based upon an exact knowledge of the capabilities of steel, this stress makes possible a saving of 12 percent in the amount of steel needed for any building, while other provisions of the specifications eliminate unnecessary rivets and unnecessary paint between points in contact, and add substantial quotas to an economy which will amount to $50,000,000 annually when the specifications are operative throughout the United States.

The elimination of the many inconsistent definitions and practices that had crept into the structural steel industry during the 35 years in which steel had been widely used in building construction was undertaken by the Institute immediately following the formulation of the standard specifications. A year was spent in research, the compilation of data, and the drafting of a code of standard practice which would clear up the various sources of misunderstanding between the buyer and seller of structural steel.

An instance of how the code works is the manner in which the various iron and steel items entering into a structure have been classified. These items have been divided into class "A," structural steel and iron; class "B," ornamental steel and iron; class "C," steel floor joists; class "D," miscellaneous steel and iron. Such classification leaves no opportunity for confusion as to what items are to be delivered under an order for any specified class of material.

In the same manner, the code also clears up the question of invoice weights. It defines what constitutes a plumb building, something which has never been done before. As for delays, rigid requirements have been laid down which are equally binding upon buyer and seller and which make the manner of compensating for and adjusting such delays simple, definite and free from obscurity or loop holes. The code is made operative on any contract by the acceptance by buyer and seller of a standard form of proposal.

The standard specifications are now in use in 59 large cities and a number of states, while their adoption has been recommended in 40 additional major municipalities. The code of standard practice is widely used on both sides of the United States-Canadian border. By means of the printed word and educational meetings attended by architects, engineers, bankers, contractors and municipal officials in all sections of the country, the Institute has been able to demonstrate the value of the specifications and the code, and secure the cooperation of the men interested in construction from one angle or another.

Arousing a Public Consciousness of the Advantages of Steel

Mr. Miller, our chief engineer, and I have just completed a speaking tour in which we addressed such educational meetings in 21 large cities from Philadelphia on the East, to New Orleans on the South and San Francisco on the Pacific Coast. In addition to the addresses delivered before the meetings, addresses were delivered to the students of eight technical schools, and before a number of Chambers of Commerce and technical societies. The space devoted to reports of the addresses in the press is evidence of the part the tour has played in arousing a public consciousness of the service and advantages of steel.

At the present time the Institute has in preparation a handbook to facilitate the work of the designer and draftsman and assure correct design. Distribution of a standard sales manual for the entire industry has already been begun. The structural steel industry has long been handicapped by the lack of assembled selling points, and the manual will serve to emphasize many salient factors which are frequently overlooked by the salesman at the present time.

Development of New Markets

In the realm of research and the development of new markets, the development of steel frames for dwellings has been one of the Institute's most significant contributions. The steel frame residences already erected show that a comparison of costs between wood and steel will favor steel. Further standardization and large scale factory production will still further lower the cost of the steel for residence construction.

A number of plants are now preparing to put fabricated steel shapes for dwellings on the market. The beams and girders alone, for an average $15,000 home will aggregate 3½ tons. When it is considered that the number of dwellings erected last year was 296,000 it is easy to understand the importance of this new market for steel.

In what I have said I have made no attempt to cover all of the Institute's activities along any line. I have tried only, by hitting the high spots, to give you a more or less impressionistic picture of its aims and the means it is using to attain them. Much has been accomplished, but much remains to be done. In educational work, for instance—in instilling a steel consciousness in those in close contact with building construction and in the general public—we have as yet only scratched the surface.

EDUCATIONAL WORK JUST BEGUN

We are now planning the organization of a corps of field engineers and a Bureau of Architectural Relations which will enable the Institute to work in closer contact with engineers, architects and the faculties and students of technical schools, in solving the problems of modern steel construction. Bulletins containing constructive data about structural steel will be prepared at frequent intervals, and the personal work of the men in the field will be supplemented by a carefully planned direct mail campaign.

We recognize the value of national advertising as a part of our educational program. It forms one of the principal planks in our platform, to be called into play at the earliest possible date. National advertising must be relied upon to a great extent to arouse a consciousness of the part played by steel in modern civilization, and a like consciousness of its inherent qualities which make it the ideal material for so many purposes.

VALUE OF NATIONAL ADVERTISING RECOGNIZED

How dim that consciousness now is I have already shown by telling the story about the brakeman who was utterly blind to steel until our chief engineer, with a few questions, restored his sight and brought steel into the foreground of his mind where it belongs. The ease with which "steel consciousness" was aroused in this individual case is evidence of what advertising could do to arouse in the public a similar consciousness that would be reflected by an increased demand.

The cold steel industry looks forward eagerly to the time when the hot steel industry will cooperate with it in the execution of a constructive educational campaign to arouse such a consciousness of steel and so protect the steel industry as a whole from the encroachment of products aggressively marketed by competing industries. It is a logical step fraught with possibilities the realization of which would lead directly to substantial increases in the tonnage output of both divisions of the industry. On the other hand, a failure to perceive in time the advantage of such a step is fraught with possibilities of grave injury to both interests.

While it is true that the mills which produce the steel may never come in contact with the purchaser, yet if the purchaser, in sufficient numbers, turns to competitive products—as in too many cases he now does—many of the mill furnaces will grow cold, their dividends will shrink, and the industry as a whole will inevitably sink from the position of industrial leadership it holds today.

ENCROACHMENT OF COMPETING INDUSTRIES A MENACE

A blow at the fabricator of steel boilers, or a blow at the fabricator of structural steel, is a blow at steel itself, and at the industry as a whole, from the mill right down the line. The mill, the fabricator of steel sheets, the fabricator of steel boilers, the fabricator of steel tanks, the fabricator of structural steel—each must view with grave concern the substitution of some competitive article for steel, even though that substitution does not take place in his own branch of the industry. Each such substitution is a blow at the prestige of steel.

It is a recognition of this community of interest that is in great part responsible for my appearance before you today in an effort to help you solve the problems of your branch of the steel industry by telling you how group cooperation is enabling us to apply modern principles of merchandising to the branch that fabricates structural steel.

Whether or not the great producers of steel from the ore realize in the near or distant future what will happen to the demand for their product should the cast iron boiler supplant the steel boiler, or a competitive product continue to displace the use of structural steel, we who depend upon the fabrication of steel boilers or the fabrication of structural steel for a living must, if we would continue to exist and progress, take the steps necessary to prevent encroachment by competitive products, to extend the field of usefulness of our product, and to arouse a public consciousness of the service steel will render.

Boiler Manufacturers Seek Trade Expansion

(*Continued from page* 157)

The officers of the association were re-elected with the exception of one member of the executive committee. The new member is Owsley Brown, Springfield Boiler Company, Springfield, Ill. The officers for the ensuing year are, therefore, as follows:

President—Geo. W. Bach, Union Iron Works, Erie, Pa.

Vice President—A. R. Goldie, Babcock-Wilcox, Goldie-McCulloch Company, Galt, Ontario, Canada.

Executive Committee—G. S. Barnum, The Bigelow Company, New Haven, Conn.; Jos. H. Broderick, The Broderick Company, Muncie, Ind.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, Ohio; Owsley Brown, Springfield Boiler Company, Springfield, Ill.; E. R. Fish, Heine Boiler Company, St. Louis, Mo.; J. F. Johnston, Johnston Bros., Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Company, Kewanee, Ill.; A. G. Pratt, Babcock-Wilcox Company, New York.

Trade Extension

After brief discussion, it developed that the members attending the convention were unanimously in favor of having a thorough survey made of the boiler manufacturing industry and several of the associate members pledged the assistance of their companies in this work.

It was finally voted, upon motion by H. E. Aldrich of the Wickes Boiler Company, Saginaw, Mich., that the executive committee be empowered to proceed with the preliminary work of arranging for a survey of the industry. The results will be submitted to the association at a special meeting to be held at a later date.

Registration

The following members and guests of the association attended the convention:

C. F. Abbott, American Institute of Steel Construction, New York.
H. E. Aldrich, Wickes Boiler Company, Saginaw, Mich.
Geo. W. Bach, Union Iron Works, Erie, Pa.
Geo. S. Barnum, Bigelow Company, New Haven, Conn.
A. L. Baylor, James Leffel & Company, Springfield, Ohio.
Grant Bradshaw, Andrews-Bradshaw Company, Pittsburgh, Pa.
Frank H. Brinig, Erie City Iron Works, Erie, Pa.
B. R. Bristol Superheater Company, New York.
Jos. Broderick, Broderick Company, Muncie, Ind.
M. H. Broderick, Broderick Company, Muncie, Ind.
H. H. Brown, THE BOILER MAKER, New York.
D. J. Champion, Champion Rivet Company, Cleveland, Ohio.
Pierre Champion, Champion Rivet Company, Cleveland, Ohio.
L. E. Connelly, Connelly Boiler Company, Cleveland, Ohio.
W. C. Connelly, Connelly Boiler Company, Cleveland, Ohio.
F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.
J. G. Eury, Henry Vogt Machine Company, Louisville, Ky.
E. R. Fish, Heine Boiler Company, St. Louis, Mo.
R. M. Gates, Superheater Company, New York.
A. P. Goldie, Babcock and Wilcox and Goldie McCulloch Company, Galt, Ont.
Chas. E. Gorton, American Uniform Boiler Law Society, New York.
J. S. Hammerslough, Springfield Boiler Company, Springfield, Ill.
A. W. Harris, Casey-Hedges Company, Chattanooga, Tenn.
Wm. Heagerty, Oil City Boiler Company, Oil City, Pa.
M. H. Jacobi, Springfield Boiler Company, Springfield, Ill.
J. F. Johnston, Johnson Bros., Ferrysburg, Mich.
J. V. Kimerer, Oil Well Supply Company, Pittsburgh, Pa.
Harry Loeb, Lukens Steel Company, New York.
Fred Low, *Power*, New York.
Geo. R. McAleenan, McAleenan Bros. Co., Pittsburgh, Pa.
H. L. McCulloch, Babcock and Wilcox and Goldie McCulloch Company, Galt, Ont.
Jas. McKeown, John O'Brien Boiler Works, St. Louis, Mo.
C. R. D. Meier, Heine Boiler Company, St. Louis, Mo.
C. W. Middleton, Babcock & Wilcox Company, New York.
Chas. O'Day, Oil City Boiler Company, Oil City, Pa.
A. G. Pratt, Babcock & Wilcox Company, New York.
J. F. Roberts, James Leffel & Company, Springfield, Ohio.
O. A. Rochlitz, Brunswick Kroeschell Company, Chicago, Ill.
N. L. Snow, Diamond Power Specialty Company, New York.
F. M. Speller, National Tube Company, Pittsburgh, Pa.
Chas. Tudor, Tudor Boiler Company, Cincinnati, Ohio.
M. B. Tudor, Tudor Boiler Company, Cincinnati, Ohio.
A. C. Weigle, Walsh & Weidner Boiler Company, Chattanooga, Tenn.
E. B. Wickes, Wickes Boiler Company, Saginaw, Mich.

Fusion-Welded Pressure Vessels*

Specifications for a 60-inch fusion-welded tank 20 feet long for a working pressure of 200 pounds

By S. W. Miller†

IT will be in order to explain why many of the A.S.M.E. code provisions are omitted in this proposed code.

Omission of Some Parts of the A.S.M.E. Code from Proposed Fusion-Welding Code

Section U17, giving the minimum allowable thickness of shell for given diameters, corresponds to similar provisions in other A.S.M.E. codes. (See section P17 of the Power Code, and Section H12 of the Heating Code.) In U17, the author believes the thickness of the smaller diameters was designed to allow for some corrosion. This is a matter that does not belong in a code, as corrosion is different in different places, and is therefore a matter for local decision and enforcement. Section U11 provides a general increase in thickness for corrosive contents, and Sections U53, U54 and U62 refer to means for internal inspection. If these provisions are followed there is no need for additional allowance in thickness requirements, which should be based, as in other codes, on the allowable distortion due to the weight of the tank, or similar considerations, so that the inherent advantage of welded thin shells over riveted ones may be available.

It is hard for one not used to welding possibilities to visualize that a tank 16 inches in diameter and No. 10 gage in thickness required a pressure of 990 pounds per square inch to burst it, but Bulletin No. 5 shows it to be a fact.

The author has omitted any minimum limits for thickness and has depended on the provisions of Section U60, which says that supports must be such as to distribute properly the stresses due to the weight of the tank and its contents, adding that in no case should the stress on any part of the tank be increased more than 500 pounds per square inch of plate by the weight of tank and contents, or attachments to the tank, over the maximum allowable fiber stresses due to pressure. This insures proper design of the supports. The third sentence of this section is not applicable to welded vessels as it refers to riveted construction only.

Section U23 contains the following provisions for fusion-welded vessels: Longitudinal welded seams shall be used only for air vessels and then the diameter cannot be over 20 inches, the length over 3 times the diameter, or the pressure over 100 pounds per square inch. Circumferential welds are limited to tanks 48 inches in diameter unless the heads are flat and 75 percent of the load is supported by stays, when the diameter may be 72 inches.

There is no sound engineering reason for any of these restrictions, and therefore they have been omitted. The tanks in Bulletin No. 5 were 24 inches in diameter and ⅜-inch thick, and many of them stood 1,600 pounds without leaking before rupture. This alone is sufficient to show that the code limitations are unreasonable. There is plenty more evidence to confirm this.

It is also evident that if it is safe to weld material ⅝-inch thick, which is permitted by the code in Section U70, and if a fiber stress of 8,000 pounds is safe, as shown by Bulletin No. 5, there is no need for any other restrictions, as these two automatically decide the diameter and pressure. The author knows that it is perfectly safe to weld material ¾-inch thick, and as tanks of this thickness have been made, tested in accordance with the code, and proved satisfactory in service, this thickness has been allowed. There is no reason why greater thicknesses cannot be welded. In fact, 1½-inch and 2-inch plates have been successfully welded, breaking at over 60,000 pounds per square inch of plate or else, with lower-strength plate, outside the weld.

Therefore the 3/16-inch thickness limit imposed by the code for longitudinal seams is uncalled for, and has been omitted.

There is no reason for limiting the diameter of welded vessels that would not apply equally to vessels with other types of joints. A weld is equally safe in 3/16-inch plate whether the diameter is 20 inches or 20 feet. If the volume of a large vessel is objectionable, either apply efficient and sufficient safety devices, or make the restrictions apply to all vessels. Other procedure than this is not based either on logic or engineering. The restriction applies only to fusion-welded vessels, and so has been omitted.

The length of longitudinal seams is limited to 3 times the diameter. There is no good reason the author knows of for this, there being no relation between diameter and length that influences the strength unless the tank be very short; and as in Bulletin No. 5 the test results show that the bursting fiber stress was practically equal to the ultimate strength of the plate, and as these tanks were not over 3 times their diameter, it is clear that with this ratio any influence of the heads is absent just as much as it would be in longer tanks, so there is no point in limiting the total tank length unless a much smaller ratio than 3 to 1 be adopted.

However, there is a practical reason for limiting the length of any course, which lies in the difficulty of welding the inside of a seam when the tank is long and of small diameter.

However, as it is not a matter on which strength depends, it has been entirely omitted from the code, and left to the manufacturer to work out.

The limit of 100-pound pressure is not reasonable because there is no greater stress on a weld in a 10-inch shell at 200 pounds pressure than in one 20-inch in diameter at 100 pounds, and because fiber stress is what governs the strength, not pressure. Also as the maximum fiber stress and maximum thickness are specified, this restriction has been omitted.

Nor is the restriction of longitudinal seams to air vessels based on any engineering reason. Content has no bearing on design, if the pressure exerted by the content be known. If it be not known, it must be determined before a design can be made. Excess pressure is always taken care of by safety valves or similar devices, and never by making a tank heavy enough to stand any possible pressure that might be generated in it. Also for a given pressure the fiber stress is the same for any content, and if the latter be dangerous, the local authorities should see that enough efficient safety devices are applied to remove the danger. This is not a function of the code, because it is impossible for it to provide for all possible conditions. The general principles given in the A.S.M.E. code, in Sections U2 and U10, go about as far as is possible in regard to safety devices.

The restriction of contents to air has therefore been omitted.

* Presented at a recent meeting of the metropolitan section of the American Society of Mechanical Engineers, New York. First installment appeared in the May issue of The Boiler Maker.

† Union Carbide and Carbon Research Laboratories, Inc. Mem. A.S.M.E.

Section U74 refers to convex heads, but its meaning is not at all clear as to the desired construction, though this could be easily remedied. But the requirement that the shell end shall be constricted is an entirely unnecessary burden, because there is no evidence that it adds to the strength. On the contrary, the treatment needed to do the crimping may cause injury to the weld. It is further evident that unless there is an exact fit between the head and shell the stress is on the weld in any case, it being in shear up to the yield point. Professor Roark gives a very good analysis of the stresses in this form of joint, in the paper referred to.

There may be no objection to an engineer specifying such a construction, but it should not be mandatory and therefore has been omitted from the code.

Section U79 provides that defective section of a weld may be repaired provided the value of the sheet has not been definitely lowered. This is impossible of enforcement, because there is no way of determining the value of the sheet. The entire section has been omitted as it is unnecessary.

SPECIFICATION FOR A FUSION-WELDED TANK 60 INCHES IN DIAMETER, 20 FEET LONG, FOR A WORKING PRESSURE OF 200 POUNDS PER SQUARE INCH

1 The tank shall be made in accordance with these specifications and the drawings attached thereto, and in accordance with the laws of the state and municipality in which it is to be operated. Unless otherwise specified it shall conform to the attached code for unfired pressure vessels.

2 The plate shall be of firebox quality made by the open-hearth process, and shall be of the following chemical composition:

Carbon	0.15 percent max.
Manganese	0.30 percent to 0.60 percent
Phosphorus, not over	0.05 percent
Sulphur, not over	0.05 percent

It shall have a maximum tensile strength of 56,000 pounds per square inch.

With these exceptions it shall conform to Sections S5 to S17 of the A.S.M.E. Power Boiler Code, and to the weight requirements of A.S.M.E. Spec. A70-24.

3 The welds shall be made by the oxyacetylene welding process.

4 All bevels shall be made by machining where possible. If it is necessary to trim or bevel plates with a cutting torch, all scale shall be removed down to clean metal. All surfaces to be welded shall be thoroughly cleaned before welding.

5 The welding rod shall be nickel steel to meet A.W.S. specifications, or of such other composition as will give practically equal weld strength and ductility, and that will meet the engineer's approval. The use of ordinary low-carbon-steel rod will not be permitted.

6 If approved by the engineer, the contractor may increase the number of girth seams to suit the size of sheets obtainable.

7 The length and radius of fillet welds shall conform to the note to Fig. U3 of the code.

8 In case a weld is found defective at any time during the test, it may be repaired as follows:

Pinholes shall not be calked, but may be welded up if the surrounding metal is properly preheated.

If a crack of any length appears in the welds at any time during the construction or test of the tank, it may be rewelded provided that it is not more than 3 inches long, that there is not more than one to each 6 feet of seam, that the weld metal along the crack is entirely removed, and that the surrounding metal is properly preheated. A general sweating of the weld under test may be repaired only by entire rebuilding of the vessel after all the weld metal has been entirely removed.

After repairs have been made, the vessel shall again be tested.

Rewelding may be done only once. Failure to pass the second test shall reject the tank.

T. D. Graham, who formerly represented the Republic Iron & Steel Company in its New York office, has assumed charge of the Cleveland territory of the Reading Iron Company, with headquarters at 850 Euclid avenue, Cleveland.

J. R. Vogelsinger, boiler foreman, Erie Railroad Company, Dunmore, Pa., has been transferred to the Erie Railroad Company shops at Hornell, N. Y., as general boiler foreman.

Fourth Annual Convention of National Board of Boiler Inspectors

THE National Board of Boiler and Pressure Vessel Inspectors held its fourth annual meeting, May 24, 25 and 26 at the Hotel Sherman, Chicago, Ill. In a brief outline of the high spots of the meeting the secretary-treasurer C. O. Myers reports as follows:

The meeting, which was well attended, brought out a thorough discussion on the question of uniform examination and uniform rules governing such examinations with the result that a committee was appointed to work out regulations covering the examination of applicants as inspectors and to prepare suitable questions and answers. It is expected that within the next year the matter of uniform examination questions will be well covered.

The board unanimously passed a resolution authorizing the secretary-treasurer to extend the stamping of the National Board to the Locomotive Code of the American Society of Mechanical Engineers. So far the National Board stamping has only been used on boilers constructed strictly in accordance with the A.S.M.E. Boiler Code.

A resolution was also passed to extend the National Board stamping to boilers constructed under the A.S.M.E. Miniature Code. However boilers built in accordance with this Code cannot be accepted in the state of Pennsylvania due to the fact that this state has in force regulations which do not conform to the requirements of the A.S.M.E. Miniature Boiler Code. The Pennsylvania representatives, however, agreed that a committee be appointed to work with the A.S.M.E. Boiler Code committee in bringing the Pennsylvania Code and the A.S.M.E. Miniature Code together.

Several new devices were submitted for approval but the board felt disposed to take action only in the case of the De Waters safety latch which was approved. All the other devices which were submitted were not essential for the safe operation of boilers and the board will not approve or disapprove any device which is not necessary for safe boiler operation.

T. McLean Jasper, director of research of the A. O. Smith Corporation, Milwaukee, Wis., delivered a very interesting address on the "Fatigue of Metals" which he illustrated by lantern slides.

Mr. Applebaum, representing H. Kriegsheim of the Permutit Company, New York, read an interesting paper on "Intercrystalline Cracks in Riveted Seams," which was also illustrated with slides.

J. P. Morrison, chief inspector of the Hartford Steam Boiler Inspection and Insurance Company, issued some instructive and interesting illustrations in the form of slides on various boiler explosions demonstrating the cause and effect of disasters of this kind.

A full account of the proceedings will appear in a later issue of THE BOILER MAKER.

New Turret Riveter

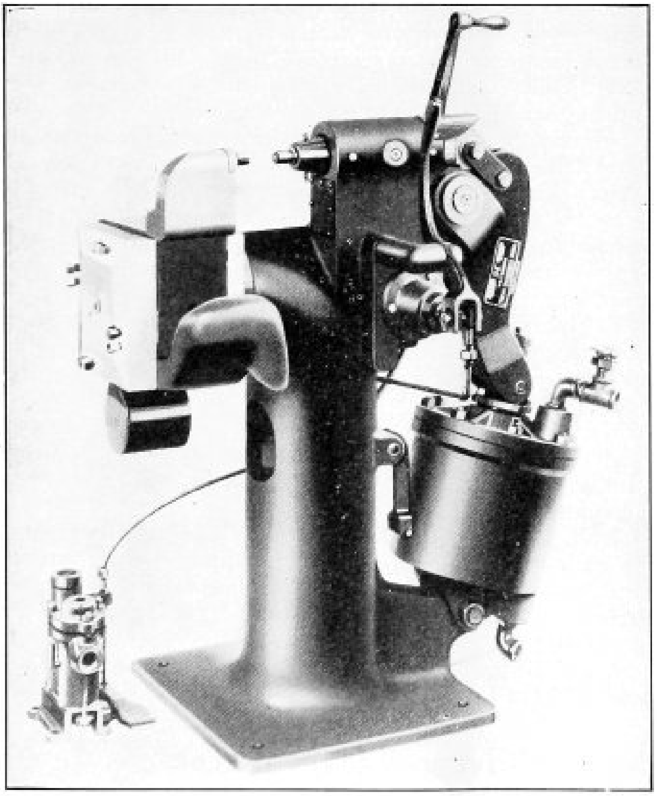
THE new riveter, shown by the accompanying illustration, is distinctive and decidedly unlike any other riveting machine offered. It is made by the Hanna Engineering Works, Chicago, Ill.

The riveting (pressure exerting) mechanism is the standard Hanna "Rapid" type. As the name implies, this mechanism operates rapidly. The principal features of design such as the air cushion at both ends of piston stroke, combined pressure flood feed lubricating system, piston packing adjustment, which is made from the outside, all contribute to this rapid operation.

The mechanism is a combination of a simple lever and toggle which combines a long die stroke with a wide range of uniform pressure, thus eliminating the necessity of screw adjustment on the die. The die travel is very rapid as the die approaches the work. The die or plunger speed gradually decreases until it enters the uniform pressure area of the stroke; hence the pressure is uniform. The advantage of this die stroke is, where the work is lightest the speed is greatest. As the rivet head forms, the pressure increases, reaches a maximum and maintains it for several inches of piston travel. Ordinary variations in rivet lengths and plate thicknesses are automatically taken care of by the wide range of uniform pressure.

The turret head has a spindle which rotates in a long hole through the large barrel of the riveter frame. It is of alloy steel, heat treated, is machined to fit in the bearings at each end of the barrel and to mesh with interrupted thrust grooves in the wall of the barrel making a breach lock construction to resist the riveting thrust which tends to pull the turret spindle out of the barrel.

The turret head is locked in the positions that bring each of the four noses into alinement by means of an index pin, which selectively engages with four holes spaced around the cylindrical surface of the turret spindle. These holes are bushed with hardened sockets, which have slots crosswise of their axis. The walls of these sockets are tapered to conform to wedge-like flats on the index pin at the end which enters the sockets. The axis of index pin intersects the axis of turret spindle and is perpendicular thereto. The taper of the wedge end of the index pin is self-locking against rotation of spindle. The index pin is of tool steel, hardened and ground.



Turret riveter incorporating Hanna "Rapid" mechanism

This index pin movement is air actuated in both directions. The double acting air cylinder is supplemented, however, by a hand lever. The spindle is rotated by a hand crank. This crank is also coupled to the valve of the index pin air cylinder so that crank movement longitudinal of the turret spindle pulls the index pin, and reverse movement forces the pin into the turret spindle.

To index the turret from one position to another, the operator moves the end of the hand crank about 3 inches front and thus pulls the pin, then rotates the crank 90 degrees about the spindle axis bringing the turret to the next position. Release of the crank allows it to move back to neutral position which results in the index pin being forced into the spindle and held there. Moving the crank further back releases it partially from the turret spindle so it may be rotated independent thereof. Therefore, the crank though limited to 90 degrees rotation is effective in revolving the turret through 360 degrees.

The swivel base with which this riveter is sometimes equipped consists of a generous size floor plate and post which is embraced by the column of the frame. Contact between these two is through the medium of a ball step bearing and a bronze annular bearing. Swiveling the riveter rather than swinging the work minimizes the floor space required and simplifies shop layout.

The riveter is locked in two or more index positions by a vertical pin in the lower portion of the frame column which engages holes in the base. This pin is geared by a pull rod and bell crank to the turret index pin cylinder so that it pulls both pins as does also the supplementary hand lever.

Movement of the riveting mechanism is controlled by one of the standard operating valves manufactured by the Hanna Engineering Works and is foot operated. The operator steps on a heel pedal and the rivet die advances. Lifting the heel reverses the valve and the die returns. When the riveting die is clear back, the valve is brought to neutral position by a Bowdin wire from the riveting mechanism. This accomplishes the double purpose of shutting off the air intake on return stroke instantly that the riveting die is returned, preventing a useless rise in cylinder pressure and of excluding all air from the riveter during all intervals between riveting strokes. The result is air conservation.

The operating valve combines a soft disk poppet type stop valve with a spool type distributor valve. The poppet is seated when the heel pedal is centralized and air is shut off dead tight at the inlet. The ease with which the valve is actuated (merely rocking the foot from toe to heel) combined with the "Rapid" riveting mechanism and quick indexing all make for high riveting production. The riveter may be operated as fast as fifty cycles per minute.

The machine occupies a floor space of 30 inches by 40 inches and is 45 inches high. Work may readily be passed over the riveter in its progress through the shop. Little, if any, foundation or anchorage is required.

Business Notes

Richard R. Harris has been appointed general manager of sales of the Pittsburgh Steel Company and subsidiary companies which include Pittsburgh Steel Products Company and National Steel Fabric Company, Pittsburgh, Pa. Mr. Harris has been general manager of sales of Pittsburgh Steel Products Company for about twenty years. George W. Jones who has been assistant general manager of sales of Pittsburgh Steel Company now becomes manager of sales succeeding John F. Hazen, resigned. Charles F. Palmer who has been manager of the Chicago office of the Pittsburgh Steel Products Company has been made manager of sales of this company and Edward L. Benedict continues as vice-president and manager of sales of the National Steel Fabric Company.

Among the improvements being made at The Ludlum Steel Company Plant, Watervliet, N. Y., is the enlarging and entirely rebuilding of one of the ingot heating furnaces for their 18-inch mill. This will give a very much increased output on this mill.

T. F. Powers,
Retiring president

J. F. Raps,
President-elect

W. J. Murphy,
First vice-president

Master Boiler Makers Meet at Buffalo

Seventeenth annual convention breaks records of attendance—Valuable work accomplished in adopting standard practices

IN the matter of attendance the seventeenth annual convention of the Master Boiler Makers' Association, which was held at the Hotel Statler, Buffalo, N. Y., from Tuesday, May 25 to Friday, May 28, broke all convention records of the association. There were nearly 900 members, supply men, ladies and their guests registered; about 400 members of the association, which includes nearly all of the active list, were at the meeting. The opening session began at 10:30 A.M., May 25, with T. F. Powers presiding.

After the invocation by the Rev. Dr. Broughton, A. G. Buckley, convention manager of the Chamber of Commerce, welcomed the convention to the city in the absence of John T. Love, acting mayor of Buffalo. F. M. Barker, who is vice president of the Chamber of Commerce as well as superintendent of the Lehigh Valley Railroad at Buffalo, amplified Mr. Buckley's remarks about the attractiveness of the city for conventions and then as a railroad officer outlined the financial condition of the railroads. The improvements made in the physical conditions of the roads in the country for the past five years have had to be met by ever increasing

Some of the members just outside the Statler Hotel bond issues, he said. The revenue derived from operation has not been adequate to bring up the standards to a higher level—this in spite of a greater degree of economy on the part of practically every division and department of the railroads. He stressed the importance of every member of this association as well as others in the employ of the railways to make known this condition to the public. Mr. Barker said that savings in the shops are important but the establishment of fair rates that will allow the roads to maintain themselves is the only direction from which real relief may be expected.

Mr. Barker was followed by Walter H. Flynn, superintendent of motive power of the New York Central, New York. In his remarks, Mr. Flynn gave great credit to the master boiler makers of the country for the manner in which with ever increasing problems of higher pressures, thicker plates, increasing weight and greater capacities of locomotives, they have overcome, the difficulties. The way is open, he said, for members of the association to carry their work to a still higher point of efficiency and since the dependence of the public on the railroads is greater than ever before from the standpoint of service and safety, the members of the association have a rare opportunity of meeting the confidence placed in them. An abstract of Mr. Flynn's address will appear in a later issue.

The president's annual address was next delivered by Mr. Powers.

Abstract of President Powers' Address

OUR past annual conventions have been successful. We have been improving each year and it is my earnest desire that this, our seventeenth annual convention, may be the most successful of all and there is no reason why it should not be.

It is only by our attendance at each and every session that we can go back to our employers and demonstrate that it paid them to send us here. I know that this will be the case for we have a reputation of being a hard working organization; one whose members are always in the meeting room during business sessions and who are anxious to take part in the discussions.

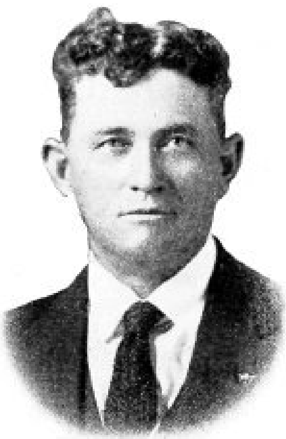
In these days of larger boilers, thicker plates, higher pressures and longer runs, there are many new and unsolved problems for the man responsible for boiler maintenance and operation, and new difficulties are arising each day.

Each one of us has his own problems to solve and it may be that someone here has solved the problem you are working on and is anxious to give you the answer. Look him up and discuss your successes as well as your failures.

The railroads today are required by law to operate their property safely and economically. This is impossible unless the personnel in charge of boilers and who are directly responsible for their safe maintenance and operation, understand and realize the responsibility that is placed upon them. That they do, is proven by the many remarkable performances obtained on the railroads today. Many of the records made in reducing expenses and increasing the mileage between engine failures are due to the efforts of the men in charge of boilers.

The boiler inspector, boiler foreman, general boiler inspector or general boiler foreman is today a very important part of our railroad mechanical organization. With the ever increasing size of the boiler, and corresponding increase in the pressures carried and due to the many shop problems involved, to say nothing of the laws governing boiler inspection and maintenance, he is indeed a specialist in his class and must be of the highest caliber if he is to be successful.

The remainder of the morning session was devoted to action on the reports of the secretary and of the treasurer and the conduct of routine business. An important motion was passed covering an amendment to the constitution with the object of arranging for the reinstatement of delinquent members. As a result of this action, a number of delinquents were received back into the association. Some of these men had not been present at conventions for a number of years. It is interesting to note that during the course of the meeting 44 new members were elected to the association.



L. M. Stewart
Second vice-president

S. M. Carroll,
Third vice-president

G. B. Usherwood
Fourth vice-president

Tuesday Afternoon Session

The Tuesday afternoon session was opened at 2:00 P.M. by the president, with the reading of the committee report on "Flue Sheets in Combustion Chamber and other Type Boilers." F. J. Jenkins was chairman of this committee having as members George Austin and J. Finucane.

Flue Sheets—Combustion Chamber and Other Types of Boilers

THE committee report was subdivided as follows:

(a) **Direction, range and extent of movement of crown sheet with relation to related parts, and how can conditions be best controlled or provided for:**

Your committee has nothing further to add to this topic than covered by report of committee on the subject to the sixteenth annual convention of the association in 1925.

We do not find any material difference in maintenance of firebox flue sheets in combustion chamber type and other types of boilers.

A few convention personalities

This committee believes the movement of crown sheet in relation to other parts can be controlled to some extent in the handling of locomotives at terminals.

While we fully appreciate the necessity of furnishing power when required by transportation department, and that it is necessary sometimes to transgress the best practice in order to furnish power as needed, still our forces in charge of the handling of locomotives in engine houses should be thoroughly educated to the importance of maintaining as nearly as practicable, equal temperatures and avoid extreme variations of temperature between one part of the structure and other parts. The practice of removing pressure and water from boilers immediately after engine has been placed in engine house, with the brick arch in coal-burning engines and the fire-pan brick in oil-burning engines still at high temperature, is responsible for many of the cracks which develop in flue sheet connection with crown sheet and other parts of firebox.

Recommendation of this committee, particularly in case of oil-burning locomotives, is that they be permitted to stand under pressure after fire is withdrawn, and cool down for a period of three hours or more before steam and water are withdrawn from the boiler. This will prevent excessively rapid contraction of crown sheet and flues.

Hot water boiler washing systems, which have come into general use in late years, are of great value in preventing damage to firebox sheets and boilers, when properly handled. Water provided for washing boilers and for fill-up purposes, should be maintained at as near the temperature of the boiler as practicable. Proper washing of boilers will obviate many of the difficulties encountered in upkeep of boilers and provide a large asset in the prevention of cracking back flue sheets in any type of boiler.

Your committee is unable to secure any information on the results obtained from "direct steaming" as installed on the Grand Trunk and other railroads. However, there may be some merit in heating the entire boiler to uniform temperature by means of this system, which consists in turning live steam from power plant directly into the locomotive boiler and raising pressure before fire is lighted in the furnace.

(b) Design of connections between flue sheet, crown sheet and side sheets:

It is an undisputed fact that a riveted connection between the flue sheet, the crown sheet and side sheets, with a short flange, creates a rigid condition in the construction, which will also contribute to the cracking of the flue sheet in the knuckle of the flange. Therefore, to provide greater flexibility at this point, it is the opinion of this committee that a welded joint at this location would provide desirable flexibility without weakening construction or jeopardizing safety of design. This also applies to door sheet connections to the crown and side sheets.

(c) Bracing of flue sheets:

We know of no other method of bracing flue sheets except the usual braces applied below the flues, the flexible design of which is most desirable, with the exception of braces applied at the sides of flue sheet to cover the area not braced by the flues, when flues are so spaced as to require such braces.

(d) Crown bolts—the design and arrangement of which have influence upon the flue sheet:

Up to the present time, nothing has come into use to take the place of flexible, or expansion stays, in the larger percentage of locomotives, which are so equipped at the front end of crown sheet.

There should be sufficient space provided between head of bolt and the cap on the sleeve, to fully take care of the upward movement of the crown sheet.

It is the unanimous opinion of the committee that the flexible or expansion type of stay has been of great advantage over the old method of staying crown sheets close to the flue sheet connection, and in the prevention of cracking at the front end of crown sheet and flue sheet in knuckle of flange. Without the use of flexible or expansion stays, these cracks would be more prevalent.

(e) Development of any form of distress in flue sheet connection with crown sheet:

This is covered in the foregoing portion of this report. Distresses developed in flue sheet connection with the crown sheet are caused by uneven temperatures to which firebox and boiler are subjected, setting up strains in this location due to unequal expansion and contraction. The severity of these stresses, of course, depends upon the length and size of the firebox.

The officer in charge of boiler maintenance can largely regulate these changes in temperature while the boiler is in his charge.

1. In what form:

Cracking due to unequal expansion and contraction. It is the opinion of this committee that the flue sheet in combustion chamber type boiler is not more subjected to cracking than flue sheet in straight firebox type boiler, if the flues are spaced an equal distance from knuckle of flange in both types of boiler.

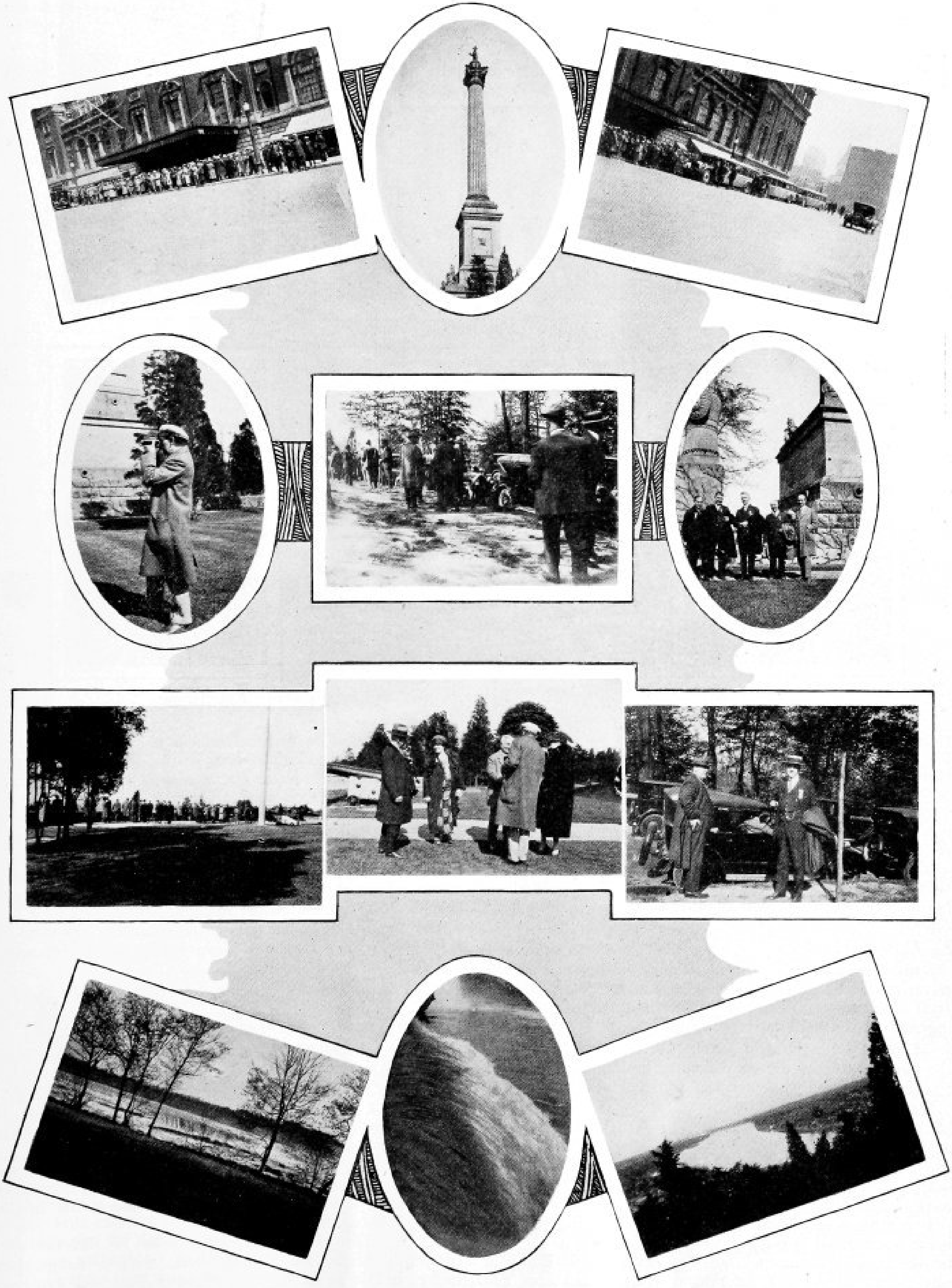
It is brought out in our own experience that when the flues are spaced too close to knuckle of flange, that cracks will develop much more quickly than when flues are spaced

K. E. Fogerty, Fifth vice-president

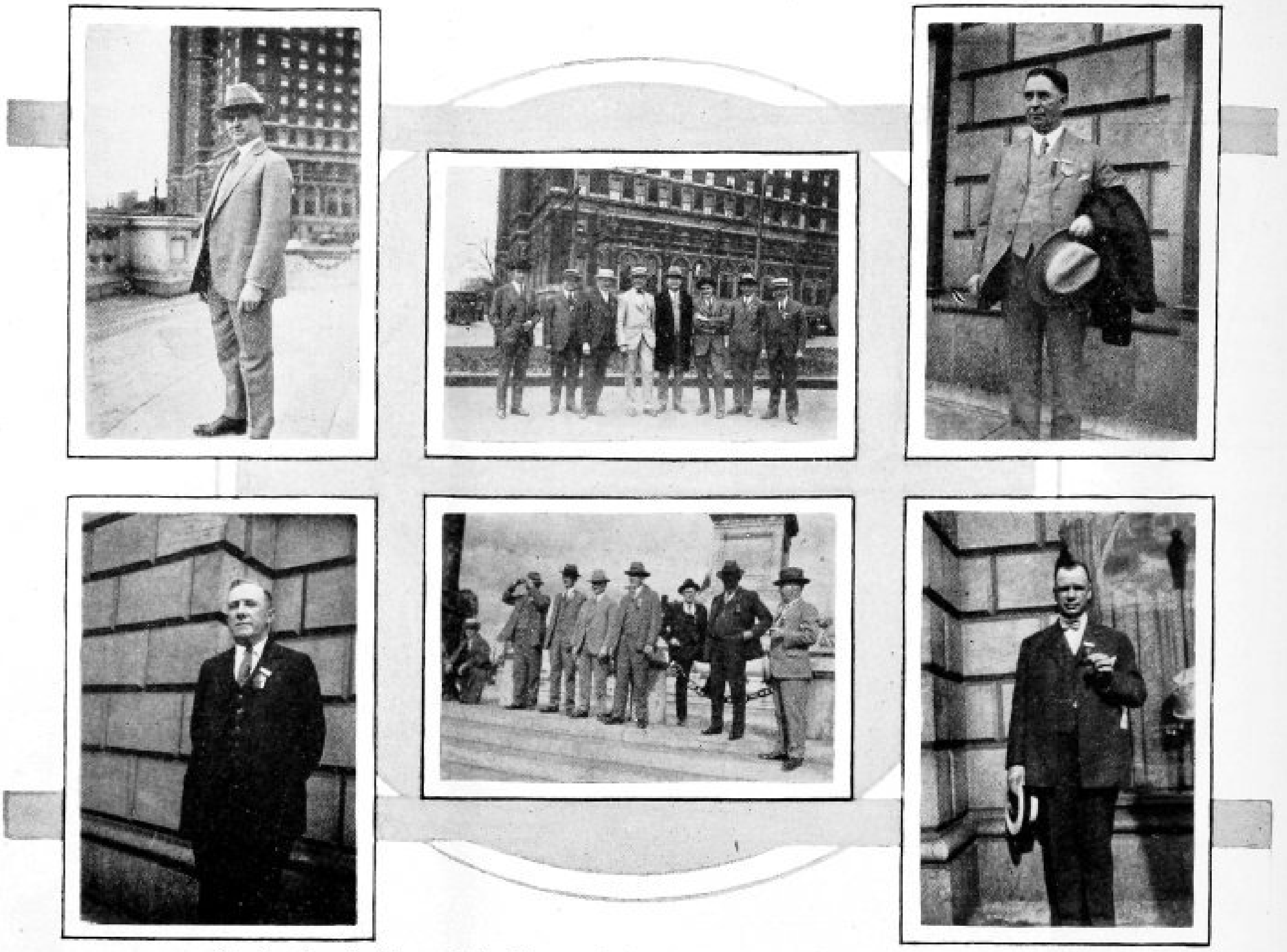
W. H. Laughridge Treasurer

Harry D. Vought Secretary

A. F. Stiglmeier, Chairman of board



Views taken on the trip to Niagara Falls and the Brock Monument



Newly elected officers of the Master Boiler Makers' and Supply Men's Associations

farther away from the knuckle of flange. It is believed that the best practice calls for a minimum of two inches from center of knuckle to the outside edge of the flue hole.

Cracks in the knuckle of flue sheet at the bottom and sides of the flue sheet in large locomotives of the present day, do not develop from excessive corrosion and pitting, but from the movement or working of the sheet at this location, caused by the flues being spaced too close to the flange, and there not being sufficient flat surface to provide flexibility with which to counteract vibratory motion due to alternate expansion and contraction.

2. **How cared for:**

This committee can add no further information to the report submitted at the 1925 convention on "Cracked bridges, cracks in flange knuckles, etc.," as regards methods of making repairs.

3. **Effect of length and staying of combustion chamber as well as the relation of combustion chamber to the barrel sheets upon the flue sheets:**

We are of the opinion that length of combustion chamber has no bearing upon the flue sheet, except that the longer type of combustion chamber affords more protection to the flues and flue sheet from the effects of extreme temperature when subjected to open flame; and believe that slightly better performance results therefrom.

It is recognized that the flexible or expansion type of stay is the best method of staying combustion chamber to the barrel sheets, with a view to providing necessary flexibility to care for expansion and contraction at the knuckle of flue sheet.

This committee has information of instances where the bottom portion of combustion chamber sheet developed crack at the calking edge of flue sheet, or the first transverse row of staybolts. This may be due to flexible sleeves being corroded, making the bolt solid and rigid, thus destroying its flexibility. The same condition prevails at the top portion of the combustion chamber, where cracks are developed along the line of the calking edge of the flue sheet; due possibly, to a slight grooving at the calking edge of the flue sheet, and the rigid riveted seam at the flue sheet and combustion chamber sheet connection.

This report was prepared by a committee composed of F. J. Jenkins, chairman, George Austin and J. Finucane.

DISCUSSION

L. M. STEWART (Atlantic Coast Lines): We have been welding fireboxes fourteen years, and we have the welded seam, of course, and we still have the cracked knuckles. I am not in a position to say whether the life of the riveted flange would be longer or shorter than the welded flange, because we have not any riveted flanges to amount to anything, but I do know that in the welded flange which we have been using for fourteen years we have any amount of cracked knuckles in the flue sheet.

J. W. HOLT (Chicago & North Western): Is it better to have a riveted flange across the flue sheet and door sheet, or a welded flange? Which gives the longest life in that particular position?

W. H. LAUGHRIDGE (Hocking Valley): So far as I personally know, the welded sheet, with a flange, long enough to take in the first row of crown bolts, will run twice as long as the sheet that is riveted in with the short flange. That is our experience with the heavy type standard.

William Moore (Pere Marquette): We are allowed to weld fire-boxes—it is also written that we can double that weld, that means in the entire firebox. There is nothing that prohibits welding in the firebox. On new firebox construction on the Pere Marquette we are welding our fireboxes with a 3/8-inch double lap weld. We do not do any butt welding closer than 15 inches below the highest point of the crown sheet. We have thirty combustion engines, and these give us more trouble on flange knuckles than our other classes of power. The flue sheets are flanged with 3/4-inch radius on a riveted end—a short combustion chamber about 20 inches long. Now we were contemplating changing the radius of our flange, going to a little larger flange, but of course in doing that we know we are getting away from the transverse crack. I would like to have some of the gentlemen in the audience who have had experience with the change of radius of back flue sheets give me their experience on going from the 3/4 to 1-inch or even 2-inch radius on back flue sheets.

T. P. Madden (Missouri Pacific): I applied a firebox twenty years ago at Sedalia on the Missouri Pacific, and in that firebox we didn't have a rivet inside of the fire line at all. I reversed both flanges on the door sheet and flue sheet. I was located at that point for three years after the firebox was applied, and during that time we never had any trouble from it. My object was to get the knuckle of the flue sheet out of the water side and put it in the fire. And that firebox ran for eight years. We had no defective knuckle on the flange of that flue sheet, but it did break at the O. G. after seven or eight years. In those days it was hard to put the flange in the water and reverse it so that it would take care of the mud ring. I believe if we should apply fire sheets—reverse the flange weld from a point 36 inches up from the grate line, that it would eliminate our trouble to a great extent.

Now we are applying 5/8-inch flue sheets in our modern fireboxes. We are not permitted on our railroad to put a patch on the top knuckle of the flue sheet when it goes through the back shop for general repairs. We are permitted to put a patch on a flue sheet in the round house.

W. J. Murphy (Pennsylvania): What depth of flange did you have?

T. P. Madden: Two and one-half inches. In applying this flue sheet with reverse flange, it was applied in a new firebox. You had to extend the crown sheet just that much longer. That is all you had to do.

W. J. Murphy: What length flues was it, Mr. Madden?

T. P. Madden: 13 feet 6.

T. P. Madden: The gentleman asked me if we should eliminate the rivets if we would apply the flue sheet like that today. I said no. You will still apply your rivets, but they will be in the water instead of the fire, down as far as you want to go. We generally weld all our flanges 36 inches above the mud ring; that is, in our coal-burning engines. On the oil burners it is a little different.

O. H. Kurolfinke (Southern Pacific): Could you not weld it cheaper?

T. P. Madden: We are not permitted on the Missouri-Pacific to do any welding on the crown sheet.

O. H. Kurolfinke: I want to bring out the point there is enough talent here to answer the question if welding would not do instead of rivets.

T. P. Madden: That is optional with the boiler makers, or the master mechanic.

John Harthill (New York Central): The question was asked whether the large knuckle was a benefit over the small knuckle—3/4-inch radius or the 2-inch. I have had considerable experience with both the 3/4 and 2-inch radius, also changing the flange from 2 1/2 to 5 1/2 inches, and I will make this statement—that flue sheets on the 2 1/2 flange 3/4 radius gave us from one and one-half years to two and one-half years service; also the 2-inch radius gave us some. Therefore, gentlemen, I will make this statement in regard to something like 500 flue sheets, that there was no difference in regard to the 3/4 radius to the 2 1/2, or the 2 1/2 flange to the 5 1/2 flange.

G. W. Bennett (Bureau of Locomotive Inspection): I have had considerable experience due to cracked flue sheets, and tried out 1 1/2 radius, 2-inch radius and 3-inch radius, with 5-inch flange and 2 1/2-inch flange, and found out that they crack just as bad as they did with the 3/4 flange or with 3/4-inch radius. With the 3/4-inch radius we got better satisfaction with the flue sheets, due to eliminating cracking, than with the large flange. And I found out that the best way to eliminate the cracking was to allow more space between the top of the flue hole and the knuckle of the flange.

H. A. Osborne (Chesapeake and Ohio): We have a few left of the unthreaded seams, old fireboxes. We have got door sheets in service today I believe that have been in for twenty years, or nearly so. And we have no trouble with them, only they pit around the staybolt holes. That is the only trouble we have with the unthreaded seam on a door sheet. I believe if he would unthread the seam on the flue sheet at the top knuckle we would be eliminating a lot of the top flue sheet flange cracks.

L. Borneman (C. St. P. & M.): In all these discussions about the top of your flue sheet knuckles cracking and everything, I will tell you the water conditions must be taken into consideration. You can hold flue sheets and fireboxes in good water many years where you cannot do it in bad water conditions.

James Doran (Gulf Lines): We have had 30 engines in the 4,000 class down in the Gulf Lines; one of them was in the bad water district and others in what we consider the good water district. In the bad water district—the knuckles had to be patched, while we also found a good many broken radial staybolts and flexibles. We didn't find the same condition in the good water district. It looks to me like water conditions and service have a great deal to do with the cracking of the flue sheet knuckles, staybolts and radial stays. By reinforcing the knuckle with welding, we got much longer service even in bad water.

A. G. Pack (Chief Inspector, Bureau of Locomotive Inspection): Mr. Doran has just spoken about plastering up the cracks that take place in the knuckle of back flue sheets. It has always been my understanding that this cracking and checking on the water side of the flue sheets was due to the working of the material, caused by contraction and expansion, which open the pores of the metal to the action of the acids in the water. I would like to ask Mr. Doran how he accounts for the failure to check and crack in welding, just as badly as the knuckle of the flue sheet itself did.

Henry J. Wandberg (Milwaukee): The best preventive I have found for cracking in the top flange of the flue sheet is clean boilers and keep the expander out of your flues. I don't think there is any such thing as reinforcing that sheet so it will stand if we continually keep working the flues.

As far as pitting is concerned, we find top flanges cracked where there is no pitting at all. We find them where they buckle up like that—cracked. We never find one where the flange is normal.

E. W. Jansen (Northern Pacific): I would like to start this discussion along on a different line of thought. I believe that a lot of this trouble is caused through an operating condition and not through construction.

Now we all know that the cracking takes place at the top of the sheet. One of the gentlemen here says that the size of the radius makes no difference. That has been my observation. Large radius or small didn't make any difference—3/4-inch or 2 1/2-inch radius.

Engines in different places working in different districts, maybe one has a more or less easy time of it, not so much shutting off or opening up—severe service—might not have

Banquet of Master Boiler Makers and Supply Men

been caused through a water condition but through the operation condition of that engine. So it might be eliminated by raising the water level.

GEORGE AUSTIN (Santa Fe): I believe that the bad water conditions are largely responsible for premature cracking of the top flanges of back flue sheets, for the reason that in bad water districts you are compelled, if you want to operate the locomotive, to wash it or change the water more frequently than you do in districts where you have what you might call good water conditions.

It is our observation, and as a result of our tests, that very serious stresses are produced when you undertake to cool down a locomotive boiler and handle it quickly and fire it up again—wash it and fire it up again, and then get it in the service. The requirements of business compel the roundhouse foremen at times to handle locomotive boilers in a way that we know they should not be handled, but it is more important to get that engine out than it is to hand the boiler entirely according to what we might consider scientific rules.

Now in regard to reinforcing the top flanges of flue sheets, I think Mr. Pack asked a pertinent question there, and I think he solved it himself. It reinforces it, and we do get a little better service, or, rather, a longer service. I wont go as far as Mr. Doran has stated, that it will last as long as the original sheet. But it does help to get a much longer life out of the flue sheet than it would have done if we had not reinforced it. And I believe the reason for that is that you make it stiff enough that you transfer that bending movement which is the cause of the crack to some other part, maybe to the front flue sheet or to the flat part below the flange of the flue sheet.

I believe that the increased cracking in the top flanges of back flue sheets is not the result of the change in staying; it is not the result of working flues. In my notion it is the result of applying a 5½ tube up there instead of 2¼ or 2-inch tube you used to have. The 2-inch used to sag of its own weight and would give a little bit. These 5½-inch tubes wont do that. They are much heavier or stronger trussed and consequently they don't give and the flue sheet has to take all that movement, and that amounts to about 3/16th of an inch in the variation of temperature of that boiler.

It was my privilege to appear before the Bureau of Standards at one time in reference to the top flanges of flue sheets cracking. We have had locomotives that failed in 23,000 miles. Top flue sheets cracked across. Others made sixty or eighty thousand. But we seldom have a flue sheet in one of our large locomotives that will run seventy or eighty thousand miles. It must be patched.

A. G. PACK: I have given the matter of the cracking at back top knuckle of front flue sheets considerable study. It is generally admitted all over the country that when you are firing up your locomotive, the flame being drawn through the flues, immediately expands your flue sheet. This, being your crown sheet, rises. Expansion stays have been put in so as to extend that back further and relieve the bending in the knuckle. But just as soon as your steam pressure gets up you bring it down and bend your knuckle just the same as was the case before.

Now if you have a right-angle knuckle—you go to one extreme—if you have the right-angle knuckle, you concentrate bending along that line, don't you? If you put in a knuckle of a longer radius, you will change that bending from one particular point which causes cracking to a greater distance over a greater area, and you relieve the very thing that causes your cracking.

About fifteen years ago I was at a point where I was having a great deal of trouble with a particular type of heavy locomotive power. And about six or eight months was all they could get out of the top knuckle. I suggested to the superintendent of motive power that he do away with this top row of flues and put in a longer radius. After that they got from eighteen to twenty-four months out of those same engines.

Now one purpose in reducing the radius of your flue sheet is to get another row of flues up there by increasing the area of your flue sheet. But in doing that you must put in a shorter radius knuckle, and whenever you decrease the radius of that knuckle you contract the radius that the bending takes place in. You may take a piece of iron or wire around a big circle, and you can work it indefinitely before you get a crack. If you bend it at right angles and begin to work it, you break it off right quickly.

I don't believe expansion stays, the old-fashioned T bars with expansion straps, amounted to that much (motioning), because you could not run them in bad water districts over thirty to sixty days, until the slots in them became perfectly solid and you could find no signs of movement at all. Therefore they were just as rigid as the button headed stay. But I am satisfied if you lengthen the radius in the top knuckle of your back flue sheet, so as to extend the working over a greater area, that you reduce the cracking. This seems logical if all the conditions prevailing at this point are taken into account.

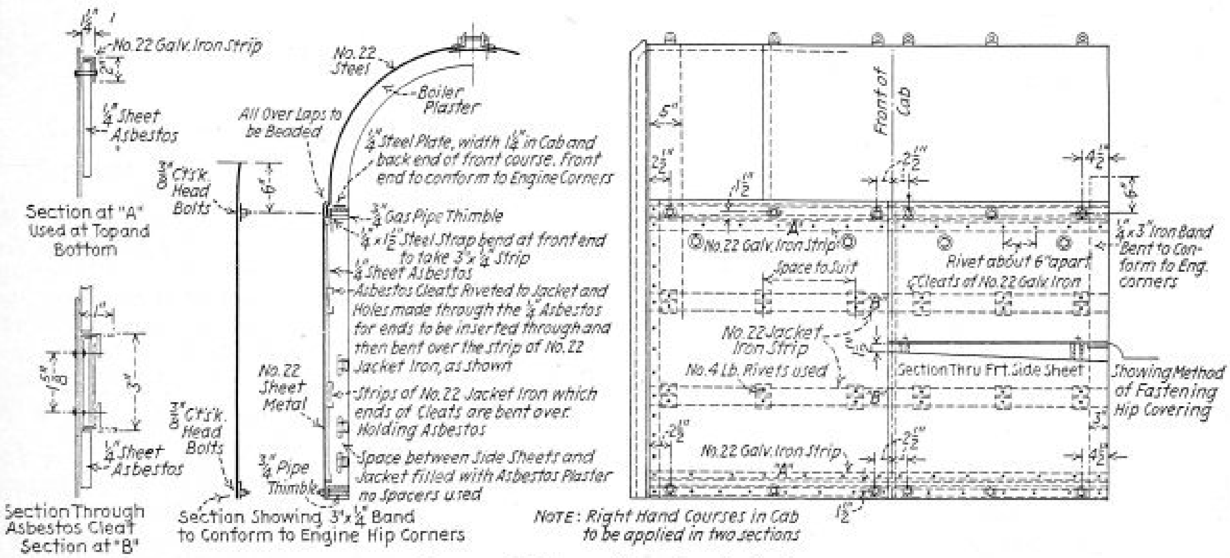
There is nothing going to stop that pitting and grooving that takes place there except to improve your water condition. Water condition has a decided effect on it. A knuckle that will run in one section of the country indefinitely will run a very short period in another section. It is the action of the water and the movement of the sheet that causes your sheets to crack.

Topic 5 devoted to the discussion of boiler lagging was next taken up by the meeting.

Best Form and Arrangement of Boiler Lagging and Jacketing

THERE are several methods of applying lagging and jacking over the tell-tale rigid bolt zone which have been used by the different railroads in the country for a number of years and have been deemed satisfactory.

The arrangement most commonly in use is that of applying the jacket in sections; each of these sections made up in the size and form which makes it easily handled and readily removed and applied to the boiler. Around the inside edges of each of these sections of jacket, a light angle made of jacket material is fastened to the jacket. The lagging is applied to each section of jacket in either board or plaster form and is supported in place with lagging wire which is fastened to the flanged angles. Jacket sections made up in this manner are sometimes perforated over the end of each staybolt. To each of these perforations a thimble is applied. This thimble is as long as the lagging is thick and in such perforated jackets, the lagging is applied always in plaster form and the thimbles used as supports for the lagging, making the use of wire unnecessary.



Suggested form of lagging for boilers

In our opinion the perforated jacket set up in sections answers the title of this paper best, as its removal is not necessary for the inspection of tell-tale holes; neither is it necessary to remove the jacket for the drilling or cleaning of tell-tale holes or to remove the broken bolts which through inspections may be found from time to time. Practically all types of sectional lagging and jacket on this location of the boiler are supported on the boiler with studs.

A very practical method for the application of sectional lagging and jacket is shown on the prints furnished with this paper. This type of jacket has been in use on the Great Northern Railroad for some time and from what this committee is able to learn has met with the approval of all those required to take care of its removal and application.

This report was prepared by a committee composed of Franklin Litz, chairman, C. C. Butler and M. J. Guiry.

DISCUSSION

GEORGE AUSTIN (Santa Fe): I would like to offer a resolution that the applying of perforated locomotive jackets so that the tell-tale holes or the holes in other staybolts may be inspected to ascertain whether or not they are open, is not necessary for the safe operation of the locomotive boilers.

J. W. HOLT (Chicago and North Western): On the question of applying jacketing to fireboxes, the proper practice in my opinion would be to thimble all holes that you possibly can before applying the jacket to allow a vision for all staybolt inspection at all times. I find that it costs more to take the jacket off of a back hip than any other part of the boiler, due to the fact that there are so many pipes and fittings there. Another question in my mind is whether it would be advisable to weld this jacket instead of riveting it?

Our regular method of applying jackets is by studs in the firebox side. And we generally use one sheet below the firebox, one sheet outside of the cab, and one inside.

P. S. HURSCH (Buffalo, Rochester & Pittsburgh): We apply jackets in pieces. There is a strip above the firebox with bolts studded about two inches or a three-quarter stud put in the boiler at each end of a piece of quarter inch flat iron, with a thimble back, standing away about two inches from the boiler. The jacket is made in two pieces, one inside the cab and one outside above the running board. This is made by using two pieces of jacket iron with a piece of 5/8-inch asbestos sheeting between them. That is bolted to the side. The back head is made in the same way, in two pieces, running up as high as the firebox line. Of course the back head is a bad place to remove lagging or jacketing, but it has to be removable. We don't use any jacket below the running board, but it is easy to remove the jackets in the cab by unloosening a half dozen small bolts that run into this quarter-inch flat iron, and you can take that piece off and inspect any bolts you want to with very little cost.

A paper on "Shop Kinks" prepared by a committee consisting of Charles J. Baumann, chairman, C. H. Browning and Ira J. Pool was next in the order of business. This paper was divided into sections and each section discussed as it was read. The complete paper and illustrations accompanying it will appear in a later issue.

Wednesday Session

The meeting on Wednesday morning was brought to order at 9:00 A.M. by the president. The first speaker of the day was A. R. Ayers of Cleveland, assistant general manager of the Nickel Plate Railroad. An abstract of his address follows:

Locomotive Developments

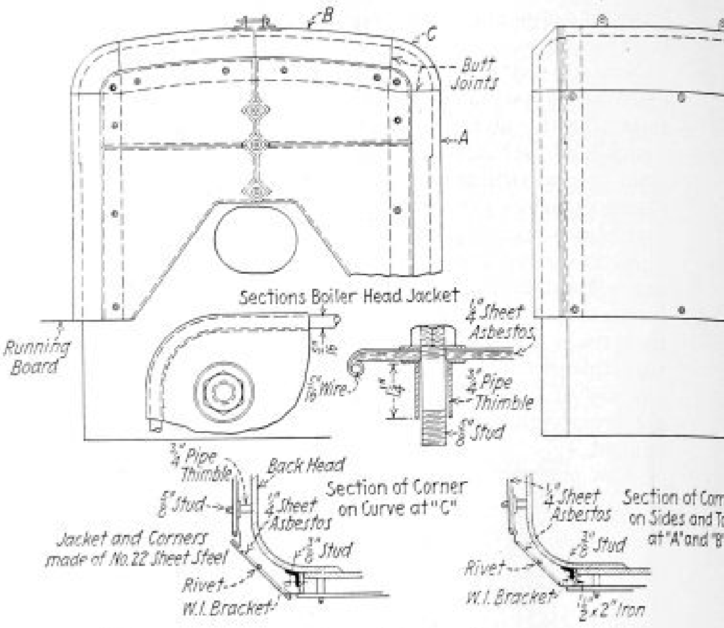
By A. R. Ayers*

SINCE I had the honor and pleasure of addressing your association four years ago—your responsibilities have continued to increase with the development of larger boilers, higher pressure and more exacting service. It is a satisfaction, at the same time, to note the extent that you are making use of machinery and power tools to relieve the boiler makers of much heavy work.

The railroads of this country have made wonderful progress in the past few years in furnishing faster and more reliable transportation than this country has ever before known—both freight and passenger locomotives are being run long distances hauling heavy trains at high speeds and you have had a large part in making this possible by building and maintaining locomotive boilers which meet the heavy demands made upon them by the service of today.

And the end is not in sight; the steam locomotive continues to develop by leaps and bounds in size as well as efficiency. Recent years have brought out some marked changes in design of boiler as well as machinery—and future years will bring out many more.

* Assistant General Manager, New York Central and St. Louis Railroad, Cleveland, O.



Sectional view showing boiler lagging details

With this in mind, I want to make a special plea that you go as far as you can in transmitting the knowledge that you gain at these meetings to the men who actually perform the work under your direction, in order that they may know as much as possible about the reasons that are behind your instructions. They will appreciate it, they will do better work, because of a better understanding, and will be better able to carry the responsibilities that will fall upon them in the future.

In the absence of R. B. McColl, manager of the Schenectady, N. Y., plant of the American Locomotive Company, A. F. Pitkin of the engineering staff of that company, read the paper which Mr. McColl had prepared for the convention. This paper will appear in abstract form in a later issue. The entire business session on Wednesday was devoted to the reading and discussion of the report on "Recommended Practice and Standards" which dealt mainly with suggested welding practice. The committee on this subject consisted of J. A. Doarnberger, chairman, H. L. Marsellis, H. H. Service, L. M. Stewart, and Albert Novak. The discussion is too lengthy for inclusion in this outline of the convention proceedings and so will be published in full later.

In the afternoon, the entire convention proceeded to Niagara Falls for an inspection tour of various power and food plants in the vicinity. A trip to the Brock memorial monument on the Canadian side was included. A number of views of the crowd taken during this trip are shown in the plates accompanying this report.

Thursday Morning Session

The meeting opened promptly at 9:00 A.M. Mr. Powers presented A. G. Pack, chief inspector, Bureau of Locomotive Inspection of the Interstate Commerce Commission, who was the first speaker of the day. Mr. Pack discussed the work of the Bureau and called attention to the improvement in the condition of locomotives throughout the country during the past few years. In outlining the need for greater improvement he illustrated his remarks with slides showing numerous fatal accidents and their causes. His complete paper will appear later.

Mr. Pack was followed by R. E. Woodruff, superintendent of the Erie Railroad at Buffalo, who addressed the convention as follows:

The Boiler Maker Foreman as a Leader

By R. E. Woodruff

MANY railroad men say that the locomotive is the most important part of a railroad and it is a fact that good roadways, good cars, fine stations, adequate yards are useless without well designed and well maintained locomotives. Like every other line of railroad work, recent years have brought about changes. The size of boilers is increasing. New parts such as superheater tubes, thermic syphons, brick arches, feedwater heaters, flexible staybolts, are being put into common use. The addition of these appliances together with stokers has in some cases made your work harder because of its being harder to get at the lower flues. On the other hand, the more general use of welding has made your work easier and you are able to do many jobs now quicker than years ago.

Each of you served your time as an apprentice and then worked as a boiler maker. In your recommended practices you prescribe that a boiler maker should work as such at least one year before being permitted to act as a boiler inspector. Probably all of you worked for years in the gang before you became foremen. During all this time you handled boilers, boiler plates and tools, but as soon as you became a foreman, your job changed. Other men handled the boilers, the tools and the material and you became the boss. You handled the men. You graduated from mechanics to foremen. You had learned your trades as boiler makers. The point is, you spent years learning to be craftsmen. How much time and effort was spent in learning to be foremen? Each one must be trained to handle boilers. Should we not also be trained to handle men?

Of course each man knows something about men. The point is all of us feel we know more about men than we really do. This is because our minds function emotionally as well as intellectually. When we judge men we think emotionally as a rule. If we like a man we overlook his shortcomings, but if he does not appeal to us, nothing he does is right. You see, we use our "hearts" rather than our "heads." So foremen need training in judging and handling men. Some do not realize the need for such training or else do not know how to go about to get it.

Part Played by Personnel

Yet figures indicate that men fail more often than boilers. For example, an analysis was made of the conditions at a division terminal. Of course no two divisions are alike, but it is interesting once in a while for each of us to sit down and analyze our work. At this terminal, a study was made of the last 87 work reports covering boiler work. These were distributed over 52 locomotives. The purpose was to find out why the work was necessary. Forty-two percent of the jobs were found to be necessary because of poor work which had been done previously, either because men did not know how to do the work or they failed in some way in carrying out prescribed methods. Forty percent of the jobs were on boilers nearly ready for the back shop and were ascribed to ordinary wear and tear; fourteen percent of the work was made necessary because of poor material; three percent due to rough usage of the locomotive; one percent to poor design of the boiler.

Analysis of Defective Work

Assuming that there is no remedy for the forty percent of the jobs due to ordinary wear and tear, on the assumption that flues must be renewed periodically and give more trouble toward the end of their life, the figures become more interesting when this forty percent is eliminated. Of the remainder, seventy percent of the work reports were occasioned by poor work; twenty-two percent by poor material; six percent by rough usage and two percent by poor design.

This clearly brings out that the question of handling men and getting them to do their work in the right way is the most important part of a foreman's job. It is not enough for him to know how work should be done, nor to be acquainted with the latest methods, nor to be supplied with modern. His job consists in getting the work done properly—handling the human element.

There is really nothing mysterious about men or about men's actions. There is a reason for everything that a man does just as there is a reason for the way a boiler will act. Because you normally deal in boilers, let's think of a man as being a boiler and talk about him in boiler maker's language.

You feed water and fuel to a boiler and it produces steam. If this steam is intelligently generated and handled it is put to useful purposes. If it is not properly handled, if more is generated than can be used, if the boiler is not equipped with proper safety valves, instead of being useful, the steam becomes dangerous because of its explosive nature. Through years of experience you have learned to correctly design boilers. You have all known of boilers that were "stingy steamers." The fireboxes and total heating surfaces were too small for the cylinders. Profiting by early mistakes, boilers are now more correctly designed for the work which they are to do.

You feed water and food to a man and he produces—not steam—but energy. As in the case of the boiler, if this energy is correctly handled and produced in proper quantities, this human energy can be put to useful purposes. If, however, the energy is not used when made, if the man is not equipped with proper safety valves, his energy becomes explosive and dangerous in character. Like boilers, some men are "stingy steamers" and have not enough energy for the hard pulls and so fail at the critical time.

Clean Boilers and Efficient Men

Boilers must be kept clean to be efficient. If the flues are covered with boiler scale left from bad water, heat is wasted and less steam is produced. You have learned much concerning the importance of good water on boiler maintenance and efficiency. In good water districts, you have little boiler trouble and your maintenance costs are small. In bad water territories, the flues and boilers soon give out, with increased cost of maintenance and operation. In bad water districts you have two ways of eliminating the trouble. The first one is simply repairing the boiler—putting in new flues, side sheets and fireboxes as often as is necessary. The second and more efficient way is to soften the water. You have found by experience that where the quality of the water can be improved, its cost is justified by the saving in the boilers.

Now what about men? In this let's consider that water in the boiler corresponds to the mental attitude of the men. Where men have the right mental attitude, they work well and honestly with few failures, but in certain districts where the men are agitators, are disloyal and have wrong ideas, you have trouble and failures, with increased cost of maintenance and operation. As in the case of boilers, there are two methods of handling the problem. The first is to hire, and fire and discipline. It is a case of constant renewal, hammering and prossering. The second method is to soften the water—change the man's attitude—and men respond just like the boiler. To soften the water, you use chemicals. To improve man's attitude you use instruction, education and fair dealing. Education takes out the acids, impurities and harmful thoughts and replaces them with an honest desire, to be fair and conscientious. The words instruction and education have been used. There is a distinction between them. Instruction means to tell—to explain—to impart knowledge. When we instruct a man, we put something into him; probably a new thought. Education, however, is a little different. Education means "to lead out off" and when we educate a man, we bring out what is in him—if possible, the best. Through education we teach him to stand on his own feet; solve his own questions.

You may be interested in considering if it is true that we instruct rather than educate our men. Should not a real supervising officer educate rather than instruct?

In a boiler, water is turned into steam through the influence of the heat in the firebox. When cold water is turned into a boiler, efficiency is lost through using the ordinary injector because of loss of heat, so you have developed feed water heaters to save steam.

In a man, energy is produced largely by his mental attitude. Right mental attitude means maximum energy. As is the boiler, when mental attitude is brought in from the outside, like cold water it takes heat to bring it to the right temperature. A man hired from the outside has to "fit into" the organization before he can be useful. For this reason, it is better to hire apprentices and train them under a good instructor so they will have the right mental attitude when they become full-fledged craftsmen.

When a boiler is constructed, only good material is selected. If, however, in the course of time part of the boiler fails or cracks, you do not throw away the whole boiler but you patch it, and your experience has taught you how this best can be done—whether to use a riveted patch or a butt weld or lap weld and when to use gas or electric welding. You even make tests to determine the efficiency of the welder before permitting him to do the important work. You know too that if a small crack is discovered in time, it can be V'ed out and welded.

Now let's apply to this our men. In hiring men, we should only hire good material, and candidates for jobs should be selected as carefully and in accordance with as rigid specifications as are used by your test department in accepting steel and material from the manufacturer. There is no mystery about hiring good men. To get good steel you prescribe its chemical content. To get a good apprentice boy, look over his parents and grandparents. If these were all good, intelligent, capable, strong people the chances are favorable that the boy will have the right stuff in him. You can't reasonably expect to get a good boy from defective ancestry. If in the course of time a man fails, he should not of necessity be dismissed but should be "patched." Men need "patching" just as well as boilers. When a crack has developed in a man's work, it takes just as much ingenuity and skill to repair it as it does to patch the boiler. There are good ways and poor ways of getting results, but it all comes down to this—of V'ing out the defective material and replacing it with good sound material—eliminating wrong ideas and notions and replacing them with correct ideas. Remember too, that while many boilers are alike that no two men are exactly alike and they require more study than boilers.

You have learned by experience that it is not enough to properly design a boiler but that from the very beginning the boiler must be periodically inspected in order to be certain of its condition. Accordingly, about once a month or more often the boilers are carefully washed and inspected and after each 12 months' service, they are given a hydrostatic test. You feel sure that if these tests and examinations are correctly made that you can depend on the performance of the boiler. Nothing is left for guesswork.

Now what about men? Is it not a fact that frequently men are hired and put to work with very little attention, that they are really not supervised? They are condemned when work is not properly done but they are not "patched." The old material is not cut out and replaced with the right material. Frequently in our instruction, new thoughts are given men without having the old defective material cut away. Other times, the defective material is cut away but is not replaced with new ideas. It is probably true that most men are not given as much attention in the course of a year as is the average boiler, but it is just as necessary that a man should be inspected, kept clean and in good working order as it is for a boiler. A little staff meeting once a month where general topics of interest can be discussed, corresponds to the monthly boiler wash. This is a good time to discuss failures, better methods of doing work and new developments.

Our tools and appliances and locomotives have improved materially in the past fifty years and they will probably improve more in the next generation, but we are entering upon a new era of progress. We are beginning to learn more about men and human nature. Good, enthusiastic, "superheated" men produce twice as much work as dull unskilled men. While it is of advantage to know all about boilers and the latest methods of maintaining them, it is equally important for a foreman to learn all he can about men. It is suggested you read all you can about Human Nature, Psychology, Psycho-analysis, Heredity, Environment, Character Analysis. Intelligence tests are all valuable subjects for any officer. Many of their ideas conflict with each other but you can learn much from them. And the chief thing is that you can learn to analyze men with the intellectual part of your minds rather than the emotional part.

Besides being practical and sensible about boilers, it should be the ambition of every master boiler maker to build an organization of strong, intelligent, trained, enthusiastic men and foremen. If he cannot now inspire and generate enthusiasm in his department, he must realize he belongs to the day of saturated steam boilers and he better ask for the installation of a superheater when he next goes in for general repairs.

The subject of "Boiler Pitting and Corrosion" occupied the remainder of the morning session. Representatives of the water service departments of several railroads presented their views on the subject and outlined the steps being taken to overcome the difficulty. In the afternoon the subject was continued by the members who discussed the matter from the floor of the convention. This paper and its subsequent discussion will appear later. Kearn E. Fogerty was chairman of the committee on "Boiler Pitting" and T. W. Lowe and B. C. King made up the rest of the committee. Both of these gentlemen read separate reports on the subject, which will also be published.

Friday Session

The final session of the seventeenth annual convention opened at 9:00 A.M., Friday, May 28, with E. V. Williams, superintendent of motive power of the Buffalo, Rochester and Pittsburgh Railroad as the first speaker. His address will appear in a later issue. F. C. Pickard of Erie, Pa., works manager of the Standard Stoker Company, gave the final talk to the association. His remarks will be published later.

Thomas Lewis, past president of the association, and general boiler inspector of the Lehigh Valley Railroad, gave a most interesting account of a tour of inspection of English boiler shops which he made last year. This paper will appear in full in a future issue.

The election of officers for the coming year then took place. The results appear below:

Election of Officers

The remainder of the closing session of the convention was devoted to the election of officers, a complete list of which follows:

President, John F. Raps, general boiler inspector, Illinois Central Railroad, Chicago, Ill.; first vice-president, W. J. Murphy, general foreman boiler maker, Pennsylvania Railroad, Olean, N. Y.; second vice-president, L. M. Stewart, general boiler inspector, Atlantic Coast Line, Waycross, Ga.; third vice-president, Stephen M. Carroll, general master boiler maker, Chesapeake & Ohio Railroad, Huntington, W. Va.; fourth vice-president, George M. Usherwood, supervisor of boilers, New York Central Railroad, Syracuse, N. Y.; fifth vice-president, Kearn E. Fogerty, general boiler inspector, Chicago, Burlington & Quincy, Lincoln, Neb.; treasurer, W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio; secretary, Harry D. Vought, New York; executive board (three years), H. J. Raps, general boiler foreman, Illinois Central Railroad, Chicago, Ill.; I. J. Pool, general boiler inspector, Baltimore and Ohio Railroad, Baltimore, Md.; John Harthill, general foreman boiler maker, New York Central Railroad, Cleveland, Ohio; chairman of the executive board, A. F. Stiglmeier, general boiler shop foreman, New York Central Railroad, Albany, N. Y., and secretary of the board, H. J. Raps.

Action was taken on the election of members retired from active service on their respective roads to be placed on the honorary roll of the association. The following therefore are now honorary members: Reynold C. Young, Chicago and North Western Railroad; Michael O'Connor, past president; E. W. Young, past president; J. F. Beck, Pennsylvania Railroad. The reading of memorials in memory of deceased members, report of committee on president's address and other routine business marked the close of what may well be called the most successful convention in the history of the Master Boiler Makers' Association.

Supply Men Elect Officers

At the annual business meeting of the Master Boiler Makers Supply Men's Association held Thursday, May 27, at the Hotel Statler, Buffalo, N. Y., the following officers were elected for the coming year:

President, J. W. Kelly, National Tube Company, Pittsburgh, Pa.; vice-president, A. W. Clokey, American Arch Company, Chicago, Ill.; secretary, W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.; treasurer, George R. Boyce, A. M. Castle & Company, Chicago, Ill.

Executive Committee (three years)—Frank C. Haase, Oxweld Company, Chicago, Ill.; F. H. McCabe, McCabe Manufacturing Company, Lawrence, Mass.; Irving H. Jones, Central Steel Company, Massillon, Ohio.

On the executive committee to fill the unexpired term of George R. Boyce, C. M. Hoffman of the Dearborn Chemical Company, Chicago, Ill., was elected.

List of Exhibitors and Supply Men at Master Boiler Makers' Convention

One of the most interesting displays of equipment for use in boiler shops was presented by the following member companies of the Master Boiler Makers Supply Men's Association at the seventeenth annual convention of the Master Boiler Makers' Association:

Air Reduction Sales Company, New York.—Represented by E. M. Sexton, B. N. Law, R. T. Peabody, W. H. Ludington, Ed Phelps, H. Hocking and G. Van Alstyne. The exhibit included Airco oxygen, Airco acetylene, Airco, Davis-Bournonville, welding and cutting apparatus and supplies.

American Arch Company, New York.—Represented by H. B. Slaybaugh, W. L. Allison, John P. Neff, George Wagstaff, R. J. Himmelright, J. T. Anthony, T. F. Kilcoyne, A. M. Sucese, T. Mahar, C. T. Pfeiffer and M. R. Smith. The exhibit included two motion electric signs.

American Locomotive Company, New York.—Represented by G. P. Robinson, A. F. Pitkin and F. J. Rice. The exhibit included Alco flexible bolts, Alco rigid bolts and the Pitkin articulated staybolt.

American Railway Appliances Company, New York.—Represented by J. W. Henry and J. Stewart. The exhibit included Superior locomotive flue blower.

Arrow Tools, Inc., Chicago, Ill.—Represented by N. W. Benedick and H. J. Trueblood. The exhibit included beading tools, calking tools, chisels, backing out punch and rivet sets.

Bethlehem Steel Company, Bethlehem, Pa.—Represented by George H. Raab and E. A. Jones. The exhibit included samples of charcoal iron boiler and superheater tubes, tube tests, etc. Also miscellaneous samples of staybolt iron and hollow drilled staybolts.

The Bird-Archer Company, New York.—Represented by C. A. Bird, H. C. Harragin, J. J. Callahan and H. P. Mauer.

W. L. Brubaker & Bros. Company.—Represented by W. Searls Rose and H. B. Morrison. The exhibit included taps, reamers, dies, screwplates, end mills, high speed spiral inserted blade taper, reamers, solid body high speed blade hand, shell and chucking reamers and various other new special tools.

The Boiler Maker, New York.—Represented by George Slate, H. E. McCandless, R. C. Moller, H. M. Brewer and L. S. Blodgett.

The Burden Iron Company, Troy, N. Y.—Represented by John C. Kuhns. The exhibit included staybolt iron, engine bolt iron, iron boiler rivets and hollow staybolts.

A. M. Castle & Company, Chicago, Ill.—Represented by George R. Boyce and L. J. Quetsch. The exhibit included rivets, tubes, boiler and firebox plate.

Central Steel Company, Massillon, Ohio.—Represented by Irving H. Jones, A. S. Taylor and George Law. The exhibit included Agathon staybolt steel, Agathon engine bolt steel and Agathon nickel tubes.

Champion Rivet Company, Cleveland, Ohio.—Represented by David J. Champion, Pierre Champion and Thomas J. Lawless. The exhibit included regular Victor rivets, Victor true tolerance rivets, coupler pins and air brake pins.

Chicago Eye Shield Company, Chicago, Ill.—Represented by Robert Malcom. The exhibit included welding glass, goggles, helmets for welding, Acme shields or grinder guards and safety glass for workmen's eye protection.

Chicago Pneumatic Tool Company, New York.—Represented by J. L. Rowe, E. K. Lynch, H. R. Deubel and D. E. Cooke.

Cleveland Pneumatic Tool Company, Cleveland, Ohio.—Represented by H. S. Covey and B. H. Tripp. The exhibit included riveting hammers, chipping hammers, air drills, Cleco pressure-seated air valves, Bowes quick acting hose couplings, etc.

Dearborn Chemical Company, Chicago, Ill.—Represented by L. P. Bowen, Nelson F. Dunn, W. H. Kinney and C. M. Hoffman. The exhibit included Dearborn water treating preparations for prevention of scale, corrosion and foaming in steam boilers and NO-OX-ID rust preventive.

Detroit Seamless Steel Tubes Company, Detroit, Mich.—Represented by H. E. Ross, C. C. Rosser, H. C. Kensing and C. H. Hobbs. The exhibit included locomotive flues, superheater tubes, arch tubes, merchant boiler tubes and mechanical tubing.

Dromgold & Glenn, Chicago, Ill.—Represented by L. S. Dromgold. The exhibit included washout plug and water column.

Ewald Iron Company, Louisville, Ky.—Represented by J. P. Bourke, W. R. Walsh and R. F. Kilpatrick. The exhibit included staybolt iron, solid and hollow.

J. Faessler Manufacturing Company, Moberly, Mo.—Represented by G. R. Maupin and J. W. Faessler. The exhibit included boiler makers' standard and special tools such as flue expanders, tube cutters, etc.

Flannery Bolt Company, Pittsburgh, Pa.—Represented by J. Rogers Flannery, E. S. Fitzsimmons, E. G. Flannery, Ernst J. Reusswig, Wm. M. Wilson, G. R. Greenslade and F. K. Landgraf. The exhibit included assemblages of the Flannery flexible staybolts, welded and screw type, also Flannery telltale flexible staybolts and the installation tools for same.

Forster Paint & Manufacturing Company, Winona, Minn.—Represented by O. T. Caswell. The exhibit included graphite, plumbago, boiler pipe joint and other cements.

Garratt-Callahan Company, Chicago, Ill.—Represented by W. F. Caspers and H. M. Gray. The exhibit included "Magic" boiler preservative.

Gary Screw & Bolt Company, Gary, Ind.—Represented by Gerald J. Garvey. The exhibit included boiler rivets.

Globe Steel Tubes Company, Milwaukee, Wis.—Represented by F. J. O'Brien, J. W. Floto, J. S. Bradshaw, T. F. Clifford and E. C. Carroll. The exhibit included samples and photographs of hot rolled seamless steel boiler tubes, arch tubes and superheater flues.

Housley Flue Connection Corporation, Indianapolis, Ind.—Represented by R. B. Housley. The exhibit included Housley safety washout plugs and Housley safety arch tube plugs.

Huron Manufacturing Company, Detroit, Mich.—Represented by H. N. Reynolds, E. H. Willard and M. T. Willard. The exhibit included Huron washout and arch tube plugs and bushings.

Independent Pneumatic Tool Company, Chicago, Ill.—Represented by A. Anderson, H. G. Keller, W. E. Dougherty, Mr. Elston, C. E. Leonard, J. P. Fletcher, Mr. Becker and C. E. Fowler. The exhibit included Thor pneumatic drills, reamers, wood boring machines, close corner drills hoists, grinders, riveting hammers, chipping, calking, flue beading and scaling hammers, sand rammers, rivet busters, core busters, clay diggers, air moisture separators, electric drills, reamers, pneumatic tool accessories: Electrical tappers, grinders, pneumatic tool hose and couplings and electric screw drivers.

Ingersoll-Rand Company, New York.—Represented by W. A. Johnson, J. E. Kroske, H. C. Burgess and George C. Williams. The exhibit included drills, riveting hammers, chipping hammers and grinders.

W. H. Keller, Inc., Grand Haven, Mich.—Represented by W. E. Hall, J. R. Bennett, C. Lewis Hawley and R. W. Andrews. The exhibit included pneumatic riveting, chipping and scaling hammers, pneumatic drills, grinders, holders-on, pneumatic tool repair parts and accessories.

Liberty Manufacturing Company, Pittsburgh, Pa.—Represented by H. A. Pastre, W. S. Myton and Thomas X. Lieb. The exhibit included Liberty and Lagonda arch and branch pipe cleaners.

Locomotive Firebox Company, Chicago, Ill.—Represented by Leslie R. Pyle, C. M. Rogers, Harry Clewer, Jr., E. J. Reardon, and E. F. Smith. The exhibit included Nicholson thermic syphon in the form of a working model locomotive boiler equipped with two syphons and a separate model arranged to show construction; also improved combustion chamber syphon.

Lovejoy Tool Works, Chicago, Ill.—Represented by W. H. Dangel. The exhibit included tube expanders, flue cutter, flue hole cutter, drill sleeves, staybolt sets, rivet set clips, recupping tools, flaring tools, Perfection staybolt chuck, backing out punches, Lacerda dollybars, special sockets, paint scalers, bolt-tapping and applying sockets, special driver nut for flexible staybolts, riveting dies, countersinking frame, universal joint and Lovejoy roughing tools.

Lukens Steel Company, Coatesville, Pa.—Represented by Harry Loeb. The exhibit included samples of steel, literature, etc.

McCabe Manufacturing Company, Lawrence, Mass.—Represented by Fred H. McCabe and Edward McCabe. The exhibit included working model of a flanging machine and flanged flue sheets, as well as moving picture display of flanging operations.

MacLean-Fogg Lock Nut Company, Chicago, Ill.—Represented by J. W. Fogg. The exhibit included "M-F" lock nuts.

National Tube Company, Pittsburgh, Pa.—Represented by George N. Riley, J. W. Kelly and P. J. Conrath. The exhibit included superheater tubes and hot rolled seamless tubes.

The Otis Steel Company, Cleveland, Ohio.—Represented by George E. Sevey. The exhibit included samples of locomotive firebox and boiler steel.

The Oxweld Railroad Service Company, Chicago, Ill.—Represented by W. A. Champieux, A. N. Lucas, J. O. O'Neil and Hugh Reeder.

The Parkesburg Iron Company, Parkesburg, Pa.—Represented by W. H. S. Bateman, George Thomas, 3rd., J. R. Wetherald and J. F. Wiese. The exhibit included literature and small samples of charcoal iron boiler tubes.

Penn Iron and Steel Company, Creighton, Pa.—Represented by C. J. Nieman. The exhibit included staybolt iron, hollow drilled bolts and engine bolt iron.

Pittsburgh Steel Products Company, Pittsburgh, Pa.—Represented by Charles F. Palmer, Charles H. Van Allen and J. D. Brandon. The exhibit included samples of seamless steel tube.

Pratt & Whitney Company, Hartford, Conn.—Represented by E. E. Cullison and A. H. d'Arcambal. The exhibit included small tools such as taps, cutters, reamers, hobs, etc., and circulars, fractures, etc.

The Premier Staybolt Company, Pittsburgh, Pa.—Represented by L. Finegan, J. F. McGann, C. E. Miller, C. B. Woodworth. The exhibit included locomotive staybolts.

The Prime Manufacturing Company, Milwaukee, Wis.—Represented by Daniel A. Lucas and C. Arthur Dunn. The exhibit included the Prime composite washout plug.

Railway Purchases and Stores, Chicago, Ill.—Represented by K. F. Sheeran.

John A. Roebling's Sons Company, Trenton, N. J.—Represented by G. W. Swan and E. T. Weart. The exhibit included sample boards, wire rope, etc., and welding wire.

Rome Iron Mills Company, Rome, N. Y.—Represented by B. A. Clements and C. C. Osterhout. The exhibit included Rome Superior staybolt iron and Rome Perfection engine bolt iron.

Joseph T. Ryerson & Son, Chicago, Ill.—Represented by A. C. Allshul, J. P. Moses, A. W. Willcuts, W. S. Campbell, H. F. Gilg, E. S. Pike and L. W. Widmeier. The exhibit included samples of all iron, steel and machinery, featuring Lewis special staybolts.

The Superheater Company, New York.—Represented by G. E. Ryder, Bard Browne, R. E. Stilwell and W. A. Buckbee. The exhibit included literature only.

The Talmage Manufacturing Company, Cleveland, Ohio.—Represented by F. M. Roby and H. B. Thurston. The exhibit included Talmage ash pan, Talmage system ash pan cleaner, Talmage ratchet hand brake, Talmage system steam chest and cylinder lubricating drifting valves, Talmage blow-off valve and Cleveland low water alarm.

Thomson Electric Welding Company, Lynn, Mass.—Represented by Freeland H. Leslie, Russell S. Donald and Harold B. Warren.

Torchweld Equipment Company, Chicago, Ill.—Represented by W. A. Slack. The exhibit included gas welding and cutting apparatus.

Tyler Tube & Pipe Company, Washington, Pa.—Represented by James R. Eriser. The exhibit included samples of charcoal iron tubes and of charcoal iron in various stages of manufacture.

Ulster Iron Works, Dover, N. J.—Represented by J. C. Campbell, C. F. Barton, E. W. Kavanagh, Norman Thulin and Edward Murray. The exhibit included wrought iron staybolt engine bolt and hollow drilled engine bolt.

United Alloy Steel Corporation, Canton, Ohio.—Represented by A. L. Roberts and George T. Ramsay. The exhibit included samples of staybolts and boiler tubes.

Registration of Members

Aiken, C. H., Dept. Boiler Equip., Bourne-Fuller Co., Shaker Heights, 3628 E. 163d St., Cleveland, Ohio.
Albert, Jacob, Asst. B. F., C. & W. I. R. R., 6721 S. Peoria St., Chicago, Ill.
Anderson, J. A., G. F., Industrial Wks., 216 N. Madison Ave., Bay City, Mich.
Andre, B. F., B. Insp. C. & O. R. R., 2209 Carter Ave., Ashland, Ky.
Austin, George, G. B. I., A. T. & S. F. Ry., 11 Devon Apts., Topeka, Kans.

Badger, R. L., Supvr. Boilers, Erie R. R., 514 Term. Bldg., Youngstown, O.
Baker, Glenn, B. M. F., N. Y. C., 601 N. Goodman St., Rochester, N. Y.
Batchman, F. B. M., N. Y. C., 1421 Krau St., Elkhart, Ind.
Baxter, W. W., Editor, *Railway Review*, 30 Church St., New York.
Beck, John F., F. B. M., G. R. & I. R. R., 426 Thomas St., S. E., Grand Rapids, Mich.
Becker, W. C., B. F., I. C. R. R., 612 Veronica Pl., E. St. Louis, Ill.
Beland, Arthur J., G. F. B. M., Chicago Junction R. R., 7346 Kenwood Ave., Chicago, Ill.
Bell, H. A., G. B. F., C. B. & Q., 316 S. 11th St., Havelock, Nebr.
Bennett, G. W., Dist. Insp., I. C. C., 15 Kent St., Albany, N. Y.
Bergstrom, C. H., B. F., St. L.-San Francisco Ry., 741 South St., Springfield, Mo.
Berrey, Frank E., F. B. M., Erie R. R., 5315 Julia Ave., Cleveland, Ohio.
Besant, W. F., F. B. M., I. C. R. R., 1426 E. 65th St., Chicago, Ill.
Billington, Matthew, F. B. M., B. R. & P. R. R., 72 Central Ave., E. Salamanca, N. Y.
Bohman, H. E., Asst. F. B. M., C. O. & I. Ry., 12 N. Brownell St., Peru, Ind.
Borneman, L., Gen. F. B. M., C. St. P. M. & O. R. R., 1121 Selby Ave., St. Paul, Minn.
Bove, Joseph, F. B. M., N. Y. C., Brewster, N. Y.
Breisacher, G. H., Gen. F., Toledo Term., 1825 Ridgewood Ave., Toledo, Ohio.
Brennan, E. J., G. B. F., Indiana Harbor Belt, 553 Summer Blvd., Hammond, Ind.
Brown, I. E., F. B. M., C. & N. W. R. R., 325 Center St., Tracy, Minn.
Browning, C. H., G. F. B. M., Grand Trunk Ry., 53 Cherry St., Battle Creek, Mich.
Browning, P., G. B. F., Penn R. R., Canton, Ohio.
Buffington, C. W., Dist. B. Insp., C. & O., Clifton Forge, Va.
Burkholtz, G. E., Trav. G. B. I., Frisco, 1019 State St., Springfield, Mo.
Burnside, G. M., B. F., Monongahela Ry., Brownsville, Pa.

Callahan, J. L., G. B. I., The Bird-Archer Co., 122 S. Michigan Ave., Chicago, Ill.
Carrigan, Jas. H., F. B. M., C. & N. W. R. R., 204 Ashland Ave., River Forest, Ill.
Carroll, S. M., G. M. B. M., C. & O. R. R., 2919 Merrill Ave., Huntington, W. Va.
Chapman, A. B., Supv. Boilers, C. & O., 1821 9th Ave., Huntington, W. Va.
Charlton, Donald, Tech. Rep., Reading Iron Co., 529 Court St., Reading, Pa.
Chastain, J. H., B. M. F., N. C. & St. L., 299 So. Blvd., Atlanta, Ga.
Christopherson, Sigurd, F., N. Y., N. H. & H. R. R., 15 Sheldon St., E. Milton, Mass.
Clark, R. W., G. F. B. M., N. C. & St.-L., 720 17th Ave., So., Nashville, Tenn.
Clas, John A., G. B. F., S. & H. R. R., 10 S. Bertha St., Albany, N. Y.
Clewer, Jr., Harry, B. Insp., Locomotive Firebox Co., 7257 Princeton Ave., Chicago, Ill.
Connors, D., B. F., Erie R. R., Kent, O.
Conrath, P. J., Boiler Tube Expert, National Tube Co., 4712 Drexel Blvd., Chicago, Ill.
Constable, Wm., Asst. F. B. M., Canadian National Ry., 11 Charron St., Montreal, Canada.
Cook, E. C., Mgr. Editor, *Railway Journal*, 537 Webster Bldg., Chicago, Ill.
Cook, James T. Jr., G. F. B. M., B. & A. R. R., West Springfield, Mass.
Cooke, J. E., M. B. M., B. & L. E., 360 So. Main St., Greenville, Pa.

Coon, George, B. F., N. Y. C., 857 E. Willow St., Syracuse, N. Y.

Cooper, H. M., B. F., B. & O., 927 N. Metcalf St., Luna, Ohio.

Cortis, Charles C., B. F., C. & N. W., Belle Plaine, Ia.

Cosgrove, P. E., G. F. B. M., E. J. & E., 103 Glenwood Ave., Joliet, Ill.

Cravens, Guy, G. B. F., Texas & Pacific, 205 Gregg St., Big Spring, Texas.

Crow, F. W., B. S. F., C. B. & Q. R. R., 1008 Jackson St., Beardstown, Ill.

Darrach, H., G. B. F., D. M. & S. R. R., Box 476, Proctor, Minn.

Davey, J. J., G. B. I., Nor. Pac., Central Office Bldg., St. Paul, Minn.

Dean, C. C., Gen. B. F., Wabash R. R., 1404 E. Prairie Ave., Decatur, Ill.

Diffily, Dan'l J., F. B. M., N. Y. C. R. R., 2516 Grand Concourse, New York.

Dillon, H. W., F. B. M., Erie R. R., 22 Reed Ave., Lackawanna, N. Y.

Dittrich, A. C., G. B. I., Soo Line, 1409 N. 5th St., Minneapolis, Minn.

Doarnberger, J. A., M. B. M., N. & W., 1502 Patterson Ave., S. W., Roanoke, Va.

Doran, James, B. I., A. T. & S. F., Fort Madison, Ia.

Dougherty, Geo. E., M. M., D. L. & W. R. R., Buffalo, N. Y.

Doyle, J. A., B. F., Penn R. R., 1516 18th St., Altoona, Pa.

Duffy, C. G., G. F. B. M., K. C. Term. Ry., 2736 Madison Ave., Kansas City, Mo.

Dunford, V. H. Jr., G. M. B. M., Seaboard Air Line, Savannah, Ga.

Elkins, C. E., G. F. B. M., M. P. R. R., 2508 W. 13th St., Little Rock, Ark.

Ellerman, Gus C., B. M. F., Santa Fe R. R., 3404 Metropolitan Ave., Kansas City, Kans.

Ellwanger, M. A., B. F., C. & N. W., 939 Wisconsin Ave., No. Fond du Lac, Wis.

Ennis, H. R., Boiler Fcr., Missouri-Pacific Ry., Hoisington, Kans.

Evans, F. C., Asst. F. B. M., Hocking Valley R. R., 45 Richardson Ave., Columbus, Ohio.

Evans, W. H., F. B. M., Georgia R. R., 1013 Broad St., Augusta, Ga.

Fairchild, E. P., F. B. M., Atlantic Coast Line, 513 Folks St., Waycross, Ga.

Fantom, Wm. F., F. B. M., I. C. R. R., 7721 Eggleston Ave., Chicago, Ill.

Fegan, Stewart A., Dist. B. Insp., Canadian National Ry., 94 Mountview Ave., Toronto, Ont.

Feisner, Adolph, B. M. F., I. C. R. R., 623 Sumner St., Waterloo, Ia.

Fennelly, M. J., Dist. B. Insp., N. Y. C. R. R., 67 St. Pauls Pl., Brooklyn, N. Y.

Finucane, John F., G. B. F., Southern Pacific Lines, 611 McGowan Ave., Houston, Tex.

Fisher, Geo., F. B. M., Belt Ry. of Chicago, 8711 Peoria St., Chicago, Ill.

Fitzsimmons, E. S., Mgr. Sales, Flannery Bolt Co., Flannery Bldg., Pittsburgh, Pa.

Fitzsimmons, J. F., B. F., L. V. R. R., 264 E. Northampton, Wilkes Barre, Pa.

Fogerty, Kearn E., G. B. I., C. B. & Q., 110 So. 28th St., Lincoln, Neb.

Foss, Merrill, Supt. Boilers, N. Y., N. H. & H., New Haven, Conn.

France, Myron C., G. B. I., C. St. P. M. & O., Randolph & Drake Sts., St. Paul, Minn.

George, Wm., B. M. F., M. C. R. R., 1224 Main St., Niles, Mich.

German, John, 9710 Parmelee Ave., Cleveland, O.

Gibler, Peter J., Asst. Gen. B. Insp., G. C. & S. F. Ry., 801 Prairie Ave., Cleburne, Tex.

Gigandet, H. V., Dist. Mgr., Canadian Ry. Serv., 92 W. Adelaide St., Toronto, Ont.

Gillespie, Wm. J., Gen. Loco. & B. I., P. & L. E., R. R., 1127 Charles St., McKees Rock, Pa.

Gill, K. K., F. B. M., A. & W. P. R. R., 205 Yancy Ave., Montgomery, Ala.

Glenn, W. T. K., B. F., S. P. R R, 401 Hopkins St., Yoakum, Tex.

Grant, Charles W., B. M. F., U. & D. R. R., 96 E. Chester St., Kingston, N. Y.

Grantly, James A., F. Boiler Shop, Am. Loco. Co., 210 Ave. "A," Schenectady, N. Y.

Gray, Frank, Tank F., C. & A. R. R., 201 W. Graham St., Bloomington, Ill.

Greene, Andrew S., G. F. B. M., Big Four R. R., 3315 E. 16th St., Indianapolis, Ind.

Grosnick, Wm., B. F., C. & N. W., 1204 4th Ave., Antigo, Wis.

Hagan, Chas. E., M. B. M., C. & W. I. Ry., 5553 S. Green St., Chicago, Ill.

Hagan, George N., B. F., Erie R. R., Green Camp, Ohio.

Hancken, W. C., B. M. F., Atlanta B. & A. Ry., 115 S. Johnson St., Fitzgerald, Ga.

Harper, Carl A., G. B. Insp. Big Four, 3006 N. Delaware St., Indianapolis, Ind.

Hart, L. E., B. F., Atlantic Coast R. R., 621 Hammond St., Rocky Mount, N. C.

Hart, Stephen F., F. B. M., B. & M. R. R., 17-A Cushing Ave., Dorchester, Mass.

Harthill, John, G. F. B. M., N. Y. C., 14708 Coit Rd., Cleveland, O.

Hasse, F. C., Asst. to V.-P., Oxweld R. R. Service Co., 333 Ry. Exchange, Chicago, Ill.

Hastings, A. G., B. F., M. & St. L., 201 S. 3rd Ave., Marshalltown, Iowa.

Healey, M. J., B. F., I. M. Ry., 2424 W. New York St., Indianapolis, Ind.

Healy, Frank J., F. B. M., Penn R. R., 233 7th St., Renova, Pa.

Hedberg, Andrew, Asst. Sys. G. F. B. M., C. & N. W. R. R., 1203 W. Howard St., Winona, Minn.

Heessel, J. H., F. B. M., C. B. & Q. R. R., 1209 W. Jefferson St., Creston, Ia.

Heiner, C. W., Fore. I. C. R. R., 212 S. 15th St., Mattoon, Ill.

Henry, W. F., B. F., I. C. R. R., 709 N. Main St., Water Valley, Miss.

Hill, F. N., Sta. B. I., N. Y. C. R. R., 66 Crouch St., Rochester, N. Y.

Hilliger, E. E., F. B. M., N. Y. C. R. R., 1327 Bailey Ave., Buffalo, N. Y.

Holt, John W., B. F., C. & N. W. R. R., 707 S. 13th St., Escanaba, Mich.

Horne, William D., B. M. F., Cornwall R. R., 1005 Cumberland St., Lebanon, Pa.

Howe, F. J., G. B. F., C. B. & Q., 221 Walnut St., Aurora, Ill.

Hubbard, E., B. M. F., C. & O. R. R., 410 E. 17th St. Covington, Ky.

Hughes, James W., B. F., I. C. R. R., 2211 Osage Ave., Louisville, Ky.

Hunt, Edw., Asst., G. B. I., I. C. R. R., 908 Central Sta., Chicago, Ill.

Hunt, E. L., F. B. M., N. Y. C., 6 Lawrence St., Oswego, N. Y.

Hursh, P. S., Supv. Boilers, B. R. & P. R. R., 17 Linden Ave, DuBois, Pa.

Jacobs, Wm. C., B. F. I., C. R. R., 1210 Wright St., Indianapolis, Ind.

Jenkins, F. J., Gen. Loco. Insp. T. & P. R. R., Dallas, Texas.

Jennings, Gilmore, G. B. F., B. & O. R. R., 6204 Dorchester Ave., Chicago, Ill.

Jensen, E. W., A. F. B. M., N. P. R. R., 3810 S. Jay St., Tacoma, Wash.

Johnson, H. E., B. M., B. & M. R. R., 34 Fenwick St., Sommerville, Mass.

Johnson, L. J. Jr., B. M F., Fla. E. Coast, New Smyrna, Fla.

Jones, J. T., G. B. F., N. K. P., 421 Madison St., Conneaut, Ohio.

Karnell, Chas. A., Supt. Boilers, N. Y. C., 10702 Elgin Ave., Cleveland, O.

Keefe, E. J., B. M. F., C. & N. W., 2411 7th St., Peoria, Ill.

Keefe, J. C., F. B. M., T. & O. C., 114 W. Liberty St., Bucyrus, O.

Keiler, W. H., F. B. M., N. Y. C., 722 Nellis St., Watertown, N. Y.

Kelly, J. W., Boiler Tube Expert, National Tube Co., 515 N. Grove Ave., Oak Park, Ill.

Kennedy, Hugh, F. B. M., G. T. R. R., 15 Auburn Ave., Toronto, Ont.

Kenny, John F., F. B. M., N. Y., N. H. & H., 27 Truman St., New Haven, Conn.

Kern, William H., F. B. M., A. T. & S. F. Ry., 421 So. Central Pk. Ave., Chicago, Ill.

Kilcoyne, Thos. F., Travel. Eng., American Arch Co., 2273 Washington Ave., Norwood, Cincinnati, O.

Kinniger, Wm. L., G. B. M. F., A. T. & S. Fe, 319 Quinton Blvd., Topeka, Kan.

Kirkwood, C. R., B. F., Big Four, 8220 Springfield Pike, Cincinnati, Ohio.

Klein, Chas. J., Dist. Insp., I. C. C., 604 U. S. Appraisers Bldg., Boston, Mass.

Klink, Chas., F. B M., C. M. & St. P., 3425 Longfellow Ave., Minneapolis, Minn.

Knight, M. H., F. B. M., N. Y. C., 802 Thomas St., Elkhart, Ind.

Koebernik, O. H., G. B. F., Nickel Plate, 315 Sandusky St., Conneaut, O.

Koenig, Joseph, B. F., T. P. M. P. R. R., 317 Bermuda St., New Orleans, La.

Koontz, R. L., Gang F., C. & O. Ry., 272 Walnut St., Huntington, W. Va.

Krum, Jno., B. M. F., N. Y. C. R. R., 735 Division St., Toledo, O.

Kurlfinke, O. H., B. Eng., Southern Pacific R. R., 65 Market St., San Francisco, Cal.

Lacerda, Harry A., Boilershop Piece Workers Insp., D. & H. R. R., Colony, N. Y.

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

Law, Geo., G. F. B. Shop, Central Steel Co., Massillon, O.

Leahy, D. J., Div. B. I., N. Y. C., 1420 Walnut St., Jersey Shore, Pa.

Lewis, J. H., G. B. F., A. T. & S. F. R. R., 613 W. Silver St., Albuquerque, N. M.

Lewis, Thomas, G. B. I., L. V. R. R., Sayre, Pa.

Linerode, Frank, B. F., Erie R. R., 639 First St., Huntington, Ind.

Litz, F. T., G. B. F., C. M. & St. P., 21½ 37th St., Milwaukee, Wis.

Lonergan, Jno., B. F., C. & N. W., 4045 Maypole Ave., Chicago, Ill.

Longacre, Chas. J., F. B. M., Penn R. R., 32 Raymond Terrace, Elizabeth, N. J.

Loveland, D. A., G. B. F., L. V. R. R., 206 So. Main St., Athens, Pa.

Lowe, Thos. W., G. B. I., C. P. R. R., 760 Westminster Ave., Winnipeg, Man., Canada.

Lucas, A. N., Oxweld R. R. Service, Dist. Mgr., 333 Ry. Exchange, Chicago, Ill.

Lucas, D. A., Works Mgr., The Prime Mfg. Co., 420 31st St., Milwaukee, Wis.

Lucas, W. H., Chief Boiler Insp., M. C. R. R., Park View Apts., Metcalf St., Thomas, Ont., Canada.

Luftus, Walter, B. M. F., N. Y. C., 1103 Washington St., Hoboken, N. J.

Lux, Peter, F. B. M., C. & N. W., 145 S. 7th Ave., Maywood, Ill.

Lyrer, Phil, G. B. F., M. K. & T. Co., Parsons, Kans.

Madden, T. P., Ch. B. I., M. P. R. R., 6957 Clayton Ave., St. Louis, Mo.

Mahar, Thomas, Trav. Eng., American Arch Co., 2 Lyon Place, White Plains, N. Y.

Mahon, Joseph, Foreman, N. Y., N. H. & H., 936 Winchester Ave., Hamden, Conn.

Maneval, E. J., F. B. M., N. Y. C. 20 Tacoma Ave., Jersey Shore, Pa.

Mansfield, J. J., G. B. I., Cent. R. R. of N. J., 74 Pearsall Ave., Jersey City, N. J.

Marinan, J. J., G. B. F., Soo Line, 525 Wisconsin Ave., Fond du Lac, Wis.

Marsalis, Harry L., Welding Supv., I. C. R. R., 317 N. Cherry St., McComb, Miss.

Marshall, R. L., F. B. M., B. R. & P. R. R., 150 Belmont Parkway, Du Bois, Pa.

Matheson, John, Fed. Insp., Loco. Boilers, I. C. C., 470 E. Broadway, Salt Lake City, Utah.

May, H. E., F. B. M., Y. & M. V. R. R., Vicksburg, Miss.

Mays, W. W., B. F., C. & O. Ry., Selma, Va.

McCallister, M. M., Boiler Expert, Am. Flexible Bolt Co., 230 E. 26th St., Erie, Pa.

McCarthy, Dan'l P., G. B. F., L. V. R. R., 900 Ridge St., Easton, Pa.

McFadden, S. L., Shop Demonstrator, Welding, Erie R. R., 172 Spring St., Meadville, Pa.

McGackle, Thos., B. F., I. C. R. R., 305½ S. Neil St., Champagne, Ill.

McGarrigal, John, G. B. F., I. C. R. R., 1050 Madison St., Paducah, Ky.

McIntosh, Peter E., B. F., M. C. R. R., 1215 Jefferson Ave., Kalamazoo, Mich.

McKenna, John F., F. B. M., New Haven R. R., 130 Burgess Ave., E. Providence, R. I.

McLean, R. J., B. F., I. C. R. R., 181 Gilleas Pl., Memphis, Tenn.

McNamara, J. W., G. F. B. M., L. E. & W. R. R., 815 N. Metcalf Ave., Lima, O.

Miller, Charles, G. F. B. M., Virginian Ry., 904 Ninth St., Princeton, W. Va.

Miller, M. C., B. F., C. & N. W. Ry., 220 N. Commercial St., Eagle Grove, Ia.

Miller, S. W., Union Carbide & Carbon Laboratories, Thompson Ave. and Manley St., L. I. City, N. Y.

Milton, M. V., Ch. B. I., C. Nat'l, 1548 Dufferin St., Toronto, Ont.

Minehan, James H., F. B. M., D. L. & W. R. R., 640 N. Washington Ave., Scranton, Pa.

Minzing, John J., Boiler Insp., E. J. & E. Ry., R-4, Manhattan Rd., Joliet, Ill.

Mitchell, Thos. D., F. B. M., K. & I. Term., 656 S. 39th St., Louisville, Ky.

Mohr, C. H., F. B. M., M. P. R. R., 330 S. "I" St., Livingston, Mont.

Moore, Wm. N., G. B. F., Pere Marquette R. R., 625 College Ave., S. E., Grand Rapids, Mich.

Morrison, H. B., Factory Rep., W. L. Brubaker & Bros., 3758 N. 18th St., Philadelphia, Pa.

Morrow, H. E., G. B. F., M. K. & T., 525 Proctor Ave., Waco, Tex.

Moses, L. O., Gen. B. I., N. Y. C., 348 King Ave., Columbus, Ohio.

Mulready, Thos., B. M. F., C. & N. W. Ry., Norfolk, Neb.

Murphy, Chas. W., Asst. B. F., I. C. R. R., 192 Allen Ave., Jackson, Tenn.

Murphy, Martin, G. B. I., B. O. S. W. Rd., 1005 Regina Ave., Price Hill, Cincinnati, O.

Murphy, W. J., Div. B. F., Penn. System, 221 N. 3rd St., Olean, N. Y.

Nicholas, Lewis, G. B. F., C. St. L. & Indianapolis, 2220 Ferry St., Lafayette, Ind.

Nicholson, E. J., F. B. M., C. & N. W. R. R., 409 Crooks Ave., Kaukauna, Wis.

Novak, Albert W., G B. I., C. M. & St. P. R. R., 4449 Xerxes Ave., Minneapolis, Minn.

Oliver, Jos. V., B. M. F., L. V. R. R., 213 Seymour St., Auburn, N. Y.

Ollis, Luke S., Dist. B. I., B. & M., Room 310 No. Station, Boston, Mass.

O'Reilly, Jas. A., Dist. I. Loco., I. C. C., 704 Peoples Gas Bldg., Pittsburgh, Pa.
Orr, J. J., G. F. B. M., D. L., & W. R. R., 428 Taylor Ave., Scranton, Pa.
Osborn, Jessie, D. G. B. F., A. T. & S. F. Ry., 2398 Arrowhead Ave., San Bernardino, Cal.
Osborne, H. A., Boiler Insp. C. & O., 3520 Carolina Ave., Richmond, Va.

Pable, Chas., B. F., C. & N. W. Ry., 990 Oakland Ave., Milwaukee, Wis.
Pack, Alonzo G., Ch. Insp. I. C. C., Washington, D. C.
Paepke, E. H., G. B. I., Union Pacific System, 224 E. 60th St., Los Angeles, Cal.
Patten, Wm. L., F. B. M., N. Y., N. H. & H., 59 Fletcher Ave., Roslandale, Mass.
Peabody, R. T., R. R. Sls. Asst., Air Reduction Sls. Co., 30 N. Arlington Ave., E. Orange, N. J.
Pearson, R. A., Boiler Insp., Canadian Pacific, 2619 15th St., W., Calgary, Alberta, Can.
Pease, Wm. B. F., M. C. R. R., 40309 Toledo Ave., Detroit, Mich.
Petzinger, C. F., G. F. B. M., Cen. G. R. R., 742 Courtland Ave., Macon, Ga.
Pollock, C. H., G. B. F., American Locomotive Co., Richmond, Va.
Pool, I. J., Dist. B. I., B. & O., Corner Merville & Manhattan Aves., Baltimore, Md.
Porter, Louis R., F. B. M., Soo Line, 2723 Ulysses St., Minneapolis, Minn.
Potts, David W., Asst. G. Loco., B. I., I. C. R. R., 112 N. Walnut St., Centralia, Ill.
Powers, John F., F. B. M., C. R. I. & P., 726 Ellis Blvd., Cedar Rapids, Ia.
Powers, John P., F. B. M., C. & N. W., 216 Lynn St., Boone, Iowa.
Powers, Thos. F., System G. F., Boiler Dept., C. & N. W. R. R., 1129 S. Clarence Ave., Oak Park, Ill.

Ramsey, George T., Salesman, United Alloy Steel Corp., Pershing Square, New York.
Raps, H. J., Gen. B. F., I. C. R. R., 7224 Woodlawn Ave., Chicago, Ill.
Raps, John F., Gen. Loco. Insp., I. C. R. R., 4041 Ellis Ave., Chicago, Ill.
Raynor, Chas. B., Welding Supv., B. & O. R. R., B. & O. Bldg., Baltimore, Md.
Reardon, Edw. J., Locomotive Firebox Co., 1908 Straus Bldg., Chicago, Ill.
Rearick, G. M., Gen. Boiler Insp., B. & S., 85 Germania St., Galeton, Pa.
Redmond, A. J., B. M. F., L. I. R. R., 22418 Orange St., Queens Village, L. I., N. Y.
Redmond, Wm., B. M. F., M. C. R. R., 404 Ring St., Bay City, Mich.
Reinhard, Fred C., Gen. B. F., A. T. & S. F. R. R., 1802 Ave. "I," Ft. Madison, Ia.
Rice, F. J., Rep., Am. Loco. Co., 30 Church St., New York.
Riley, G. N., Nat'l Tube Co., 1917 Frick Bldg., Pittsburgh, Pa.
Roberts, Arthur L., Sales Engr., United Alloy Steel Corp., Canton, O.
Robinson, G. P., Asst. Sales Mgr., Am. Loco. Co., 269 Ridgewood Ave., Glen Ridge, N. J.
Rogers, E. W., G. F. B. M., Am. Loco. Co., 1076 Ardsley Rd., Schenectady, N. Y.
Ruber, L. C., Supt., Boiler Wks., Baldwin Loco. Wks., 1312 S. Lansdowne Ave., Darby, Pa.
Russell, Robt., B. Insp., G. T. R. R. 256 Marshall St., Battle Creek, Mich.
Ryan, Jerry J., B. F., K. C. So., 1811 N. Grand Ave., Pittsburg, Kans.

Sadler, T. N., F. B. M., C. & N. W. Ry., Missouri Valley, Ia.
Schmidlin, Joseph B., B. M. F., N. Y. C. R. R., 76 Langmeyer Ave., Buffalo, N. Y.
Schmidt, J. M. L., Asst. Gen. B. Insp., A. T. & S. F., 3799 S. Hobart Blvd., Los Angeles, Cal.
Selmensberger, Geo., B. F., N. Y. C., 90 Rohr St., Buffalo, N. Y.
Service, H. H., Supv. Welding, A. T. & S. F. R. R., 308 Jefferson St., Topeka, Kan.
Shank, W. J., G. B. F., C. & N. W., 606 6th St., Clinton, Ia.
Shea, J. F., G. B. F., No. Pacific Ry., 814 W. 5th St., Sedalia, Mo.
Shingler, Norman, Gen. B. F., M. C. R. R., 22 Horton St., St. Thomas, Ont.
Shirley, John A., Asst. Chief Insp., I. C. C., 619 I. C. C. Bldg., Washington, D. C.
Shoemaker, Wm. B., Supt., Hibben & Co., 7138 Constance Ave., Chicago.
Smith, E. Frank, Loco. Firebox Co., Service Eng., 1354 Belt Ave., St. Louis, Mo.
Smith, John B., F. B. M., P. & L. E. R. R., McKees Rocks, Pa.
Smith, John J., G. B. I., C. P. Ry., 881 Wellington St., Montreal, Que.
Sorgen, Paul, B. F., I. C. R. R., Carbondale, Ill.
Stallangs, W. G., G. B. M. F., I. C. R. R., 12 S. Evergreen Pl., Memphis, Tenn.
Stapleton, T. J., Gen. B. F., B. & O. R. R., 3318 Niagara St., Pittsburgh, Pa.
Steinbuck, M. L., B. M. F., C. & N. W. R. R., Box 1081, Milwaukee, Wis.
Stephenson, E. C., Boiler Insp., C. & O. Ry., 1011 4th St., W. Huntington, W. Va.
Stevens, Henry V., Aut. G. B. I., A., T. & S. Fe, 116 N. Elmwood Ave., Topeka, Kas.
Stewart, L. M., G. B. I., Atlantic Coast Line, Box 660, Waycross, Ga.
Stiglmeier, A. F., G. B. S. F., N. Y. C. R. R., 138 N. Allen St., Albany, N. Y.
Stokes, John E., F. B. M., I. C. R. R., 300 South East St., Clinton, Ill.
Stuebben, C. A., Gen. B. F., Texas & Pacific, 1701 E. Houston Ave., Marshall, Tex.
Sullivan, F. J., B. M. F., I. C. R. R., 537 E. Empire St., Freeport, Ill.
Sullivan, Jos., F. B. M., N. Y. C., 270 Lafayette Ave., Buffalo, N. Y.

Thomas, John, B. F., N. Y. C., Niagara Falls, N. Y.
Thompson, Marcas A., Welding Supv., Boston & Maine, Room 310, North Station, Boston, Mass.
Thompson, R. H., B. F., C. & N. W., 224 Logan St., Fremont, Neb.
Thowarth, N., B. F. Frisco, 1410 E. Houston St., Sherman, Tex.
Todtz, Frederick, F. B. M., N. W. Ry., Casper, Wyo.
Totterer, Carl F., Gen. F., C. & A. R. R., 1406 N. Western Ave., Bloomington, Ill.
Tredinnick, S. W., G. B. M. F., Erie R. R., 1864 Clinton St., Buffalo, N. Y.
Tucker, William, F. B. M., I. C. R. R., Holmesville, Miss.
Tulin, Tad P., F. B. M., Erie R. R., 40 Condict St., Jersey City, N. J.

Umlauf, E. C., G. F. B. M., Erie R. R., 209 Erie Ave., Susquehanna, Pa.
Urban, William, Gen. B. M. F., A. T. & S. F. Ry., 315 S. W. 4th St., Newton, Kans.
Usherwood, George B., Supv. Boilers, N. Y. C., 302 Baker Ave., Syracuse, N. Y.
Usherwood, T. W., Dist. B. I., N. Y. C. R. R., 476 Livingston Ave., Albany, N. Y.
Usherwood, C. H., F. B. M., N. Y. C., 1005 West St., Utica, N. Y.

Vogelsinger, J. R., F. B. M., Erie R. R., 19 Collier St., Hornell, N. Y.
Voss, Otto C., Supt. Boiler Shop, Allis-Chalmers Co., 404 23rd Ave., Milwaukee, Wis.

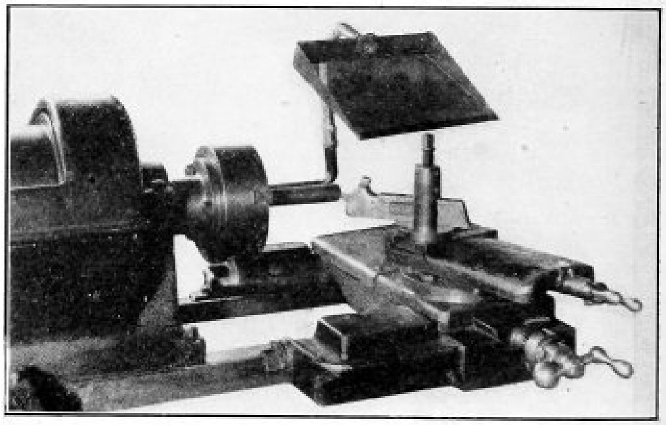
Wagstaff, Geo., American Arch Co., 17 E. 42nd St., New York, N. Y.
Wagoner, Geo. A., B. M. F., C. & N. W., 913 Elmore St., Green Bay, Wis.
Walla, Frank, F. B. M., C. St. P. M. & O. R. R., 1405 Prairie St., Sioux City, Ia.
Walker, Chas. H., F. B. M., West Shore R. R., 4639 Hudson Blvd., North Bergen, N. J.
Walsh, James T., B. F., Frisco, 1513 No. Missouri Ave., Springfield, Mo.
Wandberg, H. J., Dist. B. I., C. M. & St. P., 3033 Bloomington Ave., Minneapolis, Minn.
Warner, Victor, F. B. M., N. C. C. & St. L. R. R., 9226 Clyde Ave., Chicago, Ill.
Washburn, Leon E., Gen. F. B. M., Erie R. R., R. F. D. No. 2, Riverside Drive, Susquehanna, Pa.
Weart, E. T., Welding, John A. Roeblings Sons Co., 165 W. Lake St., Chicago, Ill.
Weis, August, B. F., I. C. R. R., 711 N. 9th St., Ft. Dodge, Ia.
Welk, John L., G. B. I., Wabash R. R., 944 E. Eldorado St., Decatur, Ill.
Whitman, C. L., F. B. M., C. & N. W., 611 52nd St., Milwaukee, Wis.
Wiles, John, B. F., N. Y. C., 43 Terrace Blvd., Depew, N. Y.
Williams, F. J., B. F., Erie R. R., 140 Brook Ave., Passic, N. J.
Wilson, Frank E., G. B. I., Florida E. Coast Ry., 129 King St., St. Augustine, Fla.
Wilson, George M., Gen. Boiler Supv., American Locomotive Co., 123 Glenwood Blvd., Schenectady, N. Y.
Wolfe, Willard E., B. F., C. R. I. & P. R. R., 408 6th St., Valley Junction, Ia.

Yochem, Frank, B. M. F., M. P. R. R., 116 S. Jackson Ave., Kansas City, Mo.
Young, C. F., B. I., L. S. & M. S. R. R., 920 Willard St., Elkhart, Ind.
Young, Geo. L., F. B. M., P. & R. Ry., 922 Madison Ave., Reading, Pa.
Young, M. J., G. B. F., Texas & Pacific, 1026 Lipton St., Ft. Worth, Tex.

Ziegenbein, Emil F., G. B. F., M. C. R. R., 121 Gilbert St., Jackson, Mich.
Zink, F., F. B. M., C. & N. W. R. R., Huron, S. Dak.

Acme Eye Shield for Machine Tools

THE Chicago Eye Shield Company, 2300 Warren avenue, Chicago, has placed on the market the Acme eye shield for use on such machines as grinders, buffers, saws, spot welders, lathes, planers, etc. The glass is of the non-shatterable type which is not easily broken and



The Acme eye shield in position on a lathe

will not scatter when broken by an unusually hard blow. The 7-inch by 4-inch glass protects the head and face of the workman.

The shield is furnished complete with adjustable steel brackets, pipe, lock nuts, wall brackets, an 18-inch flexible arm steel frame and glass. The flexible arm permits instant adjustment by hand without tools, to any desired position.

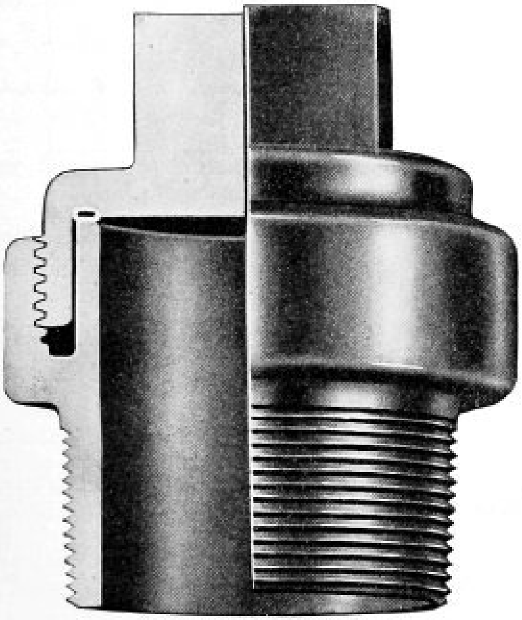
One shield can be used to cover both wheels of a double grinder, but where both wheels are in constant use, it is advisable to equip the machine with one shield for each wheel.

The Joseph W. Hays Corporation, Michigan City, Indiana, manufacturers of Hay draft gages, flue gas Analyzers, CO_2 recorders, and other combustion instruments, announces a slight change in name to "The Hays Corporation." Philip T. Prague, the new president, has been closely associated with this business for a number of years as vice-president and general manager.

Housley Safety Washout Plug

THE main feature of the Housley Flue Connection Corporation, Indianapolis, Ind., exhibit was the washout plug with an Acme thread shown in the accompanying illustration. This plug when seated on the gasket (which is compressed in a groove) has no threads showing on the cap. Should there be any threads showing when installed this is a warning that the cap is not seated on the gasket. The sleeve of this plug remains permanently fixed in the sheet. Boiler washing is carried on through the hole in the upper part of the stem or sleeve. The sectional view of the plug indicates the method of applying the lug cap.

The protecting wall safeguards the threads on the cap



Sectional view of Housley washout plug

against distortion or smashing caused by washing rods and the hose nozzle. It also prevents water and steam from touching the threads on the cap, allowing no mud, scale or any other sediment to form. It is also the seating face for the gasket.

The copper asbestos-graphited gasket used fits snugly in the top of the plug cap in a special groove and will not drop out when the cap is removed. Because of this gasket, steam leaks are impossible when the plug cap is screwed down tightly.

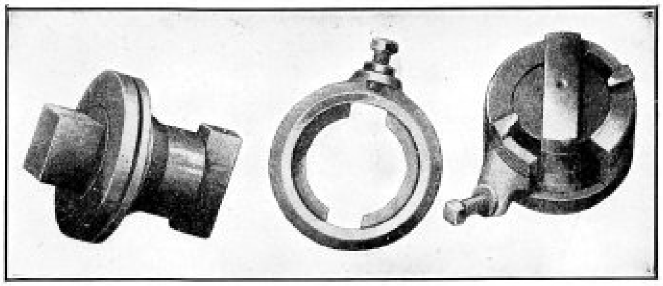
The sleeve is manufactured of the highest grade forged steel. The plug caps are also made of steel.

Threadless Washout Plug

A WASHOUT plug invented by Peter E. McIntosh, boiler foreman of the Michigan Central Railroad at Jackson, Mich., which is now being produced by Dromgold and Glenn, Chicago, Ill., was shown for the first time at the convention of the Master Boiler Makers' Association.

The illustrations shown herewith include the construction and application of the Dromgold and Glenn threadless washout plug as it is known. The sleeve or female piece of the plug screws into the boiler, the inner surface of this sleeve is tapered 1/16 inch so that after the male plug is inserted into the sleeve the connection is tightened by turning the plug to the right. The cross member shown on the bottom of the plug moves upon the incline, mentioned above as a taper section on the sleeve, and this makes a steam tight joint. The set screw is a safety feature only and is not absolutely essential to hold the plug in place or keep it from leaking.

The feature claimed for this type plug is that it cannot be moved either way with pressure on the boiler nor can it

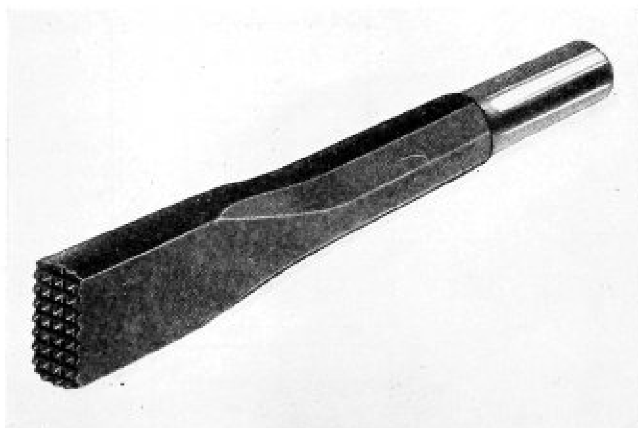


Construction and assembly of threadless washout plug

be incorrectly applied in the sleeve. If the plug is not tightened it will leak so badly that the boiler cannot be filled. When it is tightened by hand it will hold against 200 pounds per square inch pressure. This plug is manufactured of high grade steel drop forgings.

Lovejoy Roughing Tool

SPECIAL prominence in the display of the Lovejoy Tool Works, Chicago, Ill., at the convention was given to a new type of roughing tool which is illustrated herewith. This tool is for use in a pneumatic hammer, preferably the



Roughing tool used in pneumatic hammer

medium sized chipping hammer, and is handled very much like a beading tool. It is used to roughen the surface of a firebox or flue sheet around the flue holes to facilitate welding the flues to the sheet. It is stated that a better weld is possible as a result of working the sheet with this tool.

Toncan Firebox Plates

THE United Alloy Steel Corporation, Canton, Ohio, demonstrated a new application of Toncan alloy at the convention in the form of firebox plates.

Toncan is a pure iron alloyed with copper and molybdenum. The outstanding features claimed for this material are its resistance to pitting and corrosion. It will not harden when heated and quenched and will not harden when cold worked to same extent as ordinary firebox steel. The tensile strength of this material is within the American Railway Association specifications.

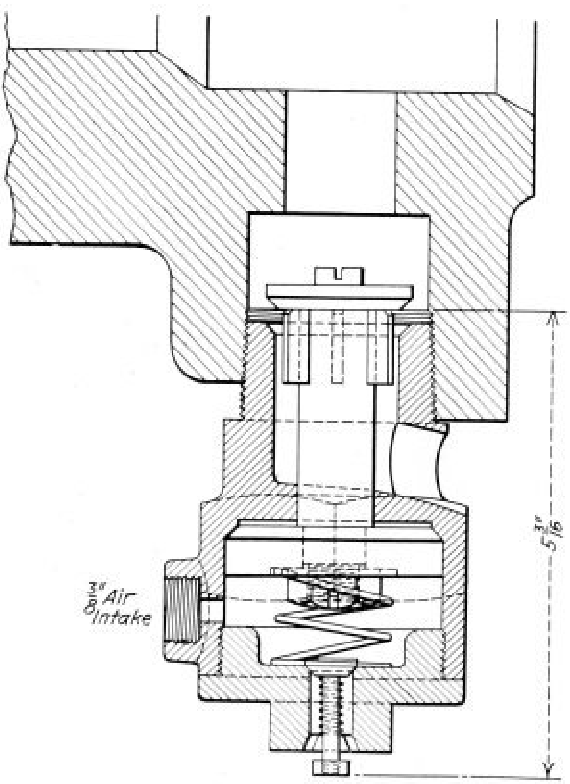
Lap Welded Pipe

IN connection with the exhibit of the Tyler Tube and Pipe Company, Washington, Pa., at the Master Boiler Makers' convention, this company included in its display lap welded pipe in sizes up to 8 inches. The company is now manufacturing this pipe in addition to its usual line of knobbled charcoal iron and open hearth steel lap welded boiler tubes.

Washout Nozzle and Gage Cock

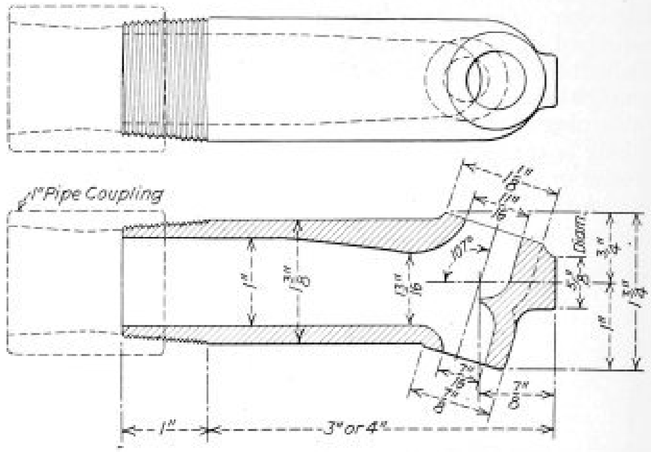
AMONG the new pieces of equipment shown by the Prime Manufacturing Company, Milwaukee, Wis., at the convention at Buffalo were an automatic cylinder cock, a washout nozzle and a double seated gage cock.

The automatic cylinder cock, which has been under test for a considerable time and has proven entirely satisfactory, incorporates the feature that it can be opened against pressure and remain seated throughout the entire stroke while the locomotive is operating steam. The valve is held open as is shown in the accompanying illustration when no pressure is being used by a small spring the tension of which is such that when the locomotive is operating the valve remains closed. The ability of this cylinder cock to operate against pressure is accomplished by allowing air from a small valve in the locomotive cab to act against a piston on the lower end of the cylinder cock valve, the area of which is greater than the area of the valve exposed to steam pressure.



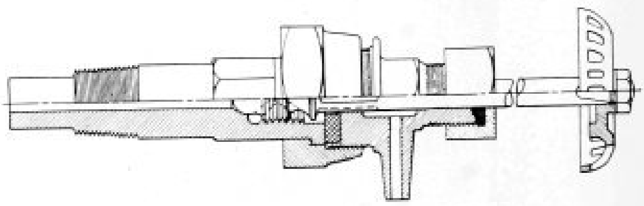
Prime automatic cylinder cock

The washout nozzle illustrated has been found to be an efficient mechanism for thoroughly washing a boiler. Due to its construction it is possible to wash behind the staybolts and thoroughly clean the boiler in accordance with inspection requirements. It is made of malleable iron and may be threaded and finished to meet any requirements.



Flue sheet washing nozzle

The double seated gage cock shown herewith has a feature of permitting the installation of a new fiber seat under pressure by engaging the steam with the emergency seat, then disassembling the outlet connection and the packing end. This device is supplied already threaded and finished for immediate application.


Double seated gage cock

New Thor Pneumatic Tools

THE Independent Pneumatic Tool Company, Chicago, Ill., demonstrated a number of new devices at the convention, including the Thor improved type riveter, the Thor ripping chisel and a new throttle and vent for the Thor air drill. These tools will be described in full and illustrated in a later issue of the magazine.

The Best Joint Is No Joint

IN a rigid structure, the best joint is no joint at all.

If it were not for the extra cost, seamless tubing would entirely displace butt- and lap-welded pipe.

A seamless steel cylinder is better than another with a seam in it, even though that seam develop 100 percent strength.

Stated in another way: jointless structures are the ideal to which constructors build. In approaching this ideal they keep the number of joints at a minimum, and then make each one as near 100 percent as possible.—*Oxy-Acetylene Tips.*

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

Steamboat Inspection Service of the Department of Commerce

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

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—C. D. Thomas, Salem, Oregon.
Statistician—E. W. Farmer, Rhode Island.

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

J. A. Franklin, International President, suite 522, Brotherhood Block, Kansas City, Kansas.
William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.
Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.
James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.
H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.
International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C. Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Avenue, Columbus, Ohio.

Master Boiler Makers' Association

President—J. F. Raps, general boiler inspector, Illinois Central.
First Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.
Second Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.
Third Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.
Fourth Vice President—George B. Usherwood, supervisor of boilers, New York Central.
Fifth Vice President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington and Quincy.
Secretary—Harry D. Vought, 26 Cortlandt Street, New York.
Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.
Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—J. W. Kelly, National Tube Company, Pittsburgh, Pa.
Vice President—A. W. Clokey, American Arch Company, Chicago, Ill.
Treasurer—George R. Boyce, A. M. Castle and Company, Chicago, Ill.
Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie, Pa.
Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.
Secretary-Treasurer—D. W. Glanzer, 840 Rockefeller Building, Cleveland, Ohio.
Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; Owsley Brown, Springfield Boiler Company, Springfield, Ill.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Wroks, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

Cities

Chicago, Ill.	Memphis, Tenn.	St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Los Angeles, Cal.	Philadelphia, Pa.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	New Jersey	Pennsylvania
California	New York	Rhode Island
Indiana	Ohio	Utah
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

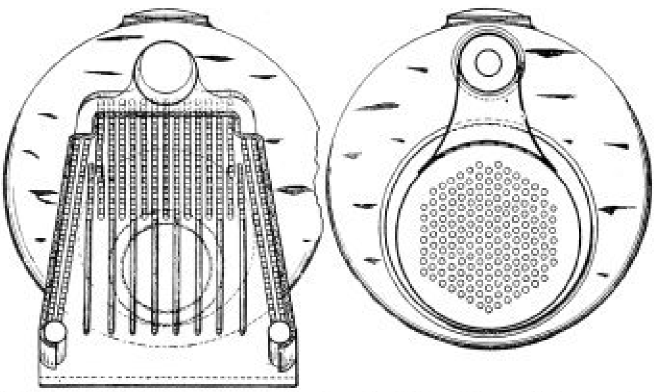
SELECTED BOILER PATENTS

Compiled by
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,578,739. STEAM BOILER. JULIUS KINDERVATER, OF NEW YORK, N. Y.

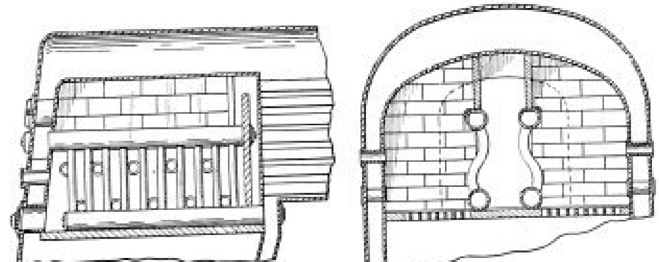
Claim 1. In a steam boiler of the locomotive type, the combination of a front and a back firebox header or water leg; a plurality of inclined water tubes, connecting said headers, and constituting the side walls of the fire-



box; a plurality of reversely inclined water tubes, interposed between the side wall tubes and connecting said headers; arch tubes leading from the front header into members of the intermediate set of water tubes; a steam drum, communicating with the headers, above the water tubes; and a combustion chamber, communicating with the firebox. 3 claims.

1,577,175 SMOKE AND GAS CONSUMING FIREBOX FOR LOCOMOTIVES. JAMES A. CONNELL, OF PITTSTON, PENNSYLVANIA.

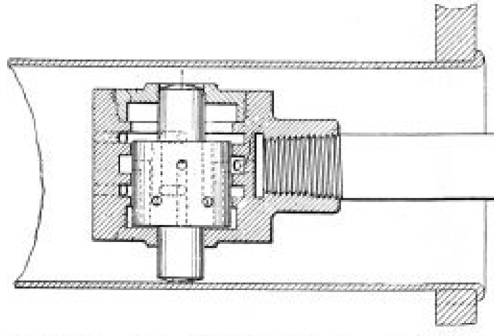
Claim 1. In a locomotive boiler, a plurality of flue tubes in the forward portion thereof, a crown sheet including a front wall receiving the flue tubes, a pair of sides, and a rear sheet, thereby forming a firebox, a grate supporting structure in the bottom of the firebox horizontally disposed, grates in the supporting structure, one to each side of the median longitudinal



dimension thereof, a pair of water grates disposed vertically in the firebox and extending longitudinally thereof in spaced relation to form a combustion chamber there between, walls rising from the water grates to the top of the crown sheet, and a plurality of draft tubes communicating the sides of the firebox with the exterior, and a baffle plate disposed in the firebox to the front of the combustion chamber and to the rear of the plate supporting the ends of the flue tubes. 3 claims.

1,577,309. BOILER-TUBE-SCALING DEVICE. STEPHEN SORENSEN, OF NEW YORK, N. Y.

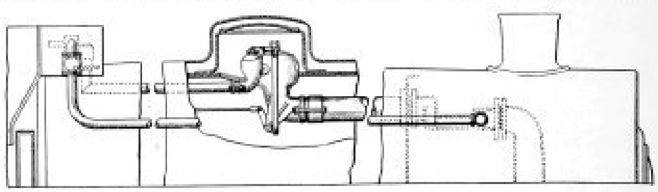
Claim 1. A body having a cylinder therein, said cylinder having a central fluid admission groove and fluid exhaust grooves, passages on opposite sides



of the admission groove, said cylinder having steam chambers at opposite ends thereof, a reciprocal piston disposed in said cylinder, said piston having axially spaced radially disposed rows of admission ports adapted to be respectively aligned with the admission groove in either extreme position of the piston within the cylinder, and with the exhaust grooves at intermediate positions of the piston and passages leading from said ports to opposite ends of the piston, whereby motive fluid is delivered to and exhausted from the steam chambers through the piston, said piston in its movement acting as a slide valve to control the flow of fluid.

1,580,266. LOCOMOTIVE. JOHN L. MOHUN, OF OMAHA, NEBRASKA.

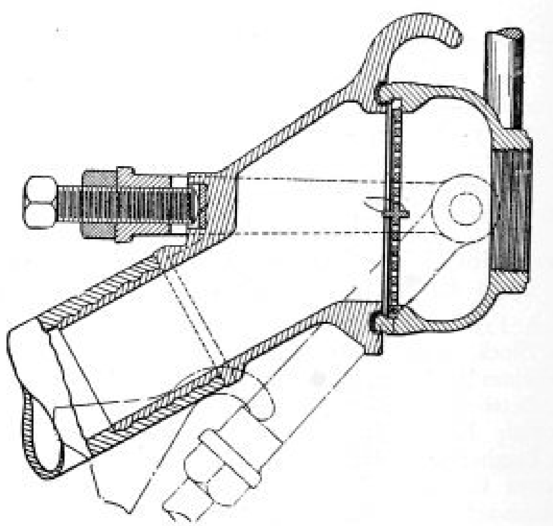
Claim 1.—In an apparatus of the character described having a source of saturated steam supply and a main steam consuming device, the combination with a super-heater; of means for supplying said super-heater with steam from said source of steam supply; a main control valve for said means; means adapted to supply an auxiliary steam consuming device with saturated



steam from said source of supply; means for supplying super-heated steam to said auxiliary steam consuming device, an auxiliary control valve for said means for supplying the saturated steam located adjacent said main control valve; and manually operable means for actuating said main control valve, said auxiliary control valve operating to supply saturated steam when said means for supplying super-heated steam is cut off, said auxiliary control valve being operable in predetermined relation with said main control valve so that when one is open, the other is closed and vice versa. Fifteen claims.

1,577,088. FEED-WATER STRAINER FOR LOCOMOTIVES. BELVIN T. WILLISTON, OF SOMERVILLE, MASSACHUSETTS, ASSIGNOR TO MANNING, MAXWELL & MOORE, INC., OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

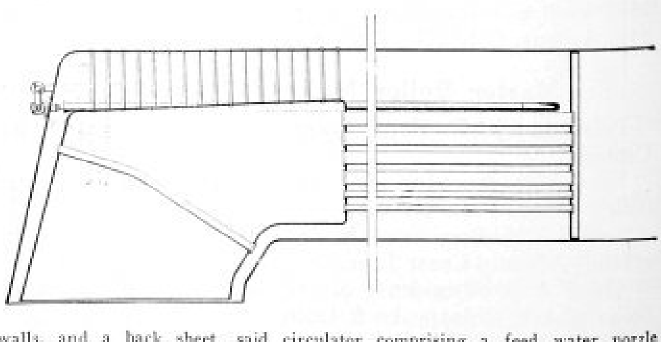
Claim 1. A strainer comprising a casing having separable sections, a member on one section movable to engage the other section for securing



said sections together, one of said sections being provided with an internal groove, and a screen or grid loosely mounted in said groove and removable therefrom after said sections have been separated by successive diametral and axial movements. 9 claims.

1,580,686. LOCOMOTIVE BOILER-WATER CIRCULATOR. WILLIAM C. SCHULTZ, OF MILWAUKEE, WISCONSIN; GULNARY SCHULTZ ADMINISTRATOR OF SAID WILLIAM C. SCHULTZ, DECEASED.

Claim 1. A circular for locomotive boiler water for use with a boiler having a fire box in the rear portion provided with a crown sheet, side



walls, and a back sheet, said circulator comprising a feed water nozzle projecting into the rear portion of the boiler adjacent the crown sheet, a circulating pipe located within the boiler with its intake end adjacent and aligned with said nozzle, said pipe extending towards the forward end of the boiler and having a delivery portion at such forward end, such delivery portion opening towards the rear of the boiler. Four claims.

The Boiler Maker

Volume XXVI July, 1926 Number 7

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Edward A. Simmons, *Pres.*
L. B. Sherman, *Vice-Pres.*
C. R. Mills, *Vice-Pres.*
Roy V. Wright, *Sec'y.*
Henry Lee, *Vice-Pres. and Treas.*
Samuel O. Dunn, *Vice-Pres.*
F. H. Thompson, *Vice-Pres.*
George Slate, *Business Manager*

Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ave.
Mandeville, La.
Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.

Cable address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

Request for change of address should reach us two weeks before the day of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

Embrittlement of Boiler Plate

WHILE the embrittlement of boiler plate is a condition which primarily concerns the boiler user, it is nevertheless something in which the boiler maker is vitally interested, for the reason that if there is anything in the design or methods of construction of boilers or in the quality of steel used that tends to cause embrittlement of the plate it is up to the boiler maker to devise means for preventing it. Hitherto the causes of embrittlement have been shrouded in mystery although in recent years the number of boiler failures apparently chargeable to embrittlement has steadily increased. To find out exactly what this troublesome phenomenon is, what causes it and how it may be prevented an investigation has been carried out by S. W. Parr, professor of applied chemistry at the University of Illinois, and F. G. Straub, special research assistant at the University of Illinois Engineering Experiment Station, the results of which are incorporated in a paper presented before the annual meeting of the American Society for Testing Materials held in Atlantic City last month.

In beginning the investigation a study was made of the cracking of rolled or fabricated plate. Three types of cracks were found: first, those due to direct corrosion of the metal; second, those due to fatigue; and third, embrittlement cracks or those which are caused by caustic solutions. Each of these is distinctive in type and can be definitely differentiated from the others by micrographic analysis. Corrosion cracks, caused by electrolytic action, follow the lines of stress in the metal but proceed across the grains and disregard the grain boundaries in their path of development. Fatigue cracks also disregard the grain structure of the metal and follow a course quite independent of the grain boundaries. Embrittlement cracks, on the other hand, without exception follow the grain boundaries and hence can be clearly distinguished from the others.

Having established a definite method of identifying any of the cracks that may occur in boiler plate, an extended geographical survey was made to find, first, if embrittlement occurred in definite areas where a specific type of natural water was used in the boiler and, second, if embrittlement could be traced to the direct application of certain feed water treatments. It was found that in the regions where embrittlement existed, the natural waters used are characterized not only by the almost complete absence of sulphates but also by the presence of free sodium bicarbonate which is primarily responsible for the embrittling action. Incidentally, it was found that embrittlement is not confined to any particular make or type of boiler nor does it occur by reason of impurities in the boiler plate. It was found to take place in all standard makes of both fire tube and water-tube boilers and in the best grade of boiler plate as well as in the poorer grades. It was definitely established that embrittlement cracks always occur below the water level in the boiler, in seams under tension and at places where the higher localized stresses might be assumed to occur. A summary of the chemical conditions which characterized the water used in boilers where embrittlement has occurred showed that sodium carbonate is the one substance which is always present in the feed water, sulphate hardness is usually absence or of a low ratio with respect to the sodium carbonate present. Boilers encountering this trouble use waters having these two characteristics and, as a consequence of chemical reaction within the boiler, develop a caustic condition with the sodium hydroxide in material excess over the sodium sulphate present. The real cause of embrittlement in steam boilers, therefore, can be summarized as concentration of caustic soda in the seams in the absence of much sulphate or carbonate, together with the existence of localized stresses in the seams.

This concentration of stresses exists in all boilers to a greater or smaller degree, due not only to the pressure in the boiler but also to the pressure exerted around the rivet holes in riveting the seams. Yet in the absence of the proper chemical in the boiler water no embrittlement will result. If the proper chemical, that is sodium hydroxide in the absence of much sulphate or carbonates, exists in the boiler water, there is a possibility that sooner or later the boiler will become embrittled. The presence of caustic soda under pressure in the boiler tends to produce a seepage of the solution into the seam between the metal surfaces. As the solution penetrates between the plates there is a tendency for concentration, due to the steam being released back to the boiler or escaping to the outside. As the concentration progresses, the penetration of the solution further into the seam continues. With time, the concentration becomes sufficient to start embrittlement and, if localized stresses are sufficient at the point of concentration, embrittlement cracks will develop.

Often this concentration is reached and embrittlement does not progress, apparently due to lack of sufficient strains and the penetration progresses until a free leak develops. On examination, no presence of embrittlement can be found. At other times, embrittlement develops, the plates are weakened and a leak develops which indicates trouble. When the plates are removed from the seams of embrittled boilers soluble salts are found between the plates. This alone would indicate that there must have been considerable concentration in the seams. Another evidence of chemical attack in the seams is the presence of finely divided black magnetic caustic deposit on the surface of the plates. The fact that the two main factors for embrittlement must occur simultaneously makes it possible for some boilers to operate under conditions which might point toward embrittlement without developing any distress but the fact that no distress has become apparent upon general inspection is no sign that the boiler is free from danger.

The results of the experimental work indicate that embrittlement can be stopped, although at present the experiments are not complete enough to cite final ratios and concentrations of the chemicals involved. Data on actual plants in use covering a period of 10 years are consistent with the experimental results, in that, by maintaining a ratio of sodium sulphate to sodium hydroxide in excess of 2 no embrittlement is found to occur. The removal of localized stresses in the seams does not appear possible in a commercial installation but the practice of inside calking in drums, if it entirely prevents seepage in the seams, will tend to retard the occurrence of this type of distress. The removal of the source of the sodium hydroxide by changing the supply water would be the most effective of any method but in some instances this is not possible and in others it would lead to the uses of waters which would produce other boiler complications. In other words, each plant must be considered by itself in order to set any prescription for feed water treatment in order to prevent embrittlement.

Further investigation of this subject will be made but the facts disclosed are sufficient to explain a troublesome condition in boiler operation reassuring boiler makers that the blame for this condition does not fall upon them.

Production in Boiler Repairs

UNDER ordinary conditions a shipyard would seem to be a rather strange place in which to find locomotive work going on but, as a result of the decreased demand for ships in the period following the war, the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., entered this field with a remarkable degree of success. An outline of the manner in which this company adapted a portion of its facilities to the rebuilding of Mallet locomotives and the conditioning of other types is contained elsewhere in this issue. The degree of success of the efforts in this direction may be measured by the great amount of locomotive repair work which has been turned out in the shops of the Newport News Company.

The way in which the organization met the problems of locomotive and heavy boiler repairs offers food for thought to the mechanical departments of railroads throughout the country. In utilizing the facilities that exist in a shipyard for work of this character the problem becomes one mainly of the boiler shop; whereas the machine work can be done by means of repetitive processes, the boiler shop must produce on what amounts to practically a unit basis.

The first step taken in the case of the Newport News boiler shop was the rearrangement of the machines to accomplish what the railroad mechanical departments have long since found necessary—namely, a steady movement of parts in one direction throughout the shop from the layout floor to the test stand. That being done, the important factor remaining on which the measure of the efficiency of the plant depended was the organization of a control system—both for material and labor. The inspection and supervisory forces which were organized together with an excellent scheduling system and the manner of specialization in shop work, known as the sub-contract method, solved the problem of production. A number of the forms utilized in the shop for routing, scheduling and group control are given in the present article. These forms aptly demonstrate some of the reasons why this concern has been able to turn out satisfactory work in competition with the best railroad shops in the country.

LETTERS TO THE EDITOR

Welded Steel Angle Rings

TO THE EDITOR:

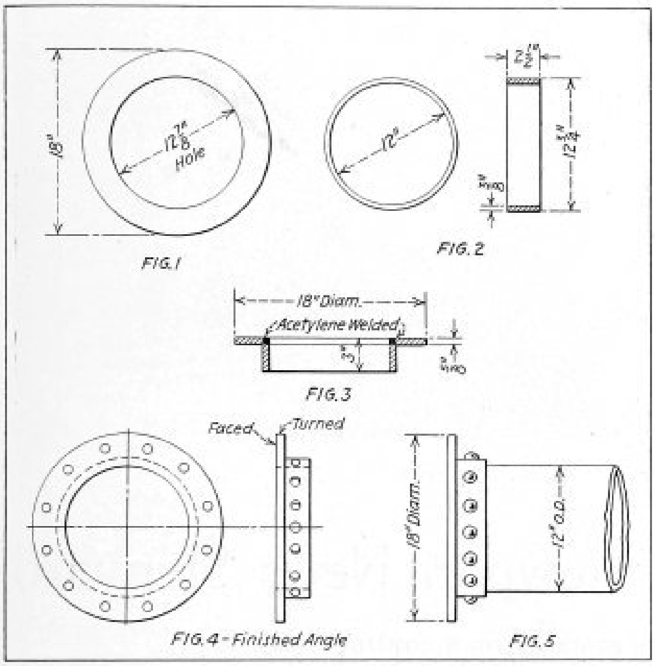
The accompanying sketches illustrate a new departure in the manufacture of angle iron rings.

To make an angle ring for a 12-inch diameter pipe, first take a flat circular plate equal in diameter to the size of the pipe flange, which in this case is 18 inches and 5/8-inch thick, as shown in Fig. 2, and cut out the center with the acetylene torch to 12 7/8-inch diameter. The next step is to make a steel band from 2 1/2 inches by 3/8 inch flat strap, 12 inches inside diameter by 2 1/2 inches wide, Fig. 2. We now have the bolt flange and the riveting flange of the angle, and these are shown assembled ready for welding in Fig. 3. Fig. 4 shows the finished angle after being faced on the bolt flange, turned on the outer edge and drilled for bolts and rivets. Fig. 5 shows the same angle riveted on to a tube or pipe. The most satisfactory process in the making of these angle rings is the oxy-acetylene process. Electrically welded rings are also good.

COST OF MANUFACTURE

These welded steel angles compare favorably with pressed steel angles in cost and are very much cheaper than an angle that has been bent from the section and fire welded. If a firm has a hydraulic press then there is no need to adopt this method but many firms are minus that very useful commodity and are faced with the proposition of bending in the orthodox way. The practical man will readily admit that a small angle say 12 inches in diameter is harder to bend than one say 4 feet diameter in proportion to its value and of equal section. The writer's experience is that up to 20 inches inside diameter the welded angle or pressed steel angle is cheaper than bending.

Economy is effected by keeping the inside part of the flange that has been cut out to make a flange for a smaller size of pipe. As a practical proposition, the welded steel flange is sound and I hope to send you a photograph of a batch at an early date. As a commercial proposition, I think there are distinct possibilities if made in quantities.



Details of angle rings

Leeds, England. JOHN GORDON KIRKLAND.

The Value of the Hammer Test *

By J. A. Snyder†

THE use of the inspector's hammer has brought to light many dangerous conditions in boilers and pressure vessels that would not otherwise have been found and that undoubtedly would have caused serious explosions within a short time had they not been discovered.

In certain parts of the country where corrosive water is used in steam boilers, the corrosion produces such uniform reduction of the plate or tube material that it is not perceptible to the eye. Where the material is wasted away so uniformly that it cannot be detected by visual inspection, it may become reduced to such an extent that a rupture or crack may develop and cause a serious explosion. Recently an inspector found a dangerous condition in the mud drum of a bent tube type of watertube boiler. He was using his hammer freely on the plate surface, and the difference in sound to his ear and feeling to his hand when he struck certain spots attracted his attention. Upon removal of some brickwork, a careful investigation was made and a dangerously thin condition of the shell was found.

While hammer testing the tubes of a horizontal watertube boiler, an inspector noted a peculiar sound given out by one tube in the top row. It seemed to be entirely free at one end. He inquired of the engineer whether that tube was being cut out, but the engineer stated that he was not taking out any tubes as the boiler had been operated the day before and as far as he knew was in good order. Upon examination it was found the tube was cracked all the way around close to the header; it evidently had cracked while the boiler was cooling down. This condition would not have been found by mere observation as the tube end was in a difficult place to see.

The Interstate Commerce Commission rules require all rigid staybolts in locomotive boilers to be hammer tested every thirty days. It is a splendid rule for it has probably prevented many explosions and failures in fireboxes. In one case, with everything appearing sound and in good condition, an inspector discovered by means of the hammer test twenty-two broken staybolts. Cracked and broken braces are often detected by the use of the hammer. Loose hangers and supporting columns are also thus detected and show insufficient support of boilers or important steam pipes.

A common bolt was found projecting from a hole in the side of a boiler that was being used in a saw mill. Upon being asked why it was there, the engineer replied, "Why, a fool boiler inspector knocked a hole in the boiler." This boiler was not approved by the inspector, and as there were no inspection laws it was continued in operation. Later the boiler exploded. There would be much less sacrifice of human life and wasteful destruction of property if some sort of inspector could knock holes in certain boilers and then not permit closing the holes by bolts, welding, or any other process, but instead have such defective boilers discontinued from service or else repaired by safe and substantial methods.

A valuable adjunct of the hammer test, particularly where old boilers or pressure vessels are concerned, is the hydrostatic pressure test. Boilers that have been in service for any length of time are likely to have developed cracks. These cracks gradually get longer and deeper, and finally penetrate through the plate. Long before this stage has been reached, however, they are dangerous, yet exceedingly difficult to detect. If the hydrostatic pressure can be kept up while the hammer test is also applied, many incipient ruptures will be revealed.

If there is any reason whatever to suspect, as a result of internal or external examination, that a used boiler is liable to fail under ordinary working pressure, it is advisable to apply a hydrostatic test equal to one and one-half times the working pressure allowed by the inspector. If the boiler withstands this test without showing signs of distress, it may be taken as evidence, contributory but not conclusive, that the boiler is capable of handling the steam pressure which the inspector advises under the conditions.

If major repairs are made on a boiler it is well to subject it to a hydrostatic pressure for the same reason that a new boiler is subjected to it on the testing floor in the shop—to show leakage at rivet and joints where these parts are not as tight as they should be. The hydrostatic test is of particular value for showing up minor leaks, particularly on new constructions.

*From *The Locomotive*, published by the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.
†Chief Inspector, Pittsburgh department.

P. G. Gibler has been appointed assistant general boiler inspector of the Gulf Lines and is succeeded as boiler maker foreman in the Cleburne, Tex., shops by R. H. Leaton.

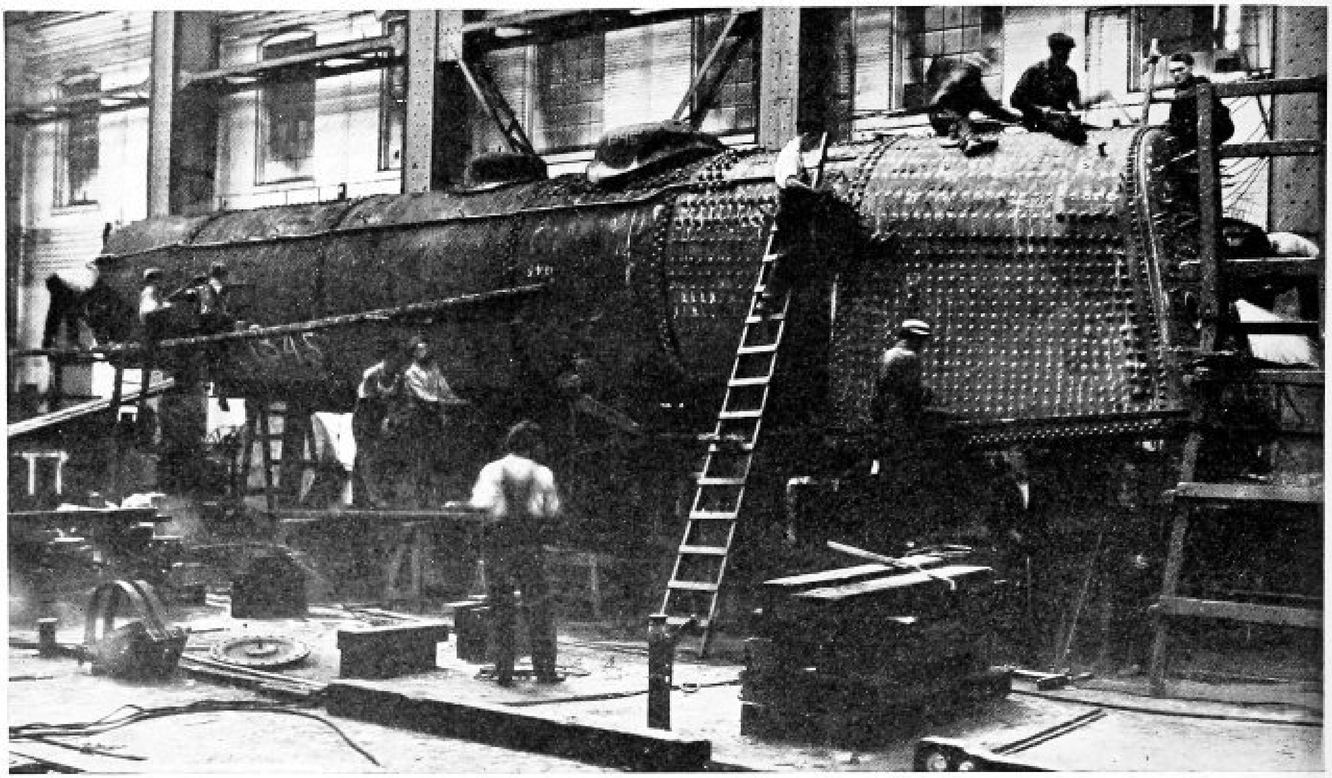


Fig. 1.—At work in the Newport News boiler shop

Rebuilding Locomotives at Newport News Shipyard

Controlling operations and scheduling material on a contract basis for work on Mallet locomotives—The boiler makers' end of the problem

By C. E. Lester

IT may well be said in the beginning that control of material is the keynote of successfully handling repair work.

When accepting a contract for repair work on locomotives at a prearranged price for the basic work, with agreed amounts for credits and extras, after competitive bids—a company accepts the responsibility of turning out a product that not only must meet a rigid shop inspection, but must also conform to rules and regulations laid down by the Inspection Bureau of the Interstate Commerce Commission. If the company is to survive all this must be done at a profit.

It is a trite truism that "well begun is half done" and nowhere is it any more applicable than on boiler repair work.

While in the machine shop, getting out new and reclaimed parts for the engines may be done in quantities, in no manner can the work in the boiler shop be called repetitive unless the flanging of a half dozen flue sheets be so called. It is, therefore, somewhat difficult to fix upon prices that are in every case equitable. The necessity for meeting competition requires that they be low and the shop and the planning division are then the mediums whereby the figures finally are placed in the profit or loss column.

Three Factors Involved

To me, there seems to be but three general factors of production involved. Preparation—organization—control.

Preparation is in its fullest sense, an estimate of the situation and the devising of ways and means of meeting the problem forearmed and engaging it to a successful termination.

This involves the procurement of material, a survey of shop facilities, a survey of equipment, the making of patterns, jigs and templates. Drawings, plans, forms are adjuncts whereby organization and control may be effective.

The particular job in mind in this article was a lot of boilers for large Mallet locomotives and involved the application of new fireboxes, new throat sheets, new front flue sheets, a new design of the smokebox liner, a reinforcing liner for the guide yoke support and a large installation of flexible staybolts; a new design of ashpan, a new cab, a new design of draft appliances and alterations to suit Duplex Stoker were also carried out. The tanks were altered to suit the Duplex Stoker;—new type front and back coal boards, new style rectangular filling hole and other heavy repairs completed the job.

The work varied considerably as some few of the locomotives had received one or more of the changes—some did not require new fireboxes and some required other work. The plans contemplated that locomotives leave the shop in the order of arrival and in view of the diversity of repairs this entailed some difficulties in organization, inasmuch as the erecting shop had practically a fixed amount of work with the exception of some new cylinders. A forty-eight day schedule took no account of the difference in the amount of repairs. This had to be controlled within the shop.

For the joint purpose of determining the exact repairs required for billing and the shop's information—an inspection service was organized. This consisted of the railroad inspectors with a chief inspector for the plant, and his subordinates; the inspectors of machinery and inspector of boilers.

The boiler inspection was a joint one with a representative of the engineering department as a recorder. As a matter of proper record-billing and general usefulness all locomotive parts were divided into groups. The groups were then divided into items.

From the joint inspection by the railroad, shop and engineering department representatives, a sheet covering every item of the inspection, signed and approved by all of them, was issued. See Figs. 2 and 3. The staybolt chart, Fig. 4 was also used to indicate each part or piece renewed. A copy of the report covering the specific groups and items over which each inspector had jurisdiction was then issued to each subforeman or subcontractor and such others as were concerned.

No work was authorized nor paid for that was not actually listed on some part of the inspection report. In the case of errors, omissions, and defective parts that developed after the regular inspection, these were cared for by issuing a supplementary report.

LOCOMOTIVE ENGINEERING DEPARTMENT
INSPECTION REPORT — DELIVERED— Eng. No. — In Shop — Insp. Group 1 — Inspector

Index No.	Line No.	Description	Size			Mat'l	No. Pieces	Renew	Elec. Weld	Machine	Straighten	Refit	O.K.	Remarks
		ASH PAN												
	1	CASTINGS												
	2	HOPPER					1		✓	✓		✓		
	3	SLIDE					1		✓	✓		✓		
	4													
	5	PLATE	SIZE											
	6	HOPPER SIDE - FRONT SECT.				19008	2				✓			
	7	" " " BACK "				"	2				✓			
	8	" " WING FRONT SECT.	⅝	48	48	"	2	2						
	9	" " " BACK "	"	39	41	"	2	2						
10	10	" " " EXTEN. FRT. SEC.	"	10	48	"	2	2						
	11	" " " " BACK "	"	10	48	"	2	2						
	12	" FRONT-TOP SECTION				"	1				✓			
	13	" " BOT. "				"	1				✓			4-22-26
	14	" " WING				"	1						✓	
	15	" BACK	⅝	30	65	"	1	1						
	16	" " WING	"	13	56	"	1	1						
	17	" CENTER FRONT SLOPE SHT.					-							
	18	" " BACK " "					-							
	19	" " TOP SHEET					-							
	20	" WHEEL POCKET				19008	2						✓	
	21	" SPRING HANGER POCKET	⅝	23	31	"	2	2						
	22													
	23	ANGLE AND NETTING												
	24	ANGLE	⅝	2	2	x6'0"		1						
	25	"	⅝	1	1	x8'6"		1						
	26													
	27	NETTING												
	28													
	29													

Fig. 2

LOCOMOTIVE ENGINEERING DEPARTMENT
INSPECTION REPORT — Eng. No. — In Shop — Insp. Group 4 — Inspector

Index No.	Line No.	Description	Size	Mat'l	No. Pieces	Renew	[illegible]	O.K.	Remarks
		BOILER AND DETAILS							
	1	FIREBOX							
	2	FIREBOX COMPLETE			x				
	3	DOOR SHEET			1				
	4	CROWN SHEET			1				
	5	SIDE SHEET - R.		[illegible]	1	1			
	6	SIDE SHEET - L.		"	1	1			
	7	TUBE SHEET - BACK			1	1			
	8	THROAT SHEET - INSIDE			1				
	9	COMB. CHAMBER BOT. SHEET			1				
	10	MUD RING			1				
13	11	ARCH TUBES			4	4			
	12	FUSIBLE PLUG	16-24		1	1			4-27-26
	13								
	14								
	15								
	16	SHELL							
	17	CHECK HOLE PATCH - 1ST. COURSE	[illegible]		1			✓	
	18	CHECK HOLE PATCH - 1ST. COURSE	"		1			✓	
	19	1ST. COURSE			1		✓		
	20	1ST. COURSE LONGITUDINAL SEAM			2		✓		
	21	2ND. COURSE			1		✓		
	22	2ND. COURSE LONGITUDINAL SEAM			2		✓		
	23	3RD. COURSE			1		✓		
	24	3RD. COURSE LONGITUDINAL SEAM			2		✓		
	25	4TH. COURSE			1		✓		
	26	4TH. COURSE LONGITUDINAL SEAM			2		✓		
	27	DOME - MAIN			1		✓		
	28	DOME TOP RING - MAIN			1		✓		
	29	DOME BASE - MAIN			1		✓		

Fig. 3

CENTRALIZED CONTROL OF MATERIAL

In this, as in other work of the same character, no material requisitions are issued from the shop with the exception of fit up bolts, graphite and tap lubricants, the foreman issues orders for this material.

From data on the inspection report—all material orders are issued. These are all handled by one man in the superintendent's office who makes all sketches for special forgings, machinings, etc., furnishes all sizes, dimensions and quantities of plate, castings, forgings, staybolts, rivets, etc., from the inspector's report and predetermined basic data of complete group members. As an example of basic data, the staybolt chart is a good one, illustrating how a complete list of bolts, sleeves, etc., may be furnished for any location in the boiler. All that is necessary is to determine the exact location of the part to be replaced and the chart will give the proper type, size and length.

In the application of new fireboxes—all staybolts, both rigid, flexible and radial are drawn from stock by the material man, threaded and delivered to the boiler without reference to anything else.

As soon as the inspector's report is received by the requisition clerk, he issues necessary requisitions to cover the fabrication of parts or secures finished or semi-finished material from the stores department. Such of these orders as are not promptly needed are held in suspense until the department material chaser calls for them and starts the material coming. There is no inter-departmental supply of material unless accompanied by the proper production routing card. No one is permitted to secure materials from the store rooms except the material man; which eliminates the usual crowd hanging round to be waited on. The uncertainty of the repairs precluded the possibility of advance fabrication of fireboxes and flue sheets except in small quantities and the considerable variation in some of these parts prohibited everything but putting in the crown stay holes and the rough fitting of fireboxes until they were checked with the boiler to which they were to be applied.

As the illustrations will indicate, room for operations was at a premium. The boiler shop was designed and equipped for marine work and the locomotive work necessarily had to take its place along side of Scotch marine boilers, uptakes breechings, stacks, air tanks, etc. Counterbalances were constructed for staybolt work that required the services of but one man on all types of bolts and taps; these were conservers of space and energy.

In order to prevent too great congestion, boilers requiring new fireboxes were taken from the frames at the stripping track and all stripping done outside and fireboxes made ready for the boiler before it was brought into the shop. This permitted the utilization of all the available space within the shop for fabrication and assembly. No pieces of discarded parts were taken into the shop except such as were required occasionally for templates. All flues were taken out and boilers scaled before entering the shop. The flue shop being a separate building these parts were kept out of the building until they were needed for application. All draft appliances were repaired and overhauled outside the shop and only brought in as required. All ashpans, grates, running boards, cabs, etc., were repaired outside. They were picked up by a locomotive crane the day wanted and taken into the shop and not before. The next problem is one of material.

GROUP CONTROL

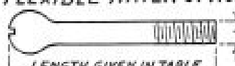
Fig. 5 illustrates the group control of material, giving complete information as to all the material in Group 74 which happens to be draft appliances and accessories. The control of material handled this way is absolute. It will be noted that the material list with its group number is most complete. The order clerk, on a request for material, checks the inspector's report against the material sheet for

RIGID WATER SPACE STAYBOLTS

LENGTH GIVEN IN TABLE + 3/4" = SHEARING LENGTH

DISTANCE OVER SHEETS + 3/4" = LENGTH IN TABLE

FLEXIBLE WATER SPACE STAYS



LENGTH GIVEN IN TABLE — SEE TABLE

LENGTH GIVEN IN TABLE = LENGTH OVER SHEETS + 2 3/4" FOR Z-3 SLEEVE; LENGTH OVER SHEETS + 3" FOR Z-5 SLEEVE; LENGTH OVER SHEETS + 1 1/4" FOR Z-F SLEEVE

RIGID WATER SPACE STAYBOLTS (Length 1¼" dia. / Length 1" dia. — Pieces)

Engine No's.	Location	Row Number	Total Each Row	1¼" dia. 8 Hollow	1¼" dia. 8 Solid	1¼" dia. 7 Hollow	1¼" dia. 7 Solid	1¼" dia. 6½ Hollow	1¼" dia. 6½ Solid	1" dia. 10½ Hollow	10½ Solid	10 Hollow	10 Solid	9½ Hollow	9½ Solid	9 Hollow	9 Solid	8½ Hollow	8½ Solid	8 Hollow	8 Solid	7½ Hollow	7½ Solid	7 Hollow	7 Solid	6½ Hollow	6½ Solid	6 Hollow	6 Solid
1326-1350	Throat	COR	–																										
1351-1362		COR	–																										
1363-1376		COR	–																										
1326-1350		1	4																	4									
1351-1362		1	4																	4									
1363-1376		1	2																	2									
1411-1476		1	4																	4									
1326-1362		2	22																		22								
1363-1376		2	22																		22								
1326-1362		2	22																		22								
1363-1376		2	22																		22								
[illegible]		4	24				2																		22				
[illegible]		4	24																						24				
All Engines	Back Hd.	1-3	26																		26								
1326-1350		8-11	30	6																	61								
1351-1435		8-11	28	6																	64								
1436-1460		8-11	48	8																	52								
1461-1475		8-11	42	8																	54								
1326-1350		8-11	30	8																		18	4						
1351-1435		8-11	28	8																		16	4						
1436-1460		8-11	48	8																		27	18						
1461-1475		8-11	42	8																		16	18						
1326-1435		12-14	58			6																		4	48				
1436-1460		12-14	58			4																			54				
1461-1475		12-14	60			4																			56				
All Engines		15-17	66																								66		
All Engines	Side	1																											
↓		2																											
1302-1475		3	22												6	6	4		6										
1476-1495		3	20												12		8												
1302-1435		4	28												8	6	4		10										
1436-1495		4	26												8	6	4		8										
		5	34												2	8	6		12		6								
		6	40													8	6		12		14								
		7	40													4	4	4	10		14		4						
All Engines		8	44															8	10		16		10						
		9	46															8			18		16		4				
		10	46																	6	12		18		10				
		11	46																	2	8		20		19				
		12	46																				20		22		4		
		13	46																				6		24		16		
[illegible]		14	12																						12				
		15	30																						30				
		13	46																				6		24		16		
1326-1362		14	14																						14				
		15	32																						32				
		13	46																				6		24		16		
1377-1495		14	12																						12				
		15	30																						30				
All Engines		16	48																								48		
↓		17	54						4																		50		
	Comb. Ch.	1	–																										
		2	–																										
All Engines		3	–																										
		4-6	–																										
		7-13	20							20																			
↓		14-17	14							14																			
1326-1350	Throat		72																	4	44				24				
1351-1362			72				2																		22				
1363-1376			70																	2					24				
1377-1410			72				2													4					22				
1411-1476			72				2													4					22				
All Engines	[illegible]		24																										24
All Engines	[illegible]		6			(This item not included in total firebox figures)																							6
1326-1350	Back Head		251	14		6															87	8	4	4	48		66		
1351-1435			248																		90	16							
1436-1460			252	16		4															77	22	18		54				
1461-1475			258	16																	80	16			56				
1326-1362	Sides		586																						122				
1363-1376									4						16	32	24	20	60	8	88		96				118		
1377-1435			582																						118				
1436-1475			580																58										
All Engines	Comb. Ch.		34							34																			
1326-1350	Total Fire-Box		959																		272	18			196				
1351-1362			964				2													12					198				
1363-1376			958	14		6													60	10	22	16	98	4	196				
1377-1410			960						4	34					16	32	24	20									184		24
1411-1435			956				2													12					186				
1436-1460			966	16		4													58		20	22	112		194				
1461-1475			964	16																	28	16			196				

FLEXIBLE WATER SPACE STAYS (Distance over sheets, inches, F / B; Length of bolt, 1⅛" and 1" dia. — Pieces; Cap and Sleeve — Pieces)

Engine No's.	Location	Row Number	Distance over Sheets F	Distance over Sheets B	Total Each Row	13 1⅛	13 1	12½ 1⅛	12½ 1	12 1⅛	12 1	11½ 1⅛	11½ 1	11 1⅛	11 1	10½ 1⅛	10½ 1	10 1⅛	10 1	9½ 1⅛	9½ 1	9 1⅛	9 1	8½ 1⅛	8½ 1	Cap Z	Cap ZF	Sleeve Z-3	Sleeve Z-4	Sleeve ZF	Row Number
1326-1350	Throat	COR	7⅝		34													20	14							34		34			COR
1351-1362		COR	7⅝		34													16	14					4		30	4	30		4	COR
1363-1376		COR	7⅝		34													16	18							34		34			COR
1326-1350		1	7⅝		16													8	4					4		12	4	12		4	1
1351-1362		1	7⅝		16													12	4							16		16			1
1363-1376		1	7⅝		18													8	6					4		14	4	14		4	1
1411-1476		1	7⅝		16													6	4					6		10	6	10		6	1
1326-1362		2	7⅜		2													2								2			2		2
1363-1376		2	7⅜		2														2							2			2		2
1326-1362		2	6⅞		2													2								2			2		3
1363-1376		2	6⅞		2														2							2			2		3
[illegible]		4	6⅝		–																					–					4
[illegible]		4	6¾		–																					–					4
All Engines	Back Hd.	1-3	7½	7⅞	20											20										20		20			1-3
1326-1350		8-11	7	6¾	16													8	8							16		16			4-7
1351-1435		8-11	7	6¾	16													8	8							16		16			4-7
1436-1460		8-11	7	6¾	16													8	8							16		16			4-7
1461-1475		8-11	7	6¾	16													8	8							16		16			4-7
1326-1350		8-11	6½	6⅝	16													8	8							16		16			8-11
1351-1435		8-11	6½	6⅝	16													8	8							16		16			8-11
1436-1460		8-11	6½	6⅝	16													8	8							16		16			8-11
1461-1475		8-11	6½	6⅝	16													8	8							16		16			8-11
1326-1435		12-14	6⅝	5⅝	12													6	6							12		12			12-14
1436-1460		12-14	6⅝	5⅝	12													6	6							12		12			12-14
1461-1475		12-14	6⅝	5⅝	12													6	6							12		12			12-14
All Engines		15-17	5⅞	5½	6													6								6		6			15-17
All Engines	Side	1	10⅜	7⅝	48	8		6		12		6		8		4		4								44	4	44		4	1
↓		2	9⅝	7⅝	50				8	2	6		14		4		10	2			4					46	4	46		4	2
1302-1475		3	9⅜	7⅝	28					2	6		6				6	2	6							28		28			3
1476-1495		3	9⅜	7⅝	30					2	6		6				8	2	6							30		30			3
1302-1435		4	9	7	22					2	6		2					2	10							22		22			4
1436-1495		4	9	7	24					2	6		2				2	2	10							24		24			4
		5	8⅝	6⅞	18							2	6						6	2	2					18		18			5
		6	8⅝	6⅞	12							2	2		2					2	4					12		12			6
		7	8⅜	6⅝	12									2	4					2	4					12		12			7
All Engines		8	8	6¾	8									2	2					2	2					8		8			8
		9	7⅝	6⅞	8											2	2					2	2			8		8			9
		10	7⅝	6	8													2	2			2	2			8		8			10
		11	7⅜	5⅞	8													2	2			2	2			8		8			11
		12	6⅞	5⅞	8													2	2					2	2	8		8			12
		13	6½	5½	4													2	2							4		4			13
[illegible]		14	6¼	–	4																	2	2			4		4			14
		15	6	5⅜	4																	2	2			4		4			15
		13	6½	5½	4													2	2							4		4			13
1326-1362		14	6⅛	–	2																	2				2		2			14
		15	6	5⅜	2																	2				2		2			15
		13	6½	5½	4													2	2							4		4			13
1377-1495		14	6¼	–	4																	2	2			4		4			14
		15	6	5⅜	4																	2	2			4		4			15
All Engines		16	5⅝	5½	6																			4	2	6		6			16
↓		17	5½	5½	–																										
	Comb. Ch.	1	9	9⅜	36				2		36															36			36		1
		2	9	9⅜	34				6		28															34			34		2
All Engines		3	9	9⅜	34				6		28															34			34		3
		4-6	9	9⅜	96				12		80						4									92	4		92	4	4-6
		7-13	9	9⅜	204				8		196															204			204		7-13
↓		14-17	9	9⅜	98						98															98			98		14-17
1326-1350	Throat				54													32	18							50	4	46	4	4	
1351-1362					54													32	18							50	4	46	4	4	
1363-1376					56													24	28					4		52	4	48	4	4	
1377-1410					54													32	18							50	4	46	4	4	
1411-1476					54													30	18					6		48	6	44	4	6	
1326-1350	Back Head																														
1351-1435																															
1436-1460					70											20		28	22							70		70			
1461-1475																															
1326-1362	Sides				244																		6			236	8	236		8	
1363-1376						8		6	8	18	18	10	30	12	12	6	18	18	30	8	16	10		6	4	240	8	240		8	
1377-1435					248																		10			240	8	240		8	
1436-1475					250												20									242	8	242		8	
All Engines	Comb. Ch.								34		464						4									498	4		498	4	
1326-1350	Total Fire-Box																														
1351-1362					870													78	70				6			584	16	352			
1363-1376					876												22	70	90					10		860		368		16	
1377-1410						8		6	42	18	482	10	30	12	12	26		78		8	16	10			4	858		356	502		
1411-1435					874																		10			856		354			
1436-1460																	24	76	70					14			18			18	
1461-1475					876																					858		356			

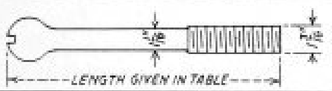
Fig. 4-a

DISTANCE OVER SHEETS + 1½" = LENGTH GIVEN IN TABLE

RADIAL STAYS - RIGID

ENGINE NO'S.	LOCATION	ROW NO.	TOTAL HORIZ. ROWS R.&L.	DISTANCE OVER SHEETS INCHES F	B	28¾	28¼	27½	27	26½	26	25½	25	24½	24	23½	23	22½	22	21½	21	20½	19½	19	18½	18	17½	16	15½	15	14½	13½	13	12½	12
						PIECES																													
ALL ENGINES	FIREBOX	4	46	27⅞	27¼	46																													
		5	46	25½	25½				46																										
		6	46	23⅞	23½							16	30																						
		7	46	21½	20½												6	16	24																
		8	46	18	16¾																		10	20	16										
		9	46	14½	12¾																							8	14	14	10				
		10	36	12	9¾																										2	2	10	10	12
ALL ENGINES	COMB.CH.	4	28	23½	26½		8	4	4	4	6	2																							
		5	28	21⅞	25					4	6	6	4	4	4																				
		6	28	20	23½									6	6	4	6	6																	
		7	28	18	20½														6	6	8	8													
		8	24	15⅝	17½																			8	8	8									
		9	10	12⅞	14																								8		2				
		10		10	11⅝																														
		11																																	
		12																																	
			458	TOTAL		46	8	4	50	8	12	24	34	10	10	4	12	22	30	6	8	8	10	28	24	8	0	8	22	14	14	2	10	10	12

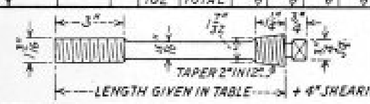
Fig. 4-b



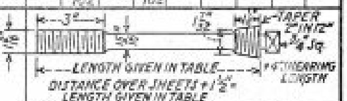
DISTANCE OVER SHEETS + 3½" = LENGTH GIVEN IN TABLE

RADIAL STAYS - FLEXIBLE

ENGINE NO'S.	LOCATION	ROW NO.	TOTAL HORIZ. ROWS R.&L.	DISTANCE OVER SHEETS INCHES F	B	27½	26½	24½	22½	21	20	18	17	16½	15½	14½	14	CAPS Y	SLEEVES Y-2
						PIECES													
ALL ENGINES	COMB.CH.	4	6	23½	26⅞	6												6	6
		5	6	21⅞	25		6											6	6
		6	6	20	23½			6										6	6
		7	6	18	20½				6									6	6
		8	10	15⅝	17½					5	5							10	10
		9	24	12⅞	14							6	10	8				24	24
		10	34	10	11⅝										8	4	20	34	34
	FIREB'X.	10	10	10	11⅝										10			10	10
			102	TOTAL		6	6	6	6	5	5	6	10	8	18	4	20	102	102



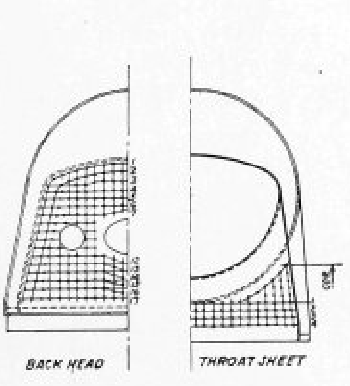
DISTANCE OVER SHEETS + 1" = LENGTH GIVEN IN TABLE



DISTANCE OVER SHEETS + 1½" = LENGTH GIVEN IN TABLE

CROWN STAYS — EXPANSION STAYS

ENGINE NO'S.	LOCATION	ROW NO.	TOTAL HORIZ. ROWS R.&L.	DISTANCE OVER SHEETS INCHES F	B	30½	30	29½	29¼	29	28½	28	27½	27	26½	EXPANSION 29⅝	28¾	28	CAPS Y	SLEEVES Y-1	NUTS Y-1 3/16
						PIECES															
ALL ENGINES	FIREB'X.	1	46	29½	29½	46															
		2	46	29	29		46														
		3	46	28¼	28¼				46												
	COMB.CH.	1	34	26½	29½	6	6	4		6	6					6			6	6	6
		2	34	26	28½			6		4	4	6	4	4			6		6	6	6
		3	34	24½	27¾					4	4	4	4	6	6			6	6	6	6
			240	TOTAL		52	52	10	46	14	14	10	8	10	6	6	6	6	18	18	18



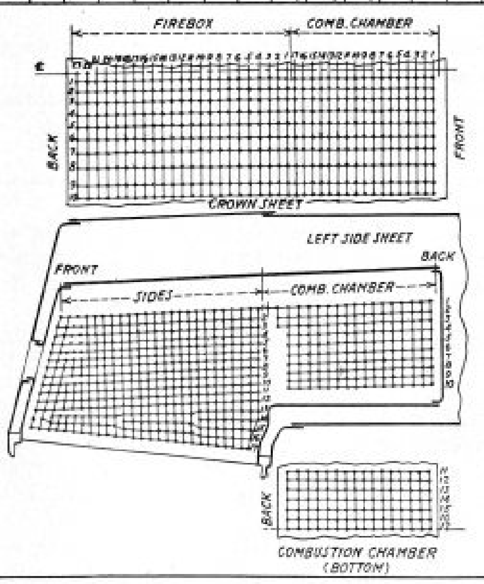


Fig. 4-c

sizes and quantities and that is what is furnished. It takes considerable skirmishing round to get anything not called for or to straighten out errors, but, by and large, it works well and as an exemplification of material control it is hard to beat. As a rule, the order clerk has most of his requisitions for material made out before they are needed or before the shop requests them. The shop material man takes a bunch of the orders, selects such as he wants promptly, the remainder he holds in suspense until needed.

Scheduling Operations

Scheduling operations has seemed to be an important factor in systematic production and one sheet of the master

SMOKEBOX MATERIAL				MALLET LOCOMOTIVES TYPE H-4				SHEET 74-1
GROUP	LINE NO.	FOR	TO	NO. PER ENG.	SIZE			REMARKS
74	1	ANGLE IRON			THICK	WID.	LENGTH	
	2	NETTING & DEFLECTING PLATE	SMOKEBOX & DIAPHRAGM	52'0"	2"x2"x 1/4"			15'0" LENGTHS AND
	3	DEFLECTING PLATE	TABLE PLATE	9'0"	3"x2"x 5/16"			MULTIPLES
	4							
	5	BARS AND PLATES						TANK STEEL
	6	DAMPER		1	1/4"	12 1/2"	76 1/2"	
	7	" STOP PLATE		1	3/16"	9"	88"	
	8	PLATE BET. HEADER AND TUBE SHEET		1	3/16"	8"	78"	
	9	" ADJUSTABLE DEFLECTING		1	3/16"	8"	78"	
	10	" DEFLECTING		1	3/16"	10"	88"	
	11	" "		1	3/16"	30"	32"	ORDER 5 SHEETS
	12	" "		1	3/16"	30"	32"	42" x 96" OR
	13	" "		1	3/16"	30"	32"	MULTIPLES
	14	" " AND SPLICER		2	3/16"	3"	29"	
	15	" TOP EXHAUST PIPE		1	3/16"	30"	88"	
	16	" TOP NETTING		1	3/16"	7"	51"	
	17	DOOR SLIDE	SIDES	6	1/4"	1 1/2"	4'6 1/2"	
	18	" "	ENDS	7	1/4"	1 1/2"	2'4"	
74	19	INT. FRAME FILLER	DOOR SLIDE	2	3/8"	1"	4'4 1/2"	
	20	DOOR		4	1/4"	1 1/2"	2'3"	
	21	"		2	3/8"	1"	2'7"	
	22	" SLIDE	CENTER	1	1/4"	1 1/2"	2'7"	
	23							
	24	BOLTS AND RIVETS			HEAD	DIA.	LENGTH	
	25	DIAPHRAGM	ANGLE	18	HEX.	3/8"	1"	
	26	DEFLECTING PLATE	ANGLE & TABLE PL.	18	"	3/8"	1"	
	27	TABLE PLATE	SIDE ANGLES	10	"	3/8"	1"	BOLTS
	28	SLIDING DOOR FRAME		28	"	3/8"	2"	
	29	TEE HEAD BOLT FOR	LOCKING DOOR	1	[illegible]	1/2"	1 5/8"	5/8" SLOT
	30	DRAFTAC	DOOR	24	CTSK.	3/8"	1"	
	31	DIAPHRAGM APRON	DIAPHRAGM	4	HEX.	3/4"	1 1/2"	
	32	ANGLES	SMOKEBOX	54	CONE	7/16"	2"	RIVETS
	33							
	34	DRAFTAG						
	35	SIDE SHEETS		2	NO. 393	31"	54 1/2"	
	36	DOOR & DOOR SHEET			"	31"	54 1/2"	
	37							
	38							
	39							
	40							
TITLE SMOKEBOX MATERIAL				SHEET 74-1 (2 SHEETS)			DRAWING NO. 126884	

Fig. 5

sheet is shown in Fig. 6 indicating the extremes of the various operations.

It may be said in passing that the thought uppermost in making up a schedule should be to complete stripping at the earliest time possible. This makes possible the early determination of the amount of repairs and renewals and necessary fabrication.

The incentive system is used throughout as a means of stimulating production, using both piecework and subcontract methods.

The Subcontract Method

The subcontract method is thought, by the writer, to be superior to piecework in that many jobs that otherwise would be "fatherless," so to speak, are properly cared for in the subcontract method. For example the contractor on the application of ashpans, has also cabs, grates, running boards, deck sheets, draft appliances, grab irons, ladders and sand box handles.

The boiler testers calk all rivets, cup all staybolts, center mark all flexible bolts for identification and stencil all plates and patches. The thought uppermost in the organization of operations is to leave no job as a place for "soldiering" or a dumping place for excess time and the like.

Specialization in operations has been followed to the greatest degree possible. This is not only good shop practice but in late years due to the dearth of good mechanics it is a matter of self production. It is a simple matter, within a short period of time, to convert a husky helper into a specialist that will give a good account of himself along certain lines.

The work may be roughly divided into four general classifications:

1.—Stripping.
2.—Fabrication and subassembly.
3.—Assembly.
4.—Test.

These classifications are in turn broken down into various smaller groups, such as fitting, drilling, reaming, riveting, etc.

Our first classified group begins work when the locomotive arrives at the water plug for washing and ends when the scalers finish.

The operations consist of:

First subgroup:

Wash out firebox, remove arch, ashpan, grates, draft appliances, running boards, flues, etc. This work occupies about 3 days and is subcontract.

Second subgroup:

Remove firebox, front flue sheet, liners, throat sheet, etc. This work is done subcontract and is started as soon as burners can get to the work. Oxy-acetylene burners do all this work except backing out rivets and knocking out staybolt stubs.

Third subgroup:

The scalers start their contract of thoroughly scaling and cleaning the entire boiler, as soon as the flues are removed and finish up, normally, shortly after the firebox is out.

It is very essential that scaling follow stripping closely, as inspection is a scheduled operation and cannot be completed until scaling is completed.

Fabrication and Subassembly

At this point our second classified "fabrication and subassembly" starts. It is difficult to establish a clear cut line of demarcation here, to say just where subassembly ends and assembly starts, however, as a general rule "subassembly" applies to all work assembled on the floor and "assembly" after it reaches the boiler. When material has been available a sufficient time in advance, fireboxes were fabricated and subassembled to the point of developing the staybolt layout on the formed boxes prior to the arrival of the boilers in the shop. Subassembly also has included the development and forming ready for application, all patches,

FIG. 6—48 DAY MASTER SCHEDULE

CLASS 2 AND 3 REPAIRS

	Days Started After Shopped	Days Completed After Shopped	Days Del. After Rct. of Mat'l
Ashpan Group No. 10—			
Remove	1	1	..
Inspect	..	1	..
Repair or renew	10	36	..
Inspect	..	37	..
Boiler and Details—Groups 13 and 14—			
Flues removed	1	3	..
Inspection	..	6	..
Remove from frame	2	4	..
Remove firebox	2	6	26
Renew front flue sheet	6	18	10
Renew outside throat	6	14	..
Refit boiler braces	152	20	..
Apply firebox	14	30	..
Apply flues	31	34	20
Test	35	36	..
Final boiler inspection	46	46	..
Boiler Smokebox and Liners—Groups 13 and 14—			
Front cleaned out	3	5	..
Inspect	..	6	..
Liner installed	10	28	26
Front complete	..	30	..
Inspected	..	31	..

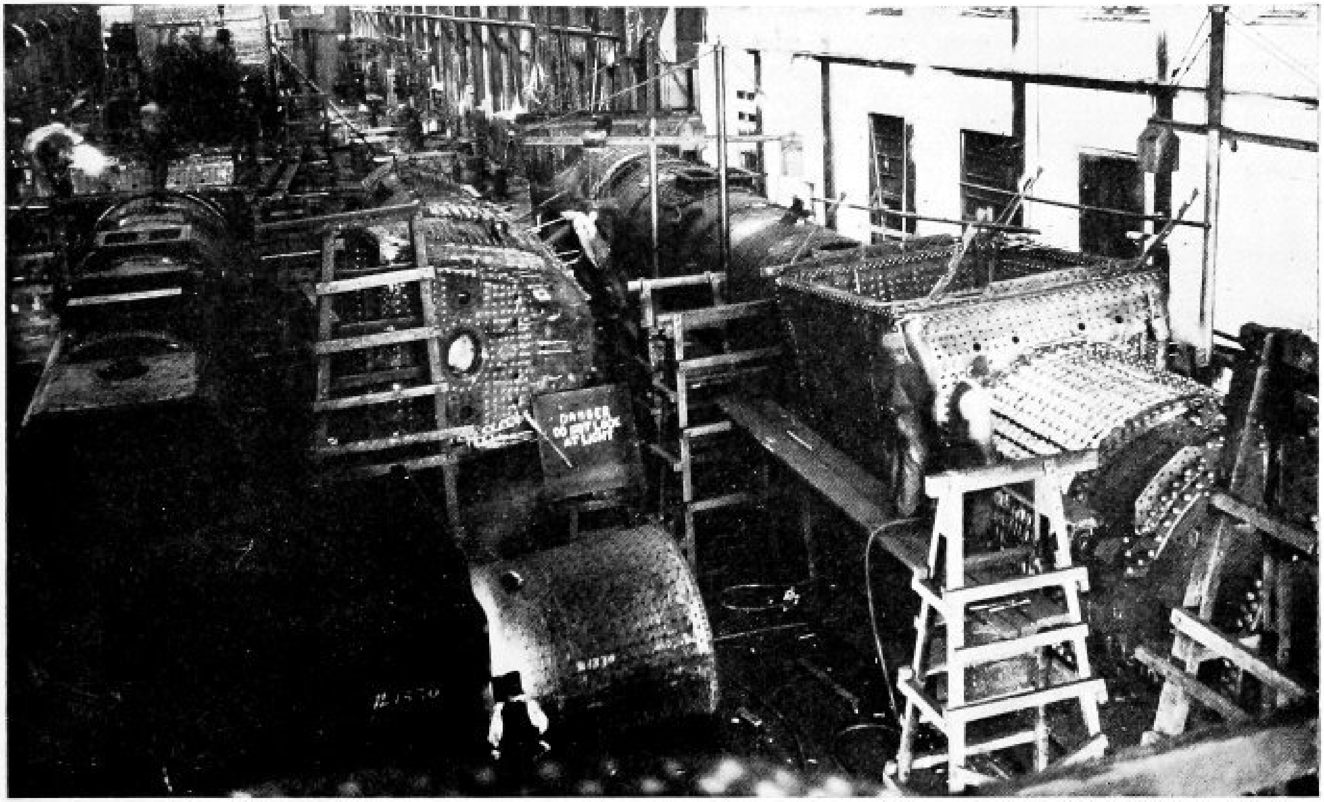


Fig. 7.—One half of the south bay of the boiler shop

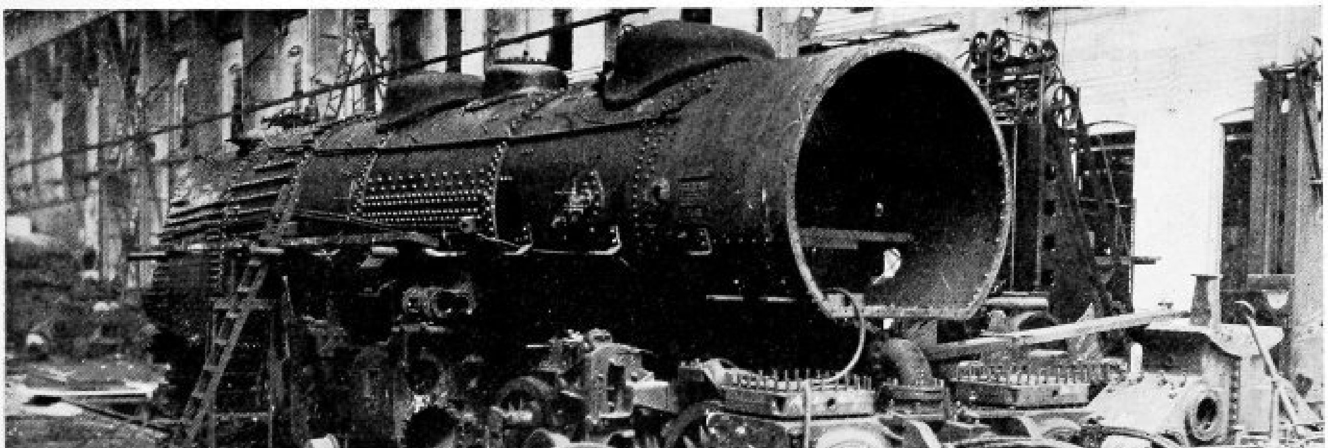


Fig. 8.—View taken in the erecting shop

liners, half sheets, etc., and delivered to the assembly gang. Under this classification also comes drillers and some burners, chippers and calkers, endeavoring so far as possible to bring the work to these men in a manner that keeps them fully occupied at their particular specialty.

Assembly begins when the firebox is applied to the boiler, or rather this is the major operation in boiler repairs. To be exact, assembly really begins when the front flue sheet, reinforcement plates or patches are applied; some of this work is really filler work and has no fixed place in the routine of regular operations, the jobs fit in here and there, as the occasion presents.

Assembly is divided into seven general groups with many subdivisions.

These groups are:

Fitting up, reaming, riveting, staybolting, calking, bracing and flues. Most of this work is but ordinary shop practice; suffice to see that the work progresses in orderly sequence until the boiler is ready to test. So far as possible the specialists are rotated from one job to another just ahead of the next succeeding job in order to prevent congestion and consequent delay.

Testing Boilers

A hydrostatic test of 25 percent excess of water is applied. This pressure is held up an hour or two. At this time all leaks possible are taken up and the hammer test is given bolts, after which the water is drained, all defective parts replaced, the superheater header applied and the pressure run up again. After this the water is lowered to the proper amount and the boiler fired. The steam pressure is raised, leaks taken up and the boiler completely gone over with a kerosene light to determine slight blows.

The water is then blown out, a quantity of soda ash applied, the boiler again filled and fired. A complete inspection with a lighted torch is again made. The extra precautions on test have been found advisable due to large installations of flexible sleeves, with consequent small steam blows at sleeve and cap, and has eliminated the necessity of frequent removal of jacket and lagging to find these leaks. After test is completed all washout plugs are removed and all minute debris removed from the interior of the boiler.

Application of Staybolts

One item of fabrication and assembly that may be mentioned as being successfully handled is the threading and application of staybolts. It is without question a difficult problem to get good fitting staybolts into old boilers without a large percentage of losses. Inasmuch as the holes and bolts are straight and the inspection requires a hammer test of all bolts to determine vibration, bolts rejected if they vibrated before hammering, the necessity for close fitting bolts is apparent.

Apparently the first requisite must be uniformity in size for both the holes and the bolts. To accomplish this the first thing has been to thread the bolts not over 0.003-inch off size. This is accomplished by furnishing the bolt cutter operator with a standard plug gage to fit his die to and a female gage to fit the bolts to. The men who apply the bolts are equipped with a "go" and "not go" gage for sizing their taps. The bolts are made accurate size and the taps must suit the bolts.

The staybolter at the beginning of a job takes half a dozen taps—taps a hole with each one, tries each hole with his "go" and "not go" gage and from the result of his test selects the taps that are of uniform size and goes to work with the assurance that most of the bolts applied will be a good fit. This method is the most successful of any I have used; however, it is not fool proof and some loose bolts will be found, due principally to irregularities in the bolt iron, careless lubrication and the tapper "riding the tap."

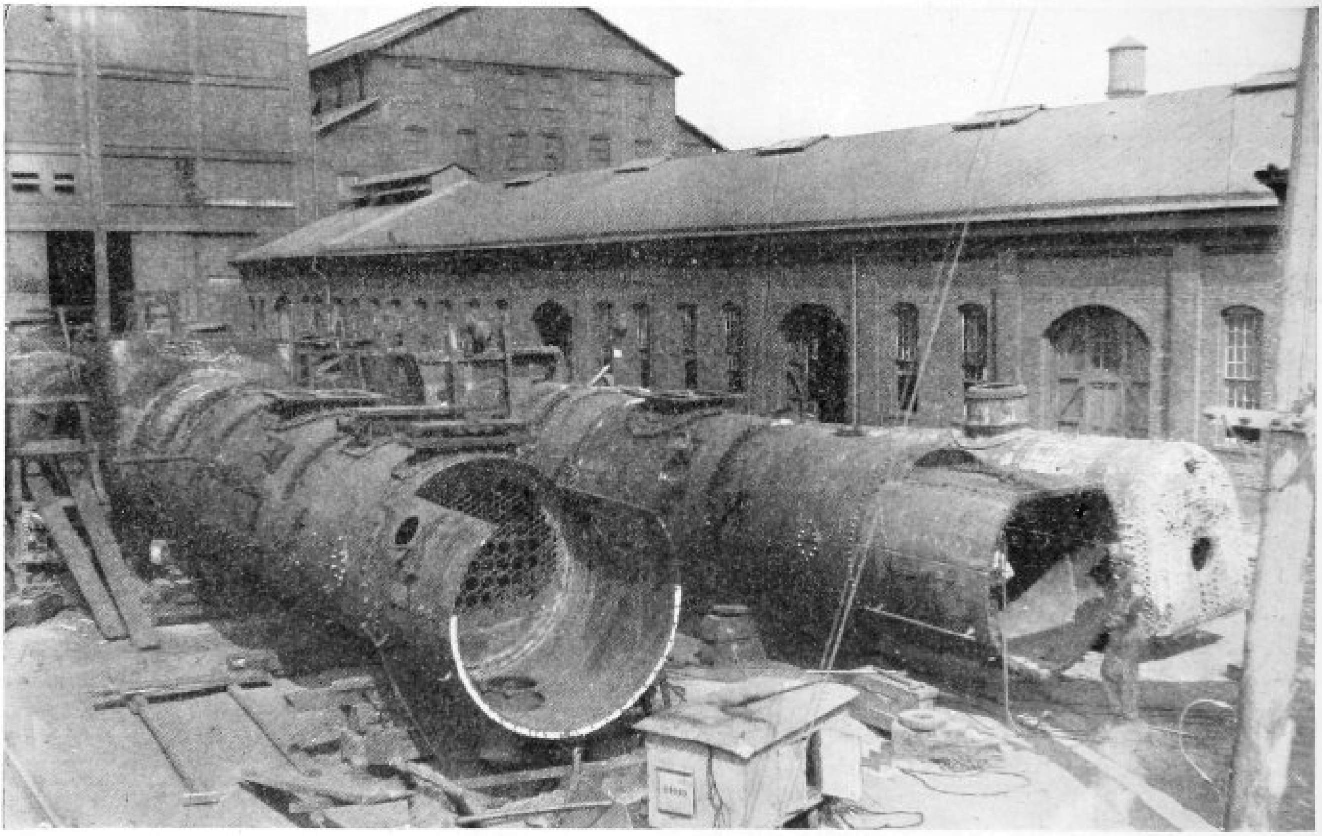
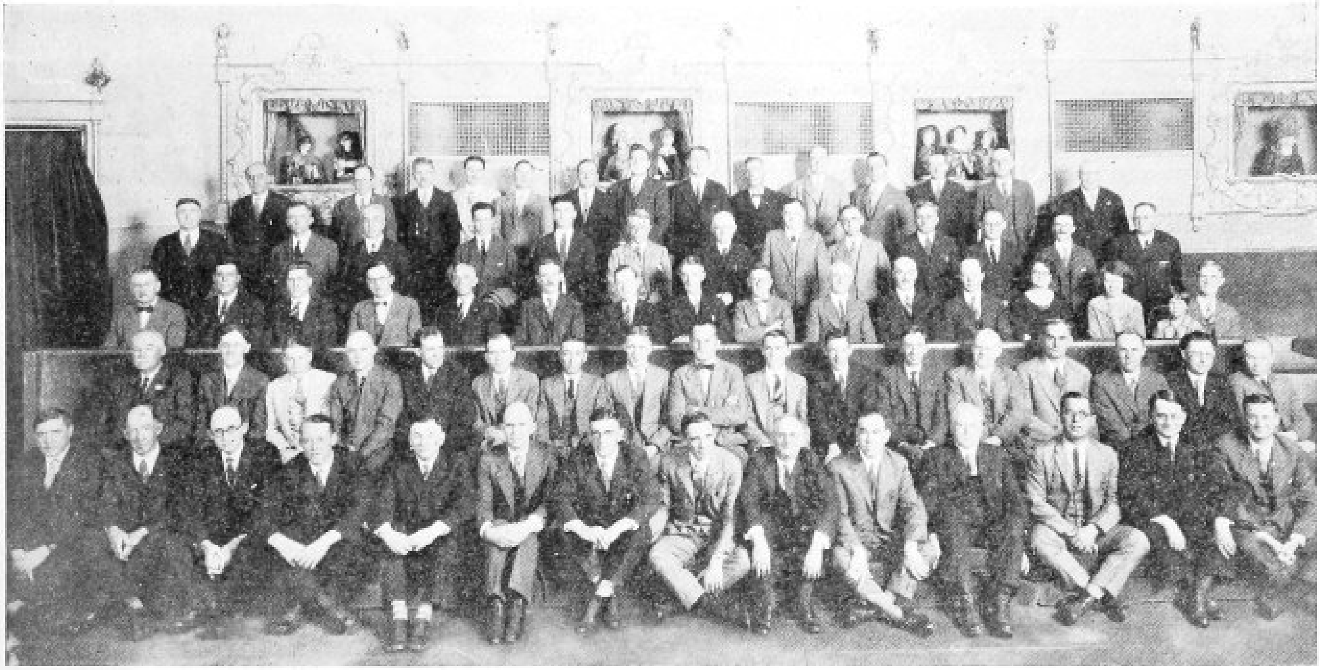


Fig. 9.—Boilers in the boiler shop annex



Members and guests at the fourth annual meeting of the National Board

National Board Meeting Proceedings at Chicago

Uniformity of examinations, and cooperation of all organizations interested in A. S. M. E. Boiler Code keynote of enthusiastic meeting

THE fourth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors was opened by Chairman Joseph F. Scott of New Jersey, at the Hotel Sherman, Chicago, May 24. Nearly 100 members, guests and invited speakers were present at the meeting.

CHAIRMAN SCOTT: A meeting of this kind always produces good results through the fact that we get the personal touch that we could not get otherwise through correspondence or other means. If there are any subjects pertaining to the National Board that seem to be of a complicated nature and do not from your viewpoint work out as they should, now is the time to take them up.

We want uniformity and we have to have cooperation. As you know, the Board was created through the demand for a system to get uniformity and the enforcement of the boiler code of the A. S. M. E. As it was, the more states that adopted the code, the more confusion occurred, for the reason that every board adopted its own rules and regulations.

As a result of the confusion that was created prior to the formation of the National Board of Boiler and Pressure Vessel Inspectors, in 1919 this idea was thought out and practically started in New York at a Boiler Code Committee meeting of the A. S. M. E. by a small body of men. It went on then until 1921 until we had a convention in Detroit. I believe it was a joint convention with the spring meeting of the A. S. M. E. in Detroit at that time. That was well attended, as most all of you were there, and you know what advances were made and you also know about the popular approval that the idea of the National Board created.

Since then we have had cooperation from the manufacturers in the country who wanted to simplify and standardize our work in the boiler field.

We had another meeting in Cleveland. That was very successful. There was no criticism of any serious nature, but a lot of suggestions and criticisms were offered to help improve our work.

In 1925 we had our meeting in Milwaukee. The result of that meeting speaks for itself. It was successful from every viewpoint. Every representative of the National Board went home feeling that we had accomplished something towards obtaining that which we wanted to realize in our work, namely, a uniform and standard method of construction, stamping and inspection of steam boilers throughout the country.

Today we are here in Chicago. We are unfortunate in a way in not having our meeting held jointly with the spring meeting of the American Society of Mechanical Engineers, but as they are in San Francisco, it was manifestly too expensive for this new body to incur or entail such an expense to go to San Francisco; so we decided that possibly Chicago would be about the most central point to meet this year. We have been assured by the boiler element of the A. S. M. E. that they are with us in our meeting, and no matter what we do or what we may propose to do, they will be glad in every instance to cooperate with us. We have the same feelings and sentiments from the insurance companies and from the manufacturers who are cooperating with us.

MR. MYERS, Chief Boiler Inspector of the State of Ohio and Secretary-Treasurer of this Body, will read his annual report giving the financial condition of the National Board at the present time and going into other matters which he has touched upon with me verbally, but which I would like to have him express as he has it outlined more fully in his report.

Report of C. O. Myers, Secretary-Treasurer

AT our last meeting a year ago I called your attention to the registration of manufacturers and commissioning of inspectors for shop inspections and it was unanimously voted that we would all accept data reports from manufacturers who have registered with the National Board without requiring individual registration in each state and municipality and I am pleased to report at this time that this has been working very satisfactorily and all persons interested seem to be well satisfied with this progress.

The study of the question of uniform boiler inspection laws and uniformity of administration of such laws is a very complicated problem and it has been my belief since the inception of the National Board that the various questions touching upon this subject should be brought out and agreed upon, and worked out to completion separately, and I further believe that it would not be policy to complicate the objects which we are working for by injecting too many phases at one time and at this meeting it will be my purpose to leave the thought with you of the importance and the necessity of creating an examination board to prepare the questions and answers for the examination of boiler inspectors.

One Examination for Inspectors

I would suggest that we work toward the object of securing one examination and this examination to be conducted by each of the State boards at certain intervals throughout the year, these examinations to be conducted on the same day. In some cases some of us would be required to change our dates but I believe that the result of such an arrangement would be well worth the effort necessary to bring it about.

We have touched upon this subject lightly at the last several meetings but no concentrated effort has ever been put forth to effectively bring this to a final and complete conclusion. This question is one which requires considerable thought and work and is one which I must admit is too big a problem for me to handle alone and I would suggest at this meeting that this question be thoroughly discussed and the ideas of the members placed upon record and an active committee appointed to establish a policy for me, as secretary, to follow. With this question finally worked out to a satisfactory conclusion, the main problems of the National Board toward securing uniformity and interchangeability of boilers will be practically solved.

Uniformity of Boiler Construction

All the efforts of the office of the secretary-treasurer have been put forth in securing uniformity in the construction and installation of power boilers and no thought has been given to the other A. S. M. E. codes, and I believe that something should be done along the line of establishing uniformity between states and municipalities on the acceptance of the Miniature Boiler Code and the Unfired Pressure Vessel Code, and we have gathered some information by mail on the position of the various states and cities on these Codes.

Low Pressure Heating Code. The results of an inquiry as to the requirements in the various states and cities on low pressure heating boilers, are as follows:

States and cities requiring A. S. M. E. construction:		No inspection required:
Michigan	Los Angeles, Cal.	Oklahoma
Rhode Island	Seattle, Wash.	New York
Oregon	Detroit, Mich.	New Jersey
Colorado	Omaha, Nebr.	Tampa, Fla.
Utah	Nashville Tenn.	
Minnesota	Erie, Pa.	
Wisconsin	Scranton, Pa	
Ohio		

Miniature Boiler Code. We requested an expression from the members of the National Board on the stamping of miniature boilers National Board, with the following results:

Approved stamping NATL. BD.:		Disapproved:
Wisconsin	Ohio	Pennsylvania
New York	Los Angeles, Calif.	Michigan
New Jersey	Memphis, Tenn.	Philadelphia, Pa.
Oklahoma	Seattle, Wash.	Scranton, Pa.
Indiana	Tulsa, Okla.	Detroit, Mich.
Minnesota		

Unfired Pressure Vessel Code. It was our purpose to determine how many states and cities had regulations covering unfired pressure vessels and the replies were as follows:

States and cities having requirements and will accept A. S. M. E. Code:	States and cities having no requirements:
California	Pennsylvania
Rhode Island	New Jersey
Oregon	New York
Utah	Wisconsin
Minnesota	Delaware
Los Angeles, Calif.	Indiana
Omaha, Nebr.	Ohio
St. Louis, Mo.	Tampa, Fla.
	Nashville, Tenn.
	Tulsa, Okla.
	Philadelphia, Pa.

The question of stamping boilers National Board and the issuing of commissions to inspectors has been worked out satisfactorily and as far as I know is agreeable to all interests affected, and I am pleased to report that we have 101 boiler manufacturers registered, for stamping boilers National Board against 85 last year. There are 467 inspectors carrying National Board commissions against 391 a year ago. In 1923 there were 12,820 boilers registered with the National Board, in 1924, 13,145 and in 1925 there were 16,170. This will give you an idea of the natural and substantial growth of the National Board for the past three years.

With reference to the financial conditions we have had a very nice growth and the receipts for the past year were sufficient to bear the expenses of this meeting.

Expense

Salary	$4,576.25	
Convention Expense	2,045.99	
Travel Expense	279.22	
Office Rent	340.00	
Stationery, Printing & Supplies	417.95	
Legal & Professional Expense	125.00	
Telephone & Telegraph	132.57	
Postage	150.00	
Depreciation (Office Furn. & Fix.)	101.95	
Miscellaneous Expense	63.85	$8,232.78
Net Gain		$ 991.70

CHAIRMAN SCOTT: Relative to Mr. Myers' report, he has touched on some subjects that ought to be discussed here very fully. One is the unfired pressure vessel section or code that has been formulated by the A. S. M. E. Boiler Code Committee. Mr. Myers and I had some correspondence during the last few months relative to the code and we decided it would be best to put this matter up before the National Board when we met here in Chicago. We are having more accidents and explosions through rupture of unfired pressure vessels throughout the country than we are with any other type of steam pressure vessel built.

About four weeks ago we had an explosion in New Jersey of an air tank used in construction work on buildings. It was a foot in diameter and two feet high. Two iron workers were using this for gunning and this tank suddenly exploded. It sent six men to the hospital, practically ruined the building as far as jarring it off its foundation, and I believe the noise could be heard five blocks away. One man got his skull fractured. This was only a little bit of an affair that you wouldn't think if it did blow up would have volume enough to do any damage. It goes to show the necessity of something being done to have legislation covering the construction of that type of vessel.

I have a sample of this metal in my office in Trenton and it looked to me like a very high carbon drawn steel, and some claimed it was cast iron. Evidently there is no attention paid to the ductility, elasticity or thickness of the metal in proportion to the use it is going to be put to.

There is no use of preventing steam boilers from exploding if we don't look into the other pressure vessels which are blowing up now and then and in a great many instances injuring people so they are handicapped from making a living for the rest of their lives. This matter should be discussed fully and we ought to adopt some regulations so we will have the moral support in the states and municipalities where we have laws to present to our legislatures, we want to have the force of the National Board and the moral support of the Boiler Code Committee of the A. S. M. E. behind it. You have to do this in order to get the proper cooperation of the legislative bodies.

Mr. Kromer of the H. K. Porter Company would like to take up here a method of stamping locomotive boilers which Mr. Myers mentioned. It ought to be discussed fully. As I understand from Mr. Kromer, the National Board stamp is not used in the stamping of locomotive boilers. The question is, should it be used. If not, why; if so, why isn't it used? Those questions ought to be discussed. We should also discuss whether the National Board stamp is necessary on locomotive boilers. These are matters for this Board to decide.

WILLIAM P. EALES (State of Pennsylvania): You mention locomotive boilers. A large manufacturer of locomotive boilers in Pennsylvania is building seventy-five locomotives. He was asked to build one more large locomotion boiler over seventy-two inches in diameter for stationary use. How about it? That locomotive boiler cannot be built for stationary use without putting in heavier tube plates. The A. S. M. E. code for locomotive boilers specifies that the tube plates should be of a certain thickness. There is a place where the track locomotive boiler could be stamped "National Board" unless these differences are ironed out. Although the boiler is to be used in Pennsylvania, we will not pass it because it is in violation of the code for stationary boilers. There are a few things like that, and before we take any definite action on this, these differences must be corrected.

W. F. BRENNAN (New York Indemnity Company): I have found in a great many cases where the railroad companies will take their locomotives, after they have seen considerable service on the road, and convert them into a stationary plant, dismantling the locomotive and installing probably two or three boilers to a battery. Immediately after that boiler is installed, it comes under the jurisdiction of the state department. There is an interference with the Interstate Commerce rule.

Speaking of locomotive type boilers, I was connected with a very large concern which designed and erected locomotives, and if we could only find some way of getting cooperation from the Interstate Commerce Commission, there would need to be only a few changes in order to design and build boilers in accordance with the code requirements. Therefore, in the future, should they decide to dismantle the boilers and put them in the power plant, there would be no violation.

This condition exists today where the locomotive is put into stationary use. The boiler is not stamped; therefore it is a violation.

C. W. OBERT (A. S. M. E. Boiler Code Committee): It takes us back over ten years, when the A. S. M. E. power code was first issued. Quite a number of the states began to place a number of codes in effect covering boilers operated in those states by mining and industrial plants, and so forth, and these little differences that Mr. Eales has mentioned began to show up. That was back in 1916 when the demand came to the Boiler Code Committee from the states. The Boiler Code Committee did not take that as its own solution. The Boiler Committee was invited to get up this separate section.

The first issue of that locomotive code was brought out in 1921, but if I recall correctly, it started in 1918. We spent about three years on it before we got it down to a working basis.

About that time when the controversy was getting rather warm, we came into contact with the new Chief Engineer of the Interstate Commerce Commission, Mr. A. G. Pack. We found in him a wonderful personality, a wonderful type of mind, and after a lot of arguing, we found we were on the same side of the fence; we were both after the same thing, that is, just reasonable safety without undue hampering of industry, and the support of the entire Interstate Commerce Commission and Mr. Pack's engineering department came over to us, and we finally worked out that first edition.

As Mr. Eales brings out, we had struggles over such points as these.

Since 1921 the Boiler Code Commtitee has established better associations with the Interstate Commerce Commission. Mr. Pack wrote us a letter this spring. He wrote that it was the practice of the Interstate Commerce Commission to refer any questions of an engineering nature and in which they were in difficulty to the Boiler Code Committee. That is a very pleasant relation. The Boiler Code Committee is supporting Mr. Pack in every way it can.

I am perhaps the only one here representing the Boiler Code Committee. The conflict of dates has been such that I don't believe anybody beside myself is here. I was instructed to bring to you the greetings of not only the Society itself, but of the Boiler Code Committee. It is the desire of the Chairman that I should express to you how much the Committee favors what you are doing and how strongly it is back of your every movement.

WILLIAM F. KROMER (H. K. Porter Company, Pittsburg): In the month of October, 1925, we completed a small locomotive boiler for Sayre & Fisher, Sayreville, New Jersey. This boiler was designed and constructed in accordance with the A. S. M. E. Locomotive Boiler Code, but with a factor of safety of shell of 5.64. We had assigned a National Board number for this boiler, but the inspector of the Hartford Steam Boiler Inspection & Insurance Company who made the shop inspection, refused to stamp it with the National Board number. Since the shipment could not be delayed, we had to assign a New Jersey number to this boiler.

Up to that date all the boilers which we built in accordance with the Locomotive Code were stamped with a National Board number by the Hartford Steam Boiler Inspection & Insurance Company. We asked the Hartford Company for an explanation as to why they refused to have a National Board number stamped on this boiler, and they replied:

"As there are a number of boiler codes, including the Power Boiler Code, Locomotive Code, Unfired Pressure Vessel Code, Heating Boiler Code, and Miniature Boiler Code, there has been a question raised regarding stamping for the various states.

"As some states have not adopted any code but the A. S. M. E. Power Boiler Construction Code, it is proper that any boiler intended for service in that state should be built and stamped in accordance with this code requirement, and unless the boiler was constructed in accordance with the Power Boiler Construction Code, it would not be acceptable to that state.

"Although practically all states have accepted the National Board stamping for power boilers, they have not adopted all of the other codes, and it would be inconsistent to stamp 'National Board' on construction meeting these other codes."

During the time we were awaiting an opportunity to bring this matter before your Board, we stamped our locomotive code boilers with a state number or A. S. M. E. number instead of a National Board number.

Our point of view on the subject is that the Locomotive Boiler Code was formulated for the design and construction of locomotive boilers, especially of such locomotive boilers as come under the jurisdiction of the states. If the opinion of the Hartford Company is upheld by the National Board of Boiler and Pressure Vessel Inspectors, the advantage of interchangeability between political subdivisions of the United States, an advantage gained through the efforts of the Board, will be wiped out as far as locomotive builders and locomotive users are concerned.

Therefore, we ask your Board to give this matter your serious consideration.

CHAIRMAN SCOTT: You have heard the remarks of Mr. Kromer. As you all know, I believe, the National Board stamping heretofore has been limited to the power code. A question as to the usage of the National Board stamping on locomotives built for state use ought to be considered at this time or during this session, whether it is today, tomorrow or the next day.

MR. KROMER: The shell happened to have a factor of safety of 5.64. It was constructed according to the A. S. M. E. Locomotive Boiler Code. The State of New Jersey has adopted the Locomotive Boiler Code and I can't see any reason why it could not be stamped with the National Board code number. Of course it wouldn't be any good in a state which had not adopted the Locomotive Boiler Code, but it would be good enough for being transferred to the State of Ohio which has adopted the Locomotive Code, but the shell has to have a safety factor of five. My understanding is that the locomotive boilers can be stamped with the National Board number if the boiler goes into a state which has adopted the Locomotive Code.

WILLIAM H. FURMAN (State of New York): In so far as shop inspection on commercial boilers is concerned, I have inspected a great many boilers under construction going into the State of Ohio, and if that boiler was built according to the A. S. M. E. code, there is no reason why that boiler could not be stamped "National Board" because it complied with the code. I can't see why that can't be universal.

MR. EALES: According to the law in Pennsylvania, this locomotive boiler, which was built in accordance with the Locomotive Code, would have been within the law as long as it was used in locomotive service, but as soon as it was put into stationary use it violated the Power Code regarding the construction of stationary boilers.

CHAIRMAN SCOTT: I believe the Insurance Company's attitude in the matter is absolutely justified in view of the discrepancies in the codes as explained by Mr. Eales. In other words, the Hartford Insurance Company inspector did not care to stamp that "National Board" due to the fact that that locomotive boiler while it was built in accordance with the Locomotive Boiler Code would have been all right when it was used that way, but when it was stamped "National Board" it would eventually be put into stationary use and it did not comply with the Power Boiler Code as to the construction pertaining to stationary boilers. I can see too that that might be the reason the inspector took the attitude that he couldn't put the stamp on the locomotive boiler. That is an argument that ought to be discussed.

C. O. MYERS: You can't stamp a boiler "National Board" other than when it complies strictly with the Power Code. That is as far as we have gone with the stamping problem. We have combined our National Board stamp with the code symbol and the code symbol is only applied to boilers that are built according to the Power Code. Before we can extend that stamp to other codes, it will be necessary to have the states approve of a form of stamping for such codes. For instance, the Locomotive Code could be "National Board—Locomotive" combined with the locomotive stamping in that case, which would distinguish between the different codes even though they had National Board stamping. And with locomotives as I see it, if they are stamped "National Board—Locomotive" and the boiler went into stationary service within a few years, there would be a question raised as to whether it could be used or not for stationary purposes.

There are some states and cities that have not adopted the A. S. M. E. Code and until they do, I don't see how we can stamp them "National Board—Locomotive." I would like to have an expression from some of the states and cities represented here on what they have done relative to the acceptance of the Locomotive Code. If they all agree to stamp them "National Board," then we can work out some form of stamp that will be approved by all, but there will have to be something to distinguish these two codes.

MR. KROMER: I cannot see the difference in whether the boiler is stamped "National Board" or "A. S. M. E." It will be the same in each case. With that particular boiler, it has the A. S. M. E. stamp on it. It has the New Jersey State number on it. What will prevent the man from putting it into stationary use? It would simply tell the man he could transfer the boiler from the State of New Jersey to New York. As far as putting the locomotive boiler into stationary service is concerned, it is the same whether it carries a National Board number or not.

C. O. MYERS: I may not understand your particular case, but in order to get down to something concrete, why do you say this boiler was built to conform with the Locomotive Code? What differences are there between this particular boiler and one built from the Power Construction Code?

MR. KROMER: The thickness of firebox plates and the test pressure, which is twenty-five percent above boiler pressure. Those are the only differences.

C. O. MYERS: Did you stamp it with the A. S. M. E. symbol?

MR. KROMER: The Hartford inspector put that on. He had no objection to that.

C. W. OBERT: The desire of the Code Committee when it first formulated the Locomotive Code was to work out a factor of five. The Boiler Code Committee couldn't see why these dinky locomotives should not have a factor of safety of five. A good deal of our three years' fight was devoted to the settling of this question.

As I stated a little while ago, the railroad officials engaged in this argument, which took place during war times, felt that if the A. S. M. E. with all the influence that it has should issue a code for locomotive boilers, even for stationary service like contractor and lumber road service, and if that code contained a factor of five, it might come into the legislature and become a law, it would react against the Interstate Commerce Commission in a very unsatisfactory way. That was the time they were just working out their factor of safety and getting the railway locomotives into a higher factor.

Please understand that our code wasn't directed toward railway locomotives, it never has been, but these railroad officials feared the reactive influence of a set of rules that we might work up for the so-called dinky locomotives coming back and influencing them.

At that particular stage (Mr. Pack has told me) when the Interstate Commerce Commission first took up its work of regulating the railroad locomotives of the United States, they found the factors of safety ranging from two and one-half up to about three and one-half in effect on the railroads. The general factors of safety on the railroad boilers were very low, and the Interstate Commerce Commission made a ruling by which the engines with factors of safety two and one-half were to be given one or two years to be brought up or put out of service, and those that had a factor of safety of three were given a little longer period, the idea being that in 1928 they should all be up to four. By that time everything in the United States must be brought up to four.

The railroad officials feared the reaction of some disagreeable explosion and a senate inquiry, such as you read about in the papers, coming back on them and upsetting their little program, and so the American Railway Association officials made the Boiler Code Committee a great deal of trouble with that argument. That is the reason it was something of a compromise from our designed factor of safety.

The Interstate Commerce Commission requires a factor of safety of four. Not all the locomotive boilers are up to four but they expect to have them within a short time, and it is safe to say they are now practically all four. Our figure of four and one-half is a compromise between that factor of safety of four and our factor of safety of five.

Mr. Lukens has asked me this question: What is the difference between the four and one-half factor of safety in the Locomotive Code and the operating factor of not less than four? The fundamental objective of the boiler code was to get all these boilers for the locomotive (what we call intra-state) designed with a factor of safety four. That was the prime objective of the Boiler Code Committee. However, there was the feeling, and it was brought upon us very strongly by the railroad officials, that some of the logging locomotives might be slipping out on the track and would then come under the locomotive rules; so they wanted to straddle these two rules.

Here is another side I want you to take into consideration before you call it a contradiction. Follow me carefully on this. Take any of your stationary boilers that are prescribed in the Power Code designed to be operated at a factor of safety of five. Did any of you ever stop to think that that boiler with a factor of safety of five is permitted by the code to operate at a factor below five? Think of this, paragraph P-270 and P-271 in the Safety Valve Section say that safety valves must be applied with enough capacity so that the pressure on the boiler when the safety valves are blowing should not get more than six percent above the highest pressure to which any valve is set. Did you ever stop to think when the safety valves are blowing and when the pressure goes up beyond one hundred pounds, you have got the condition there and it can exist as long as the pressure code says the pressure must not go beyond that point. We deliberately allow under those specific conditions a factor of less than five. It is considered by the Boiler Code Committee that this thing is just as logical under these locomotive conditions and if you state it in that way, you have provided for that condition.

Then the other condition is that if these rules should be applied to a boiler in operation when the sheets have deteriorated, and when the stays have deteriorated, that is a condition that is again more forcibly brought out in locomotive work than in stationary work. The bad water conditions that are so frequently encountered bring a more rapid deterioration in locomotive boilers. The tendency to rapid deterioration allows the boiler, through this secondary clause, to drop down as low as four. The advantage in dropping down as low as four is that it fits in with the Interstate Commerce Commission ruling. What the Commission is driving at is to get the boilers up to four at a certain time.

At the present time the Boiler Code Committee is having a similar tussle with marine boilers. This is going about in the same way. The Boiler Code Committee has been called in by Hoover's Simplified Practice Commission, the United States Steamboat Inspection Service and two others to help make a national code. Every one of those interests want their own code made national. We have found that the Scott Clean boilers have been operating on the Great Lakes and on the ocean at a factor of safety of 3.87. The Boiler Code Committee is proposing this same adjustment and suggesting that the operating factor of safety should not be less than four, and it looks as though it is going to settle that tangle there.

So you see there is quite an involved reason back of these controversies with the great amount of invested capital, shipping movements and railway movements. When you get them all in a tangle, it always necessitates a compromise along such lines.

As far as the railway locomotive boiler situation is concerned, I have no doubt at all that if you should go on record here as asking the Boiler Code Committee to take up this question with the Interstate Commerce Commission, we might get the Interstate Commerce Commission to consider a revision of those little points of difference, one of which is the tube sheet thickness, and some firebox features and test pressures. If you get them to take it up at this time, I don't see why the questions raised could not be adjusted. I think it would be very wise for the National Board to make a formal application to the Boiler Code Committee at this meeting.

Mr. Lukens: I can't yet understand the code even at this time. It certainly isn't in reference to the safety valve. I think the idea of putting in the increased pressure is to take care of safety. I think that is the reason the safety valve proposition was put there. If you want to increase that boiler's capacity possibly two or three hundred percent, it is necessary to have a safety valve. Therefore, I think the reason for putting that in the code was to limit and designate a point where to put a safety valve. I think that is the real reason, for if it went to 300, it certainly would go higher.

Chairman Scott: Relative to Mr. Obert's remark on the six percent range on the safety valve, he only brought that out to bring to your mind that if it did increase six percent, it automatically decreases the factor of safety. He mentioned this as a condition which would be created due to the fact that the pressure would increase six percent beyond its normal working pressure.

C. W. Obert: In the matter of oil field boilers the action that the Boiler Code Committee took in one of its cases was that the grate area should be considered, and I think it is the opening in the firebox.

The grate area of an oil country type boiler should be considered as well as the size of the firebox. The code, as I understand it, constitutes the grate area as the opening of the firebox and that is one reason they have that small opening.

The Committee is considering a revision of the entire paragraph, and one of the thoughts that they have, and I think Mr. Furman suggested, was that we should change it along the lines perhaps of the Canadian National Intra-sectional rules. They have it based on the lengths. The stay sheet governs this pulling and hauling that you get on the strain and might perhaps be a more intelligent basis. That is another suggestion for this Committee.

J. D. Newcomb, Jr. (State of Arkansas): In regard to the length of staybolts, I would like to say that we find more broken radial stays than broken staybolts. The condition we have in the oil fields is such that the tell-tale holes in staybolts don't tell you anything because they are soon filled up with paint or dirt. The way we are operating we can't compel them to drill them out. You have got to have them constantly drilled out to keep them of any use. The railroads have to do that. I believe in the telltale holes but it is rather useless.

L. R. Land (State of Oklahoma): Thirty percent of all oil country boilers in the State of Oklahoma are used for stationary work. There are none that I know of that have ever burned coal; nothing but gas and oil is used, and you cannot figure the grate surface according to the opening in the bottom of the firebox because that is only about one-half of the area of the firebox. We have them down there from three to twelve in a battery.

E. W. Farmer (Providence, R. I.): The pressure vessels are also under consideration. I would like to ask the Secretary of the National Board how many states have adopted the regulations of inspection of pressure vessels. We tried to pass a bill through the legislature, making amendments to our boiler law, and we wished to include pressure vessels and we found that according to some of the pressure vessel manufacturers none of the states had adopted the supervision and inspection of pressure vessels up to date, and I was surprised.

C. O. Myers: California, Utah, Minnesota, and the cities of Los Angeles, Omaha and St. Louis were reported as having laws requiring inspection of pressure vessels.

Chairman Scott: There is a movement under way which we want to discuss here. Is the procedure to be followed by the National Board? I think we ought to discuss for a while the regulations pertaining to the stamping of miniature boilers; what is being done on that, where is it required and what are the inspection methods in force in the various states and cities?

C. O. Myers: What we mean by that is practically the same as the Locomotive Code. There are some cities and states that object to the miniature boiler code and for that reason we can't stamp them National Board. We would like to have some expressions particularly some of those that won't accept the miniature code.

W. P. Eales: The State of Pennsylvania does not accept the miniature code. We have a boiler code in the State of Pennsylvania of our own.

C. O. Myers: What is the chance of getting together on that and getting you fellows to work something out so we can get somewhere?

J. E. Speed (Pennsylvania): We will accept any boiler that is built to conform to the small boiler code in the State of Pennsylvania. There are a few variances between the small boiler code and the A. S. M. E. Miniature Boiler Code.

J. M. Lukens (Pennsylvania): We inspect miniature boilers. We had 600 operating in the city of Philadelphia. We condemned 320; one was welded. They are very dangerous propositions. We consider them more dangerous in the city of Philadelphia than the large pressure vessels.

Chairman Scott: We had an air pressure vessel blow up about a year and a half ago. It cut a man's head off. It was a riveted air pressure vessel but there was a manhole on the top. It was an upright affair with a head sheet, and they wanted to weld up that manhole, put a piece on it. After they got through, they started to use this air pressure vessel. I think it carried something like fifty pounds and it leaked. The manager of the plant called up the people who welded the piece on over the manhole plate to come up and fix it. He got up there and he had his tools with him.

He put a ladder up against this tank and climbed up to see where it leaked. Just then it blew up and cut his head off. It was that part that was welded. It goes to show there must be something done by the National Board to get the proper influence and co-operation in the different states to get legislation if not for inspection, for construction. I for one wouldn't want to see anything go through requiring every miniature air vessel to be inspected, but if these manufacturers were registered under the A. S. M. E. or the National Board or responsible to the state wherein these vessels are built, this practice would be eliminated and we wouldn't have any bootleggers in this kind of work. Mr. Land speaks of them as "crossroads" builders. That is what we want to eliminate for the safety of the public and ourselves. It is very necessary that we should give this considerable thought and discussion and adopt some program so that every member can take it home to his state or municipality. Also, I think we ought to appoint a committee to draw up a standard law that could be used in every state or city to cover the construction and inspection of these vessels.

The majority of the inspectors here don't know what law should be drawn to cover it. I introduced a law to find out what the weaknesses are so we can put a law into effect next year. I think we ought to have a committee draw up a sample law. This law must be workable, be fair to the industries, be fair to the inspectors. The law has to be drawn in such a way that it is right and you have to get a certain amount of information from the industries as to what should be the requirements.

E. W. Farmer: I think a good deal of the objections could be eliminated by having the law read something like the laws in the State of Rhode Island. The law reads that all boilers shall be inspected except those which are hereinafter exempt, and the exemptions made are boilers on railroads and steamboats and boilers insured by insurance companies providing these companies give us evidence of the fact that the boiler is carrying less than fifteen pounds.

It doesn't state that the boilers are to be used for certain purposes and what size they are to be. If they are only a foot long and six inches in diameter, as long as they are boilers generating or storing steam they shall be inspected; and in trying to get the pressure vessels in, the Chairman of the Judiciary Committee intimated that as yet there were no states that had adopted the inspection and supervision of pressure vessels. One or two manufacturers' representatives came there and I suppose he got this information from them. They told me that if we really needed a law requiring the supervision and inspection of unfired pressure vessels, if we could compromise their rules for welding with those of the A. S. M. E. rules on welding, they would see that we got the law.

C. W. Obert (Boiler Code Committee): The Committee was petitioned by the American Welding Society to make those changes which would increase the pressure limit from 100 to 200 pounds and the diameter up to sixty inches, and a few other changes like the working stress from 260 pounds to 700 pounds per square inch. The Boiler Committee could not agree unanimously. We have had it at the November meeting; it came up at the February, March and April meetings. At every meeting the Committee could not get a unanimous vote. There were a certain number of the Committee afraid of the welding and would not go on record as permitting it.

That set of provisions has been set aside, laid over indefinitely on account of the fact that the American Welding Society is preparing to carry out another and quite expensive series of research on the value of welding. The Boiler Code Committee takes this stand and lays responsibility to the Welding Society. If this research brings across some real authentic data of definite value that will assist the Boiler Code Committee in putting these figures where they ought to be, they will consider it, but the Committee is definitely now in the position of laying on the table this series of revisions that Mr. Furman has just referred to until better data is available.

Monday Afternoon Session

The meeting was called to order at two-thirty o'clock, with Chairman Scott presiding.

CHAIRMAN SCOTT: In proceeding with the program, we will now hear from E. W. Farmer, Chief Boiler Inspector, State of Rhode Island. I believe Mr. Farmer has a report on statistics* and I would suggest that you all give it very close attention.

E. W. FARMER: I was a little prepared to answer any criticism on this report, but as there wasn't such criticism, I can't make that answer. If they criticized too severely, I was going to wish the work on somebody else.

We are willing to send out letters or requests to any department or any company or concern to get this information, not only from our own departments but also anywhere we feel we can get information. My object in getting all the information possible is to show that where we have code regulations and where we have a uniform standard of construction and inspection of boilers, we have less accidents, and it is a great fact to give the public. We wish to show these people who are skeptical. Sometimes when bills come into the legislatures regarding boiler inspection, whether it is good or not, we wish to get these figures to show them that it is a good thing for them to have code regulations and have departments enforcing this uniform regulation.

That is my object in trying to get all these figures and compile them as accurately as I can get them. I can place in the statistics only what is given to me. It has not been a drudge or hard work because I have been very much interested, and I wish the members in the departments when they hear of any accidents or explosions will just gather that information as far as possible, send out and find out about the boilers, how they are constructed and any information that would be valuable to me, and send it either to Mr. Myers or myself.

CHAIRMAN SCOTT: Our next paper is by Charles J. Manney, Chief Clerk, Ohio Boiler Inspection Department pertaining to "The Stamping of Boilers, Proper Handling of Data Sheets, and Keeping of Boiler Records."

Since space does not permit the publication of this report in the present issue, it will appear in full later.

C. J. MANNEY: I would like to say that it is pretty hard to cover in a paper of this kind all the details that are required in getting the data and filing it so as to find it readily, and we think in Ohio that we have a pretty good system. We don't claim that it is perfect. We would be very glad to answer any questions regarding our system of filing and explain any part of it.

We have had to change our method several times. We started in originally by trying to keep records on books and we found that did not work very well. We found that the card record system is very elastic. You can take care of 500 boilers or 5,000 boilers. It is very adjustable, and by using card signals on the cards, you do not have to remove any cards from your files. They are always in one place where they should be, and the different colors of signals tell you what the trouble is with that particular card. We have in our office four girls who handle our work and they do it very efficiently.

We issue approximately 21,000 certificates a year, which means that we have 21,000 boilers in active use. That list remains about the same each year but the list that we call our "outlist" or "dead list" grows continuously and it is now about twice the size of our active list.

As we stated in this paper, we never destroy a record card. We never destroy an original long form report. We have our bookkeeping system and our card record system so devised that one person is checking against the other. If one of us happened to make an error, the next one would catch it.

E. W. FARMER: I would like to ask Mr. Manney if he has any record of explosions and accidents and the type of boilers, that is, their construction.

C. J. MANNEY: We have a special form that we call "Accident Inspection Report." In Ohio whenever there is a boiler explosion, regardless of the kind of boiler or whether we cover it or not, our inspectors have a standing order to get there as soon as possible and get all the facts, get the safety valve and the steam gage if possible. We want to know the number of lives lost, the number of persons injured, the property loss and the cause of the boiler explosion as he determines it, not as somebody else tells it. About two weeks ago in the southern part of Ohio we had an explosion of an oil well boiler. These boilers are specifically exempt from inspection under the Ohio law, and we don't make inspections on them. Our man got down to this boiler explosion about a day or so after it happened, and of course, the safety valve was gone, the steam gage was gone. We have some very interesting photographs of it. Mr. Farmer, I think we gave you a report on the explosions, but we don't have many in Ohio.

CHAIRMAN SCOTT: I want to ask Mr. Manney about the method of giving blocks of numbers to apply to boilers in Ohio. What do you mean by that?

C. J. MANNEY: Our Department assigns the numbers that are stamped by the inspectors on the boilers. For instance, the very first boiler inspected in Ohio was No. 1. We went along and used those numbers serially. The numbers are now running about 47,000 or 48,000. We assign a certain block of numbers to an insurance company. Say we give the Hartford Company 100 or 200 numbers. They assign them to their individual men about ten numbers at a time. We stamp 100 cards with 100 numbers. Then when an inspector goes out in the field and inspects the boiler, he will stamp one of those numbers with his dies right on the boiler plate in a place specified in our code. Then he puts that number on his inspection report to the department.

When our checking inspector checks that report, he takes the card which bears this number out and destroys it, and then we make out our permanent record card from that report. Then, if the inspector should happen to use that number again, we look in this pack for it and it isn't there. We then know it is duplicated. We find the report already filed away. We call his attention to it. It also prevents the inspector from transposing figures. A person who has five numbers before him to stamp on a boiler might pick up the wrong die. When a report comes in with a transposed figure, we know it wasn't assigned to his company. Then he has to go back and correct it.

One central clerk should assign these numbers. We are very particular in our office that only one man handles it and we find it works very efficiently.

CHAIRMAN SCOTT: What do you do with the numbers where a boiler is condemned and the boiler is taken out of service?

C. J. MANNEY: That number dies with the boiler. Then that card record is taken out of the active list and put in the dead list. We keep piling up our numbers. We are working in 47,000 or 48,000 now.

I might add we use that same system of numbering with the certificates. We number the certificates serially beginning with number one. We use about 21,000 a year and in order to avoid having large numbers on our certificates, every five years we drop back to number one and start over again. In that way we avoid getting into very large figures on our certificates.

CHAIRMAN SCOTT: Do you stamp the state number on a boiler before the certificate is issued?

* This report will be published in full in a later issue.

C. J. MANNEY: Yes, all inspectors assign and stamp the state serial number on the boiler at the first inspection, whether it is condemned or not, or whether it can be legally operated in the state or not. The records are marked according to the conditions reported by the inspector. If the boiler cannot be used for any reason, and the inspector knows at the time of inspection that it cannot be operated in the state, he stamps a "XX" above the state number.

CHAIRMAN SCOTT: How do you know how many boilers you have in your state?

C. J. MANNEY: We know that by the certificates issued. We don't care anything about what the state number is when determining the number of boilers in the state.

J. M. LUKENS: How do you take care of inspections?

C. J. MANNEY: Our men have regular forms of notice. Our law requires us to give fourteen days' notice of an internal inspection. We have regular forms for that. Our men arrange their own inspections. Each individual inspector arranges that for himself.

MR. LUKENS: If there are twenty boilers in a plant, how do you handle that?

C. J. MANNEY: That is the reason why we file the cards alphabetically and the reports are filed numerically. By the cards being alphabetical, it doesn't make any difference what the number of the boiler is, all the boilers of a certain company will be together. For instance, in Ohio we have 300 or more boilers for the Pennsylvania Railroad. There may be big and little numbers and the newest boilers will have the biggest numbers. All these Pennsylvania cards are right together, behind a guide card which says on it, "Pennsylvania Railroad."

We have something like 400 boilers for the City of Cleveland Board of Education. Those will all come together. That is the reason why we like to file the cards alphabetically because we know then how many boilers that particular concern has; and then we like the reports to be filed numerically because if the insurance company should change each year, we will require each insurance company as they come along to furnish us with what we call a long form report which contains all the data similar to that on the manufacturer's report. If a boiler is inspected by five or six different insurance companies in that many different years, then there would be five or six long reports filed under that number. We can go back to our inspection reports and we can see what the different inspectors had to say about that boiler.

F. MCVICKER (Continental Casualty Co.): I would like an interpretation of the Ohio code. If the boiler is built in Ohio, you have the Ohio standard number. Now if I, representing a particular insurance company, come along, I must put on one of our own numbers.

C. J. MANNEY: You would put on a number assigned by us to your company.

F. MCVICKER: I haven't worked Ohio, but I understood all the time that if there was an Ohio state number or National Board number, we didn't put any more numbers on the boiler; we just reported to the State that it was stamped Ohio State or National Board.

C. J. MANNEY: Are you referring to a boiler now located in Ohio? You see we do all our record filing in the State of Ohio under the serial number we have assigned to it, but we do file the manufacturers' reports in our office under Ohio Limited or National Board numbers until the field inspection report comes in. We give it what we call a state number and that state number is identified by an arrowhead in our state record so that you can't add to it on either side and make something else out of it.

F. MCVICKER: If I go from Illinois to Ohio and make a field inspection of a boiler and it has the Hartford Insurance stamp on it but has no field inspection number on it, should I stamp that boiler with the number that is assigned? I didn't understand when we should put the number on and when we shouldn't.

C. J. MANNEY: We want it done on the very first inspection.

CHAIRMAN SCOTT: We will now hear from Mr. C. D. Thomas, Chief Boiler Inspector, State of Oregon, and Vice-Chairman of the National Board.

C. D. THOMAS: I haven't an address for this meeting at all for the simple reason that my duties in the office generally keep me pretty busy. In fact we have a small number of boilers in the State of Oregon and as a result of that, financially we are not fixed so we can hire all the help that is absolutely necessary, and a great deal of clerical work devolves upon me. In fact I check all reports and I am subject to call when something happens on the outside. It happens quite frequently that they call for the Chief Inspector.

But while crossing the mountains and coming over the plains in order to reach the United States which is located in Chicago, just a few little things came into my mind, and I am simply going to give you the benefit of that and let it go at that. (This paper will appear in a later issue.)

THE DISCUSSION IS CONTINUED

B. P. BAYLOR (The James Leffel Co.): Take for instance an inspector comes in and passes on a boiler in our shop. We will ship that boiler out the next day and he has to send in his report to the insurance company. We don't get their report for possibly ten days or two weeks. The boiler is already shipped and probably installed before we get the report. The man has broken down his old boiler and wants his boiler right away.

E. W. FARMER: The report doesn't go to the insurance company and the purchaser is entitled to a report when he buys the boiler. The insurance inspector sends a report to his own company only.

B. P. BAYLOR: We send them all out when we get our inspection certificates back to the company.

E. W. FARMER: It should be sent with the boiler.

G. R. SMITH (Industrial Works): I am speaking as a boiler manufacturer and I want your views on this boiler report business because it is a thing I thought of before. When we ship a boiler, we send two copies of the National Board report to Mr. Myers. Sometimes I know where that boiler is to be used, if it is to a manufacturing concern. If it is the New York Central or Pennsylvania Railroad, I do not know; so I can see where in those cases there is bound to be difficulty. All Mr. Myers has on that report is the New York Central Railroad, New York City.

I had a case very recently where the Chief Inspector of the New York Central Railroad wrote me saying he had been informed by the Albany authorities that he had such and such a boiler. He asked me where that boiler was located. By digging back through the records, I finally found that we didn't ship that boiler into New York, we consigned it to some other state. I didn't happen to know that when I was sending the report out.

We have a case of this sort very often. We may sell one of the iron companies in Cleveland a boiler or a machine. All of our boilers are placed on locomotive or wrecking cranes so they are not going to be definitely located in some town. We may sell this boiler to the Hanna Furnace Company in Cleveland and they may ship the boiler into Wisconsin. I may be able to locate that fact and I may not before the boiler is shipped. I will send the two copies of the regular report to Mr. Myers. Am I supposed to give any report to the owner of that boiler, or just the Secretary?

CHAIRMAN SCOTT: I don't think so. I don't see why you should. I think it is nonsensical to hold up a boiler installation awaiting receipt of the report, providing the boiler is a certified boiler and is stamped.

E. W. FITT (City of Omaha, Neb.): This is the way we handle that matter. Supposing he ships a boiler for resale to somebody in Nebraska. That passes through some sales company or comes direct. You send it to your sales people. You don't send it direct from your factory. They send it for resale. These resale parties in Omaha send me a notice that they have received a certain boiler, A. S. M. E. number so and so. If I don't hear from Mr. Myers in the meantime, we will find that boiler and inspect it and pass it or reject it. Then the resale agent will notify us where he sold that boiler and we get a register on it. That is the only way we can get those things at the present time. You can't tell who the owner is going to be. You can't tell who is going to get them. You can't send your certificate to the owner. The only thing you can do is send it to Mr. Myers.

We have another ruling like this. You take a low pressure boiler, for instance. The firm sends us a shipping notice the day the boiler is shipped; that comes to my office. Then after that we trace the boiler for resale.

C. D. THOMAS (State of Oregon): The inference shouldn't be drawn from that little article there that I intended to criticize the manufacturers. I do in a way as far as that is concerned because where it is possible to furnish this information I have found some manufacturers didn't do it, but the case that I have reference to of a boiler not meeting the code requirements being installed puts us in a rather bad light. The fault lies with the inspector more than it does the manufacturer. He had no business to stamp that boiler.

Now I had another boiler in the State of Oregon forty-four inches in diameter and no manhole in it, stamped A. S. M. E. code. That is the fault of the inspector. Of course, the manufacturer may be to blame in a way because he didn't know better, but it was the inspector's duty in that shop to see that it should be done.

CHAIRMAN SCOTT: That stamp was registered?

C. D. THOMAS: The manufacturer had authority from the A. S. M. E. Society but they did it through ignorance. I made a personal inspection. Then I jumped all over the inspector. It hasn't happened since.

CHAIRMAN SCOTT: It was an unintentional mistake; it is not the practice.

The important feature of Mr. Thomas' paper was overlooked and that is uniformity in examination of inspectors, as Mr. Myers has mentioned in his paper. I understand from Mr. Myers that the committee appointed on the examining board to draw up examination questions has not been active, and as Mr. Thomas said in his paper, there should not be an examination held for boiler inspectors by any one individual. It ought to be by a board consisting of more than one, so that they cannot at any time accuse political pull or favoritism or brotherly love as being the means of passing the boiler inspector's examination.

Also following up that remark, there ought to be some method adopted on the uniform number and type of questions used in examinations and a set date on which examinations would be held in every state or city at certain times in the year. Mr. Myers has brought that out in his paper and we would like to hear from him on the subject.

C. O. MYERS: I was surprised at Mr. Thomas' paper. It struck along the line of thought I had in mind, that is, working out a plan of uniform examinations and uniform dates for giving the examinations and the examinations to be given only by certain boards; also that a set of rules should be gotten up for conducting such examinations.

As Mr. Scott stated, we have had an examination committee but we have never concentrated any effort to bring that point about. I would like to see something started at this meeting so we can bring that to a conclusion, that is, we can have at least something started on it. We might not possibly have all the details ironed out but we might get a start within the next year at least. I would like to hear from some of the members on that. I expressed myself in my report this morning and I think possibly some of the other chief inspectors and chief inspectors of the insurance companies will have something to suggest along this line.

CHAIRMAN SCOTT: The idea is, can some arrangement be brought about by which a uniform day or a set day will be allotted for examinations for steam boiler inspectors in every state and city operating under the code.

The next question is a uniform method of compiling questions. Now that is a big question for the simple reason that it is hard to tie any particular board down to that, although it can be done under this National Board. As a suggestion, we will take the committee on questions. Each member of that committee could formulate a number of questions every three months. Those questions could in turn be mailed to the Secretary. The Secretary in turn could pick out from that list a number of questions at random and mail them to the places where the examinations are to be held in the different states and cities. He could mail them to the chief inspector of the board and say, "Not to be opened until the day of the examination," or an arrangement of that kind. But each board in the state conducts the examination; no one person conducts it.

CHAIRMAN SCOTT: Most all states draw laws according to the recommendations of the people interested in them. There is no reason why that law can't be amended so that it can be done that way. The legislature is only a body to pass laws, but they have to be guided by the recommendations and instructions from those persons that are supposed to know. The insurance companies are troubled with a dozen different examinations for one inspector. There is no reason why this Board as a National unit body cannot get together and change those laws. If an inspector qualifies in New York or New Jersey, it ought to be reciprocal in other states operating under the Boiler Code rules.

MR. HUBERT SYKES (Maryland Casualty Co.): Speaking as an inspector of the Maryland Casualty Company and taking up Mr. Morrison's question which I perfectly agree with, I am a qualified inspector in one state and believe I have qualified to inspect in other states. If all the code states accept and the National certificate is issued to me, but which if I didn't have and I got from you later on, then where would you get the power to give me that power to inspect in Wisconsin, which I have not got today.

W. H. FURMAN: The National Board certificate does not permit you to inspect boilers in Wisconsin.

CHAIRMAN SCOTT: That is only shop inspection, not for local inspection.

E. W. FARMER: I think Mr. Edgar ought to get a few of the laws changed in Wisconsin, if possible, so that he could get some of the inspectors who have National Board certificates inspecting boilers in Wisconsin if necessary.

In the State of Rhode Island we are not troubled that way, but the Governor of Rhode Island informed me at one time that outside of the Governor, I was the State of Rhode Island as far as boiler inspection was concerned.

M. A. EDGAR (State of Wisconsin): I haven't seen any great necessity for the Industrial Commission of the State of Wisconsin accepting the say so of any other state. I haven't seen any insurance company put to any great expense in having inspectors come up and inspect in Wisconsin. I think it is mighty good to have inspectors come for examination every year. Formerly if a man was inspecting in Wisconsin and he didn't like his job or his boss didn't like him, they would fire him out and send him down to New Mexico, and they would pull in any one. I am sure that we have clerks in insurance offices holding Wisconsin certificates. They got them when they were passed out free. I think we ought to discourage the ease with which insurance companies shift men around. I think men ought to be left in that territory as long as they are useful. The easier you make the securing of certificates, just so much easier it is going to be to shift men around. I think the desirable thing to do is to leave men in one place.

C. O. MYERS: Up to this time I haven't seen any great need in reciprocity of inspectors for field work, and I believe along the lines of Mr. Edgar, that if an inspector is going into a certain state to inspect boilers in the field, there is very little expense attached to sending that man to the state department and having him interviewed at least by the state officials.

Our main function is the reciprocity of inspectors on new boilers or shop inspection. In that I think we all agree that we all accept National Board inspectors on shop work, and I think that that is as far as we ought to go at this time at least and leave the work in each state to be handled by the inspector of the department in that state. That would be my opinion.

C. O. MYERS: There is one point that I would like to get cleared up a little for my own information regarding the inspectors that are holding National Board commissions that have not taken a written examination. If there are any such inspectors, we would like to know who they are as we have the application for National Board commissions so arranged that we thought it was fool proof. We ask this question, whether the examination was oral or written, inquiring of the state where they took this examination, the number of the certificate of competency issued to them, and requiring them to make affidavit to that effect; and then in order to secure ourselves further on that, we refer this application to the chief inspector of the state where he says he took the examination for his approval of the statements that are in this application; and in no case do I recall that we have ever issued a commission to an inspector that hasn't taken a written examination. If there is any such case, we would like to know it, and I think the chief inspector who O. K.'d the application should be held responsible for it.

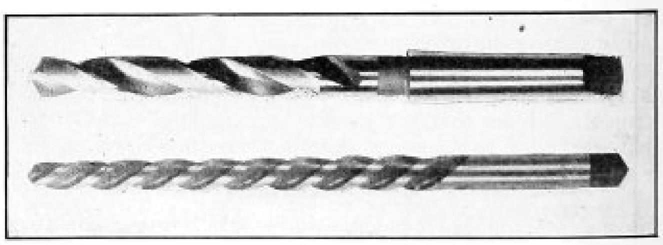
(To be continued)

Attendance at National Board Meeting

Bert Aldrich, Travelers Indemnity Co., Chicago, Ill.
S. B. Applebaum, Permutit Company, New York, N. Y.
Thomas R. Archer, Chief Boiler Insp. State of Delaware, Wilmington, Del.
C. E. Austin, Edge Moor Iron Co., Chicago, Ill.
Arthur C. Barnes, Public Service Co. of N. Ill., Chicago, Ill.
L. M. Barringer, Chief Boiler Inspector, Seattle, Wash.
B. P. Baylor, The James Leffel & Co., Springfield, Ohio.
Geo. D. Bragdon, General Accident Assur. Corp., Philadelphia, Pa.
W. F. Brennan, New York Indemnity Co., New York, N. Y.
F. G. Brinig, Erie City Iron Works, Erie, Pa.
B. O. Burhans, Hartford Steam Boiler Insp. & Ins. Co., Wilmette, Ill.
W. R. Cameron, The Frost Mfg. Co., Chicago, Ill.
A. P. Campbell, Kewanee Boiler Co., Chicago, Ill.
A. B. Cariaccioli, London Guarantee & Accident Co., New York, N. Y.
F. X. Carroll, New York Indemnity Co., Chicago, Ill.
Geo. E. Corbett, Geo. E. Corbett Boiler & Tank Co., Chicago, Ill.
Phil. A. Corbett, Geo. E. Corbett Boiler & Tank Co., Chicago, Ill.
J. F. Dickson, Kewanee Boiler Co., Kewanee, Ill.
T. R. Donlin, Chicago, Ill.
F. S. Dunham, Chicago, Ill.
Wm. P. Eales, The Travelers Indemnity Co., Hartford, Conn.
M. A. Edgar, Chief Boiler Insp., Madison, Wis.
Jos. P. Edwards, Maryland Casualty Co., Indianapolis, Ind.
Jos. Ernst, Boiler Inspector, Buffalo, N. Y.
Mr. E. W. Farmer, Statistician, National Board, Providence, R. I.
Mr. E. W. Fitt, Chief Boiler Insp., City of Omaha, Neb.
F. C. Fosdick, General Accident Assur. Corp., Chicago, Ill.
Wm. H. Furman, Chief Bolier Insp., Albany, N. Y.
Michael P. Galvin, Royal Indemnity Co., Chicago, Ill.
Gerald Gearon, Boiler Inspector, Chicago, Ill.
J. J. Graham, Kewanee Boiler Co., Kewanee, Ill.
A. E. Grunert, Commonwealth Edison Co., Chicago, Ill.
J. M. Guptill, Maryland Casualty Co., Chicago, Ill.
Walter L. Hanan, Fidelity and Casualty Co., Chicago, Ill.
T. A. Heringer, Chief Boiler Insp., Salt Lake City, Utah.
J. D. Hunter, Continental Casualty Co., Chicago, Ill.
C. B. Jackson, Hartford Steam Boiler Insp. & Ins. Co., St. Louis, Mo.
T. McLean Jasper, A. O. Smith Corp., Milwaukee, Wisc.
P. V. Johnson, New York Indemnity Co., Chicago, Ill.
Evan R. Jones, Chief Boiler Insp., Scranton, Pa.
C. C. Joys, Jr., A. O. Smith Corp., Milwaukee, Wis.
Harry Kohl, Chief Boiler Insp., Chicago, Ill.
Carl H. Kroeschell, Brunswick-Kroeschell Co., Chicago, Ill.
Wm. F. Kromer, H. K. Porter Co., Pittsburgh, Pa.
L. R. Land, Chief Boiler Insp., Oklahoma City, Okla.
P. M. Lattner, P. M. Lattner Mfg. Co., Cedar Rapids, Iowa.
John M. Lukens, Chief Boiler Insp., Philadelphia, Pa.
E. Mandel, Commonwealth Edison Co., Chicago, Ill.
Chas. J. Manney, Ohio Boiler Inspection Dept., Columbus, Ohio.
Andrew Mellody, The Travelers Indemnity Co., Chicago, Ill.
Dan B. Moore, Kewanee Boiler Co., Kawanee, Ill.
J. P. Morrison, Hartford Steam Boiler Insp. & Ins. Co., Chicago, Ill.
Alex M. Munro, Ocean Accident & Guarantee Corp., Chicago, Ill.
C. O. Myers, Secy. National Board, Columbus, Ohio.
Robert McKinley, General Accident Assurance Corp., Detroit, Mich.
Samuel J. McMahon, Royal Indemnity Co., Chicago, Ill.
John W. McNeal, Chicago Down Draft Furnace Co., Chicago, Ill.
F. McVicker, Continental Casualty Co., Chicago, Ill.
J. D. Newcomb, Jr., Chief Boiler Insp., Little Rock, Ark.
Wm. Nichols, U. S. Government Steamboat Div., Chicago, Ill.
John D. Noonan, Ocean Accident & Guarantee Corp., Chicago, Ill.
F. W. Norris, Marion Steam Shovel Co., Marion, Ohio.
C. W. Obert, Secretary A.S.M.E. Boiler Code Committee, New York, N. Y.
W. W. Palmer, Maryland Casualty Co., Chicago, Ill.
L. C. Peal, Chief Boiler Inspector, Nashville, Tenn.
Geo. T. Peers, New York Indemnity Co., Chicago, Ill.
Dee Powell, Chief Boiler Insp., Tulsa, Okla.
Geo. L. Prentis, Everlasting Valve Co., Chicago, Ill.
Wm. J. Ranton, Fidelity and Casualty Co., Rochester, N. Y.
J. W. Rausch, Maryland Casualty Co., Baltimore, Md.
Alvin D. Reed, Chief Boiler Insp., St. Louis, Mo.
Hugh Rensford, Maryland Casualty Co., Milwaukee, Wis.
Phil. A. Schwab, Schwab Boiler & Machine Co., Milwaukee, Wis.
Jos. F. Scott, Chairman National Board, Trenton, N. J.
H. P. Sherwood, The Permutit Co., Chicago, Ill.
R. L. Shrock, Marion Steam Shovel Co., Marion, Ohio.
G. R. Smith, Industrial Works, Bay City, Mich.
Wm. J. Smith, Indemnity Ins. Co. of N. A., Chicago, Ill.
W. P. Smith, The Frost Mfg. Co., Galesburg, Ill.
Jas. E. Speed, Chief Boiler Insp., Erie, Pa.
Frank Steffanides, Industrial Commission of Wisconsin, Milwaukee, Wis.
R. J. Strasser, Sargent & Lundy Co., Chicago, Ill.
F. G. Straub, Eng. Exp. Station University of Ill., Urbana, Ill.
Herbert Sykes, Maryland Casualty Co., Chicago, Ill.
C. D. Thomas, Vice Chairman National Board, Salem, Oregon.
J. H. Thompson, Travelers Indemnity Co., Chicago, Ill.
Eugene Webb, Hartford Steam Boiler Insp. & Ins. Co., St. Louis, Mo.
C. F. Werdermann, Jr., Fidelity & Casualty Co., Milwaukee, Wis.
Geo. Wilcox, Chief Boiler Insp., St. Paul, Minn.
Ira F. Wildey, Royal Indemnity Co., Chicago, Ill.
Wm. J. Williams, Edge Moor Iron Co., Chicago, Ill.
J. B. Wilson, General Accident Co., Chicago, Ill.
Thos. Wilson, "Power," Chicago, Ill.
C. W. Zimmer, Hartford Steam Boiler Insp. & Ins. Co., Chicago, Ill.

Forged Type Drill and Taper Pin Reamer

REALIZING the demand for a rugged, sturdy drill of the forged type, the Morse Twist Drill & Machine Company, New Bedford, Mass., has developed a forged type drill of the type shown in the illustration. These drills are furnished in sizes ranging from 5/16 inch to 2 inches. This company has also added to its line of drills and reamers a three-flute taper pin reamer. This reamer was submitted to the Tinius Olsen Testing Machine Company, Philadelphia, Pa., for comparative tests with reamers of the three-flute left-hand spiral and straight flute types. These tests were made at the same time in machine steel 1½ inches long, feeding the reamers through 2½-inch penetration. The results of these tests showed that only the straight flute reamer broke at a maximum torque of 34 inch-pounds, while both the spiral reamers completed the operation intact. The left-hand spiral flute reamer reached a maximum torque of 5½ inch-pounds and this torque developed smoothly to a maximum at the maximum penetration of 2½ inches, while the torque on the right-hand spiral reamer varied widely, reaching a maximum of 55 inch-pounds at approximately 1⅞ inch penetration and again just before the completion of the test.



Top—Morse high speed forged type drill; Bottom—Taper pin reamer

Boiler Corrosion, Pitting and Grooving*

Analysis of the Problem from the boiler makers' point of view — Discussion from the floor of the Master Boiler Makers' Convention

THE Lines West of the C. B. & Q. R. R. Company, comprising 5,000 miles of territory, have been doing everything possible that could be done in the way of treating water for low motive purposes, but still there is a great field for improvement in connection with pitting and deterioration.

On one of the divisions we have more or less alkali along the division, and while we have lime soda softening plants at different points, they do not reduce the alkali salts in the water, rather they increase them slightly. The untreated supplies of water on this division all contain rather high alkali salts, mostly sodium sulphate and carbonate of soda and magnesia. The pitting condition is mostly in our flues, and especially just inside the front flue sheet, causing deterioration and ringworming around the flues. Very little pitting has been found in the body of the flues on this division, but the condition mentioned has been practically eliminated by applying copper shims around all flues in the front sheet, allowing the copper to project into the boiler one inch. After these flues have given the required service, on being removed an inspection showed that there was no pitting or grooving in the location mentioned, so that all flues on this division are now being applied with the copper shims projecting into the boiler one inch.

On other divisions we have pitting conditions the entire length of the flues, and generally on the top side these pits are deep enough to cause a defect. Usually a rusty like crust covers the pit, and when this is removed the clean metal is exposed as if acid action had taken place. On this division, and especially in the winter months, there is considerable alkali salts present in the water. There is no free acid in the treated water, but the alkali salts is mostly sodium sulphate and it has been observed that where alkali salts run very high, say 125 parts per 100,000, the pitting is greatly increased, and I must say that if it was not for the treated water on this division I doubt very much whether flues would give longer service than six or seven months.

On another division the mileage on flues is very good, and no trouble experienced from a flue pitting standpoint. However, the pitting on this division is confined to the top flange of back flue sheet and across the front of crown sheet, also on the lower sections of the combustion chamber. Up to the present time we have had very little pitting or corrosion on any of the boiler shell plates on any of the divisions mentioned.

The brand of material in use on the C. B. & Q. is standard for all boiler construction and repairs, but of late we have been experimenting with different grades of flues, such as steel and iron. However, I would like to mention that on the divisions where the most severe pitting conditions occur, especially on same class of power and operating on the same division, we do not find the pitting conditions of the same nature, for on some of this power we will receive 20,000 to 30,000 more miles than we do on the others operating over the same territory.

May I also mention that while we treat our water for scale formation very successfully and we control foaming tendencies with a satisfactory anti-foaming compound, used by the enginemen, we face the destruction of the metal of our boiler through corrosion with apprehension.

*Paper and discussion delivered at the Master Boiler Makers' Association Convention, Buffalo, May 25 to 28.

We know that that kind of corrosion which is due to acids in the water is easily offset by the addition of alkaline chemicals; but we are facing something more difficult when we find pitting in waters already heavily alkaline.

Best authorities tell us that corrosion in the form of pitting takes place in alkaline waters, as the result of electrolytic action. This means that the water in the boilers acts as the electrolyte or the carrier for the currents between electrodes which are the different metals in the boilers; just as in the case of an electric battery.

It is understood that there are electrical contrivances which introduce counter electric potentials in these metals to offset the natural action, but it would seem simpler to change the chemical nature of the water, to prevent its acting as an electrolyte.

It is understood that to make a boiler water act as an electrolyte, certain impurities must be present. It is further understood that these certain impurities are the magnesium salts, all nitrates, all chlorides, and sodium sulphate.

Many waters of the western territory carry all of these impurities, and practically all carry some of them.

Even the water from wayside treating plants, which is treated and settled, carries sodium sulphate, which is coming to be believed as the worst pitting impurity of all.

It is my understanding that another railroad has adopted this latter method mentioned above, with good success. Chemical compounds containing the necessary inhibitives are used through the engine tanks. The water, in both tanks and boilers, is kept charged, with the result that rusting of the tanks, as well as pitting in the boilers, is remarkably reduced, if not stopped.

If this is true, and I have no reason to doubt my information, we have the solution, and we should take advantage of it.

The road which I represent is about to try this method, and a report will be available later.

This report and supplementary reports read at the convention were prepared by a committee composed of K. E. Fogerty, chairman, T. W. Lowe and B. C. King.

Discussion

MR. BARDWELL (Water Engineer Hocking Valley): The subject of pitting and corrosion is an important and serious one. It is not only serious from a financial standpoint, but also serious from a safety standpoint. The question of scale is of more economical importance, but that is generally now under a fair degree of control. However, there seems to be considerable pitting and corrosion still existing.

You have one and all undoubtedly noticed in the railway journals during the past few months a number of articles on this subject. A particularly good one in THE BOILER MAKER for April and May which gave a good summary and history of these conditions as applying to railroads.

Now personally I have been studying this subject along with other lines of water treatment for the last twenty years.

The chemical constituents in water that affect pitting and corrosion in the locomotive boiler are fairly well understood. But that is only one phase of the trouble. These constituents have to be present in varying amounts to cause the trouble, and the effects are very frequently caused by other things outside of these various salts in the water, but it is a usual thing, and as a matter of fact the water gets the blame. The subject of water chemistry for water supplies is not a problem to be handled in the laboratory or for routine examination in the testing department. The water chemist on a railroad, if he is to make his work a success, must cooperate to the fullest extent with the men who are members of this association. He must cooperate with the transportation officers and he must cooperate with the traveling engineers, and he must receive cooperation from you gentlemen and the other departments if he is to get anywhere.

The chemical tests that are made in the testing laboratory are hardly fundamental. They show that condition of the water that comes in, but the action going on in the field may or may not be different. He has to deal not only with the chemical end of the work, the chemist does, but there is a human element, an economic and engineering element. You can propose the finest scheme imaginable for treating water, but if it is not followed up carefully, not once a week or once a month, but every day, it wont amount to anything.

The water is pumped on most railroads under the jurisdiction of the maintenance of way department. The men handling that work are necessarily a low paid class of helper. Sometimes they do what they are told and sometimes they do not. Necessarily they must be followed up. That applies to external roadway treating plants. On internal systems where chemicals are added in the roundhouse, supervision is of equal importance.

Mr. Lowe brought up the important fact that the chemical test of the water before it goes into the boiler is only one phase that should be examined. The water after it has been in the boiler should be examined. And with the road with which I am connected that is one of the important duties of the chemist handling this work. The success of any method of water treatment is a point that I want to stress again, and it lies in eternal vigilance and check. And it is only by close cooperation by all concerned that satisfactory results can be expected.

There are approximately eight different causes of pitting and corrosion in locomotive steam boilers. Now any one of those causes or any combination of those causes may produce the results which you have noted. In arithmetical consideration, the number of results that can be produced from combinations of eight factors figures out, I think, 176. In other words, there are approximately 176 different causes of pitting and corrosion in locomotive steam boilers. Now that brings up the point that any individual case cannot be taken and you cannot say offhand just exactly which one of the 176 causes brought about those results. It takes a study of each individual situation to determine what brought about the pitting in that case.

As Mr. Lowe brought up in his paper, everybody knows water contains acids; mineral acids or even organic acids will cause pitting and corrosion. Those are frequently encountered around the coal mine districts in the oxidation of the acid in the coal, conditions particularly noticeable during the dry seasons when the natural rainfall is low and the water in the streams largely drainage from the coal mines containing this sulphuric acid. That is one of the most simple problems of pitting and corrosion, and can be very easily controlled and corrected by neutralization with soda ash or caustic soda.

As you go further into it, the waters which contain high sulphates or high chlorides will also cause pitting. This feature is brought out to quite an extent in the report of the Water Service Committee of the American Railway Engineer Association for 1924. Very careful experiments were conducted to show that the ordinary indicators used by chemists did not record delicately enough to show when the water is acid, particularly when it contains considerable alkali salts.

Now as water boils in the locomotive, the pure water goes off in steam, leaving the salts, to continually concentrate. As this concentration increases, a point is reached where corrosion may take place or may not, depending upon the alkalinity of the water. This report of the American Railway Engineer Association gives a formula for keeping that alkalinity within safe limits.

Another point that has come up is the question of oxygen. It has been known for a long time in the stationary field that oxygen does have a very important influence on pitting of stationary boilers, and devices that have been put in to separate the oxygen from the water have been successful. But in the locomotive field there is considerable question as to the nature of this oxygen still. There are some types of feedwater heaters on the market that practically eliminate oxygen and dissolve gases in the water. These have been in service for some time, and the results as far as the effect on pitting is concerned, are being watched very carefully, but to date there has been no conclusive demonstration that the elimination of this oxygen from these open type feedwater heaters has materially helped the situation. Still there is that possibility that this may have some effect, and it is one of the subjects that are still under investigation.

Another possibility that should receive consideration is the question of quality of material. A homogeneous product is necessary for the best results. This is a question that is being handled by most railroads' testing departments and has been a subject given much consideration by the American Society of Testing Material, who have made specifications for proper material for the different parts of a boiler and, I believe, if followed out, will give satisfactory results.

And there is a point I think I brought up last year in the handling of material, conserving of material. If flues and firebox sheets are allowed to stand out in the weather, and exposed to atmospheric rust, that action will continue. It is generally accepted when this pitting starts on the boiler tubes and sheets, even in the best water conditions, the action will continue. Therefore, if material is allowed to lay out and rust, and pitting gets started, why, when those tubes and sheets are put in service the action will continue, and a year or so later this corrosion will become serious enough to be given consideration with renewals.

H. J. WANDBERG (C. M. & St. P.): Our water supervisor has certainly done wonders in getting away from leakage, but we have accomplished nothing that I can see to eliminate pitting. Pitting seems to be on an increase with us instead of a decrease. Of course we have divisions where it doesn't bother, but we have numerous sections where we can only get about twelve or fourteen months out of a set of flues, and when they are scrapped they are pitted from one end to the other. We have divisions, again, where our principal trouble is grooving, the eating away around the front flue sheet. This is confined mostly to our engines with long flues. Very little of that condition we find where we have a short flue. Whether that is brought about through vibration I am not prepared to say, I sometimes think that that grooving around the front flue sheets, especially the bottom flues, is caused by vibration on the long 2-inch flues.

Now what we have done and what we are going to do and what can be done to eliminate pitting I would think is a chemist's job rather than a boiler maker's, but I agree that it is up to us to furnish them all the information that we possibly can.

C. E. ELKINS (Missouri Pacific): Since we have been treating our water on the Missouri Pacific, we have eliminated the leaks. A leaky firebox and leaky boiler is something practically unknown with us, but we are just as far away from a solution now as ever, as far as the pitting is concerned. We are renewing fireboxes in six, seven or eight years on account of the crown sheets being pitted. They go right around the staybolts all the way back, and firebox, after the firebox is renewed. With flues we have the same trouble. We will put in a new set of flues and after the engines have made a mileage of twenty-four to twenty-eight months, 50 percent go in the scrap.

George Austin (Santa Fe): We have all kinds of water except good water. The pitting is the heaviest with us in waters which deposit considerable scale. The pitting around the radials and the crown sheet or around the bolts is usually under a scale deposit that has been formed around the bolt and on the sheet at the same time. That is where the pitting usually starts.

About the feedwater flues in the Mallet engines, we never made any improvement, I don't believe in preventing excess pitting in those. They simply eat up. We thought it was the metal, and we have taken the flues out of the main boiler and put them in the feedwater heaters, and they didn't last at all. So it was not a question of metal.

We have water conditions so bad that we sometimes have more than 200 grains to the gallon of solid. We have to treat that water. I might state that we have on the Santa Fe today I think it is 135 water treating plants, and we endeavor to treat all waters, and in addition we are using at this time three or four different kinds of boiler compounds, including the anti-foaming compound, and I have always thought that was a help.

H. A. Bell (C. B. & Q.): On the C. B. & Q. lines, west, we have had the same trouble Mr. Elkins spoke of and in just about the same manner. The fireboxes are in there black as your hat on the inside, on the fire side. But when you get into the water side, then you put in a new box or new sheet. We have not noticed any difference with engines equipped with feedwater heaters or engines not so equipped. Our chemists have told us sometimes that the presence of the oxygen in the water contributes to these pitting conditions, but we find our worst pitting conditions where the circulation of water is the greatest. At the top of the flue sheet, the front of the crown sheet and the top of the door sheet seem to pit worse than other portions of the firebox. At the present time we have also run into a condition of pitting on the lower portion of the combustion chambers that is causing us trouble.

M. C. Thompson (Boston & Maine): On the Boston & Maine, we are in what is known as a good water district. The life of our fireboxes is from 18 to 25 years. Our flues are changed every four years. And just recently, within the last three weeks, I was called to our main shop to inspect a crown sheet on one of our Pacific engines which was installed in July, 1920, and from our inspection, after removing the bolts we found 106 holes pitted, and 50 percent of these holes were pitted on the sloping side, and were half way through the sheet. We are having pitted holes in the good water district, and quite a number of them. And our chemists have been for the last two years that I know personally making a study of the water conditions, and it is something that we cannot detect as to what is causing pitting in our section.

John F. Raps (Illinois Central): As far as scale is concerned, that is an easy proposition, but when they eliminated the scale they gave us worse troubles, and those are the things we have to overcome. We can overcome pitting in a water where we treat it by raising the alkalinity, and so on, but it is in our territories where we have the real pitting without very much scale, and that is the matter that is putting the gray hairs in the chemist's head.

Just a short time ago I was visiting a shop and the foreman showed me a set of flues he took out of an engine, in a territory where we had never had pitting. We had to scrap about fifty percent of the flues, and they were literally eaten up. We are not surprised about that in some localities especially in mining districts or where we have free acids in the water or where after the acids get in the water we have chemical reactions that cause certain things to develop that cause pitting and corrosion, but when you have it handed to you out of a clear sky on a territory where you have never had pitting before, you take notice.

I remember in Chicago I was telling you about our Santa Fe locomotives where we were having trouble with the flues grooving, the bottom row in the front flue sheet. I said at the time we were trying the long verticals. We tried it and the iron shims we put on those flues were eaten through just as the flues were. It doesn't affect the copper shim so much. I told you we had put an engine in that territory equipped with siphons to see if the circulation would help. That engine has been in the territory about sixteen months and up to the present time we have had no trouble with the flues corroding just inside of the front flue sheet, showing that the circulation at the forward end of the boiler is going to eliminate a lot of trouble.

L. M. Stewart (Atlantic Coast Line): As I told you last year, our troubles are mostly in the crown, around the root of the thread of the radial stays. We have very bad conditions down in Florida. On one division there we wash our boilers every other trip and change our water every other trip; change the water one trip and wash the boiler the other.

We treat our water; that doesn't seem to overcome the trouble. We are now getting away from surface water, but our water supply supervisor claims it has tannic acid in it. We are now experimenting along the lines—we have bought an acre of ground and put down what we call points, and pump it in about forty feet, and we have improved the water conditions in some of our wayside water stations wonderfully in that method.

Phil Lyrer (M. K. & T): Our road seems to have more or less trouble around the first three rows of the crown sheet, pitting around the bolts. Then as we gradually go back our pitting lets up. Our sheets will sometimes be taken or the knuckles cut out at as high as only fourteen months' service. Then we have considerable pitting of the flues on several districts, and we have done everything that we know of to overcome this. Our road has spent considerable money in experimenting with different things, and is now spending lots of money experimenting. We are trying different kinds of iron flues, steel flues, putting half and half in the boilers. We have another locomotive now which has a set of lead eyes flues. So you can readily see we are trying to do everything possible to get something to do away with the pitting on our road. Whether we will be successful or not I cannot say. But as far as I can remember back, the old saying was, What can we do for corrosion and pitting? I cannot tell you what there is to be done. There seems to be or we have had numerous chemists, specialists, and everything, treat this water, but I believe the day and time has come now whereby we must find some kind of a metal that will resist this pitting.

N. H. Laughridge (Hocking Valley): We have very bad pitting in the flues. We have none in the crown sheet except the grooving in the first, second, and sometimes the third row of crown bolts. That we attribute to the movement of that sheet at that point. No doubt that is the trouble there. That is what makes your grooving in the knuckle of your back flue sheet. But what I want to ask of these gentlemen that have this excessive pitting around the crown bolts, is if they bombard these crown bolts now and then. That is our practice, to bombard them on a quarterly inspection. Keep that little ring of scale where this corrosive matter gathers and eats the sheet.

Thomas F. Powers (C. & N. W. R. R.): Pitting on the Northwestern Railroad is a menace. We have every conceivable kind of pitting, from the pitting of the barrels of the boilers, and I have seen it at times run as high as 40 percent of the locomotives in the boiler shop. I have seen 40 percent of the locomotives in the boiler shop have either the first half of the second or third course renewed on account of excessive pitting. There are roads in this country today spending as much as a quarter of a million dollars a year for new tubes. The cost between applying safe ends to a set of tubes and having to apply a new set runs close to a thousand dollars for material and labor for every engine that it is necessary on.

There are a few thoughts I want to get before the convention at this time that it may be that some of them are the cause of pitting. We are doing more scaling to boilers today than ever, notwithstanding the fact that pretty nearly everybody who has made a study of pitting tells us that it is a mistake to destroy the surface, the original surface of the metal. Every time we take a set of flues out we either scale with an air hammer and scaling tools or sand blast the shell of the boiler down to the metal. It is just possible that the long runs on some railroads is the cause of the increase in pitting. Personally I know of certain districts where our railroad has increased the length of the runs of locomotives where in one district there was no pitting, but when we ran the engine into another district pitting started.

Where you have the presence of what we call Glauber's salts, it is almost impossible to operate the locomotive and keep the water in the boiler, even with the use of anti-foaming compound, with over 2 percent of alkalinity. If that is a fact, and it is, it becomes impossible to use this remedy. We have pitting on shells, as I stated before, we have pitting of flues where we have districts that after from 12 to 18 months we throw away the entire set of flues, including the superheater flues. We have locomotives in certain districts where the fireboxes from the fire side are apparently in good condition, and when we get inside them we have to take the fireboxes out on account of pitting in the crown sheets. We have districts where the staybolts groove just above the plate, the firebox plate, half way through in a year and a half, sometimes less. And, to be brief, we have every conceivable kind of pitting, and it is on the increase, notwithstanding the fact that we are making more effort today to overcome pitting than ever.

F. J. Jenkins (Texas and Pacific): Down on the Texas and Pacific, we have water from Fort Worth, west, where we renew our fireboxes every two years. We renew the flues every eight months. They are over in the scrap pile. It doesn't make any difference what kind of a flue it is. However, we are testing some copper content flues, and from my observation I believe we are getting some benefit from it. We have an entire box applied out of what we call copper bearing steel, and I believe we are getting good results. It is not pitting so bad as the common steel. We are applying all of our back flue sheets out of this steel and getting better results than from the common steel. It won't crack or pit and corrode as readily.

T. P. Tulin (Erie Railroad): In the last year or two we have introduced doctors of water or chemical engineers. Now some gentleman brings out, or several have, that two engines of the same type, operating in the same water district, and having the same runs, do not have the same condition upon their plates and firebox surfaces. Doesn't it stand to reason that the nature of the metal has to be taken into consideration? Why not now try and invite metallurgists into this discussion in connection with water engineers and ourselves, which will throw a light or some bearing on the action and behavior of the metal under these conditions?

George Austin (Santa Fe): The only thing I can offer is, as has been suggested, and as proven out in our experience on the Santa Fe, that will mitigate it to some extent, especially crown sheet pitting, is to keep boilers clean, and to keep the scale off.

One other thought: It is my observation that in cases where locomotives of the same type and in the same service—one pits and the other does not. The principal cause for that is the man that operates the locomotives. You have a different man on each locomotive, especially on these preferred runs. One man will favor the water at certain tanks because he thinks or perhaps it does carry better, and, by the way, the engine man will always pick the water that carries the best in the boiler, and usually that water that carries the best in the boiler contains the most corrosive agents. He will dodge, if you let him have his own way, the treated water because of its foaming possibilities, and get the raw water. Now if we can get our people to steer clear of these tanks which we know don't foam at all and which we are positive is corrosive water, we will save a lot of pitting.

One of the reasons why more pitting is shown today on the Santa Fe, especially in the flue pitting, I attribute to the fact that we get more mileage two or three times over out of flues today since we started treating water than ever before. A corrosion has got to have a certain time to break through the flue. Before water treatment on the Santa Fe we would only get twenty-five or thirty thousand miles out of a set of flues, and often not that much. A pit might start, but before it got through the flues were taken out and the scale cleaned off and the flues put back in again. The flue makes seventy-five or a hundred thousand miles and the pit breaks through and the flues are badly pitted.

Mr. Callahan (Chicago): I happen to be one of the so-called water doctors, if you term it that. Fortunately perhaps I also happen to be a boiler maker.

My work brings me in contact with a good many railroads and trouble with all kinds of water conditions. In water, as we know, there are many problems to contend with. My opinion of the job to overcome some of these things is to find some of the causes. In waters we have the change of chemical reactions, just in the water. We know that certain acid conditions cannot be cured or corrected by chemicals. In other words, in your mining countries where you have a pitting condition, which has generally been mentioned here with reference to crown sheet conditions, it is sulphuric acid. In other waters we have certain normal conditions known as hydrochloric acid. The sodium sulphate in the water is of a normal condition that we find in the raw waters. In some cases the application of chemicals cannot be corrected. We pay particular attention to the washing of the crown sheet at the rear end, at the rear flues, but little water is allowed to get in at the front end. Our belly plugs are generally back four or five feet from the front flue sheet, and very little washing is done there. I also believe that to overcome some of that pitting it would be greatly helped if we could reduce the amount of heating surface in our flues. Our flue sheets are crammed, our flue spacings are small. The mud that will accumulate at the front end with the chemical changes taking place sets up an acid condition that with washing could overcome a lot of that.

We have, on the other hand, electrolytic and galvanic actions. In the waters there are three conditions, acid, neutral and alkaline. An acid condition will cause pitting and also soft scale forming solids. In the neutral there is generally the hard sulphate waters. In neutral water very little pitting is found. In the alkali water, which is sodium chloride or alkali salts, that you will find through the Western country, we have the sodium sulphate which goes in with the water. That causes your pitting.

We have now in the past few years a new problem which they term alkaline electrolytic action. The water is so high in alkalinity that with the circulation of water the boiler sets up an electrolytic action perhaps due to having the positive and negative with the copper shims that produce pitting.

I say to correct the pitting, treat your water with the proper chemicals, whether it is wayside or internal treatment. That can be determined through chemistry. Check up on the design of the boiler; free circulation; then source of supply. Much of our pitting I think today is agitated through surface water. We find all over the country we are taking water where it is easiest. If we find a river through the country, why, we take the water. All the sewage is going into that creek, and there is nothing that will produce a pitting condition quicker than that.

Welding Given Unusual Test

USING a gas-engine driven electric arc welding outfit with 1,000 feet of cable between the generator and the electrode, a successful welding demonstration was recently staged on the west coast. The Southern Pacific Railroad Company needed welding equipment that would weld with 3/16-inch high carbon steel electrode and furnish sufficient heat through 2/0 cable 500 feet from the set.

A test was therefore arranged by the Brown Brothers Welding Company of San Francisco at the plant of the Pacific Coast Steel Company. A General Electric type WD-12 welder was used with 1,000 feet of old cable with loose joints. The electrode holder cable was fastened to the extension cable by laying it across and taping it, and the connection to the ground plate was made through an old bolt shoved into a hole in the plate with a piece of iron laid against it to keep it from dropping out.

During the first test 3/16-inch electrode was used and some fine beads were laid, drawing about 200 amperes from the set. Some ¼-inch electrode was next tried and was used successfully.

Such a test is remarkable in view of the fact that it is seldom necessary to work at a distance of 500 feet from the set.

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

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

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

Below are given interpretations of the Committee in Cases Nos. 520 to 522, inclusive, as formulated at the meeting of March 19, 1926, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

CASE No. 520.

(Annulled.)

CASE No. 521. *Inquiry:* Is it to be understood from Paragraph U-59 of the Code that any fitting other than a nozzle is prohibited for all pipe connections over 3-inch pipe size? In other words, will not riveted or welded connections with threaded fittings be permissible under this section of the Code?

Reply: Par. U-59 requires flanged nozzles or fittings for all pipe openings over 3-inch pipe size when the maximum allowable working pressure exceeds 125 pounds per square inch. It is the opinion of the Committee that this paragraph was not intended to limit the method of attachment of nozzles and outlet fittings to the shells of pressure vessels, provided they meet all of the requirements of the Code for Unfired Pressure Vessels.

CASE No. 522. *Inquiry:* Is it permissible, under the requirements of Par. P-252 of the Code, to insert tubes into the thick-shell drums of high-pressure water-tube boilers by counterboring the tube holes on the inner face

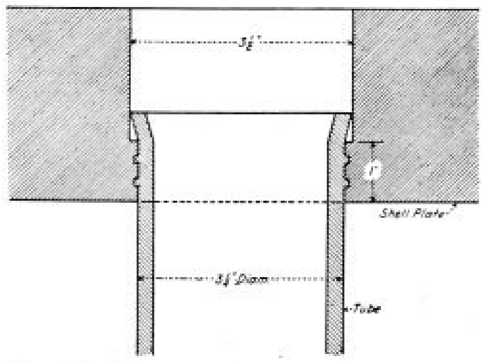


Fig. 22.—Narrow tube seat formed by counter-boring inner face of drum

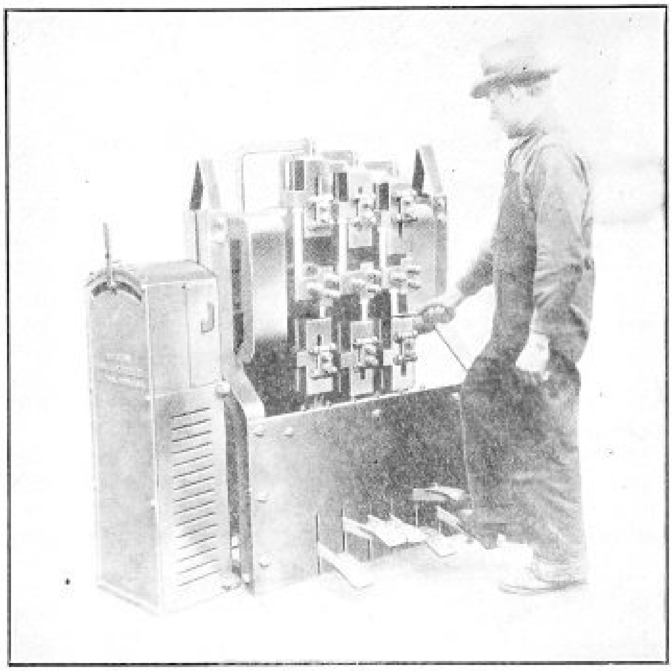
of the drum, as shown in Fig. 22, so as to form a narrow seat into which the tube end can be properly expanded?

Reply: It is the opinion of the Committee that this method of forming the seats for the tube ends will meet the requirements of Paragraph P-252, provided the diameter of the counterbore is sufficiently greater than the diameter of the tube seat to permit of a proper amount of flare of the tube end.

The American Electric Rivet Heaters

THE American Hoist & Derrick Company, St. Paul, Minn., has recently placed on the market electric rivet heaters which are built with an interchangeable center contact block. This enables the operator to unclamp the mid-section and repair any pit marks that may have developed during several months of constant usage. The pits in this center contact block, as well as in the interchangeable sliding jaws can then be fiilled with welded copper which, when cool, is hammered down to add hardness. The contact surfaces of the jaws and center blocks can then be gone over with a file and polished with sand paper.

The heat control is another feature of these heaters. The control instantly regulates the current so that rivets from ¼ inch by ½ inch to 1 inch by 8¼ inches can be heated quickly and without burning. This fits these machines for heating nuts, pins, bolts, etc., for tempering. The Models B and BB rivet heaters have been provided with nine steps of heat control; the Models A and AA heaters have been provided with six steps, while the Model C has six steps of control which permit 24 heat combinations to be made. The



Six rivets can be heated at one time in this American rivet heater

control is conveniently located at the left of the operator, and amount of current can be immediately changed by the operator without moving from his position.

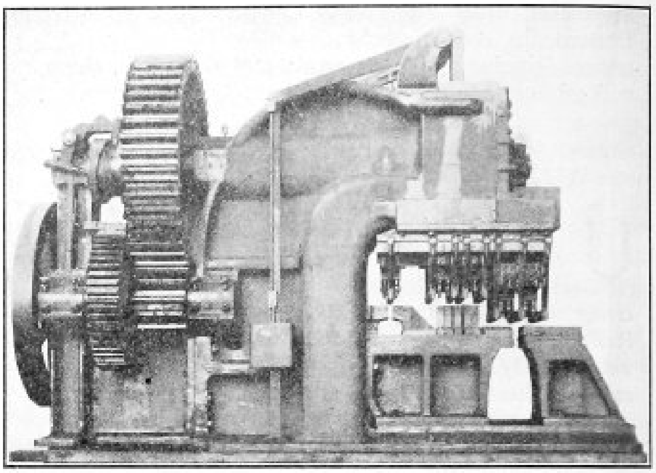
Due to the step arrangement, and the uniform contact tension on the heater's sliding jaws, mushrooming of rivets does not occur. These sliding jaws, which are the contact blocks, are manipulated by foot pedals. The jaws slide up and down giving a perfectly square and constant end compression on every rivet, regardless of the length. Another advantage of the sliding jaw design is that it permits a minimum and constant air gap between the secondary "E" elements and the laminated iron core, their source of power. This is the main cause of the high power factor obtained. The sliding jaws, previously mentioned, permit these "E" elements to be constructed of solid cast copper in such a manner as to hug the laminated iron core on three sides. These elements with their sliding contact blocks or jaws are made so they have thirty times the current carrying capacity of a one-inch rivet.

The transformer has been placed close to the field of action and within a few inches of the rivets to be heated, thus eliminating the necessity of conducting the secondary current by cable.

Open Gap Punching Machine

ITS large size, the wide range of work that it will handle, and the fact that it will punch both flanges and webs without changing tools, are outstanding features of a new punching machine that has been brought out by the Cleveland Punch and Shear Works Company, Cleveland, Ohio. The capacity is for punching 8-inch to 30-inch Bethlehem girder beams in the flange and web without changing tools. Bethlehem H-beams, ranging in size from 8 inches to 14 inches, may be punched, and by placing an overhanger at the rear of the throat, standard 6-inch to 9-inch H-beams and standard I-beams may be punched without changing other set-ups of tools. The machine may be used also for punching plates.

The punching tools are arranged in three standardized rows parallel to the main shaft. With the distance between the rows fixed and standardized, connecting angles can be punched with the same set-up as employed for the webs and flanges. The punching tools are adjustable for a minimum of 2¼ inches to a maximum of 48 inches. The strippers are adjustable and may be set up to clear the flange and web without change. The stripper arms are attached by a single bolt. The frame is a solid casting of the I-beam type of construction. The drive is of the double-gear type, and an automatic clutch of the safety type is employed to prevent a repeat stroke. The gears are of steel with cut teeth, and the jaw plate for the gears is a separate steel casting tongued and bolted on. All gears are bronze bushed. A safety feature is found in the elimination of an overhead counterweight. In its place are two



A wide variety of work may be performed on this punching machine without tool changes

counterweights, one on each side at the rear of the throat, these being guided on vertical rods.

The machine is driven by a direct-connected 40-horsepower motor. The compactness of the driving end of the machine may be noted from the illustration, and saving of floor space is a feature of this design. The overall dimensions are: height, 15 feet 3 inches; length, 15 feet 9½ inches.

Pneumatic Tool Pocket List

The Ingersoll-Rand Company, New York, has prepared a handbook of convenient pocket size showing the principal uses of pneumatic tools in railway shops with the sizes of tools found best adapted to the different operations encountered in locomotive and car construction and repair.

The book is indexed so that references to the proper sizes of tools and illustrations showing their use can be readily found for boiler shop operation, tender repairs, erecting and machine shop, steel car repair, passenger car work and operations in the foundry. The final section is devoted to specifications of the various tools and accessories manufactured by this company.

The Superior Steel Pipe Company a new corporation with offices at 2111 Farmers Bank Building, Pittsburgh, Pa., has acquired the works of the former Memphis Steel Construction Company located at Greensburg, Pa. The works will be thoroughly remodeled and equipped with new and up-to-date machinery and contracts for additional buildings are under way. This company will manufacture steel plate products of all kinds such as steel tanks, stacks and breechings, kettles, ladles, stand pipes, and will also be equipped to make riveted or electric welded steel pipe from 24 inch diameter upwards.

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Circular Patches

Q.—Being a reader of your magazine THE BOILER MAKER, I would be pleased to know the formula to obtain the efficiency of circular patches. Upon what basis will this efficiency compare with the longitudinal seam?—W. J. N.

A.—This question has been answered a number of times, refer to the July issue, 1917, of THE BOILER MAKER.

Conical Roof Layout

Q.—Would like information for laying out a conical roof for a large oil tank, say 115 feet diameter with parallel seams.—A. R.

A.—Refer to THE BOILER MAKER, page 111, April issue, 1923. Therein is given a complete layout and explanation of problems of this description.

Respirators

Q.—Having been a subscriber to THE BOILER MAKER for a number of years, I am writing to ask if you or any of the readers know where a respirator could be purchased, suitable for men working in sulphuric fumes. We do quite a bit of repair and structural work in nickel smelter and get troubled a lot with the gas. I know this is a little outside of your valuable magazine, but thought that some of the readers might have been up against the same kind of trouble and could give us a line on where a good one could be bought. I will watch the magazine for a reply. Thanking you in advance.—J. S.

A.—Write Paul O. Abbe, Inc., 71 Murray Street, New York, and Safety First Supply Company, Pittsburgh, Pa.

Suggestions on Riveted Joint Designs

Q.—Will you kindly answer the following questions for me: In a properly designed riveted joint, which should be stronger, the net section of plate or rivets? Why? Awaiting your early reply.—H. G. S.

A.—The strength of a riveted joint at the various sections through which it may fail should be approximately equal. Owing to the number of conditions affecting the design it is safe to proportion the joint so that the ultimate strength of the rivets in shear is greater than the net section of plate.

The object in the theoretical design of a riveted joint for boiler work is to obtain an efficiency as high as possible, but practical considerations limit the design within a small range of rivet diameters and pitch of rivets.

The size of rivets, plate thickness, arrangement of rivets and type of joint must be duly considered; the greatest permissible pitch must be such as to obtain steam tight work, and the smallest pitch that will allow for the forming of the rivet head.

Stack Hood

Q.—Inclosed is a sketch with plan and elevation. This problem is a rain hood going around a stack that goes through an A-roof. The hood drops down 24 inches from the rivet line in the outside course from the front and back to the right and left sides. My trouble is in finding the true length of the sloping rivet line. I triangulated this hood and took the ordinates from the plan and it did not agree with the sloping rivet line by about 3 inches. Hoping the plan and elevation will be plain enough and hoping for a speedy reply.—W. J. C.

A.—This problem can be readily laid out by triangulation, as indicated in Figs. 1 and 2. Fig. 1 shows a partial

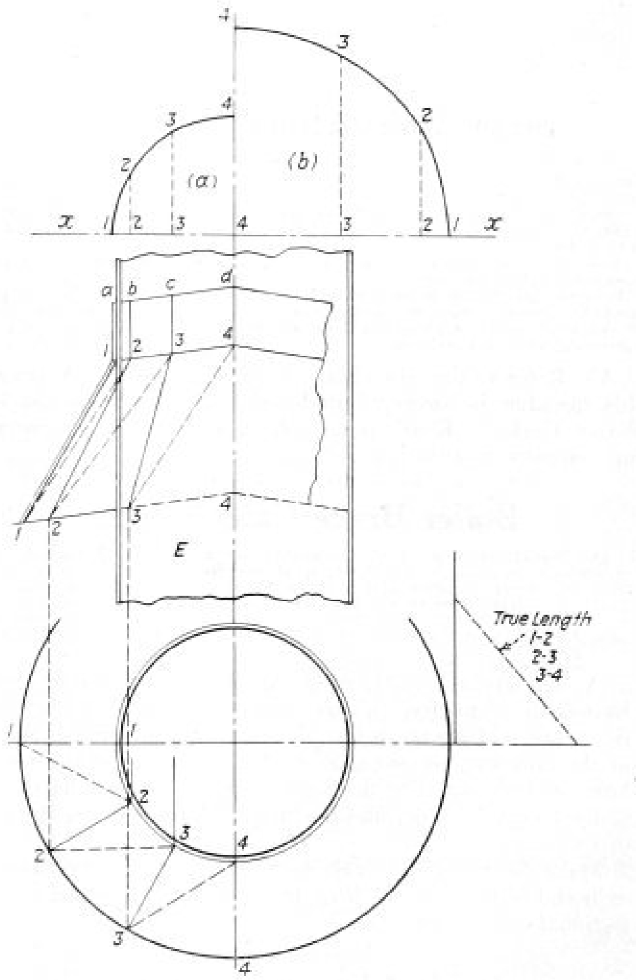


Fig. 1.—Triangulation applied to hood layout

plan and elevation. Divide one quarter of the plan into a number of sections and likewise the elevation. The solid radial lines *1—1*, *2—2*, *3—3* and *4—4* are all equal, so are the dotted diagonals *1—2*, *2—3*, *3—4*, the true length of which is shown to the right of the plan. The base of the triangle is equal to the diagonal length *1—2* of the plan and the height to *4—4* of the elevation. The section of the cone through the plane of the roof is an ellipse as is also the flare of the top section of the cone. A quarter view of the ellipse is developed in (a) and (b).

The lengths *1—2—3—4* on line *x—x* are equal respectively to those on the slope of the roof and flare of the top circular section of the hood. The lengths *2—2*, *3—3* and *4—4* are transferred from the plan.

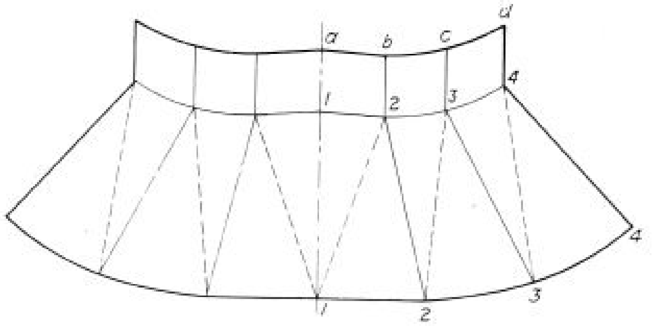


Fig. 2.—Patterns for hood

In Fig. 2 is given a half pattern of the hood, and as the construction lines are numbered to correspond with those in Fig. 1 the development should be readily understood.

Stress Calculations for Tanks

Q.—Would be pleased to have you advise if you could furnish me information concerning the calculations governing the design of rectangular steel boxes or pans.

Desire the formulas for calculating plate thickness, size top angle, angle stiffener size and spacing and size of the rods required when box is filled with water.

Also could you advise formula for figuring size of brackets or lugs for supporting cylindrical tanks.

Perhaps you publish some technical book giving this information, if so, would be pleased to have you advise price, etc., or if you have no publication of this kind, would be pleased to have you give me any information you can concerning above calculations. W. O. C.

A.—Refer to the May issue, 1925, THE BOILER MAKER; this question is answered under the heading, "Stresses in Water Tanks." Kent's handbook on Mechanical Engineering contains data on this subject.

Boiler Brace Calculations

Q.—Would appreciate it if you would show me how the following construction is calculated: In the form of crowfoot in the rear head of a horizontal return tubular boiler, below the tubes where the crowfoot is made of ½-inch plate with a separate crowfoot for each rod, each crowfoot being attached by four rivets to head. How are they calculated to pass A.S.M.E. and Mass. Laws? Thanking you for any attention given. —J. A. S.

A.—Refer to P. 223, A. S. M. E. Code. Design each branch of a crowfoot to carry two-thirds the total load on the brace. Make the net sectional areas through the sides of the crowfoot, tee irons or similar fastenings at the rivet holes at least equal to the required rivet section. That is, at least equal to 1¼ times the "required cross sectional area of the brace."

Make the combined cross sectional area of the rivets at each end of the brace at least 1¼ times the "required cross sectional area of the brace."

Draft Plate and Stacks

Q.—Please let me know what the functions of the petticoat pipe and draft sheet are and what effect does raising and lowering them have on the fire? From what source does the height and diameter of a locomotive stack derive?—J. F. D.

A.—The petticoat pipe was originally used for locomotives having short smokeboxes and for the purpose of equalizing the draft. With present types of locomotives its function is to increase the length of the stack and confine the gases so that the exhaust steam has a better action in carrying them upward. The draft plate or apron is for the purpose of regulating the draft through the tubes. By lowering the draft plate the flow of gases is checked somewhat through the upper tubes, causing the fire to burn stronger at the forward end of the firebox. By raising the draft sheet the flow of gases is retarded in the lower tubes and the fire burns better at the rear of the grates.

Stacks are made straight in cylindrical form, and tapering having the taper about 1 inch in 12 inches, with the large diameter at the top. The diameter varies and the height is usually from 2 feet 6 inches to 3 feet. The height of straight stacks is from 12 inches to 3 feet depending on the size of the boiler and clearances of the road.

Are Sweats, Leaks

Q.—Every practical boiler constructor or inspector knows that a boiler (new or one which has seen service) will sweat when subjected to a severe cold water test, weather conditions also being a factor.

The sweat which causes a dampness about the rivet heads, or in some cases a drop of water to eventually collect, is of no consequence and in no manner indicates a weakness of the boiler. Such sweats appear and disappear to some extent. There is no mystery as to the cause. A riveted joint being flexible, gives or "breathes" during a cold water test and thus causes dampness about the rivet head.

A boiler which thus sweats will, if filled with water heated at about 150 degrees F., be dry, and under its own steam, as dry as the Sahara Desert. Therefore, should a rivet which sweats, under circumstances cited, be calked? The writer holds that such calking is more harmful than beneficial, besides an unnecessary expense.

Still there are others who hold that such sweats should be calked. Can they justify their position? This should prove an interesting subject to the readers of THE BOILER MAKER, and the hope is expressed that men recognized as "authorities" will express their views.—T. F. S. J.

A.—Tight seams should primarily be obtained by good riveting, rather than calking. However, calking is indispensable but it should not be overdone, as too much heavy calking will produce injury to the metal and weaken the joint. A joint or rivets that sweat under tests will take up under steam. Your understanding of this subject is practical. This subject is, however, left to our readers for further discussion.

Welding Tubes

Q.—I am in the boiler and tank manufacturing business, also do a general line of repair work on locomotive, marine and H. T. boilers. We have just recently added to our equipment an arc welder or electric welder to help out on our repair work, and have a customer who has made inquiry as to welding boiler tubes into back flue sheet. Is it practical to weld in tubes that have been installed with copper ferrules and beaded over, or would it be a more thorough job to just let tubes protrude through flue sheet about 3/16 inch and weld without beading? Kindly give me all the information you can on the above or let me get in touch with some of your reliable correspondents on same. Also would like to find out about what would be a reasonable price per tube for welding; size of tube, 1¾ inches in diameter; superheater tube, 4½-inch diameter. I am a recent subscriber to THE BOILER MAKER and have already gained some good information from it. I am a boiler maker from the old school but am trying to inject new ideas into the game all of the time. Thanking you for anything you can send my way in regard to my inquiry.—E. N.

A.—The welding of beaded tube ends in the back tube sheet is practical, if properly done. The tubes are set with copper ferrules placed approximately 1/16-inch from the face of the tube sheet. Tubes should be expanded and beaded. Clean the surface around the bead and tube sheet.

In performing the weld start at the bottom center and work up to the top on one side then return and weld up the other side. The weld should not extend over the top of the bead.

We cannot advise you on the prices for handling such work, as so much depends on local conditions.

CONNELLY BOILERS.—The D. Connelly Boiler Company, Cleveland, Ohio, has introduced a new catalogue under the above title which opens with an historical outline of the foundation and growth of the organization. The plant and equipment are briefly described as well as the various types of boilers built here. Numerous illustrations accompany the text which show views taken in the plant and various installations of these boilers throughout the industrial works of the country.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

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

Steamboat Inspection Service of the Department of Commerce

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

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.

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

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

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.

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

Vice-Chairman—C. D. Thomas, Salem, Oregon.

Statistician—E. W. Farmer, Rhode Island.

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

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

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

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

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

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

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

Master Boiler Makers' Association

President—J. F. Raps, general boiler inspector, Illinois Central.

First Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.

Second Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.

Third Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.

Fourth Vice President—George B. Usherwood, supervisor of boilers. New York Central.

Fifth Vice President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington and Quincy.

Secretary—Harry D. Vought, 26 Cortlandt Street, New York.

Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.

Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—J. W. Kelly, National Tube Company, Pittsburgh, Pa.

Vice President—A. W. Clokey, American Arch Company, Chicago, Ill.

Treasurer—George R. Boyce, A. M. Castle and Company, Chicago, Ill.

Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie, Pa.

Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.

Secretary-Treasurer—D. W. Glanzer, 840 Rockefeller Building, Cleveland, Ohio.

Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; Owsley Brown, Springfield Boiler Company, Springfield, Ill.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Wroks, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

Cities

Chicago, Ill.	Memphis, Tenn.	St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Los Angeles, Cal.	Philadelphia, Pa.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Missouri	Pennsylvania
California	New Jersey	Rhode Island
Delaware	New York	Utah
Indiana	Ohio	Washington
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Nebr.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Memphis, Tenn.	Philadelphia, Pa.	Tampa, Fla.

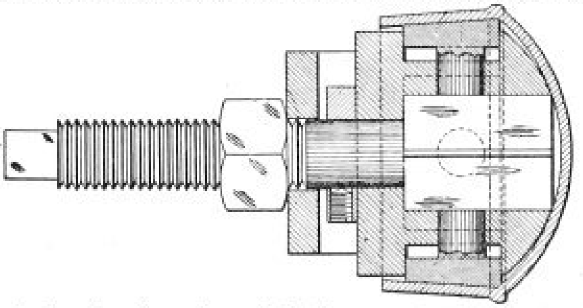
SELECTED BOILER PATENTS

Compiled by
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,544,181. WILLIAM RICHARDSON AND JOHN S. FOLAND, OF ST. LOUIS, MISSOURI, ASSIGNORS TO HEINE SAFETY BOILER COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI. TOOL FOR INSTALLING HANDHOLE CLOSURES IN BOILERS.

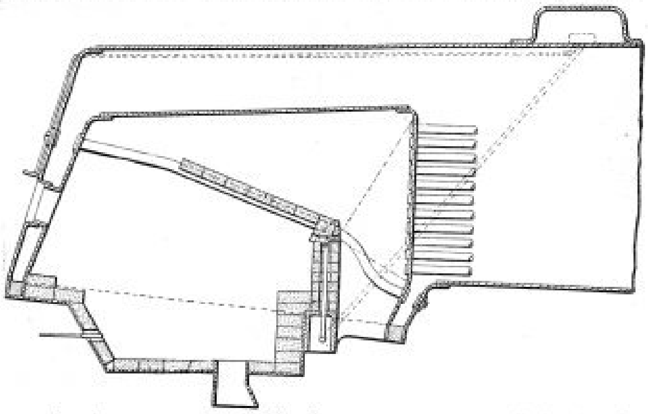
Claim. A tool for the purpose described, comprising a substantially yoke-shaped member, a jaw carrying member, radially-disposed jaws in said jaw carrying member, a shaft projecting rearwardly through the cross piece of



said yoke-shaped member and provided with a tapered or inclined part that forces said jaws outwardly when said shaft is moved longitudinally, means for preventing said shaft from rotation with relation to said jaw carrying member, and means for preventing the jaws from dropping out of said jaw carrying member when the tool is not in use.

1,582,203. FLUE-SANDING APPARATUS FOR LOCOMOTIVE FIRE BOXES. ALFRED H. WILLETT, OF WEST NEW YORK, NEW JERSEY, ASSIGNOR TO AMERICAN ARCH COMPANY, A CORPORATION OF DELAWARE.

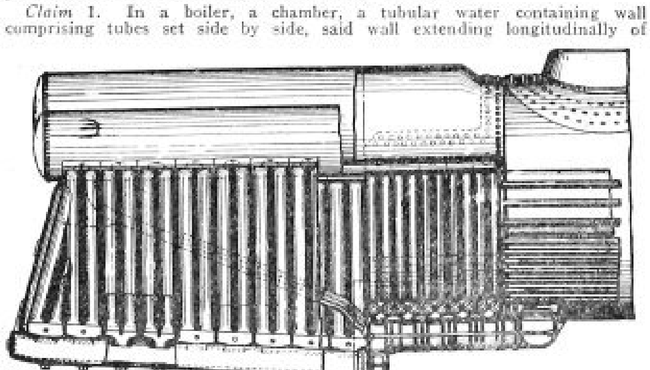
Claim 1. The combination with a locomotive fire box and a refractory structure obstructing the same behind the flue sheet and flues, of sanding



means for them protected in said refractory structure and discharging forward therefrom. Two claims.

1,580,063. JAMES M. McCLELLON, OF EVERETT, MASSACHUSETTS; HAROLD B. McCLELLON ADMINISTRATOR OF SAID JAMES M. McCLELLON, DECEASED. BOILER.

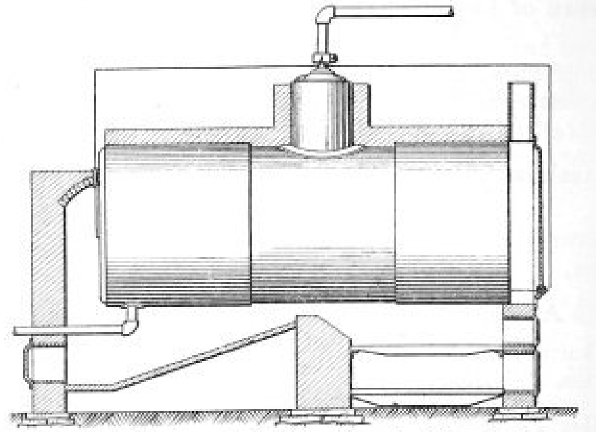
Claim 1. In a boiler, a chamber, a tubular water containing wall comprising tubes set side by side, said wall extending longitudinally of



the chamber and means for placing said tubes in communication with the interior of said chamber comprising headers each communicating with said chamber and with a group of said tubes.
7 Claims.

1,581,024. METHOD AND APPARATUS FOR ELIMINATING SCALE IN FLUID CONTAINERS. KARL SCHNETZER, OF AUSSIG-SCHRECKENSTEIN, CZECHOSLOVAKIA, ASSIGNOR TO ANTI-SCALE LIMITED, OF YORK, ENGLAND.

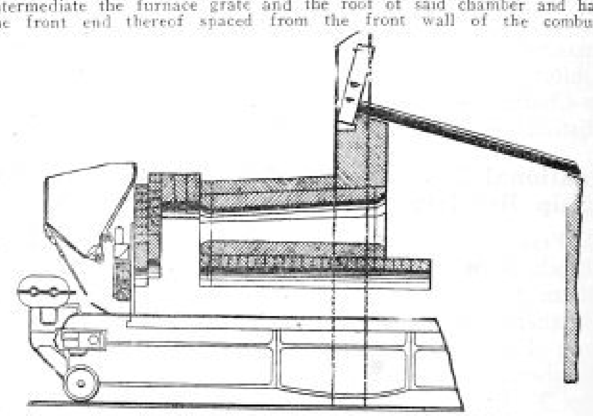
Claim 1. The method of protecting metallic surfaces in contact with a body of fluid against formation and adhesion of scale thereon which comprises including the metallic surface in a metallic electric circuit, causing



electric current to flow in said circuit so formed while maintaining across that part of said metallic surface that is included in said circuit a voltage below that which will cause appreciable electrolytic corrosion of the metallic surface beyond what would normally occur in the absence of said voltage, and thereby preventing the formation and adhesion of scale on said surface. Four claims.

1,580,205. JAMES KEMNAL, OF LONDON, ENGLAND, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY. BOILER FURNACE.

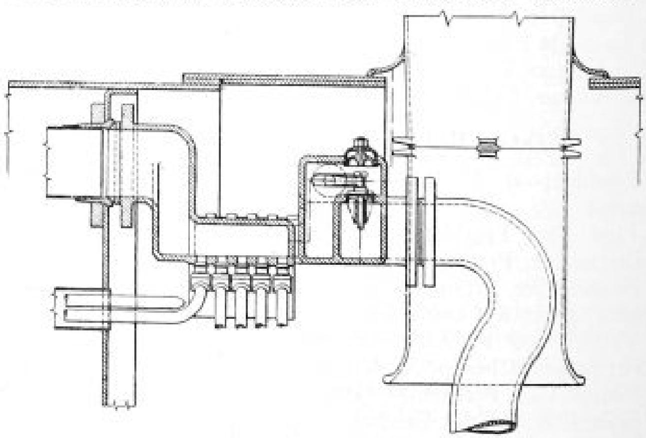
Claim 1. In a boiler furnace, a combustion chamber, an arch disposed intermediate the furnace grate and the roof of said chamber and having the front end thereof spaced from the front wall of the combustion



chamber and a plurality of structures having longitudinal passages in the space between said arch and the roof of said chamber protecting the upper side of the arch from the flames and affording a passage for the products of combustion therethrough to the furnace chamber.
5 Claims.

Re. 16,285. RAY M. BROWN, OF YONKERS, NEW YORK. LOCOMOTIVE.

Claim 1. In apparatus of the class described, the combination of a superheater comprising an elongated chamber having a series of ports along its length through which superheated steam is delivered to the chamber,



and having an outlet through which the steam is conveyed to the point of use; partitioning means separating the inlet ports from the outlet and provided with a series of relatively small openings distributed opposite said steam delivery ports; and a corresponding series of valves each controlling one of said openings.
10 Claims.

The Boiler Maker

Volume XXVI | August, 1926 | Number 8

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Edward A. Simmons, *Pres.*
L. B. Sherman, *Vice-Pres.*
C. R. Mills, *Vice-Pres.*
Roy V. Wright, *Sec'y.*
Henry Lee, *Vice-Pres. and Treas.*
Samuel O. Dunn, *Vice-Pres.*
F. H. Thompson, *Vice-Pres.*
George Slate, *Business Manager*

Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ave.
Mandeville, La.
Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.
Cable address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

Request for change of address should reach us two weeks before the day of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

Boiler Corrosion

THE problems of boiler corrosion, pitting and grooving, although highly technical in their nature, hold an important place in the work of the boiler shop since it is here that their effects on locomotive boilers must be corrected. The final solution to the difficulties experienced through the ravages of these boiler diseases must of course come from the metallurgical and the chemical laboratories. However, in eliminating or at least in reducing the tremendous yearly loss due to corrosion, the boiler maker is in a position to materially assist those charged with the major work of finding materials and water treatments that will overcome the trouble.

For the past three years this subject has been given a prominent place on the program of reports and discussion, at the Master Boiler Makers' Association conventions. Two of the individual reports on the subject at this year's meeting which appear in this issue of The Boiler Maker and the subsequent discussion of this question brought out information from all parts of the country on various effects of corrosion that should prove invaluable to the water treatment departments of the railroads in their future work. The subject is being continued by a standing committee of the association and will be taken up again at the meeting next year. Realizing how valuable their testimony based on experience with corrosion, pitting and grooving may be, the members of the committee as well as all members of the association will do well to study the subject with even more care than in the past.

In the course of the discussion at this convention, the fact was brought out that several steel companies who supplied boiler materials are devoting a great deal of time to the metallurgical study of the problem in an attempt to develop a steel that will be more resistant to corrosion than has been available in the past.

All the efforts of the various organizations interested in lessening the effects of what has become an operating menace to the railroads deserve commendation and it is to be hoped that the next year will have found the solution.

Productive Capacity of the Boiler Industry

AT the annual meeting of the American Boiler Manufacturers' Association in June a resolution was passed that a survey of the productive capacity of the boiler manufacturing industry had become imperative in order to determine to what extent this capacity had been met by members of the association in the output of their various plants. Following up this resolution, the secretary of the association has sent out a letter of notification to all members which appears in this issue that a committee has been appointed and that it would be the object of this committee to procure definite and complete data on the subject. In a short time a questionnaire will be sent out to members and non-members of the association who are interested in the manufacture of boilers by the Department of Commerce with the urgent request that the information required would be supplied promptly.

This movement deserves all the cooperation that can possibly be given it, for the statistics that are to be collected will constitute the basis in the future for a definite knowledge of conditions in the industry. Up to this time no information of this character has been available and boiler manufacturing concerns have had but the vaguest measure of the output or demand for boilers throughout the country.

When the National Board of Boiler and Pressure Vessel Inspectors was formed a few years ago the compiling of statistics and records of boilers built, repaired, inspected and like information was recognized as an essential function of the organization. As rapidly as possible this body has gathered statistics covering the subject in as comprehensive a manner as possible through the efforts of its statistician. These records in conjunction with those to be compiled by the American Boiler Manufacturers' Association, will form a fairly complete picture of the boiler industry in the United States and all future work required to maintain these statistical data accurately and up to date will be a comparatively easy matter.

Just how far it will be possible to go in collecting information of this character is problematical. It is certain, however, that to be of maximum value every source of data in non-code states as well as those governed by the A. S. M. E. Boiler Code must be utilized and every inspection body, insurance company, the Uniform Boiler Law Society, the National Board and other organizations must unite to make the records complete.

Shop Articles

PERIODICALLY the attention of our readers is called to the opportunity offered through the medium of the various departments of The Boiler Maker for their comments on current matters pertaining to the boiler making industry. New contributors of articles on shop descriptions, their methods of carrying out special operations, inspection articles, new equipment descriptions and the like are always welcomed in our pages. A subject of great interest to our readers is that of laying out boiler, tank and heavy plate work, but few of the experts in this line take advantage of the chance to describe unusual jobs which they carry out in the course of their work. One article of this type appears in this issue and undoubtedly many of our readers will be able to point out other ways in which this layout can be as advantageously solved.

Then too, the explanation of simple problems by the older hands will be of great benefit to the younger generation of layerouts who are learning the trade. Many of our readers are well qualified to explain layout problems encountered frequently as well as to discuss many other phases of boiler work in a way that will be helpful to the apprentice and beginner in the shop. The Boiler Maker will welcome such articles and earnestly solicits our readers to send in material of this kind.

The section devoted to letters from our readers also offers an excellent opportunity for their comments on boiler and allied subjects but comparatively few take advantage of this clearing house for the exchange of ideas.

Finally, attention is again called to the service offered in the Questions and Answers department where any question applying to boiler work will receive prompt and careful attention. For the benefit of our new readers as well as the older ones we particularly wish to emphasize the fact that no matter how complicated the question may be it will have the benefit of the best advice available and should be submitted for solution. The sole value of this service depends on the extent to which it is utilized and we earnestly hope that more of our readers will take advantage of it as an aid to them in their work.

LETTERS TO THE EDITOR

Boilers in the Transportation Industries

ACCORDING to an interesting report relating to the transportation industries which I have before me, 23 percent of all the power plant installations are firetube boilers and 77 percent are watertube boilers.

On a capacity basis 7 percent are firetube boilers and 93 percent are watertube.

The report furthermore shows that 42 percent of the firetube boilers are from one to 10 years old; 58 percent are 11 to 20 years old; and none are 21 years old or older. At the same time, 28 percent of the watertube boilers are from one to 10 years old; 35 percent are from 11 to 20 years old; and 47 percent are 21 years old or older.

It is claimed that the figures in the above report are based on nearly seven hundred replies to an investigation made by a large New York concern.

Newark, N. J. W. F. Schaphorst.

Locomotive Boiler Firebox Design

To the Editor:

The writer had an opportunity recently of inspecting one of the widely used ¾-inch thick firebox tube sheets for low gravity, high thermal heat value, fuel-oil burning locomotives.

This inspection was made from the fire door of the locomotive. It was claimed that the tubes and sheet had rendered excellent service for three months. However, the writer is of the opinion that sooner or later fractures will develop that will more than offset the saving in maintenance on flues, as there has been no allowance made in the design for this heavy sheet, as it is designed along modern manufacturing lines, being a pressed sheet in one plane, flanged and securely connected to mud ring, side sheet and crown sheet.

It may be a modern idea, applying this thick sheet and letting the heat blister and flake until the line of radiation coincides with the maximum line of convection, leaving the tube holes reinforced; however, as the writer was not inside the firebox the grooving process was unnoted.

The boiler designers for locomotives should have the sympathy of the mechanical world. They have problems a plenty, the very important benefits of superheat, and the ever increasing prime mover being two of the many.

The opinion of the writer is that the rigid firebox tube sheet of today with the flattened crown sheet has developed a weakness in the staying zones that is becoming dangerous, and now the radical idea of applying ¾-inch firebox tube sheets should call for very serious consideration. Flexible stays have safety limits of application, there must be a sacrifice some place or radical changes in design.

The writer's opinion of boiler design is that the inside shell should be the same shape as the outside shell; for example, a round and straight outside shell and a round straight inside shell stayed the full length of the boiler with watertubes crossing the inside shell would be his idea of the correct boiler.

However, the suggestions given herewith embrace only improvements on our present designs of boiler in service.

As mentioned previously, in order to have the same form between the outside and inside sheets, there should be a fire-combining chamber extending into the shell of the boiler for at least 7 rows on the complete circle. This, it is believed, would partially eliminate the breaking of bolts in the front zone, especially with top operated checks with delivery tubes in the center of the boiler. The inner shell, or firebox, should have the shape formed as nearly concentric as possible with the outside shell. A flat crown sheet should be avoided unless the outside shell is of the horn type or flattened. A crown sheet with the concentric radius of the first course of boiler shell, both slightly tapered, would be better from the breaking standpoint, as it would allow more water on the curve of the crown sheet and thus hold, to some extent, the U-tube effect of the water to syphon to a higher than normal level at the gaging point. The passing of circulation under the extended fire-combining chamber sheet would also have a noted effect on this building up of water at the back end.

This design, while it shortens the tubes and lessens the heating surfaces, would probably not lend itself advantageously to the extending of the front flue sheet. However it makes possible a thick tube sheet without increasing the strains on the boiler and thus, to a large extent, eliminates bolt breaking. The same design, when used with standard firebox sheets, would also give good results and, should the back end of the boiler have one cylindrical course of about 10 rows of stays, or be short enough so that in a coal burner the fireman could scoop coal through the neck and clean the fire, the staybolt breakage in locomotives would be comparatively slight. This extended ring, of course, should be designed with care as to diameter, due to the direct relations the length has to the diameter in this case.

With the front and back end of the firebox extended as fire-combining chambers in this design, we would have a semi-rigid firebox and, if the front tube sheet were extended free from the outside shell, we would have a full floating firebox and tube sheets; for an oil burner, the design could be almost cylindrical inside and outside, leaving only an opening of sufficient width within the mud ring to extract carbon in the event of incomplete combustion and thus nearly approaching the writer's ideal boiler with the exception of watertubes.

The probable advantage of superheat may be one of the reasons for holding so rigidly to the present form of flattened crown sheet. The writer can see no serious objections to superheat being applied to the outside of the boiler, cutting draft openings through the firebox on either side. This can be efficiently drafted from the front end and be protected with dampers while not in use and probably remove the objection to a concentric crown sheet.

Guantanamo, Cuba. C. C. Hall.

Boiler Explosions vs. Boiler Inspections

An accident that particularly emphasizes the necessity of expert boiler inspection occurred October 19, 1925, when the portable sawmill boiler owned by Messrs. Walker and Graw exploded at Roxbury, N. H. One man was killed and four others injured, and two horses were blinded. The sawmill was completely destroyed. The front end of the boiler was torn off and projected about 500 feet away. The main portion of the boiler traveled about 200 feet in the opposite direction but was retarded in its flight by three large trees which it broke off.

This boiler was of the locomotive firebox type, 48 inches in diameter and 17 feet long. At the time of the explosion it had been in operation but one day after being completely overhauled and repaired. The studs securing the door frame had broken off and so the frame was spot welded to the front head. As the throat sheet had become thin at the blow-off connection, a 1½-inch standard flange coupling was welded to the sheet and the blow-off pipe screwed into this coupling. Likewise a ¾-inch flange coupling had been welded over the fusible plug opening in the crown sheet, thus leaving a small pocket for mud or sediment to collect over the end of the plug. In addition, several tubes had been renewed, a new fusible plug inserted, and the boiler painted so that it looked to be in good condition. It was evidently the intention of the owner to have the boiler placed in first class condition.

The failure of the boiler cannot be attributed to any of these repairs but rather to the failure of the staybolts. The staybolts in the boiler were originally of ¾ inch diameter, having a net cross-sectional area of 0.288 inch. They were spaced on 5-inch centers; hence the area supported by each bolt was 24.712 square inches. (Supported area minus area of staybolt.) The total stress allowed in a ¾-inch staybolt by the A. S. M. E. Boiler Construction Code is 2,160 pounds, which when divided by the area 24.712 square inches, gives an allowable operating pressure of 87.5 pounds. At the time of the explosion the boiler is said to have had 110 pounds pressure. The safety valve, which incidentally was too small, was set at 120 pounds. Under normal conditions, therefore, the staybolts were overloaded, and this condition was seriously aggravated by the fact that they had materially wasted away. This reduced the effective cross-sectional area to about one-sixth of normal and increased the unit stress in inverse proportion, thus effectually overcoming any reasonable factor of safety. During the overhauling, the hand-hole covers in the bottoms of the water legs are said to have been removed and the mud and sediment washed out, so it would seem as if these corroded staybolts must certainly have been seen at that time. However, the persons who did the work evidently failed to appreciate this to be a dangerous condition and so made no comment on it.—*The Locomotive.*

Survey of Boiler Production

The following letter has been sent out by the Secretary of the American Boiler Manufacturers Association to the membership of that body:

"For the information of those members present and not present at the 37th annual meeting of the American Boiler Manufacturers Association at Hot Springs, Va., June 2nd, please be advised the absence of statistical information in the Boiler Industry was discussed at great length and the following resolution was unanimously passed:

"RESOLVED: The President appoint a committee of three members to devise ways and means of making a survey of productive capacity in the industry, the extent to which such productive capacity has been made use of in the recent past, and such general statistics of the industry as will prove of assistance and interest to those both in and out of the industry; and further, to obtain currently statistics of business placed in the future,—the method of procedure to be left entirely to the discretion of the committee."

"Since the passage of the above resolution a special committee has been appointed, composed of Mr. A. G. Pratt of the Babcock-Wilcox Co., Mr. W. C. Connelly of the D. Connelly Boiler Co., Mr. Starr H. Barnum of the Bigelow Company, and Mr. Geo. W. Bach of the Union Iron Works.

"To procure definite and complete data, and to insure the success of the survey, the committee made a special trip to Washington to interview Mr. Wm. M. Steuart, Director, Bureau of the Census, and Mr. Mortimer B. Lane of the Industrial Statistical Bureau, both of the Department of Commerce. This procedure also was deemed necessary by the committee so that more accurate statistics could be obtained, and to take advantage of information available and to receive the benefit of the Bureau's general experience in work of this nature.

"A questionnaire will be mailed to members and nonmembers by the Department of Commerce which the committee trusts will be given careful attention and properly answered."

Suggestions for a Watertube Locomotive Boiler

Outline of advantages to be expected from a carefully developed watertube locomotive boiler design

By Louis A. Rehfuss

THE following notes are appended to the drawings of a proposed watertube locomotive boiler as a brief explanation of the design and as an indication of its purpose.

Feeling as the author does that the present staybolted firetube type of locomotive boiler is not well adapted to reach into the fields of higher pressure and greater efficiency that the future will undoubtedly demand, he has turned to an all watertube boiler as the obvious solution.

At once the question of space limitations creep in. If we dispose the tubes longitudinally and at too low an angle we limit the degree of overload rating to which the boiler may be driven. If we arrange them vertically, our tubes become too short and the number of joints becomes excessive for a reasonable amount of evaporative surface. By arranging the tubes inclined in the manner shown these difficulties are somewhat overcome. Not only are the tubes kept straight and easily replaced, by comparison with all bent watertube boilers, but they are sufficiently pitched and short enough to stand the high percentage of overload firing customary in locomotive practice.

Economies Sought

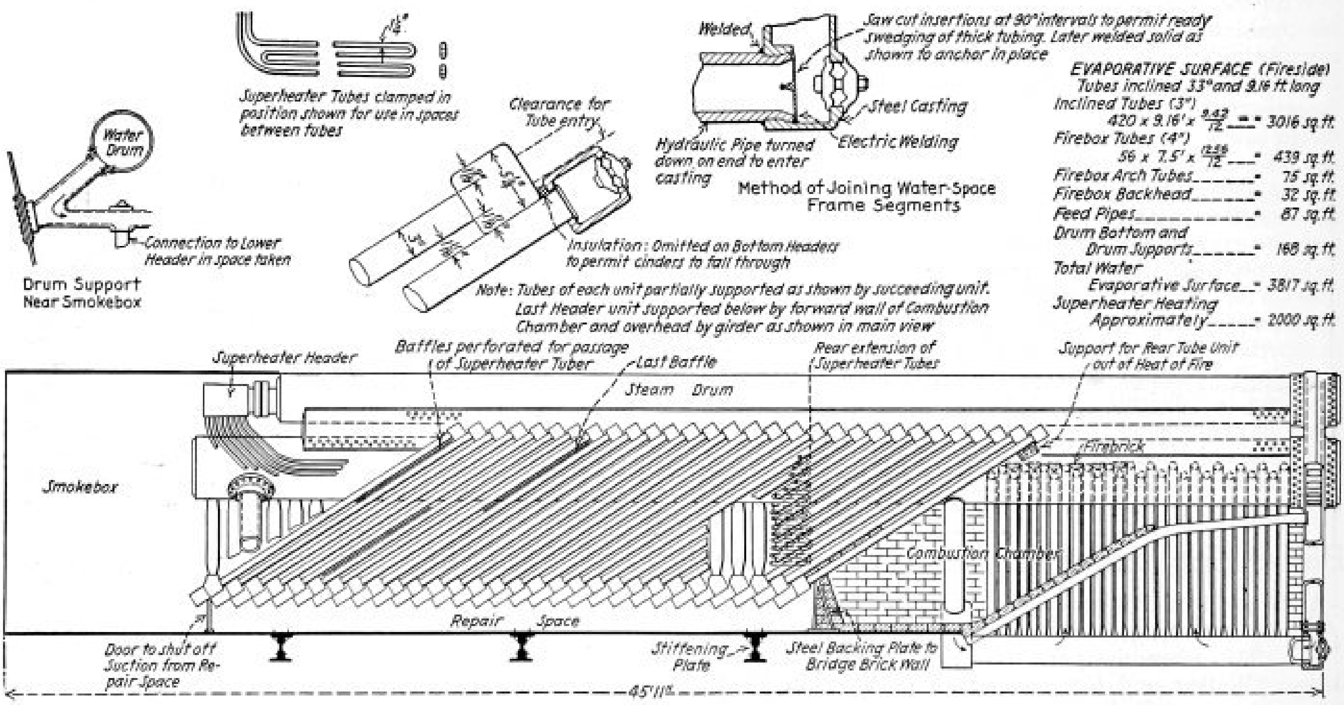
From the viewpoint of operating economies, we could reasonably expect an improvement over current firetube practice from each of the following considerations:

1. *From the Use of Higher Pressures:*—In the present design 350 pounds pressure is employed as a reasonable first step. In the stationary field watertube boilers up to 2,000 pounds pressure have been built and while beyond our reach at present serve as an indication of what can be done with watertube designs. The gain from higher pressures, as is well known, lies in obtaining the higher pressure at very little more heat expenditure than is required for the lower pressure.

2. *From More Rapid Steaming:*—Due to the large water capacity and poor circulation of firetube boilers it takes 3 to 4 hours to get steam up from a cold boiler to the desired pressure. When the run is finished all this stored up energy is useless. Since the watertube boiler requires only from ½ to 1 hour to get high pressure steam from a cold boiler, a considerable saving in both fuel and labor is possible before the run commences.

3. *From Superior Circulation:*—This lessens the priming and wetness of the steam, effecting a coal saving in this way. It also lessens scale deposits, reducing this expense in maintenance. From the superior evaporation per unit of surface under given firing conditions, induced by this factor of circulation, a very much less amount of evaporative surface would be required the same power as compared with firetube practice.

4. *From Better Combustion Efficiency:*—At the high rates of firing common in modern railroad practice, as 120 pounds of coal per square foot of grate per hour, it is found that 25 percent of the coal used in locomotive boilers remains unburnt, passing out with the gases as unburnt sparks and cinders and the like. Naturally as soon as the gases strike the small bore tubes in the firetube boiler, there is little chance for continued combustion. In the watertube arrangement proposed, the space outside the tubes, occupied by the gases, is naturally larger than the space inside the firetubes of the customary boiler, so that the combustion space is extended. The fact that the flames strike the tubes at an angle also tends to break up the sparks, giving them a better chance for combustion. The extensive use of superheater tubes in the main portion of the barrel reduces the hydraulic depth sufficiently to prevent the gases from entering the smokebox at too high a temperature. However by employing superheater units either shorter or longer as desired it is possible to extend the combustion space (discussed above) at will.

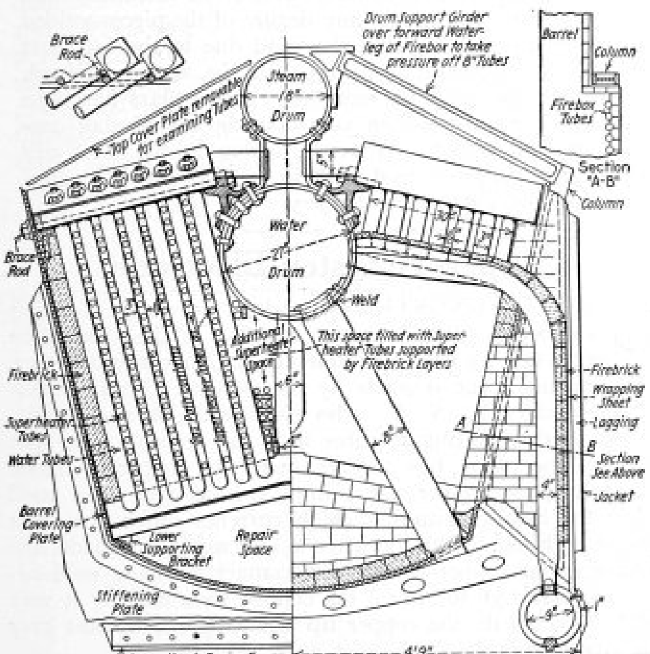


Proposed design of high pressure watertube locomotive boiler

Evaporative Surface and Superheating

The proposed boiler has 3,800 square feet of water evaporative surface. While this is considerably less than firetube locomotive boilers of the same outside dimensions, it should be amply sufficient for the purpose. It is not the amount of the surface, but its nature that counts. A recent steam generator built in England, of a stationary watertube type, showed an evaporation of 70,000 pounds of steam per hour with but 2,000 square feet of evaporative surface. The swift circulation, freedom from scale and angle at which the flames strike the inclined tubes of our proposed boiler should combine to make the individual unit tube extremely effective.

In this connection we would call attention to the fact that the tubes deliver their combined steam and water burden through headers at about the water line or slightly above it. Where tubes enter a water drum considerably below the water line, their action becomes explosive and intermittent at high rates of forcing. Experiment has shown, on the other hand, that where watertubes deliver above the water



Section through firebox of watertube boiler

line, the steam formation causes a syphon action which becomes stronger and swifter and more perfect the higher the fires are forced; so that at high rates of firing the circulation becomes better than ever. In the proposed design since the headers discharge midway between the steam and water drum the best water level could be determined in practice and maintaind accordingly.

Small Evaporative Surface in Firebox

We have placed comparatively little evaporative surface, only about 600 square feet, in the firebox. This is done with the idea of increasing the combustion efficiency of the coal itself. Where excessive evaporative surface is placed in the firebox, we feel that the firebox temperatures are lowered to a point where sparks and cinders are more apt to escape unburned than otherwise. By doubling the row of tubes around the firebox, the total water evaporative surface of the boiler could be increased if desired.

Space for the superheating tubes as shown is sufficient to provide 2,500 square feet of superheating surface if required, an abnormally large amount. This would permit the benefit of compounding with intermediate as well as initial superheating. Where high pressures of 350 pounds or over are employed, we naturally would be exhausting from the high pressure cylinders at pressures sufficiently high, 75 to 100 pounds, to make this superheating intermediately an attractive proposition. At 100 pounds pressure steam is sufficiently dense not to require the excessive heating surface that would be necessary in superheating steam at 50 pounds pressure, which occupies two-thirds greater volume per equal unit of weight.

Resistance to Jars and Shocks

In the proposed boiler the outside shell is intended to act as the main supporting framework for the whole. To this end we have angle iron and stiffening plates disposed on the outside to stiffen the whole, between which the lagging would be laid. Cross-brace rods run across to the drums as shown at each upper header, while the headers themselves rest in supporting brackets, beside being partially supported by the tubes of the next unit immediately behind. The last unit is specially supported as shown on the print. The drums are stiffened by disposing one above the other, rigidly riveted together by the connection plates. At the firebox the drums are supported by the waterleg backhead, and by the two large feed-pipes in the combustion chamber. Near the smokebox the drums are supported by the triangular waterleg casting shown, as well as by any further brackets thought necessary. In the main body of the boiler each vertical feedwater pipe running to the lower headers tends to support the drums, as does the whole construction in fact. The watertubes, being only 9 feet in length, with the flexible connections provided and aided by effective circulation, should readily take up any expansion that might otherwise cause leaks. The whole construction is trussed up in such a way that undue strains from shock or other causes should be avoided, although additional bracketing could be provided if desired.

The upper part of the water drum is out of contact with the hot gases and should be secure from temporary low water conditions. Should this drum become completely dry and no surge issue from the tubes to keep its temperature down, its spherical shape is its best guarantee against dangerous explosions.

Miscellaneous Considerations

Radiation to the outside air is prevented by a firebrick lining between the watertubes and the shell, which is lined on the outside with the customary lagging. If desired the firebrick may be partially replaced along the forward part of the barrel by feedwater preheating tubes.

Dry steam is assured by the fact that the top *headers* discharge at right angles to the discharge compartment between the steam and water drums, so that as long as the water level is not maintained too high, only the surge or splash of the water can enter the steam drum. The steam drum can be equipped with a perforated baffle plate to prevent any such surge from entering the superheater. The steam may be made to throttle at the superheater headers, or at some point along the steam drum, running dry pipes down each side thereof.

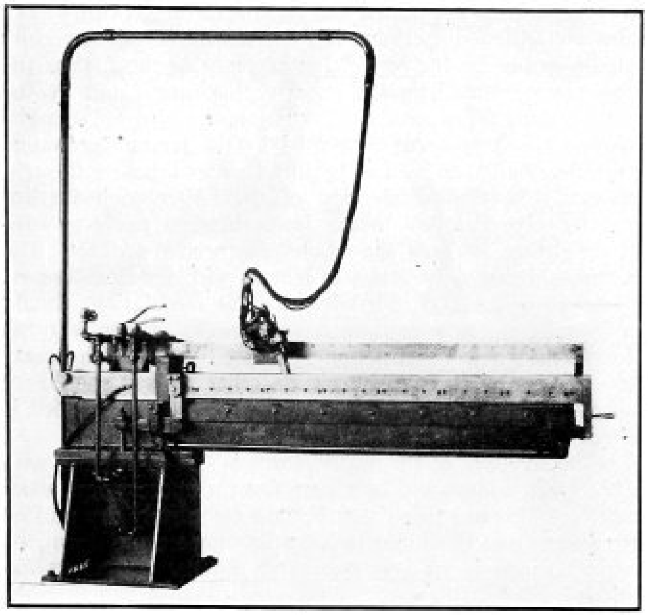
Because of the braces and headers required, it is probable that the weight of the proposed boiler would exceed that of a comparable firetube boiler. This is, however, more than made up for by the smaller amount of water carried, so that in running conditions this boiler should be lighter for equal power than its firetube competitor.

The first cost of a boiler is only about 25 percent of the cost of the locomotive as a whole, so that the boiler first cost could be increased considerably without increasing the total locomotive cost more than nominally. This would be justified if thereby sufficient savings in operating and maintenance cost could be attained, or if the ton-mile cost could be reduced by the placing of more powerful boiler units on engines of given weight.

Ductile Carbon Arc Welds Made on New Machine

Recent developments in the Research Department of the Lincoln Electric Company, Cleveland, Ohio, have resulted in a substantial advance in welding practice. Machine driven carbon arc equipment has been developed for welding light gage steel (12 gage and lighter) at a high rate of speed and at the same time obtaining a ductile weld. The necessity for using hydrogen, water gas or similar reducing atmospheres has been entirely eliminated.

The principle of operation of the equipment for producing ductile welds in sheet metal is simple. The seam to be welded is clamped into the machine with water cooled copper faced clamps. Such filler rod as is required to make the seam the desired thickness is merely layed on the seam. The machine then carries the carbon arc along the seam fusing the edges together. The bottom copper faced clamp is grooved to give the desired amount of reinforcing to the seam. Thus, the reinforcing on the underside of the seam is accomplished by the metal running into the groove at the instant it is molten. Owing to the fact that the coppers are kept cold by water ducts, the hot metal of the seam does not weld to the clamps.



Machine driven carbon arc welding outfit

Ductility in either a gas weld, a metallic arc weld or a carbon arc weld in dead soft steel is obtained by minimizing the amount of atmospheric oxygen and nitrogen which combines with the steel while it is in the molten state. In the oxy-acetylene welding process this is accomplished by an envelop of neutral or reducing gas around the metal which is molten. In the metallic arc welding process, since metal is continually traveling across the arc, the conditions are most unfavorable for protection of the molten metal and it is therefore necessary to provide an envelop of gas which under the influence of the arc becomes a powerful reducing agent. In the carbon arc process, no metal passes across the arc and the problem of decreasing atmospheric effect is far simpler. By increasing the amount of heat produced by the carbon arc and increasing the speed with which it travels, the length of time a certain amount of metal in the seam is actually molten is reduced to a fraction of a second. Thus the atmospheric effect is confined to the surface and appears in the form of blue oxide which is thrown off by the rapid contraction of the metal leaving the surface bright and clean.

Using the machine driven carbon arc equipment, it is claimed that low costs are obtained on making ductile welds. Elimination of the gas envelop contributes to the simplicity of the equipment as well as eliminates this item of cost. The speed of travel of the carbon arc to produce a ductile weld on 14 gage steel is about six feet per minute. This results in an overall cost per foot of the welding of under one cent per foot of seam, including electric power, labor and carbon electrodes. The item of filler rod is not included since it is a variable quantity depending on the amount of reinforcing required on the seam.

Ductility in sheet metal seam welds is sometimes a necessary quality. On heavier plate and structural shape welding, however, lack of ductility of the weld material is not a matter of great consequence. As a matter of safety, the weld section is always made greater in thickness than any adjacent section so that any flexure of the pieces welded together will never occur in the weld due to the fact that the weld is considerably stiffer than the sections joined. Ductility in the weld for materials of this class has been obtainable for the past ten years by the use of slag covered metal electrodes. However, owing to the relatively high cost of these electrodes, their use has not been considered economical in this country.

Copper-Tungsten Electrode

Copper-tungsten electrode, a development which is expected to prove of great value in the fabrication of metals, is now available for use in manufacturing. This announcement is made by the General Electric Company, Schenectady, N. Y., who evolved the new electrode.

One of the limiting features in many resistance or spot welding operations has always been the copper electrode used, the pure copper not being hard enough when used under the high pressures at high currents common to this type of welding. Usually, after a few welds are made, the surface of the copper electrode in contact with the weld becomes hot enough to anneal the copper, thus making it very soft. As a result, the copper tip rolls and mushrooms over the edges, giving a large spot weld.

Copper-tungsten, as its name indicates, is a mixture of two metals, one a good electrical conductor and the other very hard. The alloy has a hardness of 225 (Brinnell) as compared with 82 for hard copper and 30 for soft copper. The compressive strength of the copper-tungsten is 208,000 pounds per square inch as against 58,000 pounds per square inch for hard copper. The tensile strength is 56,350 pounds per square inch compared with 30,000 pounds for soft copper and 50,000 to 70,000 pounds for hard drawn copper.

Copper-tungsten does not anneal at red heat. Thus there is no soft surface metal to roll or mushroom over when used in resistance welding. It has not been found necessary to form the entire electrode point or die of copper-tungsten, but rather to use inserts of this alloy by any one of a number of methods, such as forcing an oversized piece in a hole in the die, brazing a block in the wearing surface or placing pieces in a mold and casting the die around them. The remainder of the die is made of copper as before.

In view of the higher first cost of copper-tungsten, its chief value is expected to be in special applications. It is particularly adapted for use under severe conditions where copper will not stand up, such as hot upsetting rivets electrically, and in facings for clamps for rod welding, split dies for welding steel spokes to both rim and hub of steel wheels and in many other applications where copper cannot be used because of its softness. In such instances, without the use of resistance welding which is now made feasible, it would be necessary to adopt other and more expensive methods.

A Two-Piece Elbow Connecting Two Parallel Tubes of Different Diameters and Whose Center Lines Meet

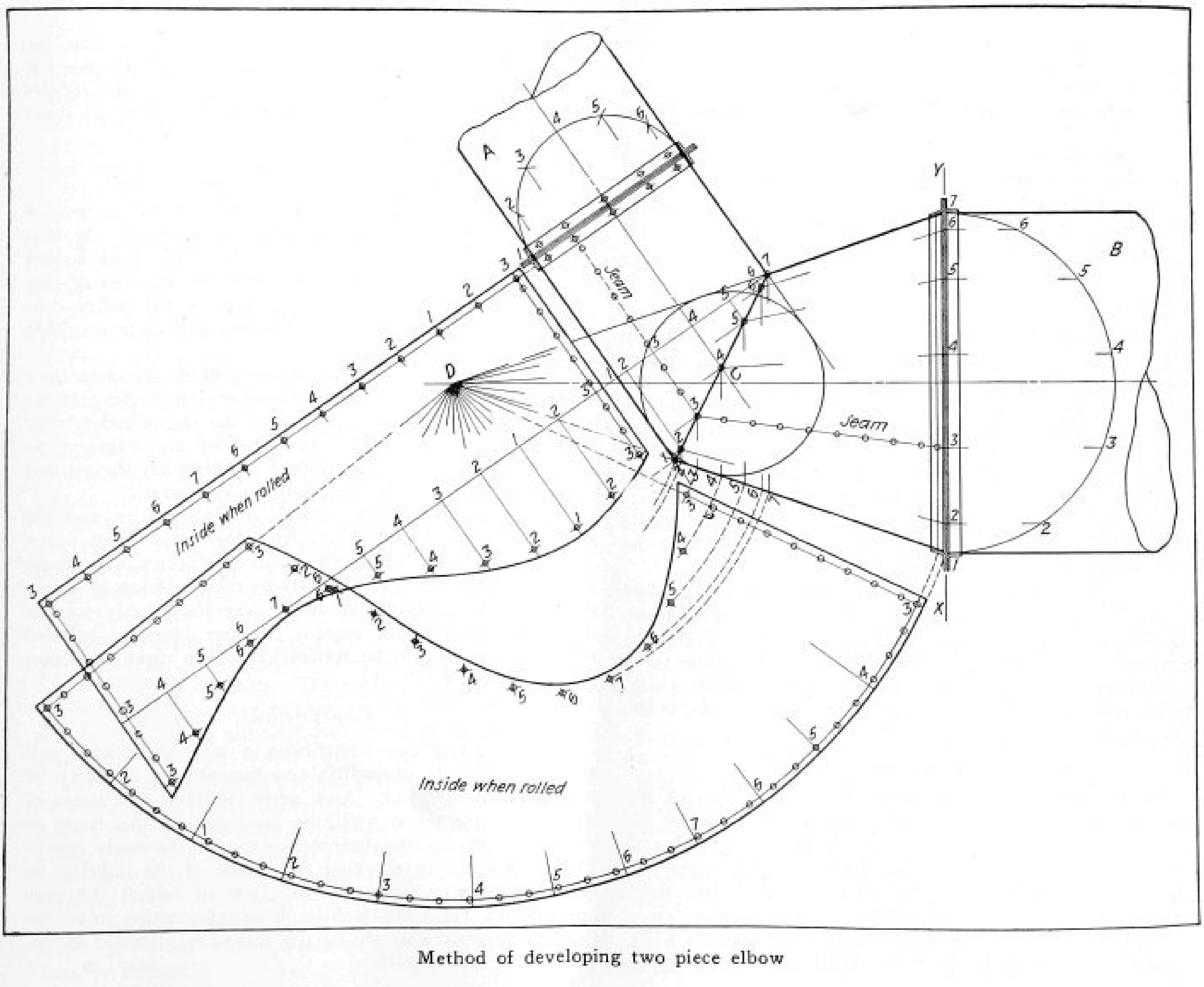
By I. J. Haddon

A and *B* are two pipes of any diameter and in any position with their center lines meeting in *C*. With *C* as center describe a circle equal to the diameter of the smaller pipe *A*; draw lines from 1 and 7 of the smaller pipe *tangent to the circle*, as shown. Draw lines from 1 and 7 of the larger pipe *tangent to the circle*, and meeting at *D*, also crossing the other lines drawn from the smaller pipe in 1 and 7 as shown; connect 1 to 7, this line will be the miter line of the cone and pipe. Draw the small semicircle as shown and divide it into 6 equal parts as 1 to 7. From the points obtained drop lines perpendicular to 1, 7, crossing the miter line in 1 to 7 as shown. Draw lines from the apex of the cone through these points on the miter line, to the base of the cone. Draw the large semicircle and drop lines from the points 1 to 7 perpendicular to *X*, *Y* and cutting the large semicircle in 1 to 7. The lines 3, 3 on the cone and pipe will (in this case) be the seam lines, as at this part of the miter the joint would lie flat and would not have to be bent in making a connection.

Before developing the conical part, draw lines from 1 to 7 on the miter line, parallel to the base of the cone, and crossing the side of the cone in 1 to 7, as shown. Then *D*—1, *D*—2, *D*—3, etc. On the side of the cone will be the true lengths of *D*—1, *D*—2, *D*—3, etc., on the miter line.

Conical Section Development

To develop the conical part: From *D* as center and radius *D*—1, *D*—2, *D*—3, *D*—4, *D*—5, *D*—6, *D*—7 and *D*—1 on the *side of the cone*, draw arcs as shown. At any convenient place draw a line from *D* to represent the center line of holes for the seam as *D*, 3, 3. From 3 on the base curve, and radius 3 to 4 of the semicircle cut the arc in 4, then from 4 and radius equal to 4, 5 of the semicircle cut the arc in 5 and so on as shown. Draw lines from these



Method of developing two piece elbow

points to the apex of the cone and crossing the other arcs as shown in *3*, *4*, *5*, *6*, etc.; these new points will be the center of holes for the miter; allow on the lap required, also space holes for seam; also space holes for angle ring at base as shown to complete the development.

I hardly think it necessary to detail the development of the pipe cut at an angle, as the drawing is so fully detailed that anyone can easily follow it, and a pipe cut at an angle has been so often explained that I do not think it necessary to repeat it.

I might point out the following facts: The miter line *1* to *7* is an ellipse of *exactly* the same size *on the cone* as *on the pipe*, also that *any* size ellipse may be cut from *any* cone, but according to the position of the pipes *A* and *B* and their sizes, there can only be *one* cone that will cut and form a true miter line. In other words, *no other cone* would apply to this problem providing the center lines were to meet in *C* as shown and the pipes to be at the angle as given to each other and their diameters as given.

Judicial Construction of Explosion Policy Covering Boilers

By Leslie Childs

THE question of the extent of the liability of an insurance company under a boiler explosion policy is one of considerable interest to holders of such policies. In other words, how are losses in such a situation to be measured? And will liability attach only for the direct damage caused by an explosion, or will damage for indirect losses also attach?

It is of course obvious that each case of this kind must be decided in the light of its facts, and the terms of the policy involved, which precludes the covering of the subject by a hard and fast rule. However, as an example of judicial reasoning in a situation of this kind, the Ohio case of Cleveland Drop Forge Company vs. Travelers' Indemnity Company, 151 N.E. 671, may be reviewed with interest and profit.

Facts in the Case

In this case the Cleveland Drop Forge Company carried a boiler insurance policy with the Travelers' Indemnity Company. The policy provided for indemnity for loss or damage directly caused by an explosion, and the term "explosion" was defined as a "sudden rupture or sudden collapse of a boiler or its furnace flues, or other parts, caused by pressure of steam."

A certain horizontal tubular boiler with a firebox underneath near the front was covered by the policy. The circular head of the boiler was fastened by rivets, and on its lower part the rivets had become drawn so as to enlarge the holes in which they were fitted.

There was testimony to the effect that within four feet of the boiler head, in the circular shell of the boiler above the firebox, a bag or bulge had been formed. Following this, water coming from the holes made by the sprung rivet, caused an accumulation of sediment at the bulge point, which produced such a pressure of steam against the boiler head as to cause its rupture.

Company Entitled to Recover

On the above state of facts the forge company took the position that it was entitled to recover under its policy for both the cost of sealing the rupture in the boiler head, and for the repairs made to the bag beneath. A dispute followed which culminated in the instant action by the forge company to recover under its policy.

In this action two legal questions were presented. First, whether the damage to the boiler head was caused by an explosion within the meaning of the policy? Second, whether the forge company was entitled to recover the cost of repairs to the bag in the boiler where there was no rupture? After a trial in the lower court, and an appeal to the Court of Appeals, the cause reached the Supreme Court of Ohio, and here in construing the policy in respect to whether there had been an explosion within its terms the court, in part, said:

Liability for "Rupture" Upheld

"By the terms of the policy the insurance company agreed 'to indemnify the assured, * * * in the event of an explosion of any such boiler, or for his loss or damage directly caused thereby.' Were this the only provision in the policy contract covering loss or damage by explosion it is obvious that no liability would attach. There was no explosion in the sense that term is popularly known or as it is defined by lexicographers.

"However, this policy seems to recognize this fact, and, with a view of extending its liability by defining the term, it provided that 'an explosion shall mean the sudden rupture or sudden collapse of a boiler * * * caused by pressure of steam.' * * *

"The breaking apart of the boiler head, in which the rivets were sprung, therefore was a 'rupture' within the meaning of the policy for which the insurance company was liable. Moreover it was a 'sudden rupture' caused by the pressure of steam, for on the first parting of the rivets from the plate a rupture occurred, and liability immediately attached."

Following the above disposition of the first question, the court directed its attention to the second, i.e., whether the forge company was also entitled to recover for the repairs to the bag under the boiler. In this connection the court reasoned as follows:

Recovery Denied for Repairs to Bag

"Was the plaintiff (forge company) entitled to recover under this policy for repairs made to the bag? At that particular point the lower part of the boiler had bulged downward over the firebox, but there was no sign of any rupture thereto. The manifest purpose of the policy contract was to insure against *explosions* and their resulting damage.

"Recognizing that pressure of steam might sometimes not produce explosions of violent character, but might produce a splitting apart of some portion of the steam boiler, with a lesser violence than that produced by an ordinary explosion, the insurer obligated itself to indemnify the assured for the damage directly caused by the rupture.

"The damage *directly* caused by the rupture was the springing apart of the rivets from the boiler head plate. The damages covered by the insurance policy were those caused directly and not indirectly by the explosion as herein defined. The insurance company was liable only for the damages caused by the rupture. Those damages included repairs necessary for the restoration of the ruptured places in the boiler. * * *"

Conclusion

The foregoing case constitutes a very clear and well reasoned example of judicial construction of a policy of insurance of this kind. And, when the facts and terms of the policy are taken with the language of the court in stating its conclusions thereon, the case is obviously one of force and value in marking the extent of the liability in boiler insurance contracts. In view of which the case appears to carry a worthwhile bit of information to executives in general, who are in any measure interested in insurance of this character.

Boiler Corrosion on the Canadian Pacific Railway

Independent report on paper, "Boiler Pitting and Corrosion," presented at annual meeting of Master Boiler Makers' Association

By T. W. Lowe*

THE Western Lines of the Canadian Pacific Railway comprising over 9,000 miles of territory provides a vast field for research work if we attribute to the water supplies the blame for all the corrosion, pitting and grooving which effects all boilers more or less.

As has been frequently repeated, the analysis of water by chemists is of great help to them in determining the quality of any one supply, but it does not decide what the analysis of the water is in a boiler at the end of its run, after having evaporated 30,000 or more gallons of water from various supplies, or explain the cause of pitting, etc.

The boiler inspector or other officers see the corrosion, pitting and grooving going on continuously in districts where the chemist states the analysis of the water does not show that it should be under suspicion.

More Corrosion in Modern Boilers

In this vast territory in northwestern Canada we find that in the reputed good water territory there is more serious corrosion, pitting and grooving occurring with the modern design of boiler than was and is experienced with boilers of older design. As a matter of fact many of the original designs of boilers continue to operate in the same district as modern designs without complaint as to a reasonable life being obtained from tubes, superheater flues, staybolts or boiler plate.

The brand of material in use over the Canadian Pacific Railway is standard for all boiler construction and repairs.

The method of feeding the water is alike on all power, as well as the position of entrance of the water into the boiler.

The brick arch equipment is as near alike as dimensions of firebox will permit.

There are no restrictions as to the general use of any of the water supplies in the good water territory. There are restrictions in bad water districts which necessitate passing up different bad waters which are only to be taken as an emergency.

With these deductions before us, the mysterious part of our investigation begins, because if we decide that oxygen, carbonic, sulphuric or hydrochloric acid as well as galvanic, electric, or any other action is the cause of the corrosion, pitting and grooving which is prevalent, we are confronted with many conflicting experiences in our endeavor to discover a remedy. Chief among them is that the older type of locomotive boiler runs over twenty years without shell repairs and the tubes and superheater flues are fit to safe-end as often as we wish. The modern combustion chamber boiler in freight service has not necessitated any boiler shell repairs in 6 years, although the life of the tubes and superheater flues is about 75,000 miles. The cause for this short life is because of pitting extending from the front tube sheet in numerous scattered spots for a distance of about 8 feet. They groove entirely through the tubes and flues immediately inside the front tube sheet. The pitting and grooving is more extensive on the top position of the tubes and flues than the bottom, although not sufficiently excessive on the top to suggest that the action is not general throughout 8 feet at the front. The remaining portion of the tubes and flues is normal.

* General Boiler Inspector, Canadian Pacific Railway.

So that the information quoted in this report will be understood I am attaching six drawings, three of which give the analysis of waters spoken of and three of which give particulars of the boilers using these waters.

Sheet 1. Analysis of waters in the northwestern part of Canada where the ground waters are hard and weather conditions very severe in winter. Prairie lands. The samples were taken in February when the water is hard. During spring, summer and autumn analysis of water fluctuates.

Sheet 2. Comprises an analysis of water in the territory of the foothills and over the summit of the Rocky Mountains where the ground waters and rivers are not as hard as on the prairie. The weather in winter is less severe than on the prairie. Analysis of water taken during any time of the year does not show much change.

Sheet 3. Includes the analysis of one water supply on the Maple Creek subdivision and the analysis of the water removed from the try-cock of a yard engine just prior to a weekly washout having used that source of supply without having used other waters.

Sheet 4. Particulars of passenger and freight engine boilers running in districts where Sheet 1 water is used.

Sheet 5. Particulars of passenger and freight engine boilers using water shown on Sheet 2.

Sheet 6. Particulars of yard engine boiler using water shown on Sheet 3.

Mechanical Prevention of Hard Scale

We do not have excessive corrosion, pitting and grooving accompany the use of water shown on Sheet 1, excepting when we permit leaks to ooze from the tubes and staybolts following the removal of the fire. Leaks result in the plates being grooved or channeled out where the water runs over them. Hydrochloric acid is the attacking agent. To prevent this we keep the staybolts free from scale ferrules in the water space by using chemicals, blowing down through the blow-off cocks and a hammering process which prevents scale formation and reduces leakage. By these methods we obtain about five years good service before the renewal of freight engine fireboxes, and the body of the tubes and superheater flues can be successfully safe-ended six times. The boiler shell using Sheet 1 water grooves out immediately under the root of the front tube sheet as far as the tubes extend. The root of the front tube sheet flange is affected similarly for the same distance. Considerable corrosion and pitting takes place in this sheet above and among the nest of tube holes, but as its life and that of the sheet of the boiler under it is about twelve years we do not consider this serious. The greatest harm resulting from the use of Sheet 1 water is its scale forming properties, and the reason it is referred to under this topic is so as we may profit from the comparison of this hard water with other waters in use such as shown on Sheet 2, which are pronounced good.

Sheet 2 water, which analyzes as good, pits, corrodes and causes grooving in certain design of boilers far in excess of what occurs using Sheet 1 water which is referred to as hard. The G-2, G-4, and D-10 engines using Sheet 1 water do not differ as regards the extent of the corrosion, pitting and grooving to be recordable.

Points of Pitting and Grooving

The S-2 locomotive using Sheet 2 water is an excessive tube and flue pitter. The pitting extends from the front tube sheet about 8 feet back and is more noticeable at the top of the flues than at the bottom. Tubes and flues in this class of power necessitate the engines being shopped in advance of machinery repairs on account of pitting and grooving causing the tubes and flues to fail immediately inside the front tube sheet. The mileage of failure fluctuates between 50,000 and 75,000 miles. Slight pitting and grooving occurs in the front tube sheet above the tubes, and on the crown sheet surrounding the radial bolts as well as between the rivets joining it and the tube sheet. At each renewal of tubes and flues about 65 percent of them have to be scrapped. During five years life no firebox or boiler plate renewals have been necessitated. The G-4 boiler becomes similarly affected except that it runs its machinery dates before shopping.

The D-9 boilers using Sheet 2 water are not effected by corrosion, pitting and grooving to any extent. Tubes and flues give sufficient life to allow the application of as many safe-ends as we desire, and although the boiler shells and outside firebox are over twenty years old no renewals have been necessitated. Front tube sheets groove around the heel of the flange and are renewed about every ten years. We still are experimenting to determine why the modern boilers on the G-4 and S-2 engines corrode, pit and groove so seriously, whereas the D-9 boilers scarcely suffer although they all operate under similar conditions, using the same water supplies with identical methods of feeding the water.

The experience with tubes in a V-1 engine using water shown on Sheet 3 is that they had to be scrapped at every general repair. The analysis of the raw water supply in use did not altogether expose why we experienced such serious results. To determine what did, we extracted sufficient water from the top try cock of the boiler just prior to the weekly washout and had it analyzed with a view of finding out if the concentration caused by the evaporation of a week's use of this supply was sufficient to expose in the analysis what was happening, and if it did, what the cost would be to neutralize it.

Comparing the two analyses shown on Sheet 3 will make it clear why a prominent chemist wrote about them as follows:—

"I am afraid I did not make it quite clear to you just exactly what happened in the case of the water removed from a switch engine boiler following a week's service when I said that some of this sodium chloride may exist as magnesium chloride, although the analysis only shows the presence of sodium chloride. But in this water even when cold and contained in an iron vessel such as a boiler, a change over of the irons takes place. The magnesium sulphate giving up its SO_4 and forming sodium sulphate, while the chlorine from the sodium chloride unites with the magnesium. When this is heated a further disassociation takes place, the magnesium chloride parts with some of its chlorine to form free hydrochloric acid which attacks the iron of the boiler causing corroding and pitting, and as this hydrochloric acid after attacking the iron is split up into hydrogen and chlorine the chlorine again unites with the magnesium and thus is ready for further disassociation into magnesium and hydrochloric acid, and thus a vicious cycle is set up on the boiler and the addition of any fresh water from this source only extends to concentrate the hydrochloric acid in the boiler. It is possible to partially neutralize the action of the water but I am afraid not completely, and the reagent to use would prove rather expensive. Barium hydroxide will precipitate all the sulphates and the addition of a little soda ash would precipitate most of the magnesium and calcium. Cost of treatment using these two reagents thirty to thirty five cents per thousand gallons alone."

SHEET No. 1
PARTS PER 100,000 WATER ANALYSIS = BRANDON TO BROADVIEW INCLUSIVE C.P.RY.

Supply: Location	Supply: Source	Calcium: Carbonate	Calcium: Sulphate	Magnesium: Carbonate	Magnesium: Sulphate	Sodium: Sulphate	Sodium: Chloride	Remarks
BRANDON	ASSINIBOINE RIVER	15.7	25.8	19.6		11.5	3.0	SAMPLES TAKEN FEB. 1923
KEMNAY	" "	17.1	23.1	20.3		20.2	3.3	
OAK LAKE	" "	15.8	26.2	20.3		9.1	2.6	
VIRDEN	" "	15.0	25.8	21.0		10.8	2.6	
ELKHORN	SHALLOW WELLS	17.0	7.1	7.0		0.9	2.6	
FLEMING	SLOUGHS	15.3	12.6	16.8		2.8	3.0	
MOOSOMIN	RESERVOIR	7.6	28.2	29.4		2.5	5.6	
WAPELLA	SHALLOW WELLS	21.5	37.4	5.3			1.0	
BROADVIEW	" "	24.5	13.9	16.8		17.7	2.6	

TO CONVERT THE ABOVE TO GRAMS PER U.S. GAL. MULTIPLY BY .5835

SHEET No. 2
PARTS PER 100,000 WATER ANALYSIS = CALGARY TO FIELD INCLUSIVE C.P.RY.

Supply: Location	Supply: Source	Calcium: Carbonate	Calcium: Sulphate	Magnesium: Carbonate	Magnesium: Sulphate	Sodium: Carbonate	Sodium: Sulphate	Sodium: Chloride	Remarks
CALGARY	SHALLOW WELL	14.7		7.0		1.3	6.6	2.3	
COCHRANE	BOW RIVER	6.1	10.0	6.0				0.6	
MORLEY	BOW RIVER	5.8	10.2	6.3				0.6	
CANMORE	SHALLOW WELL	6.6	6.4	3.8				0.3	
BANFF	40 MILE CREEK	6.1	13.0	6.0				0.3	
CASTLE MTN.	STREAM AND RESERVOIR	5.3	3.0	3.9				0.3	
LAKE LOUISE	PIPE STONE CR.	5.0		3.5		4.6		0.3	
HECTOR	MOUNTAIN STRM.	5.3	3.0	2.8				0.3	
YOHO	TUNNEL SEEPAGE	5.6	9.5	7.0				1.0	
FIELD	K.H. RIVER	8.0		3.5			2.4	0.7	

TO CONVERT THE ABOVE TO GRAMS PER U.S. GAL. MULTIPLY BY .5835

SHEET No. 3
PARTS PER 100,000 WATER ANALYSIS = DUNMORE ON MAPLE CREEK SUB. DIV. C.P.RY.

Supply: Location	Supply: Source	Calcium: Carbonate	Calcium: Sulphate	Magnesium: Carbonate	Magnesium: Sulphate	Sodium: Carbonate	Sodium: Sulphate	Sodium: Chloride	Mineral Matter on Solution	Total Solids by Evaporation	Remarks
DUNMORE	SHALLOW WELL	21.2		4.9		3.7	65.1	2.9	97.8	93.3	
IN BOILER OF YD. ENG. AFTER ONE WEEKS SERVICE			89.8	8.6	37.5		117.9	10.2	264.0	250.0	SAMPLE TAKEN FROM TRY COCK

TO CONVERT THE ABOVE TO GRAMS PER U.S. GAL. MULTIPLY BY .5835

SHEET No. 4
PARTICULARS OF G2, G4 PASS. ENGS. AND D10 FRT. ENGS. C.P.R. WITH ORDINARY AND COMBUSTION CHAMBER FIREBOXES IN USE WITH SHEET 1 WATER

Engine: Class	Engine: Press	Firebox Inside: Width	Firebox Inside: Length	Tubes: No.	Tubes: Length	Tubes: Diam.	Fire Heating Surface Sq. Ft.	Heating Surface Sq. Ft.: Super	Heating Surface Sq. Ft.: Firebox	Heating Surface Sq. Ft.: Tube	Heating Surface Sq. Ft.: Total	Remarks
G2	200	5' 9 5/8"	7' 10 1/8"	189, 22	19' 4 5/8"	2 1/4", 5 3/8"	2945	539	175	2770	3484	ORDINARY FIREBOX
G4	200	7' 0 5/8"	9' 3 5/8"	205, 38	18' 4 5/8"	2 1/4", 5 1/2"	3529.6	803	297.6	3232	4332.6	COMB. CHAMBER FIREBOX
D10	200	5' 9 5/8"	8' 6 7/8"	237, 24	14' 2 5/8"	2", 5"	2418	408	180	2238	2826	ORDINARY FIREBOX

SHEET No. 5
PARTICULARS OF D9, G4 PASS. ENGS. AND S2 FRT. ENGS. C.P.R. WITH ORDINARY AND COMBUSTION CHAMBER FIREBOXES IN USE WITH SHEET 2 WATER

Engine: Class	Engine: Press	Firebox Inside: Width	Firebox Inside: Length	Tubes: No.	Tubes: Length	Tubes: Diam.	Fire Heating Surface Sq. Ft.	Heating Surface Sq. Ft.: Super	Heating Surface Sq. Ft.: Firebox	Heating Surface Sq. Ft.: Tube	Heating Surface Sq. Ft.: Total	Remarks
D9	190	5' 10 1/8"	8' 6 1/8"	240, 24	14' 4 5/8"	2", 5"	2442	408	180	2262	2850	ORDINARY FIREBOX
G4	200	7' 0 5/8"	9' 3 5/8"	205, 38	18' 4 5/8"	2 1/4", 5 1/2"	3529.6	803	297.6	3232	4332.6	COMB. CHAMBER FIREBOX
S2	200	7' 4 5/8"	10' 0 5/8"	219, 43	20' 4 5/8"	2 1/4", 5 1/2"	4256	1015	360	3896	5271	COMB. CHAMBER FIREBOX

SHEET No. 6
PARTICULARS OF YARD ENGINE WITH ORDINARY FIREBOX IN USE WITH SHEET 3 WATER

Engine: Class	Engine: Press	Firebox Inside: Width	Firebox Inside: Length	Tubes: No.	Tubes: Length	Tubes: Diam.	Fire Heating Surface Sq. Ft.	Heating Surface Sq. Ft.: Super	Heating Surface Sq. Ft.: Firebox	Heating Surface Sq. Ft.: Tube	Heating Surface Sq. Ft.: Total	Remarks
V1	180	3' 6 3/8"	9' 1 7/8"	236	12' 8 11/16"	2"			145	1574	1719	ORDINARY FIREBOX

Series of charts showing water conditions on Canadian Pacific lines

The accuracy of the chemist's writings was fully discussed at the time with the result that we adopted a systematic blowing out of the concentrates accompanied with more frequent washing out. This brought about normal conditions. The cost of treatment suggested was prohibitive, and particularly so when the action was not predicted to be completely neutralized even at the expense quoted.

Effect of Raw Water Supply

Digesting this prominent chemist's remarks still further it appears to me that we too often speak of the origin of the trouble as being the raw water supplies, whereas we require to consider the change occurring to the different supplies when they become mixed under evaporating conditions such as exist in a locomotive boiler. If these be our conclusions we should put into practice the determining and regulating of the frequency of washouts and systematic blowing out of the boilers from the analysis of the water in the boiler at the end of the runs. We know the boiler is a "chemical laboratory" and yet we leave it to the boilermaker to regulate the period between washouts. It should be a chemist's job to know when the water in the boiler requires changing and a boilermaker's job to know when the boiler is dirty enough to require washing out. The boiler maker knows the boiler is due for a washout before the mud and scale approaches the tube closest to the shell of the boiler because when allowed to gather higher between washouts a blockade occurs which holds over it all future precipitants resulting in early tube renewal. The firebox may have only a couple of hundred square feet of heating surface and the tubes and flues a couple of thousand square feet. This comparison is given to show how wrong it is to say boilers do not require washing out when they have only 3-inch deposits of scale and mud over the ring because that might mean 10 or 12 inches in the shell of the boiler where the space is limited to 3 or 4 inches between the flues and the shell. Analysis of the water in the boiler after each trip is the only true and accurate way of determining the harm that can result from an insufficiency of blowing out or washing out.

I venture to suggest that when a chemist sets the periods between washouts many will find it necessary to perform twice the washing out they now do. This will be profitable in the ratio of spending one dollar to save five because it will reduce pitting, economize on fuel and provide better operating conditions.

The advent of the modern boiler as well as the increased complaint about abnormal grooving, pitting and corrosion are growing up together. The former a good healthy progressive development and the latter the most vicious and detrimental agent which can attack its successful progress.

Size of Boiler Not a Factor

In my opinion it is wrong to say that the modern boiler inherits this corrosion, pitting and grooving disease because of its size. We have not given its care enough thought and when we do the mystery which veiled our vision and led us to believe that it is everything under the sun except what we are quite capable of remedying will be lifted and the modern boiler will then be found to function normally.

The advocates of extended periods between washouts with the use of treated waters either internally or externally of the boiler are the worst enemies the modern locomotive boiler has today. Their intentions may be good, but they have not yet attained that promised state of efficiency which was prophesied with their undertakings, and while I admit the boilers operate more successfully, are more free from scale-building and leakage, this has been accomplished with greater destruction to boilers, flues and tubes by the fact that corrosion, pitting and grooving has increased.

Feeding at the Top of the Boiler

Changing the position of feeding the boiler from the side to the top reduced the pitting in the shell of the boiler and increased tube and flue pitting. Our experience is that we should endeavor to favor the shell of the boiler with immunity from this action because of an allowance of four years between internal inspections. A pitted flue will expose itself without inconvenience and seldom results in a service failure.

The cleaner the flues are kept under the entrance of the feedwater frequently determines the extent of the pitting to the flues. It is considered good practice to collect the precipitants on a pan suspended above the flues.

The grooving attacking the flues in combustion chamber boilers immediately inside the front tube sheet affects them alike in all waters, with the exception that the failure occurs about three times as early where the water contains hardness and reagents are used. Our conclusion about this grooving of flues inside the front tube sheets is that it will cease altogether when the combustion chamber is prevented from moving towards the firebox due to expansion. This is best accomplished by applying stays to the shell of the boiler and chamber. To be of any value they must be in tension which necessitates connecting them to the shell of the boiler ahead of the chamber. Their application will decrease the breakage of staybolts in the chambers.

Some years ago the Canadian Pacific railway built a Mallet engine boiler with an intermediate chamber spaced between two sections of flues. From inquiries we received when it was in operation it would appear that other railroads were experiencing very severe pitting of flues in the front section of the boiler whereas the Canadian Pacific railway had freedom. The only known difference in their construction was that the Canadian Pacific railway used external circulating pipes for the purpose of connecting the front portion of the boiler with the rear portion which other railways connected differently. It seems proper for me to suggest that the pitting occurring with the modern boiler will be arrested and cured with the application of external circulating pipes. The modern boilers are in need of external by-pass circulating pipes with their long boilers because of the much greater efficiency now developed from the firebox which produces a very violent tide or flow of water and impurities against the front tube sheet where it becomes concentrated, sluggish and out of circulation.

The only reason I know why pitting has increased with the use of treated water is because it has been accompanied with extended periods between washouts. It is very true that we all desire clean boilers and extended periods between washouts because that is the achievement we aim for with treated water. Let me remind you that the constant analysis of the water after treatment by chemists is to teach us that insofar as the treated supplies are concerned the boiler will not be harmed due to extended periods between washouts. My contention is that the chemists should arrive at such conclusions only following the analysis of water removed from the water at the end of the runs. This procedure will expose the concentration as well as permit all of us to decide which is the more profitable—frequency of washouts, or the purchase of inhibitives. The executives of the railroads must decide this for themselves.

Hot Water Washout Systems

During my long experience over the western lines of the Canadian Pacific railway I have always been a strong advocate of building up a chain of hot water washing out systems for the very purpose of performing frequency of washouts, to meet the ever increasing necessities of modern power, to develop efficiency and avoid concentration of water and foaming. The good results we have obtained where they are located is one of the strongest recommendations in their favor, because frequency of washouts has been decided to be the determining factor as to the extent of pitting discovered. Let us then keep down the concentration of salts which are the creation of pitting by the most profitable means we can employ.

Summed up, my experience recommends the following as productive of good results to arrest corrosion, pitting and grooving:

A. Raw water which analyzes as a pitter should not be used under any circumstances to feed steam boilers.

B. The chemists should advise the regulation period between washout from the analysis of the water taken from boilers at the end of the run.

C. The boiler maker should decide when the boiler is dirty enough to require washing out.

D. When feedwater enters the boiler at the top use a pan to collect the impurities.

E. Apply "tension stays" to combustion chamber boilers as described to prevent grooving inside of front tube sheets.

F. Apply external by-pass circulating pipes to modern boilers which are afflicted with pitting.

G. Adopt systematic blowing out to relieve the concentration of salts.

Boiler Corrosion, Pitting and Grooving —Methods of Prevention*

By B. C. King†

In recent years the pitting tendencies in boilers used on western railroads has increased tremendously. The alarming feature about the situation is that the pitting appears to be increasing more than proportionately in waters which have been treated in wayside treating plants. This means that after the expenditures of considerable sums of money in the installation of wayside treating plants, some railroads are apparently suffering new evils more serious than those which the plants were installed to eliminate.

Some of the common corrosive impurities in the water are fairly easy to offset with proper treatment, other corrosive impurities cannot be treated out of the water, and are sometimes actually treated into the water.

Sodium sulphate, commonly called or known as Glaubers salts, seems to have distinct acid qualities or properties when concentrated in boiler water. This impurity is present in solution in all waters treated with soda ash, as a result of the soda ash reaction upon the scale forming lime. Other corrosive impurities are as follows:

Magnesium Chlorides
Magnesium Sulphate
Calcium Chloride
Calcium Nitrates
Sodium Chlorides (common salt)

Where pitting is due to impurities of acid nature, the action merely consists of the dissolving of the metals of which the boilers are constructed and the cure simply consists of making the water alkaline by suitable reagents.

It is now felt, however, that the really serious pitting mentioned in the first paragraph of this paper is the results of electrolytic action with the different parts of the boilers considered as the electrodes, and the water in the boiler, under certain conditions on concentrated impurities, forming the electrolyte.

This class of pitting seems to have increased with the trend toward higher pressures, which means higher temperatures, and unless a cure can be found, it may serve to limit boiler pressures at a point no higher than the present, although it is known that new locomotives for railroads in the east have recently been developed to carry much higher boiler pressures.

That it is possible to prevent this electrolytic action of pitting by means of a chemical inhibitive has been demonstrated with considerable success on the Northern Pacific Railway.

The process consists of keeping the water continuously charged with an inhibitive, this is effected by charging the chemical inhibitive both directly into the boiler, after each washout, and between washouts, into the engine tanks. The chemical treatment is made up in solid form, in order that the tank charges will not entirely dissolve in the first tank of water, thus it is possible to place the material in the form of bricks in the tanks at the engine terminals, and to trust to the low rate at which they go into solution to take care of the several tanks of water which must be taken in a trip over the division.

Thus the water which is used to fill the boiler in the terminals, as well as the tanks of water which are taken on the line, is kept charged at all times with the chemical inhibitive which is mentioned.

While it cannot be stated that corrosive action represented in pitting and grooving has been completely stopped, it is safe to say that it has been greatly reduced this past year. It is, interesting to note, that this same chemical compound treatment serves to replace all other treatment in keeping down what would otherwise be a heavy scale formation. While the exact composition of the chemicals forming the compound cannot be given here, it is known that dependency is placed by the manufacturers, on the value of chromates as inhibitives.

Potassium chromate was at one time used in test work by the Northern Pacific Railway with some degree of success but it is understood that the cost of material, when used alone, was too high to permit of the continuation of the practice.

On the Northern Pacific, up to the middle of the year 1925, it was not possible to recover and safe-end for restoring to the boiler any of the flues removed in the case of engines operating on the Yellowstone Division, even though they were usually removed after only a very short life.

The new treatment was put into effect in January, 1925, and by the middle of the year it had become evident that boiler practices on the Yellowstone Division could be changed to conform with that of better water districts or divisions. In other words, it was found that flues could be safe ended and returned to service and that service mileage had been considerably increased. Engine failures on the line due to the opening up of pit holes in flues have completely disappeared; they had been very troublesome previously.

What has been said of the flues is also true of the firebox sheets and boilers sheets, the reduction in corrosive action being proportionate and the increased life of these sheets being proportionally greater.

This matter is being watched every closely on the Northern Pacific, and it is expected that the results will be so that more accurate information of the results of the above inhibitives will be forthcoming in a short time.

*Independent report on Boiler Pitting and grooving at Master Boiler Makers' Association annual convention.
† Assistant General Boiler Inspector, Northern Pacific Railroad.

Safety in Locomotive Operation*

By A. G. Pack†

One of the most essential things in successfully carrying out of any work is "enthusiasm." I do not know of any better place where we can restore our enthusiasm than at such conventions as this.

The great system of railroads with which we are blessed has made us almost next door neighbors. Our modern methods of communication have almost brought us in personal contact. The railroads are the great arteries of transportation, therefore, the life blood of the nation. The steam locomotive is the heart of transportation and the boiler is the heart of the locomotive. Steam and the railroads have revolutionized industry and have advanced civilization faster possibly than anything else. Your task is to see to it that the most vital part of the most vital instrument of transportation is properly and safely constructed, properly inspected

*Abstract of address before the 17th annual convention of the Master Boilermakers' Association held in Buffalo, May, 1926.
†Chief Inspector Bureau of Locomotive Inspection, Interstate Commerce Commission.

and properly and safely repaired, so that the machine as a whole—the railroads—may function in a most economical, efficient, safe and satisfactory manner. No one of you should ever forget or fail to realize the responsibility resting upon you individually and collectively.

Naturally I presume that you expect me to talk on the safety of locomotive operation. This is a matter often discussed and constantly in my mind. It is my first and greatest duty. It is also your duty. We may increase our enthusiasm, we may bring about cheaper construction and lower maintenance cost, but if we can do something that will save the life or limb of one man, we have accomplished something that cannot be evaluated. Much has been accomplished toward making the locomotive more efficient and safe, but much remains yet to be done. When some great disaster occurs we are stirred into action, but should our efforts be less because the prevailing condition appears fairly satisfactory. We must constantly strive for bigger and better accomplishments.

Every day in our daily routine we observe some condition that if not remedied will sooner or later result in accident and personal injury. If all the deaths and injuries caused by locomotive boiler failures during any single year were the result of a single accident, or occurred in a single day, it would be termed calamitous and carried on the front pages of newspapers all over the country, but when they occur one by one they are too often given little thought and consideration, too often considered the result of a natural cause. The untimely loss of life or limb to a single person is just as serious to him and his family as though there were thousands of others killed or injured in the same accident.

Position Taken by Bureau

My position has given me a broad perspective—my view is that of the country as a whole. I find that accidents of a particular nature occur at some places which seldom, if ever, occur at others. They are too scattered to come under the observation of all of you. The necessity for being ever alert in remedying improper and unsafe conditions even though you as individuals have not had the lesson brought home to you is ever present. Beware, the next experience may be yours.

These meetings should do much good by making known to one another the source of failures, with their causes and remedies. The protection of human life and limb should always be foremost in your mind. It is too well known that locomotive and train operation are hazardous under the most favorable circumstances. Practically all accidents result from causes which could be avoided by means which are well known to those well informed and to prevent them is usually a matter of doing that which should be done at the right time and place. To prevent accidents, requires constant vigilance. Vigilance is the price of safety. We cannot therefore too strongly urge or bring to your attention the sources of accidents and the necessity for their prevention, because to falter for a moment may result in the loss of life or limb and great property damage. Some of the minor things neglected too often result in serious disaster.

The sources of accidents are varied, some of them are, however, of special interest because they are the most prolific source of serious and fatal injuries due to boiler and appurtenance failures.

Number of Locomotive Accidents

Since the Locomotive Boiler Inspection Law became effective there has been 827 boiler explosions, resulting in the death of 508 persons and the serious injury of 1,135 others.

During the fiscal year ended June 30, 1923, there were 57 boiler explosions, resulting in the death of 41 persons and the serious injury of 88 others.

During the fiscal year ended June 30, 1924, there were 43 such explosions, resulting in the death of 45 persons and the serious injury of 59 others.

During the fiscal year ended June 30, 1925, there were 28 such explosions, resulting in the death of 12 persons and the serious injury of 49 others.

This shows a reduction of 50.8 percent in the number of accidents, 70.7 percent in the number killed and 44.3 percent in the number injured over the year 1923.

During the first 10 months of the current fiscal year there have occurred 32 explosions, resulting in the death of 14 persons and the serious injury of 52 others.

I may say at this time that in my opinion motive power has been in better condition to render efficient and safe service during the past 18 months than I have ever before seen it, but there are many discrepancies yet.

It is true that most of these explosions were caused by overheated crown sheets due to low water. In many of the cases, however, strong contributory causes were found. Proper inspections and repairs of all parts and appurtenances of a locomotive are essential to safe operation. The whole machine should be maintained in a highly efficient condition, if its earning power is to be fully utilized and accidents are to be avoided.

Many accidents occur due to flue failures, which may be divided into two classes, those due to poor safe end welds and those due to deterioration caused by corrosion. During the past several years a number of accidents have been caused by superheater flues being corroded and thin and otherwise in defective condition.

In 1913 the then chief inspector in order to avoid numerous safe end welds on superheater flues, every one of which multiplies the opportunity for failure with additional peril, said that the removal of superheater flues would not be required at the time that the small tubes are removed, provided they are in good condition and the boiler could be thoroughly cleaned and inspected without their removal, unless further investigation should prove that it was necessary to do so.

From our records it is apparent that many carriers have taken advantage of this and allowed superheater flues to remain in service in a condition not warranted when the small tubes were removed. Therefore, unless flues are given better attention we may be compelled to require the removal of all flues at more frequent intervals.

Arch Tube Failures

Another source of serious accidents which can be easily prevented is the failure of arch tubes. These failures may also be divided into two classes, those not having been properly applied and those caused by overheating due to an accumulation of mud and scale. If arch tubes are extended through the sheet and are properly flared or beaded over at the end, they will not pull out. Most of you have rigid instructions that this shall be done, but such instructions are of no value unless they are followed up to see that they are carried out.

It is a most frequent occurrence for our inspectors to find arch tubes which have been cut too short and which extend only a part way through the sheet or just flush with the water side of the sheet, with not sufficient stock protruding to either flare or bead, merely being held in place by the stiffness of the tubes and the friction in the hole in which they are applied.

Arch tubes will not burst under the present methods of manufacture if they are kept clean on the water side and any reasonable surface inspection made of arch tubes will show an undue accumulation of scale on their interior by their reddish and rough appearance on the outside. Arch tubes should be thoroughly cleaned and inspected each time the boiler is washed. An arch tube should not be permitted to remain in service with any bulging or undue indication of overheating. The next trip might prove to be the fatal one.

Since the law became effective 124 accidents resulting in the death of 7 persons and the serious injury of 180 others have occurred due to arch tube failures.

The standardizing and maintenance of grate shaking apparatus have not been given due attention. Since the law became effective 723 accidents resulting in the death of 1 person and the serious injury of 724 others have been caused by the failure of grate shaking apparatus. Practically all, if not all, of these accidents could have been prevented by means well known.

Washout and arch tube plugs have caused many serious and fatal accidents by blowing out. We have records of 239 accidents resulting in the death of 21 persons and the serious injury of 304 others. In most cases the threads on the plug and in the sheet were found in poor condition and shoulders of hardened graphite had been allowed to accumulate on the plugs. Too frequently an attempt was made to tighten the plugs while under pressure.

Slides

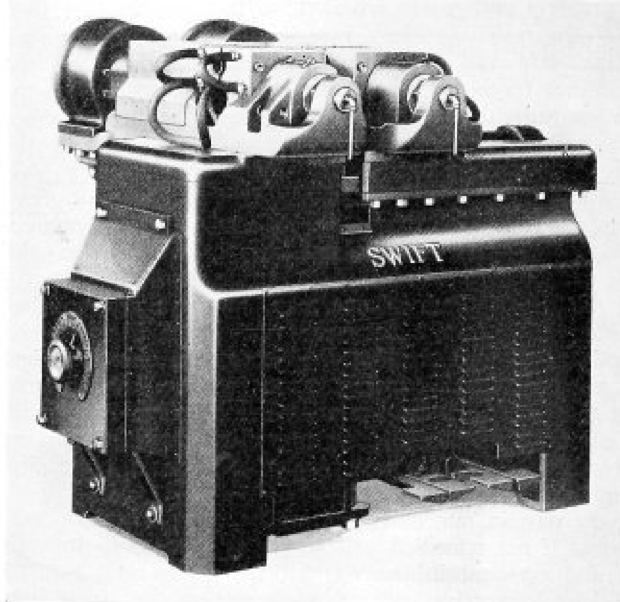
As has previously been said these are but a few of the conditions which cause serious and fatal injuries. The big question is what are we going to do to prevent the loss of life and limb and the enormous property damage. It is a duty placed by law upon every carrier to properly construct, inspect, and maintain every part and appurtenance of the locomotive. This is also a moral obligation. You, as representatives of these carriers, filling responsible positions, have a legal and moral obligation to do your duty to the best of your ability and to see to it that those under your supervision perform their duties in a proper way. You have been selected for your present positions from among your associates because of your superior knowledge and ability to supervise and direct those under you. Because of your superior ability and the influence which you may exert it becomes your duty to direct and inform those under and around about you, who may be less informed and have less ability to distinguish right from wrong, to guard and caution them against evil consequences and to throw every safeguard possible around them in the protection of life and limb and of property. The fulfillment of these duties on your part will do much to eliminate accidents with their woeful consequences.

As I have said before and on many occasions this is an old, old story, but it can not be too often repeated—it should be kept constantly before you. As we progress, we must enter new fields—fields not yet fully explored—but in entering such fields, we must enter with caution, good judgment and discretion, otherwise, we may tear down that which has been built up. Let us profit as we go through life by the experiences of others. Let your experiences and mine be given so that others may profit.

New Electric Flue Welder Improves Flue Shop Equipment

Joseph T. Ryerson and Son, Inc., Chicago, Ill., has taken over exclusive selling rights for a new electric flue welder recently developed by the Swift Electric Welder Company. This machine was designed for safe-ending flues and also the welding operations in reclaiming small pieces. With proper dies it can be used for any kind of butt welding. When not engaged on its regular work, it may be used for welding round or bar stock, or used for annealing, upsetting, heating, and stretching, etc.

This welder is flash proof, thus insuring long life to the winding and bearings. All moving surfaces slide on hardened and ground steel plates, thus assuring perfect alinement.



Swift type flue welder sold by Jos. T. Ryerson

The clamps are of improved flash and slag proof adjustable type, sliding on hardened steel guide plates to minimize wear. Foot operated air cylinders, leave the operator's hands free to handle the work. Three-fourths of a cubic foot of air at approximately 80 pounds pressure is required for a weld.

Two pair of dies are used for each set. One set of dies handles work on both two-inch and three-inch tubes. On the larger work a separate set of dies is required for each size of flues. All the dies are water cooled and have hardened steel guide plates to minimize wear.

The machine is equipped with a pressure cylinder for pushing up the work. This cylinder may be connected to either a hydraulic accumulator, oil gear pump or a hand operated oil-jack. Eight hundred pounds pressure per square inch is required for 6-inch tubes, and for smaller work proportionately less. The volume required is 0.6 gallon per welding cycle.

The welder is operated by a remote control system, consisting of a contactor panel separately mounted and operated from a lighting circuit by a push button switch on the welder. By this method the power is entirely removed from the welder except at the instant of making the weld. This economizes on power and eliminates all danger to the operator.

The welder can be supplied for either 220, 440 or 550 volt primary circuit and preferably 60 cycles. The primary circuit is air-cooled; secondary circuit, dies and die blocks are water cooled. The standard rating is 150 K.V.S. at 85 percent power factor.

The welder has a capacity for boiler flues and superheater tubes in any size up to 6 inch diameter.

Death of T. P. Kimman

Theodore P. Kimman, works manager of the Cleveland plant of the Chicago Pneumatic Tool Company, Chicago, Ill., died at his home July 24, 1926, from heart disease.

He was the inventor of the first four-piston air drill and was considered an authority on mechanics. He was associated with Edward N. Hurley, chairman of the shipping board, in the development of air drills.

Mr. Kimman was superintendent of the Cleveland plant from 1903 to 1921 when he succeeded his brother, H. J. Kimman, as works manager.

National Board Meeting Proceedings at Chicago*

Subject of uniform examinations continued and discussion on boiler appurtenances—Matters pertaining to the A. S. M. E. Boiler Code

J. D. NEWCOMB (Little Rock, Arkansas): Let me offer a suggestion. Why not formulate a uniform set of questions and send them to the different states to be used for the examination and have written examinations. Then the written examination should be sent to somebody or some committee appointed to pass on these examinations and the certificates issued on the examinations; let the secretary or the central body pass on the questions and determine whether the man is qualified or not for the certificate. It seems to me in that way there will be no fraud or guesswork as to whether the man passed or not.

CHAIRMAN SCOTT: That is a good suggestion. What we want to do is to get some uniform method of overcoming the arguments that Mr. Eales brought up. It is a hard thing to please every board because each board thinks they are as perfect as any board ought to be, but to simplify the examination, we would like to do something like that. We want suggestions to put forth before this body through the secretary at a later date, and I propose to appoint a committee to work out some plan along those lines. We haven't held any examinations in New Jersey yet for the simple reason we have never found it necessary. We have never been asked to by the insurance companies because there are so many licensed inspectors whom we can recognize.

When we do hold examinations, we would like to have them held under National Board regulations, a written examination, and these papers approved by somebody, if you want it that way, or the board in the State of New Jersey which has that power. Personally, I believe there are too many boiler inspectors' examinations held in the various states. That is not for me to say. It is only my opinion. There is such a thing as holding too many examinations where you can hold one or two good ones a year that will answer the purpose.

CHAIRMAN SCOTT: We will now hear some remarks from M. A. Edgar, Chief Boiler Inspector, State of Wisconsin on "What is an explosion?" and "What is a Major Boiler Accident?"

M. A. EDGAR: I cannot recall ever having seen a comparison between boiler explosion statistics for this country and other countries, but I have been under the impression that we enjoyed a record in boiler explosions that we should not be proud of, and I must confess that I got that impression to a great extent from conversing with engineers who have received their training abroad. I meet many of these engineers when they present themselves for examination as to their fitness for making boiler inspections in Wisconsin, and I learn that many of them have served their time in shops in foreign countries and also possess marine engineer's licenses. They invariably praise conditions in their home country and dwell particularly on the excellent boiler rules in force, high quality of materials and workmanship, prompt and expert inspection service and then substantiate their statements by mentioning the very few real boiler explosions that take place in those countries.

This may all be true. I hope it is and am willing to believe it. I also believe we, in this country, have perhaps as good a set of boiler rules that are designed for reasonable safety as you will find any place, in the A. S. M. E. Boiler Code. The sooner we get behind that code and make it universal I am positive just so much sooner will we have a maximum of safety in boiler operation. I know from personal knowledge that our boiler manufacturers are conscious of their duty to the public and can be depended upon to put forth their best efforts in the matter of workmanship. As evidence of the fact that the manufacturers are doing the best they can, I call to your attention the fact that they have always been strongly in back of the Boiler Code Committee of the A. S. M. E. and this National Board also, in trying to obtain safe boiler practice both in design and construction.

I am not quite so sure that if I was called upon in a case right now to define a boiler explosion or a major boiler accident that I would be able to do so. Of course, I have in a general way a knowledge of what these things are, but to get right down to "brass tacks" and define either one so that the majority of you men would agree with me, I would be right up against it.

In order to start something along that line and finally come to some definition that will adequately explain these occurences and enable us to tabulate them so that in the future we will be able to make comparisons between explosions in this country and abroad, I have decided that the definitions arranged in the following manner would probably be suitable.

First, I would define all minor accidents such as local ruptures and cracks as "boiler failures."

Second, any accidents of sufficient force to cause the boiler to leave its setting should be known as a "boiler explosion."

Third, any boiler accident that causes loss of life or total, permanent disability should be known as a "major boiler accident."

I don't have any idea that these definitions will be accepted as they have been stated, and I merely advance them as a starting point or perhaps as a basis for future thought or discussion with the hope that something definite will grow out of them.

W. P. EALES (Travelers Indemnity Company): You talk about explosions in the experience of this country and abroad. I happen to be on the mailing list of some European journals. They have a pretty tidy few during a year on the other side. I will tell you why many serious boiler explosions occur on this side that do not occur on the other side as far as I can determine. We say, "There is the boiler. There is the structure of the boiler." Abroad, though, from reading their reports, they go into far more detail on the appliance attachments and details than we do here.

For example, there were five boiler explosions in Pennsylvania since the 29th of September. Each of those occurred from tube failures. The furnace doors were not properly latched shut as they should have been, which resulted in scalding some men. That accounts for five fatalities since September.

The paragraph in the A. S. M. E. code requires fire doors, access and inspection doors to be effectively latched or fastened. There doesn't seem to be any authority on devices for closing or latching the doors. We have some device for use on fire doors that will be opened every five

* The first installment of the report of this meeting appeared on page 195 of the July issue of THE BOILER MAKER.

minutes. Of course, it is not an effective device for a fire door, nor is it practical for an access door on a stoker fired boiler. The A. S. M. E. Code Committee doesn't appear to go into that, and I think it should. Another thing about explosions is the explosion of furnace gas. They are getting to be numerous and serious. They had one down in Virginia which resulted in considerable property loss. It was not the structure of the boiler. There are some things that cause explosions that this Board should cover.

M. A. Edgar: I was just wondering if it wouldn't be a good plan for this National Board to get in touch with the engineering societies abroad and determine just what they call a steam boiler explosion, and I think we ought to have definitions on what a steam boiler explosion is. I also think statistics ought to be kept in such a manner as to show the size of the boiler.

Chairman Scott: Here are some questions possibly some of the members would like to answer.

"What code or rules should be applied in the construction of a blow-off tank?"

C. W. Obert (Boiler Cover Committee): We have had so many questions come up on the explosion proposition that I have been asked by the Boiler Committee to make an investigation in the United States and Canada. I have here a great mass of replies. I will say about half the replies indicate they have something on blow-out tanks. The remainder have nothing. If this thing is of any interest to the National Board, I would be very glad to see that your secretary has a copy of our tabulated results as soon as we get the report completed.

Chairman Scott: I think that would be mighty fine because we are all interested in that subject more or less. I think all over the country we are asked about blow-out tanks and there is no rule regulating.

Chairman Scott: Here is another question. "Should any time limit be set on National Board Commissions where inspectors holding such commission no longer act in the capacity of inspector and do not make inspections for a period of one year or longer?"

C. O. Myers: We have provided for that in the preparation of the National Board Commission so that the holder of a commission could hold it indefinitely but it would only be effective while he was employed regularly by any political subdivision of the United States or by any boiler insurance company authorized to insure boilers by any such political subdivisions. That is stated right on the commission, which automatically takes care of that question.

Tuesday Morning Session

The meeting was called to order at nine forty-five A. M., Mr. Scott presiding.

Chairman Scott: We have some very interesting discussions this morning by men who are very thoroughly conversant with the subject they have to deal with, and it will be education as well as enlightenment on matters that possibly we don't know as much about as we should.

First we will hear from T. McLean Jasper, Director of Research, A. O. Smith Corporation, Milwaukee, on "Fatigue of Metals."

T. McLean Jasper: Members of the National Board of Boiler and Pressure Vessel Inspectors and Visitors: It is with a great deal of trepidation that I get up before you men this morning to give you a talk on the "Fatigue of Metals."

I know that you are dealing with the practical side of the use of metals in boilers and pressure vessels and I want to come to you as a man who has been dealing with the practical side of the use of metals in many and various ways.

The subject, "The Fatigue of Metals," as I see it, does not enter as acutely in your work as it does in many other industries, and for that reason I will try to deal with it in a manner which will give a practical application of the results of the tests that have been carried out at the University of Illinois under the auspices of the National Research Council and the University.

I was introduced as Director of Research of the A. O. Smith Corporation. Until a very few weeks ago I was with the University of Illinois as Special Research Associate Professor of Engineering Materials, and therefore I would like to come to you not as the Director of Research of a large corporation but as a man who has been engaged in research in a broad and general way on metals.

(Mr. Jasper's paper will appear later.)

Chairman Scott: Next on the program is Mr. H. Kriegsheim, President, The Permutit Company, New York, N. Y., and his topic is "Intercrystalline Cracks in Riveted Seams." I believe Mr. Kriegsheim has some slides also.

Samuel B. Applebaum (The Permutit Company): Mr. Kriegsheim regrets he is not able to be here. He asked me to present the paper and answer any questions.

Mr. Jasper has referred to fatigue and to other forms of failure and his paper fits in very well with this because this paper really discusses the other types of failures that he referred to that are frequently assumed to be due to corrosion.

Chairman Scott: Mr. Applebaum has explained in a technical manner that through long, practical experience they have found a number of cases where water is treated and boiler fractures rupture that engineers and boiler inspectors are inclined to blame it on the treatment of water when in reality it is a construction condition that originated in the plant where the boiler was built. This is a very instructive article that Mr. Applebaum has given here, and the inspectors in the field and the Chief Inspectors ought to try and get a copy of that and go over it very thoroughly when they receive the minutes.

In many cases you will come across boiler fractures and ruptures that will be laid in a number of instances to the treatment of feed water, etc. There has been considerable discussion before the Boiler Code Committee of the A. S. M. E., and Mr. Applebaum has, I believe, satisfied a good many here in their minds that the treatment of feed water does cause cracks.

J. P. Morrison, Chief Inspector, Hartford Steam Boiler Inspection & Insurance Company, will now speak to you. I believe Mr. Morrison is located in Chicago.

J. P. Morrison: I surely appreciate the manner in which Professor Jasper and Mr. Applebaum have covered the ground. They have apparently left very little to be said, so if what I have to say is considerably curtailed, you will know the reason for it.

(This paper will appear in a later issue.)

Wednesday Morning Session

The meeting was called to order at ten o'clock, Mr. Scott presiding.

Chairman Scott: The first address on the program is by Mr. Prentiss of the Everlasting Valve Company. Mr. Prentiss conferred with me several times relative to combination valves which I believe they have on steam boilers, and their president asked permission to have a representative here to describe this before the National Board in convention. I think it is a very good thing under the circumstances because a thing of this kind ought to be brought to your attention, as more than likely before we meet again you will have to decide on a valve of this type in some part of this country where you are interested and located.

Geo. Prentiss (Everlasting Valve Company): This is going to be a short talk and not a formal one at all.

Now one of the things that Mr. Applebaum showed very clearly was the enormous cracking of the average mud drum of a watertube boiler, especially the suspended types. Then you will remember the pictures of fracture blow-off flanges. The Everlasting Valve Company makes blow-off valves like that.

This is not a valve. What has been done by the Everlasting Valve Company is this: We have realized that when we have a boiler under pressure and we open a blow-off valve, we subject the pipe line, the valve and the boiler to instantaneous and very heavy shocks. There is no question about it. The boiler, of course, doesn't get anything like the shock that the pipe line does and the valve does, but the shock is there.

Some years ago Mr. Wilson of the Everlasting Valve Company made up his mind to get up a scheme to avoid shocks. Out of this idea grew this process which I am going to just put down on the blackboard and let you see, and you will see it just as plainly as if I talked a year. I don't have to talk. The thing will talk for me, and when this process was invented, it was necessary for the Everlasting Valve Company to prove that it would really be true protection, so it took them a good while, four or five years to be exact, and that protection having been secured, they proceeded to develop it commercially. Mr. Prentiss drew a sketch of the blow-off tank and valve arrangement, fully explaining the workings of this lay-out.

A complete discussion of the matter was carried on by the members at the conclusion of Mr. Prentiss' talk.

Chairman Scott: Mr. Brennan of the New York Indemnity Company was going to talk on this subject, but he had to go away and left it on my hands. This is a safety latch on a boiler.

Here is a letter from the DeWaters Safety Latch Company:

"In going through our files we find a letter addressed to Mr. C. O. Myers, Secretary of the National Board of Boiler and Pressure Vessel Inspectors, showing that we sent him on November 2, 1923, a number of blue prints and pamphlets describing the merits of the DeWaters Safety Latch.

"At that time we were bringing this device before the insurance inspectors of the various states and cities with the view to obtaining their approval of this device. We are writing to you to ask if you will kindly take the subject up with the heads of the various inspection units of the states and cities who operate under the National Board.

"Our device has been accepted by the United States Government and is installed in the Bureau of Standards; it has been approved by the States of Pennsylvania, New Jersey and New York, and is strongly recommended by the State Compensation Insurance and other insurance companies; it has been installed in the capitol buildings at Harrisburg, Pa. and Albany, N. Y. It has also been tested and listed as standard by the Underwriters Laboratories of Chicago.

"We are preparing to send a model of this device to Chicago, to be exhibited at the annual meeting of the inspectors."

When I got here there was a letter from an insurance company which reads as follows:

"Our experience with utility and industrial power plants is that the majority of fatal and serious accidents which have occurred to boiler room employees are due to one cause—the bursting of tubes. Practically all of these accidents occurred when the boiler doors were closed and they could have been prevented if substantial and effective latches had been in use. The attached circular describes our last fatal accident which occurred in August 1925. Accidents have occurred in connection with both firing doors and side access doors, at least one fatal accident having occurred at the side of a boiler when a furnace access door blew open.

"It is true that outside of this one cause, our record for boiler room work has been rather good and this is probably a tribute to the effectiveness of the work done by the boiler inspectors. At the same time the fact that fatal accidents have occurred because of lack of proper latches seems to us to indicate the need for some very definite action. We, ourselves, are interested in the matter from a compensation insurance point of view, that is from the point of view of the employees in these plants. The inspection of boilers and their equipment is, however, a highly special subject and we rely upon the care and judgment of the trained boiler inspectors.

"Is there any reason why the boiler inspectors can not emphasize this question more than they have apparently done in the past? The A. S. M. E. Code is written principally to cover the construction of new boilers and its requirement for substantial and effective latches has unfortuately not been worded so as to apply to existing installations where the greatest hazard probably exists. The application of the principles, however, to existing installations is very properly one which belongs to the administrative or inspection authority concerned. Some of the states recognize this by definite rulings, and it would seem to us that a boiler inspector approving an existing installation might be subject to severe criticism if an accident occurred later because of defective or inadequate latches. We will be interested in hearing whether any action can be taken in the matter."

This is really a synopsis of what most all insurance companies are doing today relative to safety latches. It don't apply particularly to this safety latch, but in view of our compensation law there seems to be a general movement under way to have the doors equipped with latches for the purpose of preventing an explosion or blowing out on the fireman.

This DeWater safety latch has been on the market a number of years and I don't believe we have given any approval on it and I don't believe it was ever taken up with this Board before. This latch was sent here by Mr. DeWaters. He requested permission to do it. There is a model of it and there are several latches which he sent on for you people to inspect. Look it over and let us hear what you have done in your states in regard to safety latches. Do you require it, and is it a good thing to take up?

C. O. Myers: Before you go into this, there seems to be a lot of misunderstanding relative to approval and disapproval by this Board, and it has always been my understanding and the opinion of various members that it is our duty to approve only such devices that are necessary for the safe operation of boilers. It appears to me that something like this is necessary for the safe operation of boilers. I wish you would bear that in mind. I believe some action should be taken by this Board on a device of this kind to either approve or disapprove. I don't see anything more necessary for the safe operation of a boiler than a safety latch.

Chairman Scott: I believe as far as the code requirements, it is only a recommendation. There are lots of things that the code only recommends which they expect us to be intelligent enough to interpret as being necessary.

Mr. Speed: I believe, Mr. Scott, that the code doesn't recommend, but they make it mandatory to have safety latches on boilers.

Mr. Farmer: The code makes it mandatory, but the A. S. M. E. Code will not go on record as approving. In 1920 I visited the first installation and approved it. They are very successful.

Chairman Scott: I believe this body, as a Board, when an appliance comes before us as being good and workable and meets the purpose for which it was designed, we ought to go on record as approving it. It doesn't make any difference who manufactures it. I don't believe you will be subjected to criticism by approving something that is a good thing. If that thing is all right, we ought to be able to back it up to the point that we recommend it, and we ought to approve it along that line. Mr. Myers has suggested to have a roll call relative to the acceptance and approval of that latch.

The roll call was taken.

Chairman Scott: As a result of the roll call, this latch is approved and the manufacturer should be so advised by the National Board that it has unanimous approval.

Mr. Edgar: Before we get off that approval, I think there ought to be some standard method of advising these manufacturers so they wont get an idea we are recommending it. We just approve it as meeting the code requirements. There seems to be a misunderstanding about that.

CHAIRMAN SCOTT: We approve the device as being acceptable as a boiler safety appliance.

C. O. MYERS: Here is a device for cleaning the boiler plate over the fire in a firetube boiler which was submitted to me yesterday for the first time to bring to the attention of the Board, and it is my opinion that a device of this kind isn't necessary for the safe operation of a boiler, and I told the parties who presented it to me that my personal view of it was that the Board wouldn't take any action. They insisted I show it to you. It is a device to be used on a horizontal return tube boiler. This represents a bank of tubes and the lower manhole and on the inside is a scraper with a handle that fits on the outside that scrapes back and forth. That would scrape the mud off the bottom of the plate.

CHAIRMAN SCOTT: I think a motion should be made that as a safety measure we don't feel it is essential, but as a practical method of eliminating scale, we have no objection to its use.

C. W. OBERT: How would it do to express it this way: "This is something that is not covered by the code, but we see no objection to it."

CHAIRMAN SCOTT: That is what we have in mind. We have no objection to its use.

C. O. MYERS: Mr. Chairman and Members: I have a motion here that I would like to make on this device: "It is moved that the device for scraping scale and mud from the shell plates of an externally fired boiler over the fire is not necessary for the safe operation of a boiler, but we can see no objections against the use of such an arrangement where conditions require it."

The roll call taken resulted in not approving the device.

Wednesday Morning Session

The Executive session was called to order at eleven-forty A.M., with the chairman presiding.

C. O. MYERS: There are several questions that should be taken up. The first thing, I am going to ask the Board to discuss and take some definite action on the stamping of miniature boilers "National Board," that is, boilers that are constructed in accordance with the Miniature Code of the A. S. M. E. I would like to have the views of the members on that question first, whether the National Board should extend their stamping to boilers built according to the Miniature Code or whether we should let it go as it is.

CHAIRMAN SCOTT: What is the practice now, Mr. Myers?

C. O. MYERS: We are not using the stamp of the National Board. Our stamp is used only on boilers that are constructed in accordance with the power section of the code.

W. P. EALES (Travelers Indemnity Company): May I suggest, why limit the scope of the National Board to power boilers? I think the use of the symbol or facsimile should be extended to all A. S. M. E. boilers so that there will be a record.

CHAIRMAN SCOTT: A record should be available of all the boilers of A. S. M. E. construction.

W. H. FURMAN (State of New York): I would like to recommend putting on the year at the shop. It is not being done in the field under the A. S. M. E. code.

CHAIRMAN SCOTT: Under the National Board stamp the year is stamped on the boiler. That question of the year built, is sometimes a hard one, or the year put into service. Sometimes the boiler is not put into service for three or four years after it is built, and I have known of some cases that it has been fifteen years that the boiler hasn't been put into service.

C. O. MYERS: I don't see why we should be so particular about the year being stamped on the boiler. We have the data report on file which states the exact date when the boiler was built. Why is it necessary to have all that stamped on the boiler?

W. H. FURMAN: For the information of the man who is buying the boiler and the man in the field inspecting the boiler.

C. O. MYER: The man who is buying should ask the state department or insurance company to make an inspection before he purchases and the report requires the age of the boiler.

Taking the last analysis, I think it is a requirement of stamping that could be done away with. That is my opinion.

E. W. FARMER (State of Rhode Island): I think it is a proper course to take and stamp them the year they are manufactured the same as on a data sheet, the miniature boilers or any boiler for that matter. I think it would be a good idea to stamp miniature boilers or any boilers built under the A. S. M. E. code.

CHAIRMAN SCOTT: Gentlemen, we have got to do something on this matter and decide if the states will accept the miniature boiler stamp. It has been suggested by Mr. Myers that the states that cannot accept the miniature boiler stamping vote no; those that can, vote yes for those respective states. There is no reason why the states that recognize the miniature boilers built under the A. S. M. E. code could not have some kind of a lever.

J. E. SPEED (Erie, Pa.): I move that the Chair appoint a committee to work with the A.S.M.E. Boiler Code Committee and see whether they can't iron out the differences.

CHAIRMAN SCOTT: We are going to appoint a committee to cooperate with the A. S. M. E. committee to overcome the technical differences between Pennsylvania and the A. S. M. E. These states want some kind of an acceptance of the miniature code as adopted by the boiler code subject to revision. We will now have a roll call on the resolution.

CHAIRMAN SCOTT: Judging from the roll call, it is the sense of this body that the National Board stamp be applied to miniature boilers built under the Miniature Code of the A. S. M. E.

W. H. FURMAN: I move that the Secretary-Treasurer be instructed to extend the National Board stamp to boilers built in accordance with the A. S. M. E. Locomotive Code, and the pressure allowed on such boilers be based on a factor of safety of five when such locomotive boiler is transferred for stationary purposes.

CHAIRMAN SCOTT: This motion means that the pressure allowed on such boilers be based on a factor of safety five when or where used for stationary purposes.

C. O. MYERS: The question now before the house is that we extend the National Board stamping to boilers that are built in accordance with the locomotive code, and we understand that as boilers of locomotives, not of locomotive type boilers.

CHAIRMAN SCOTT: I think it is a state condition anyway. You can increase the factor and take care of that.

M. A. EDGAR (State of Wisconsin): Would it be possible to put the National Board stamp on these locomotive boilers and then put the letter "L" to designate they were built for locomotive purposes?

W. H. FURMAN: "National Board—Locomotive."

The meeting continued with the discussion of various proposed measures pertaining particularly to the functions of the Board.

C. W. OBERT (Boiler Code Committee): Before you close there are two or three points I would like to bring up here.

I made a note of a few things that I think ought to be mentioned during this convention. One of the things that I had in mind talking of is this response to the council reports on the interpretations. You members that are members of the National Board are members of the Conference Committee to the Boiler Code Committee and of course you get your reports of each meeting of the Boiler Code Committee, or you should get them. If you don't, I would like to know it.

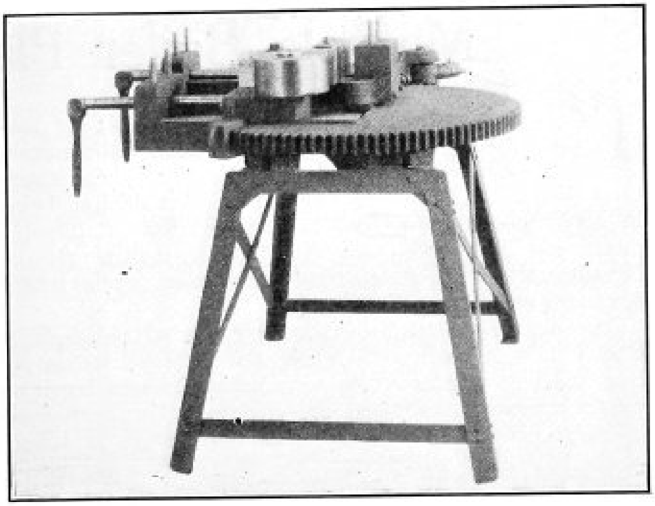
I want to reiterate what I brought out at the Milwaukee meeting last year of the importance of giving your answers. I have talked to a number of men individually during the meeting and have been told by them if we don't hear from them in ten days, the time limit specified, we are to understand that you are in agreement. I hope you will all work that thing the same way and act that way whether you have expressed yourself so or not. It is quite embarrassing to the Boiler Code Committee to go through the procedure of passing an interpretation on something and submitting it to you as well as all others on the Boiler Code Committee and then getting what we understand to be a unanimous ballot, turning it over to the publisher, and then find some of you don't agree with it; you probably turn some construction down and make the statement you never agreed to that case. I feel like pointing out to you fellows what an important part you are taking in this movement. The Boiler Code Committee is not the only thing. It is one link in this chain and you men form the more important link. The Boiler Code Committee really handles a very unimportant part of it. They perhaps collect technical data, a lot of ideas, and spread them in a certain way. You are the ones to apply the code by bringing out these interpretations. If something comes across and you don't like it and then keep still about it, it seems rather almost breaking faith with this bunch of men who are working so hard. And remember, gentlemen, they are working without a cent of profit. The members of the Boiler Code Committee do not get a cent for their service. They don't even get their traveling expenses. They are coming down just for the good of the cause. It seems to me personally like breaking faith if you don't object to a case and the case goes through, and when it comes out before you in the form of some construction, you object to it. There have been a few cases of that kind and when they do happen, they make us a lot of trouble. If it were allowed to go to any extent, it would discourage the Boiler Code Committee from acting the way it is now.

So I want to emphasize that thing as strongly as I know how.

Wallace No. 9 Hand Operated Bending Machine

The No. 9 hand operated bending machine manufactured by the Wallace Supplies Manufacturing Company, 1312 Diversey Parkway, Chicago, Ill., is designed for making sharp corner bends of 90 degrees or less and radius bends of 180 degrees or less, in flat, round or square bars and in pipes and conduits, thus covering a wide range of this class of work usually found in most railroad shops.

The pressure rolls and also the eccentric clamping device for holding the stock, to prevent slippage in tne process of bending, are mounted on movable blocks fitted into tapered slides. Each block is operated by means of a large screw to permit of quick adjustment to suit the various sizes of forms as well as the different thicknesses of materials. Bolts are no longer required for clamping these parts to the machine, and the setting up of the dies or forms for various kinds of materials is, therefore, accomplished



Bending machine designed for hand operation

with comparative ease and rapidity. The tapered slides are of sufficient strength to withstand the pressure and strain of bending the maximum sizes of materials for which this machine is rated to handle in the repair shop.

When bending material cold, the machine will handle ¾ inch by 4 inch flat stock, 1½ inch round, 1¼ inch square and 1¼ inch square twisted or less. When bending hot material, the machine will handle 1 inch by 4 inch flat, 1¾ inch round, 1½ inch square, and 1½ inch twisted or less. For bending ⅞-inch round or square bars or anything smaller the ratchet handle may be thrown out of engagement and the direct lever used. A rod or pipe about 4 feet long is then inserted in the socket provided for this purpose. In service an auxiliary ratchet lever operates a pinion against a series of teeth in the frame at a large enough ratio to handle the work.

Fall Meeting of the American Welding Society

The fall meeting of the American Welding Society will be held in Buffalo, November 17, 18 and 19. An international welding and cutting exposition will be held in connection with the meeting which will open Tuesday afternoon, November 16. The technical sessions include railroad, welding apparatus, welding science in the engineering curriculum of universities and welding in a gaseous atmosphere. The entertainment includes a trip to Niagara Falls, a view of the Falls from the American side, with an inspection trip through the Niagara Falls power house, a buffet supper on the Canadian side and a special illumination of the Falls. There will be the usual annual fall banquet and a meeting of the American Bureau of Welding, the Board of Directors and the Welding Wire Specifications Committee.

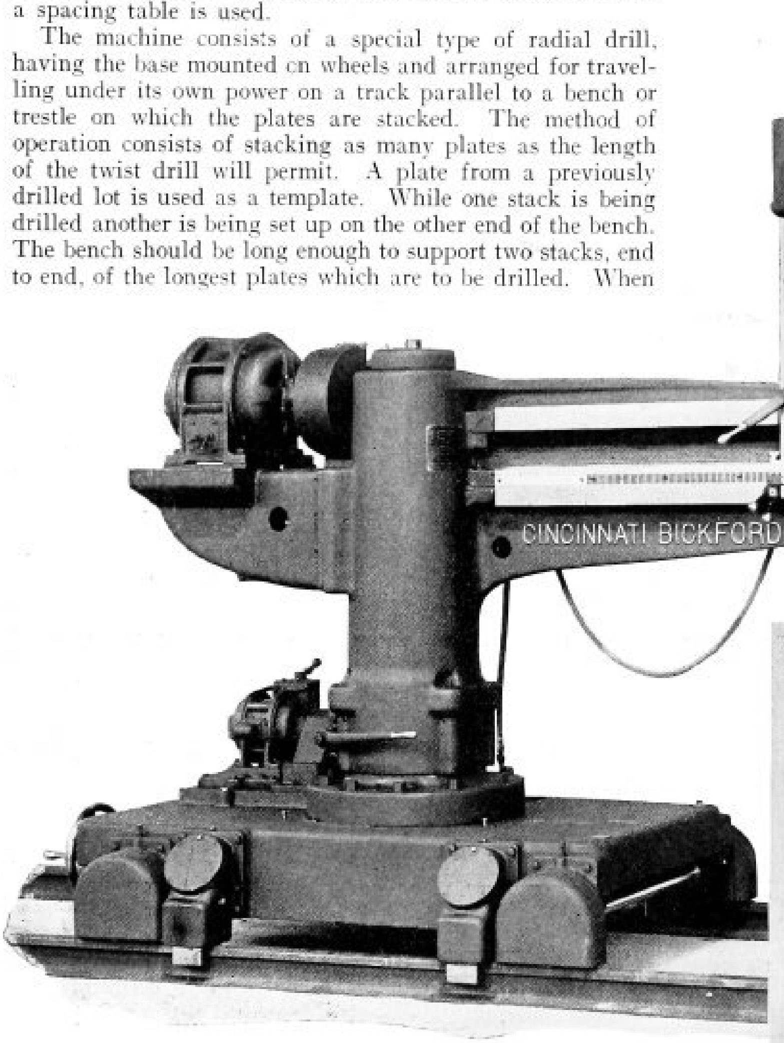
Charles S. Orne has been appointed manager of the Central Steel & Supply Company, Railway Exchange building, Chicago, Ill. This company represents the Ross-Tacony Crucible Company, William F. Jobbins, Inc., Neely Nut & Bolt Company; Rockford Malleable Iron Works and the Riverside Iron Works. A. A. Orne has charge of casting sales and I. R. Robinson specializes on crucibles.

B. A. Clements has been elected president of the Rome Iron Mills, Inc., with office in New York, to succeed Edward Marshall Zehnder, who died on June 21. In April, 1916, Mr. Clements became vice-president of the Rome Iron Mills, Inc., and remained in this capacity until his election as president.

Multiple Boiler Plate Drilling Machine

THE heavy type plate and rivet hole drilling machine shown in the accompanying illustration was especially designed for boiler, tank, and structural shops. It is particularly adapted for drilling holes in duplicate plates and on that class of work it offers a production that is rarely exceeded except by multiple punching where the entire plate is punched at one stroke or where a spacing table is used.

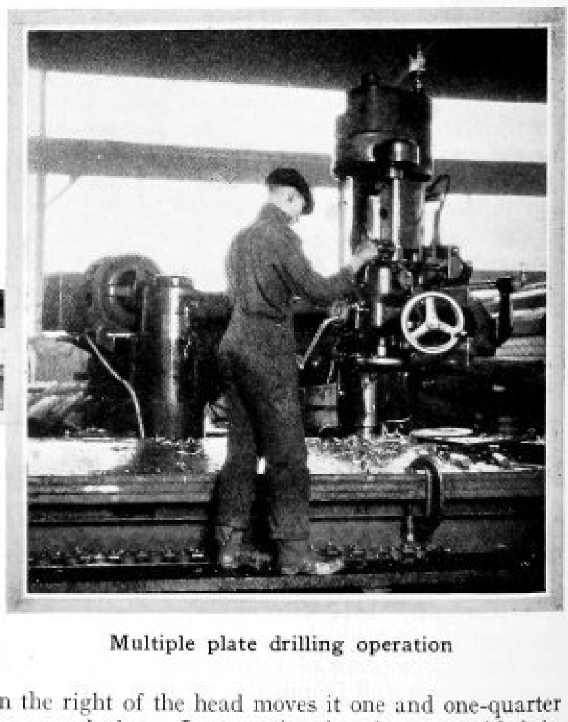
The machine consists of a special type of radial drill, having the base mounted on wheels and arranged for travelling under its own power on a track parallel to a bench or trestle on which the plates are stacked. The method of operation consists of stacking as many plates as the length of the twist drill will permit. A plate from a previously drilled lot is used as a template. While one stack is being drilled another is being set up on the other end of the bench. The bench should be long enough to support two stacks, end to end, of the longest plates which are to be drilled. When one stack is finished the operator runs the machine under power to the other stack and continues drilling.



Cincinnati-Bickford plate and rivet hole drilling machine

The economies claimed as a result of the use of this equipment are that only one man is required to operate the machine—helpers are not needed; the usual labor gang is used only to stack the plates on the bench prior to drilling and to remove those which have been drilled. Laying out of holes is practically eliminated as a plate from a previous drilled lot serves as a template. Idle machine time is negligible for it occurs only when the machine is traveling between two stacks of plates. In erecting, further economies are realized. Reaming is almost entirely eliminated because the duplication of holes in the plates is perfect. Easier and better riveting results, because the sides of the holes are straight and not tapered as is the case in punched holes. Drill breakage rarely occurs because of the extreme rigidity of the machine.

Unusual consideration has been given to manipulation. The control levers have been so located that each movement required of the operator is performed through the shortest possible distance and with the least amount of effort. The arm swings under the pressure of one finger. The head has been carefully balanced on the arm so that it moves easily and swiftly. A large hand wheel on the right of the head moves it one and one-quarter inches per revolution. Lost motion has been provided in the head moving mechanism which gives a hammer blow effect for quickly alineing the drill with the hole in the template.



Multiple plate drilling operation

The feed trip automatically disengages the power feed when the drill penetrates the bottom plate of the stack. It acts directly on the main feed clutch instead of disengaging an auxiliary jaw clutch as is commonly done. As a result two less movements are required of the operator for each hole drilled. This feature effects a decided saving in the time required to move from one hole to the next one.

Electric or air arm-clamping equipment is furnished on special order. On the former the arm is clamped by means of a small motor; on the latter, by a double acting air cylinder. The control of both devices is located on the head near the spindle and is so arranged that the operator clamps and unclamps the arm without leaving his operating position at the head. There only hand clamping is used, the operator is required to make two trips from the head to the column for each hole drilled. The time and energy saved by the use of either electric or air arm-clamping is considerable.

A countersinking attachment can also be furnished if desired. It consists of a long lever attached to the feed pinion shaft, which provides a powerful lever feed to the spindle. With this attachment the operator can position the head and arm with one hand and countersink with the other.

The frame of the machine is of unusually heavy construction. The arm is of box section and is integral with the column sleeve. The column is the rigid member upon which the arm swings. It is heavily ribbed and is secured to the base with a wide flange which has almost twice the thickness of the ordinary flange. An exceptionally large amount of clamping surface on the lower part of the column is positive assurance against any side movement of the arm while drilling. This is an important factor in preventing drill breakage.

The base is strongly reinforced throughout with heavy flanged ribs. The machine is locked to the rails by four clamps located near the wheels. These clamps grip both sides of the rail head and are operated in unison by a large diameter hand wheel. An equalizing system insures uniform clamping. The wheels are of steel, machined and carbonized and are mounted on roller bearings. A two horse power motor, mounted in the base, furnishes power for propelling the machine on the track. It is geared direct to the axle through an enclosed worm drive and is controlled by a reversing drum type controller.

Speeds and feeds have been carefully selected. They are effectively graded to cover a wide range of drilling. A production of 800, 11/16 inch diameter holes per hour in ¼ inch plates has been obtained with this machine.

The machine is built in four sizes, having four-, five-, six-, and seven-foot arm lengths respectively. In addition to the heavy type plate and rivet hole driller the Cincinnati Bickford Tool Company, Ohio, is prepared to furnish their standard radial drills mounted on the track type base.

Atomic Hydrogen Arc Welding

FIFTEEN years ago, while studying the loss of heat of the tungsten filaments of incandescent lamps in an atmosphere of hydrogen gas, Dr. Irving Langmuir of the General Electric research laboratory at Schenectady, N. Y., found that at a high temperature the hydrogen gas changed from the molecular to the atomic state. In the molecular state, two atoms of the gas are grouped together as a unit; in the atomic state each atom acts as a unit. The molecular form is the more stable, and when the atoms recombine to form the molecules intense heat is liberated.

Dr. Langmuir's study of the filaments in hydrogen was a theoretical investigation. Now, fifteen years later, the results have been applied in a different field—in the development of a new method of welding, by which it is possible to produce welds as strong and as ductile as the original materials.

Continuing the theoretical investigation, Dr. Langmuir found that more atomic hydrogen was formed by passing powerful electric arcs between tungsten electrodes at atmospheric pressure. By directing a jet of hydrogen from a small tube into the arc, the atomic hydrogen could be blown out of the arc, forming an intensely hot flame of atomic hydrogen burning to the molecular form and liberating about half again as much heat as does oxy-hydrogen flame. In this flame molybdenum, one of the most refractory of metals, melts with ease; quartz, however, melts less easily, in spite of its lower melting point. This indicates that the metal assists in the action as a catalyzer—which scientists define as a substance which accelerates a chemical change.

By this method, iron can be welded or melted without contamination by carbon, oxygen or nitrogen. Because of the powerful reducing action of the atomic hydrogen, alloys containing chromium, aluminum, silicon or manganese can be welded without fluxes and without oxidation. The rapidity with which such metals as iron can be melted seems to exceed that in the oxy-acetylene flame, so that the process promises to be particularly valuable for welding.

The technical development of this welding process has been the work of several men in the Schenectady laboratory, including R. A. Weinman and Robert Palmer. These men have developed and tried many types of welding torches, and have tried them under varying conditions. At the same time tests of numerous types of welds have been conducted.

The two electrodes of the torch are tungsten rods, held at an acute angle with each other by lava insulators. When not in use, the electrodes are in contact with each other; they can be separated by pressure on a lever mounted on the handle. A set screw is provided for making slow adjustments of the electrodes. The hydrogen is supplied by a tube through the handle. Sufficient gas is used so that not only are the electrode tips surrounded by enough to form the blast of atomic hydrogen but by an additional quantity to surround the work with hydrogen.

Either alternating or direct current can be used. The first mentioned has been found more convenient, and electrodes of smaller diameter can be used. The gas pressure required to operate the torch is very small; in the laboratory, with short lengths of tubing, a pressure of less than one pound per square inch was sufficient with metals up to one-half inch in thickness. For ordinary welding, the rate of gas consumption varies between 20 and 30 cubic feet per hour.

Since the maximum rate of heating is desired in welding, the torch is held close to the metal. Best results have also been obtained when the torch is inclined so that the blast of hydrogen from the torch passes over the pool of molten metal in a direction opposite to that in which the torch is moved along the line of the weld.

Experiments have been conducted with several gas mixtures and various electrode materials. The best results have usually been obtained with tungsten electrodes and hydrogen alone.

Materials of many kinds have been successfully welded by this method. Low carbon steels up to one-half inch in thickness have been welded without additional material after butting together tightly. Considerable work has also been done in connection with full automatic welding using a butt joint and with no metal being added to the seam. A number of welds have been made on seamless tubing having a wall thickness of one-quarter inch and an outside diameter of four inches and with boiler plate iron one inch thick. Welds on deoxidized copper such as silicon-copper have been made up to three-eighths inch thick metal, giving unusually good sections.

In testing welds made by this process, the welded portions have been twisted and bent double without cracking or otherwise being injured. Such a procedure has not been possible with the ordinary arc weld, since such welds are usually brittle because of the presence of nitrides or a thin film of oxide or scale, removed in the new process by the presence of hydrogen.

Revisions and Addenda to the A. S. M. E. Boiler Construction Code

IT is the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision in the Rules in its Codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the Code, to be included later on in the proper place in the Code.

During the past two years the Boiler Code Committee has received and acted upon a number of suggested revisions which have been approved for publication as addenda to the Code. These are published below, with the corresponding paragraph numbers to identify their locations in the various sections of the Code, and are submitted for criticisms and comment thereon from any one interested therein. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

After 30 days have elapsed, which will afford full opportunity for such criticism and comment upon the revisions as approved by the Committee, it is the intention of the Committee to present the modified rules as finally agreed upon to the Council of the Society for approval as an addition to the Boiler Construction Code. Upon approval by the Council, the revisions will be published in the form of addenda data sheets, distinctly colored pink, and offered for general distribution to those interested, and included in the mailings to subscribers to the Boiler Code interpretation data sheets.

For the convenience of the reader in studying the revisions, all added matter appears in small capitals, and all deleted matter in smaller type.

Revisions and Addenda

PAR. P-9 REVISE FIRST SECTION TO READ:

P-9. When the maximum allowable working pressure (see Par. P-179) exceeds 160 pounds per square inch, cross-pipes connecting the steam and water drums of water-tube boilers, headers, cross-boxes and all pressure parts of the boiler proper over 2-inch pipe size, or equivalent cross-sectional area, shall be of wrought steel, or cast steel of Class B grade, as designated in the Specifications for Steel Castings. WHEN ROUND OR SQUARE TUBING MATERIAL IS USED FOR THE CONSTRUCTION OF SINUOUS HEADERS OF BOILERS WHICH CONFORMS TO THE SPECIFICATIONS FOR BOILER TUBES OR OTHER PIPE MATERIALS AS CONTAINED IN SECTION II OF THE CODE, THE FLATTENING, CRUSHING, OR BENDING TESTS ARE NOT REQUIRED AS THE WORK DONE ON THE MATERIAL FORMING THE SINUOUS HEADER TAKES THE PLACE OF THESE TESTS. Malleable iron, as designated in the Specifications for Malleable Castings, may be also used when the maximum allowable working pressure does not exceed 350 pounds per square inch, provided the form and size of the internal cross-section perpendicular to the longest dimension of the box, is such that it will fall within a 7-inch by 7-inch rectangle.

PAR. P-194 REVISE FIRST TWO SECTIONS TO READ:

P-194 Domes. The longitudinal joint of a dome 24 inches or over in inside diameter shall be of butt and double-strap construction, or made without a seam of one piece of steel pressed into shape, and its flange shall be double-riveted to the boiler shell. In the case of a dome less than 24 inches in diameter, for which the product of the inside diameter and the maximum allowable working pressure does not exceed 4,000 inch-pounds, its flange may be single-riveted to the boiler shell and the longitudinal joint may be of the lap type, provided it is computed with a factor of safety not less than 8.

[The longitudinal joint of a dome less than 24 inches in diameter may be of the lap type, and its flange may be single-riveted to the boiler shell provided the maximum allowable working pressure on such a dome is computed with a factor of safety of not less than 8.]

PAR. P-197 REVISED:

P-197. The corner radius of an unstayed dished head measured on the concave side of the head shall not be less than

[1½ inches or more than 4 inches and within these limits shall be not less than 3 percent of L in Par. P-195] 3 TIMES THE PLATE THICKNESS UP TO $t = ½$ INCH. FOR THICKER PLATES THE CORNER RADIUS SHALL NOT BE LESS THAN 3 PERCENT OF L AND IN NO CASE LESS THAN 1½ INCHES.

PAR. P-200. REVISE FIRST SENTENCE TO READ:

P-200. Staybolts. The ends of staybolts or stays screwed through plates SHALL EXTEND BEYOND THE PLATE NOT LESS THAN TWO THREADS WHEN INSTALLED, AFTER WHICH THEY shall be riveted over or upset by AN equivalent process WITHOUT EXCESSIVE SCORING OF THE SHEETS; OR THEY SHALL BE fitted with THREADED nuts THROUGH WHICH THE BOLT OF STAY SHALL EXTEND.

PAR. P-204. REVISED:

P-204. The formula in Par. P-199 was used in computing Table P-6. Where values for screwed stays with ends riveted over are required for conditions not given in Table P-6, they may be computed from the formula and used, provided the pitch does not exceed 8½ inches WHERE THE STAYBOLTING OF SHELLS OF BOILERS IS UNSYMMETRICAL BY REASON OF INTERFERENCE WITH BUTT STRAPS OR OTHER CONSTRUCTION, IT IS PERMISSIBLE TO CONSIDER THE LOAD CARRIED BY EACH STAYBOLT AS THE AREA CALCULATED BY TAKING THE DISTANCE FROM THE CENTER OF THE SPACING ON ONE SIDE OF THE BOLT TO THE CENTER OF THE SPACING ON THE OTHER SIDE.

PAR. P-218. REARRANGE THE FIRST SENTENCE TO READ:

P-218. When stays are required the portion of the heads below the tubes in a horizontal-return tubular boiler shall be supported by through stays with nuts inside and outside at the front head and by attachments which distribute the stress at the rear head.

PAR. P-230*b*. CHANGE THE REFERENCE TO "PAR. P-212*b*" NEAR THE END OF THIS PARAGRAPH TO READ "PAR. P-212*d*."

PAR. P-274. REVISE SECOND SECTION TO READ:

The heating surface shall be computed for that side of the boiler surface exposed to the products of combustion, exclusive of the superheating surface. In computing the heating surface for this purpose, only the tubes, fireboxes, shells, tube sheets and the projected area of headers need be considered. The minimum number and size of safety valves required shall be determined on the basis of the aggregate relieving capacity and the relieving capacity marked on the valves by the manufacturer. Where the operating conditions are changed, OR ADDITIONAL HEATING SURFACE SUCH AS WATER SCREENS OR WATER WALLS IS CONNECTED TO THE BOILER CIRCULATION, the safety-valve capacity shall be increased, if necessary, to meet the new conditions and be in accordance with Par. P-270.

PAR. P-291. REVISED:

P-291. Water Glasses and Gage Cocks. Each boiler shall have at least one water-gage glass, WITH CONNECTIONS NOT LESS THAN ½-INCH PIPE SIZE. The lowest visible part of THE WATER GLASS [which] shall be not less than 2 inches above the lowest permissible water level. THE WATER-GAGE GLASS SHALL BE EQUIPPED WITH A DRAIN.

The lowest permissible water level shall be that at which there will be no danger of overheating any part of the boiler when it is operated with the water not lower than that level. This level for the usual types of boilers is given in Par. A-21 of the Appendix.

PAR. P-293. REVISED:

P-293. When shut-offs are used on the connections to a water column, they shall be either outside-screw-and-yoke type gate valves or stop cocks with levers permanently fastened thereto and marked in line with their passage; and such valves or cocks shall be *locked or sealed open.* WHERE STOP COCKS ARE USED THEY SHALL BE OF A TYPE WITH THE PLUG HELD IN PLACE BY A GUARD OR GLAND.

PAR. P-295. REVISED:

P-295. No outlet connections, except for damper regulator, feedwater regulator, drains, [or] steam gages, OR APPARATUS OF SUCH FORM AS DOES NOT PERMIT THE ESCAPE OF AN APPRECIABLE AMOUNT OF STEAM OR WATER THEREFROM, shall be placed on the pipes connecting a water column to a boiler.

PAR. P-297. REVISED:

P-297. The dial of the steam gage shall be graduated to approximately double the pressure at which the SAFETY VALVE IS SET [boiler will operate] but in no case to less than 1½ times THIS [the maximum allowable working] pressure [of the boiler].

PAR. P-299. REVISE FIRST TWO SECTIONS TO READ:

P-299 Fittings. Flanged cast-iron pipe fittings [including those for steam and for feedwater and where the pressures do not exceed 160 pounds] shall conform to the American Standard given in the Appendix. If the fittings are below the water line they shall be extra heavy.

[For ressures exceeding 160 pounds per square inch, fittings more than 2-inch pipe size or equivalent cross-sectional area, shall be of cast or forged steel (see Pars. P-9 and P-245). The dimensions of the flanges and drilling shall conform to the American Standard given in Table A-6.]

PAR. P-301. REVISED:

P-301. Stop Valves. Each steam-discharge outlet, except safety-valve and superheater connections, shall be fitted with a stop valve located as near the boiler as practicable. When such outlets are over 2-inch pipe size, the valve or valves used on the connection shall be of the outside-screw-and-yoke RISING-SPINDLE type.

PAR. P-310. REVISED:

P-310. The blow-off piping, and any piping or fittings connecting them to the boiler, shall conform to the requirements of Par. P-25. The blow-off valves shall be the full size of the blow-off pipes. All fittings between the boiler and valves shall be of steel. FOR PRESSURES OVER 250 POUNDS PER SQUARE INCH, THE VALVES OF COCKS SHALL BE OF STEEL CONSTRUCTION.

PAR. P-321. REVISED:

P-321. The water connections to the water column of a boiler, when practicable, shall be provided with a cross at each right-angle turn to facilitate cleaning. For steam pressures of 200 pounds or less, the water connection, if pipe is used, shall be of brass. [Either] The water column [or this connection] shall be fitted with a drain cock or drain valve with a suitable connection to the ashpit, or other safe point of waste, AND IF THE WATER CONNECTION THERETO HAS A RISING BEND OR POCKET WHICH CANNOT BE DRAINED BY MEANS OF THE WATER-COLUMN DRAIN, AN ADDITIONAL DRAIN SHALL BE PLACED ON THIS CONNECTION IN ORDER THAT IT MAY BY BLOWN OFF TO CLEAR ANY SEDIMENT FROM THE PIPE. The water-column blow-off pipe shall be at least ¾-inch PIPE SIZE. For steam pressures over 200 pounds, the [water] connections shall be of steel pipe or tubing, wrought-iron pipe or [the equivalent] OF OTHER MATERIAL CAPABLE OF SAFELY WITHSTANDING THE TEMPERATURES CORRESPONDING TO THE MAXIMUM ALLOWABLE WORKING PRESSURE.

PAR. P-322. REVISED:

P-322. The steam connection to the water column of a horizontal-return tubular boiler shall be taken from the top of the shell or the upper part of the head; the water connection shall be taken from a point not less than 6 inches below the center line of the shell. FOR THE FIREBOX TYPES OF BOILERS, THE WATER CONNECTION TO THE WATER COLUMN SHALL BE TAKEN AT A POINT NOT LESS THAN 6 INCHES BELOW THE LOWEST WATERLINE OR AS NEAR THERETO AS POSSIBLE, AND IN NO CASE LESS THAN 18 INCHES ABOVE THE MUD RING.

PAR. P-323. REVISE FIRST SENTENCE TO READ:

P-323. Methods of Support. A horizontal-return tubular boiler over [78] 72 inches in diameter shall be supported from steel hangers by the outside suspension type of setting, independent of the boiler side walls.

PAR. P-324. REVISED:

P-324. A horizontal-return tubular boiler, 14 feet or more in length, or over 54 inches and up to and including [78] 72 inches in diameter shall be supported by the outside-suspension type of setting as specified in Par. P-323, or at four points by not less than eight steel or cast-iron lugs set in pairs. A horizontal-return tubular boiler up to and including 54 inches in diameter shall be supported by the outside-suspension type of setting as specified in Par. P-323, or by not less than two steel or cast-iron lugs on each side. THE DISTANCE GIRTHWISE OF THE BOILER FROM THE CENTERS OF THE BOTTOM RIVETS TO THE CENTERS OF THE TOP RIVETS ATTACHING THE HANGERS SHALL BE NOT LESS THAN THE SQUARE OF THE SHELL DIAMETER DIVIDED BY 675. If more than four lugs are used they shall be set in four pairs, the lugs of each pair to be spaced not over 2 inches apart and the load to be equalized between them (see Fig. P-20).

PAR. P-332. REVISE FOURTH SECTION TO READ:

Each boiler shall be stamped adjacent to the symbol as shown in Fig. P-22, with the following items WITH LETTERS AND FIGURES AT LEAST 5/16-INCH HIGH with intervals of about one-half inch between the lines:

PAR. A-21*k* REVISED:

k In Edge Moor Boilers, Standard Type—in the bottom of the steam and water drum [24 inches from the center of the rear neck] NOT LESS THAN 6 INCHES ABOVE THE BOTTOM OF THE DRUM, OVER THE FIRST PASS OF THE PRODUCTS OF COMBUSTION, and projecting through the sheet not less than 1 inch.

PAR. A-21*q* REVISED:

q In Dry-Back Scotch Type Boilers—in the rear head, not less than 2 inches above the upper row of tubes, and projecting through the sheet not less than 1 inch. WHEN THE DISTANCE BETWEEN THE UPPERMOST LINE OF TUBES AND THE TOP OF THE STEAM SPACE IS 13 INCHES OR LESS, THE BOTTOM OF THE FUSIBLE PLUG MAY COME AT A LESSER DISTANCE THAN 2 INCHES ABOVE THE UPPER ROW OF TUBES; BUT IN NO CASE SHALL THE PLUG BE LOCATED BELOW THE LEVEL OF THE TOP OF THE UPPERMOST ROW OF TUBES.

TABLE P-11 CHANGE THE DISCHARGE CAPACITY OF "198 POUNDS OF STEAM PER HOUR FOR ¾-INCH OUTLET AT 75 POUNDS GAGE PRESSURE TO "223 POUNDS."

PAR. S-11 ADD NEW SECTION TO READ:

Bend Test for Universal or Edge-Rolled Plates when

Permitted for Double-Strap Construction. *b* THE BEND-TEST SPECIMEN SHALL WITHSTAND BEING BENT COLD THROUGH 180 DEGREES WITHOUT CRACKING ON THE OUTSIDE OF THE BENT PORTION AS FOLLOWS: FOR MATERIAL 1 INCH OR UNDER IN THICKNESS, AROUND A PIN THE DIAMETER OF WHICH IS EQUAL TO 1½ TIMES THE THICKNESS OF THE SPECIMEN; AND FOR MATERIAL OVER 1 INCH IN THICKNESS, AROUND A PIN THE DIAMETER OF WHICH IS EQUAL TO 3 TIMES THE THICKNESS OF THE SPECIMEN.

PAR. H-1 REVISE SECTION *c* TO READ:

c For conditions exceeding those specified above, the rules for CONSTRUCTION AND SETTING OF power boilers shall apply.

PAR. H-14 ADD NEW SECTION TO READ:

b THE MINIMUM THICKNESS OF TUBES, IF OF COPPER, EITHER STRAIGHT, BENT, OR COILED, FOR USE IN WATER-TUBE OR FIRE-TUBE BOILERS, MEASURED BY BIRMINGHAM WIRE GAGE, SHALL BE AS FOLLOWS:

IN WATER BOILERS WHERE WORKING PRESSURES OF OVER 30 POUNDS AND NOT TO EXCEED 160 POUNDS PER SQUARE INCH MAY BE USED:

$$t = \frac{D}{30} + 0.03$$

WHERE t = THICKNESS OF TUBE WALL IN INCHES, AND D = OUTSIDE DIAMETER OF TUBE IN INCHES.

FOR STEAM BOILERS TO BE USED AT PRESSURES NOT EXCEEDING 15 POUNDS PER SQUARE INCH, AND WATER BOILERS WHERE THE MAXIMUM ALLOWABLE WORKING PRESSURE DOES NOT EXCEED 30 POUNDS PER SQUARE INCH:

$$t = \frac{D}{45} + 0.03$$

IN NO CASE SHALL A TUBE THINNER THAN NO. 16 GAGE (B. W. G.) BE USED.

PAR. H-21 REVISE THIRD ITEM ON PAGE 8 OF HEATING CODE TO READ:

C = 135 for stays screwed through plates and fitted with single nuts outside of plate, OR FOR STAYS WELDED INTO SUCH PLATES, PROVIDED THEY ARE SUPPORTED AT INTERVALS NOT EXCEEDING 5 FEET.

PAR. H-31 REVISED:

H-31 Flanged Connections. Openings in boilers having flanged connections shall have the flanges conform to the American Standard given in Tables A-5 or A-6 of the Appendix to the Code, for the corresponding pipe size, and shall have the corresponding drilling for bolts or studs. OUTLET NOZZLES AND FLANGES IF OF STEEL CONSTRUCTION MAY BE RIVETED OR WELDED TO THE SHELL, BUT IF OF CAST-IRON CONSTRUCTION MUST BE RIVETED THERETO.

PARS. H-51 and H-104 REVISED:

H-51 [Every] EACH safety valve or water-relief valve SHALL [have] BE plainly [stamped on the body or cast thereon] MARKED BY THE MANUFACTURER in such a way that the markings [can] WILL not be obliterated in service, BY STAMPING OR CASTING ON THE CASING OR BODY OF THE VALVE, OR BY STAMPING OR CASTING ON A PLATE SECURELY FASTENED TO THE CASING, the letters A.S.M.E. Std., the manufacturer's name or trademark, and the pressure at which it is set to blow. The seats and disks of safety or water-relief valves shall be made of non-ferrous material.

PARS. H-53 and H-106 REVISE FIRST SECTION TO READ:

H-53 The minimum size of safety or water-relief valve or valves for each boiler shall be governed by the amount of the grate area as given in Tables H-6 or H-7. IN DETERMINING THE MINIMUM SIZE OF SAFETY OR WATER-RELIEF VALVES FOR DOUBLE-GRATE DOWN-DRAFT BOILERS, THE EFFECTIVE GRATE AREA SHALL BE TAKEN AS THE AREA OF THE UPPER GRATE PLUS ONE-EIGHTH OF THE AREA OF THE LOWER GRATE.

PAR. H-61 REVISED:

H-6 *Water-Gage Glasses.* Each steam boiler shall have at least one water-gage glass, THE LOWEST VISIBLE POINT OF WHICH SHALL NOT BE LOWER THAN THE LOCATION SPECIFIED IN PAR. H-64 FOR THE FUSIBLE PLUG.

PAR. H-64 REVISED:

H-64 Fusible Plugs. A fusible plug, if used, shall be placed at the lowest safe water line and in contact with the products of combustion. THE LOWEST SAFE WATER LINE IS THAT AT WHICH THE HEATING SURFACES OF A BOILER ARE EITHER COVERED OR ARE NOT EXPOSED TO PRODUCTS OF COMBUSTION UNTIL THESE PRODUCTS HAVE PASSED OVER NOT LESS THAN 75 PERCENT OF THE TOTAL HEATING SURFACE OF THE BOILER.

PAR. H-74 INCREASE SULPHUR REQUIREMENT IN LAST LINE FROM "0.04" TO "0.05" PERCENT.

PAR. U-6 REVISED:

FOR VESSELS IN WHICH PRESSURE IS NOT GENERATED BUT IS DERIVED FROM AN OUTSIDE SOURCE, each safety valve shall [have a full sized opening to the vessel. It shall] be so connected TO THE VESSEL, VESSELS OR SYSTEM WHICH IT PROTECTS so as to prevent a RISE IN pressure BEYOND [in excess of] the MAXIMUM allowable pressure (see Par. U-2) [and so located that the contents of the vessel will not interfere with the operation of the safety valve] IN ANY VESSEL PROTECTED BY THE SAFETY VALVE.

FOR VESSELS IN WHICH PRESSURE MAY BE GENERATED, THE SAFETY VALVE OR VALVES MUST BE CONNECTED DIRECTLY TO THE VESSEL WHICH IS TO BE PROTECTED OR TO A PIPE LINE LEADING TO THE VESSEL; THE INTERNAL CROSS-SECTIONAL AREA OF THE PIPE LINE SHALL NOT BE LESS THAN THE NOMINAL AREA OF THE SAFETY VALVE OR VALVES USED, AND WITHOUT ANY INTERVENING VALVE BETWEEN THE VESSEL AND THE SAFETY VALVE OR VALVES PROTECTING IT. All vessels, the contents of which are likely to cause interference with the operation of a safety valve if attached directly to the vessel, shall have the safety valve or valves connected in such manner as to avoid such interference. When an escape pipe is used, it shall be full-sized and fitted with an open drain, to prevent liquid from lodging in the upper part of the safety valve, AND NO VALVE OF ANY DESCRIPTION SHALL BE PLACED [between the safety valve and the vessel nor] ON THE ESCAPE PIPE between the safety valve and the atmosphere. When an elbow is placed on an escape pipe, it shall be located close to the safety-valve outlet, or the escape pipe shall be securely anchored and supported. When two or more safety valves are placed on one connection, this connection shall have a cross-sectional area at least equal to the combined area of these safety valves.

PAR. U-17 REVISED:

U-17 For all pressure vessels the minimum thicknesses of shell plates, heads and dome plates after flanging shall be as follows:

When the Diameter of Shell Is

[14] 16 in. and under ⅛ in.	Over [14] 16 in. to 24 in. 3/16 in.	Over 24 in. to 36 in., ¼ in.
Over 36 in. to 54 in., 5/16 in.	Over 54 in. to 72 in., ⅜ in.	Over 72 in. ½ in.

except that for riveted construction the minimum thickness shall be 5/16 in.

PAR. U-28 REVISED:

U-28 On longitudinal joints, the distance from the centers of rivet holes to the edges of the plates, except rivet holes in the ends of butt straps, shall be not less than 1½ and not more than 1¾ times the diameter of the rivet holes; this distance to be measured from the center of the rivet holes to [the top of] the calking edge of the plate before calking. The corresponding distance for circumferential seams shall be not less than 1¼ times the diameter of the rivet holes.

PAR. U-61 REVISED:

U-61 In laying out AND CUTTING the plates care must be taken to leave one of the stamps required in the Specifications for material used, so located as to be plainly visible when the vessel is completed; or in case these are unavoidably cut out, the heat number, quality of plate, minimum tensile strength and maker's name shall be accurately transferred as to form by the pressure-vessel manufacturer, to a location where these stamps will be visible. The form of stampings shall be such that it can be readily distinguished from the plate maker's stamping.

Par. U-66 REVISE THE FIRST TWO SENTENCES TO READ:

U-66 Each such pressure vessel shall be marked in the presence of the inspector, A.S.M.E. Std. P. V., and with the manufacturer's name and serial number and working pressure. These markings shall be LEGIBLY stamped with letters and figures at least 5/16-inch high on some conspicuous portion of the vessel, preferably near a manhole, if any, or handhole, OR ON A NAME PLATE BRAZED OR OTHERWISE IRREMOVABLY ATTACHED TO THE SHELL PLATE.

Par. U-84 Revised:

U-84 For flanged heads dished CONCAVE TO PRESSURE, the depth of flange measured from a point tangent to the [corner] radius of the head to the end of the flange, shall not be less than 5 inches. FOR HEADS DISHED CONVEX TO PRESSURE, THE DEPTH OF FLANGE SO MEASURED NEED NOT BE MORE THAN 2½ INCHES.

Par. U-112*a* INSERT THE HEADING "GRADE A" ABOVE PRESENT COLUMN OF CHEMICAL REQUIREMENTS, AND INSERT THE FOLLOWING COLUMN OF ADDITIONAL CHEMICAL REQUIREMENTS:

GRADE B
NOT OVER 0.20 PERCENT
NOT OVER 0.22 PERCENT
0.35 TO 0.60 PERCENT
NOT OVER 0.06 PERCENT
NOT OVER 0.04 PERCENT
NOT OVER 0.05 PERCENT

Par. U-115 INSERT THE HEADING "GRADE A" ABOVE PRESENT COLUMN OF PHYSICAL REQUIREMENTS, AND INSERT THE FOLLOWING COLUMN OF ADDITIONAL PHYSICAL REQUIREMENTS:

GRADE B
50,000
0.5 TENS. STR.
27,000
27

Par. U-122*a* Revised:

U-122 Marking. a The name or brand of the manufacturer, melt or slab number, CLASS, and lowest tensile strength FOR THE GRADE specified in Par. U-115*a*, shall be legibly stamped on each plate. The melt or slab number shall be legibly stamped on each test specimen.

Par. U-126 Revised:

U-126 The steel shall conform to the following requirements as to chemical composition:

Carbon	not over [0.24] 0.28 percent
Manganese	not over 0.60 percent
Phosphorus	not over 0.04 percent
Sulphur	not over 0.05 percent

Par. M-1 REVISE LIMIT OF HEATING SURFACE TO READ:
20 square feet [total] WATER heating surface.

Par. M-2 REVISE FIRST SENTENCE TO READ:

M-2 Specifications are given in Pars. S-1 to S-213 of Section II of the Code, for the important materials used in the construction of boilers, and the materials for miniature boilers, for which specifications exist, shall conform thereto, except that STEEL PIPE FOR SIZES OVER 3 INCHES IN DIAMETER SHALL BE OF OPEN-HEARTH STEEL. [in lieu of definite specifications for boiler-plate material, there may be used for the shells or drums of miniature boilers, seamless drawn shells with integral heads, or seamless or extra-heavy lapwelded steel or iron pipe or tubing, provided it is of open-hearth material and the weld is formed by the forging process.]

Par. M-19 REVISE FIRST SECTION TO READ:

All boilers referred to in this section shall be plainly marked with the manufacturer's name, maximum allowable working pressure, which shall be indicated in arabic numerals, followed by the letters "lb.," and the serial number. All boilers built according to these rules shall be marked A.S.M.E. Std.—Miniature. THE SYMBOL AUTHORIZED FOR USE ON POWER BOILERS SHALL NOT BE USED ON MINIATURE BOILERS BUILT ACCORDING TO THESE RULES, NOR SHALL ANY ACCESSORY OR PART OF THE BOILER BE MARKED A.S.M.E. OR A.S.M.E. STD., UNLESS SO SPECIFIED IN THE CODE. Individual shop inspection is required for miniature boilers in the same manner as for power boilers.

Manufacturers' Data Report for Miniature Boilers. Revise item 3 in the Manufacturers' Data Report to read:

3. Type....Boiler No. (....) (...) (...) Yr. built.
(Serial No. Manufrs.) (State No. State and) [(A.S.M.E. No.)]

Portable Universal Boiler and Firebox Drill

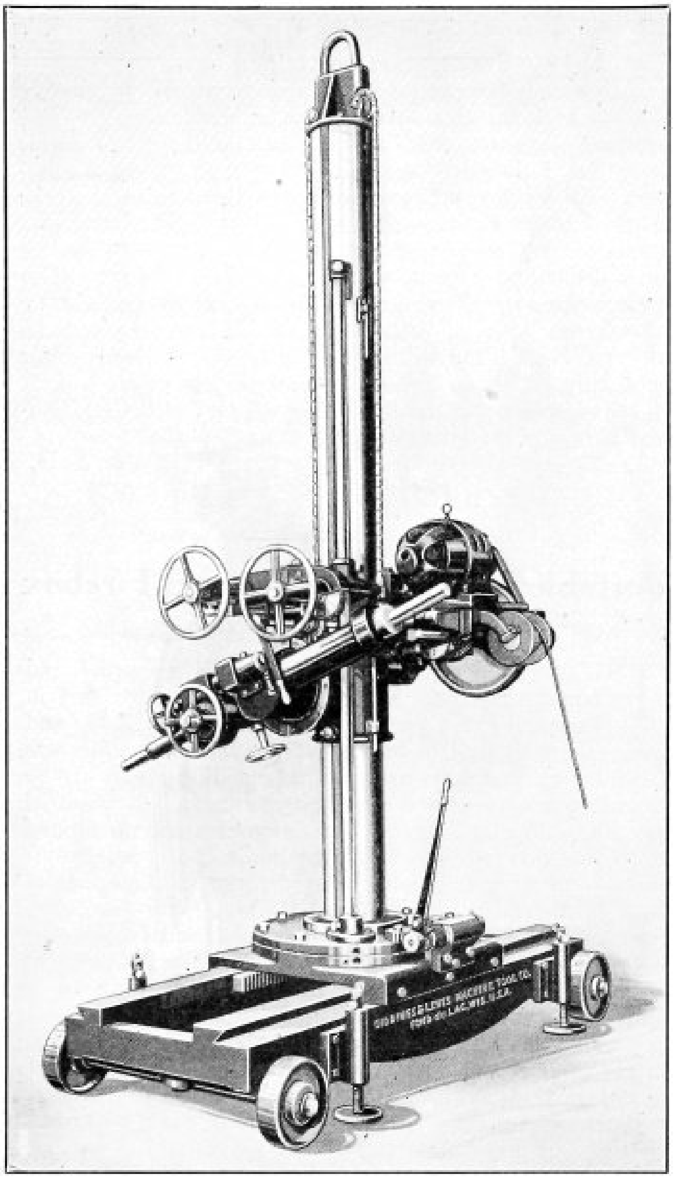
The portable electrically driven drilling, boring and tapping machine, here illustrated, is chiefly used in locomotive and car manufacturing shops, tank and boiler shops as well as locomotive repair shops. The two advantages in using it are that the machine can easily be moved to any place and put in operation in any required position without elaborate preparations for setting up the work, and that it can be employed in places where it is impossible to work with any other drilling machine. It is built by the Giddings & Lewis Machine Tool Company, Fond du Lac, Wis. When drilling holes of small and medium diameters the weight of the machine affords sufficient stability. For drilling larger holes or when the head is high on the supporting column the rigidity of the machine is strengthened by four spreaders attached to the base plate.

The column is of a heavy tubular section and well braced to withstand all strains. After being machined it is ground to diameter and fully balanced. There is a self-contained drill spindle unit consisting of a heavily ribbed box section, having long guiding ways to insure correct alinement on the column. Power feed is provided for moving the spindle head on the column. The complete spindle unit can be clamped to the column at any desired location. The spindle is made of high-carbon steel and runs in bronze bearings and is liberally supplied with oiling facilities. A friction clutch is provided to reverse the spindle for tapping. Furthermore, a segment on the spindle head permits the setting of the drill spindle at an angle of 30 degrees from the center line of the column in both directions. The complete spindle unit is properly counterbalanced through the chain, sheave and counterweight, the latter sliding in the column.

The driving motor is mounted on the spindle head and the power is transmitted to the speed box through a pinion gear. A winding reel with 30 feet of cable is furnished with the machine for connecting with available current.

The speed and feed box is a self-contained unit. The levers for changing the speed and feed are easily accessible and within the reach of the operator at all times. The gears run in heavy oil and are enclosed by the speed case proper, the cover of which is easily removed for inspection.

The portable base is of heavy ribbed girder construction and is provided with a planed runway for supporting the platen for the column. A rack and pinion, of liberal size, including a ratchet lever, is furnished for moving the drill on the runway. All of these drills, which are desig-



Portable universal boiler and firebox drilling machine mounted on a four-wheel truck

nated as No. 250, are furnished with a segment, worm and ratchet lever to enable a 30-degree movement of the column in both directions. The controls are centralized.

Lubrication of all moving parts has been provided for by a few central oiling points from which the oil is automatically distributed to all parts.

For Safety in Industry

INDUSTRIAL Commissioner James A. Hamilton of the New York State Department of Labor and Morris E. Siegel, director of evening and continuation schools of New York, have combined their energies in a campaign of education of the teachers in the continuation schools in the principles and practice of "accident prevention" especially as it applies to industry. According to the New York State Laws, the Board of Education in each city and school district of the state must establish part time or continuation schools which all children under 16 in gainful employment must attend for not less than 4 nor more than 8 hours a week. The number of children in industry who are receiving educa- in the continuation schools is approximately 50,000 so that the inauguration of special lectures and instruction in this group for the purpose of future prevention of disease and accident hazards in industry may be expected to bring forth good results. No one will dispute the benefit of early training of children. In the case of the continuation schools this proposed training in "accident prevention" has a special significance in that the children in continuation schools, already in gainful employment, are likely in future to produce an increased percentage of foremen and it is generally conceded that the prevention of accident hazards very largely depends upon the character of the foreman and his inclination and ability along "accident-prevention" lines.

Inspection Rules for Locomotives Other Than Steam

PURSUANT to the requirements for rules and instructions for the inspecting and testing of locomotives propelled by other than steam power, in accordance with the act of February 17, 1911, amended March 4, 1915, June 26, 1918, and June 7, 1924, the Interstate Commerce Commission has compiled, published, and issued a set of rules and instructions for inspecting and testing all locomotives other than steam, to become effective July 1, 1926, except as otherwise specified in the rules.

These follow very closely the general arrangement of the rules and instructions now in use for the inspection of steam locomotives, and in order that there may be no misunderstanding as to the application of the new rules, definitions are given as to the equipment they cover. A locomotive is defined as a self-propelled unit of equipment designed solely for moving other equipment. A motor car is defined as a self-propelled unit of equipment designed to carry freight or passenger traffic, and is not to be considered as a locomotive.

These rules and instructions were formulated at conferences participated in by representatives of the carriers, representatives of the employes, and the chief and assistant chief inspectors of the Interstate Commerce Commission. They were approved by order of Interstate Commerce Commission December 14, 1925, and include rules number 200 to 261 inclusive, and 300 to 337 inclusive, together with cuts, tables, drawings and forms of the usual type required for the inspection of steam locomotives.

One section is general and outlines the scope and application of the rules and instructions. In this section it is stated a locomotive, as constructed by these rules, may consist of one or more units. The term "units" as used in these rules and instructions meaning the least number of wheel bases, together with superstructures, capable of independent propulsion, but not necessarily equipped with an independent control. The rules also provide that each locomotive be stenciled with the letter "F" on each side near the front end to designate the front or head end of the locomotive. Each unit of the locomotive must be numbered also on each side. As is the case with steam locomotives, each locomotive must be inspected after each trip or day's work, and forms are illustrated on which reports of these inspections are to be made.

Charles J. Murray has recently resigned from staff of The Linde Air Products Company, to become associated with the Oklahoma Contracting Company. He is now organizing a new division of that concern to engage exclusively in oxwelded pipe line construction. During his association with the Linde Company, Mr. Murray specialized in this class of work and has studied the construction problems connected with a large number of notable trunk line projects.

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Layout of Jacket Connecting Cylinders

Q.—Will you kindly send me the layout of a casing connecting two cylinders. J.F.D.

A.—The plan and elevation, Fig. 1, are produced in order to obtain the miter line between the pipes and conical section. In the plan, draw circles representing the cylindrical pipes and show the position of the conical piece. Extend the sides of the cone to intersect in the apex *x* and on the base line *1—7* of the extended cone, draw a semicircle. Divide the semicircle into equal spaces and locate them on the base line *1—7* by projection. Connect these points with *x*.

In the elevation reproduce the cone relative with the cylinders, and also the elements of the cone *1—7*, *2—6*, *3—5*, etc.

The intersection of the elements of the cone and the cylinder locates points on the miter lines. These points are shown in the plan, and are projected to the elevation to intersect the corresponding elements of the cone in that view.

The true lengths of the elements are found by projecting them to the outer element of the cone at right angles to the axis *x′—7* as indicated in the elevation.

The pattern is laid out in Fig. 2, using the radius *x′—y* for drawing the base circle. On the arc so drawn, set off the stretchout for the base of the cone and divide it into two times the number of spaces shown for the semicircle plan view.

Draw the radial lines and from *x′* in the elevation to points *1*, *2*, *3*, *4*, etc., on the outer element set off these distances in the pattern.

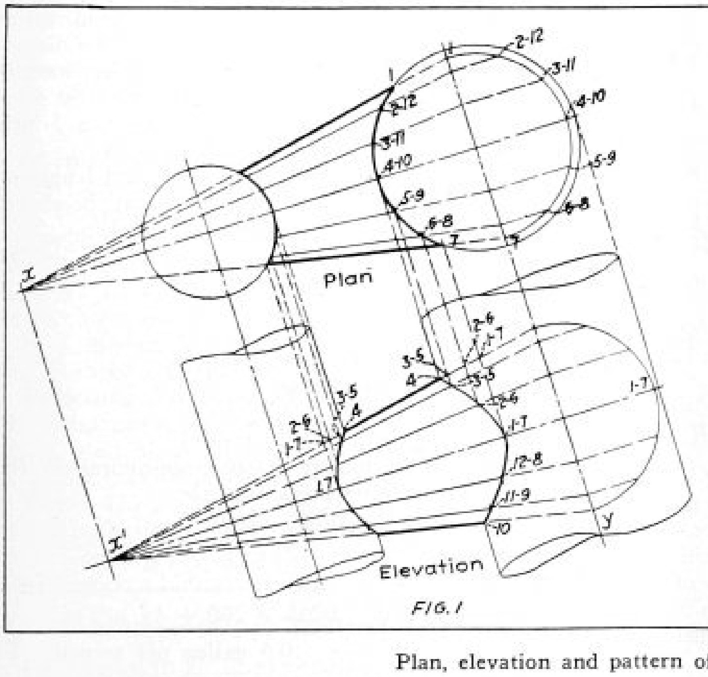


FIG. 1

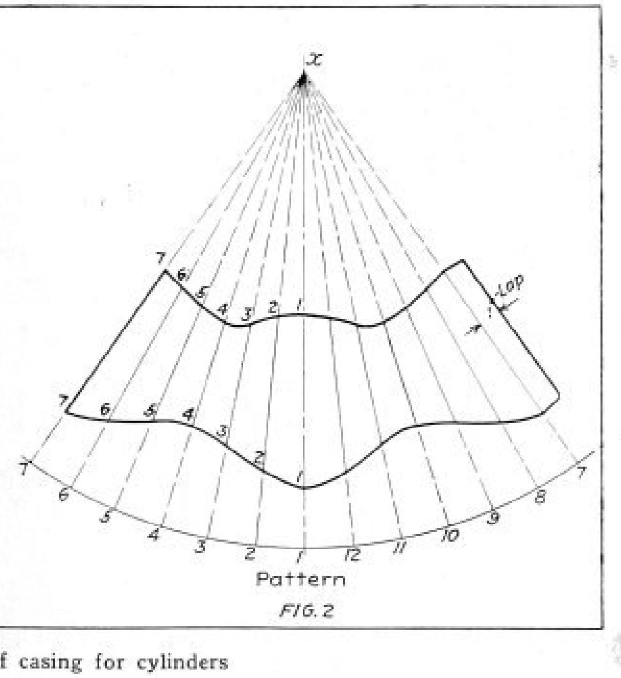


FIG. 2

Plan, elevation and pattern of casing for cylinders

Channel Ring Calculations

Q.—Some time ago a formula was given in THE BOILER MAKER for the layout of angles and channels so that when layed out they could be rolled to exact size. On Saturday, May 1, we had occasion to use the formula but did not get the results desired. What we wanted was a channel rolled to fit a cylinder, sometimes called an outside ring; the channel was 6 inches deep, 8 pounds per foot. The structural hand book gives the information thus: for a 6-inch channel, weighing 8 pounds per foot, the distance of the center line of gravity y-y measured 0.52 from the outside face of the web of the channel. The channel ring is 77 inches inside diameter, therefore:

77 inches diameter + 2 x 0.52 x 3.1416 = 245.1700464 or 20 feet 5 3/16 inches.

When rolled this ring should measure by using the wheel on the inside 241 15/16 inches or 20 feet 1 15/16 inches; the actual dimension on the ring already rolled is 20 feet 4 inches, so you see there is quite a difference.

Kindly advise if this method is supposed to be accurate or if I did not follow the formula as directed. N.W.

A.—It is only possible to give a rule that approximates the required length of stretchouts for bent angles, tee bars and channels. This is because the method of bending and the temperature at which the bending is done affects the finished size; therefore, it is always desirable to have a length of stock in excess of the amount actually required.

Diagonal Seam and Patch Joints

Q.—I will greatly appreciate any information you might be able to send me on the calculation of boiler patches, particularly those of "diamond" shape. Is the efficiency of such a patch calculated in like manner to a boiler seam and the figure thus obtained multiplied by a factor obtained by dividing the hypotenuse of the triangle formed by the vertical and horizontal center lines of the patch and the center line through the outer rows of rivets by the leg of the triangle as shown in the attached print? This would be the secant of angle *e*. I have been unable to obtain any authentic information on the above. I want to use this information in our apprentice schools. T. C. G.—A. S.

A.—In THE BOILER MAKER, February issue, 1922, is given a complete explanation of the principles of helical joints. This question has also been answered in this column on different forms of patches, their application and calculation of the riveted joints.

Boiler Difficulties

Q.—I recently became a subscriber to your journal THE BOILER MAKER and later received a very cordial letter from you inviting me to submit any problems with which I come in contact, and offering your assistance and advice. Possibly you could help me with the following difficulty:

We have a number of boilers from 40 to 60 horsepower which are in continual use, some for furnishing steam for drilling wells, other as stationary boilers used for furnishing steam for pumping, etc.

These are partly locomotive type boilers with mud-rings firebox, 3-inch flues and steam dome; in fact the usual oil country drilling boiler. We also have some 75 horsepower and 100 horsepower marine boilers, these have a corrugated furnace, dry back and with built-on combustion chambers with 3½-inch flues. These latter are used as station boilers.

The maker of the 75-horsepower boiler is Ward-Whitman & Company and the 100 horsepower boilers, Walsh-Weidner & Company. Our trouble has been that these flues continually leak. This occurs when the boiler is washed or when varying loads are carried which is usual. I might mention in this connection that we fit copper ferrules on the firebox ends of the flues; also, due to the scattered situation of the boilers, we have had bad water.

The suggestion has been put forward that we electric weld the flues to the tube plate each end allowing the flues to project over the tube plate say 3/16-inch.

I would like your opinion as to whether this is practical and if so what kind of an outfit you would suggest as being suitable for this work, remembering of course that such outfit must be self contained and essentially portable, and could be used on other welding jobs such as patches, etc.

We also have trouble with mud-rings on our 45-horsepower to 60-horsepower oil field boilers. Our usual practice has been to fit patches over the thin places with patch bolts and where possible rivets. In other cases we have acetylene welded patches on the mud-rings, but with varying degrees of success.

Many boilers have had thin mud-rings all around and we have up to now junked them, though the remaining parts of the boiler may be in good shape.

I would like to know your opinion of electric welded patches on these mud-rings and, in the cases of the junked boilers referred to, whether there is any practical method of repairing the mud-rings without heavy expense.

I would like to say in conclusion that I think your paper is going to be a real help to me and the company and I look forward to reading the many interesting articles. Trusting I shall not occupy too much of your valuable time and assuring you of my appreciation and thanks. G.G.

A.—The length of time that tubes will remain tight in a boiler depends on the extent to which the boilers are forced. Thus in boilers of ample size for steaming requirements, the tubes may remain tight for years, but with small boilers, in which is required a rapid generation of steam under forced conditions, the tubes will leak in a short time. The continual expansion and contraction under such operations produces leaky tubes.

Welding tubes as explained in July's issue, 1926, of THE BOILER MAKER, may be applied.

The expanding of leaky tubes reduces the thickness of the ends, and if continued the time comes when the thickness is so thin that the tubes cannot be made tight. Such tubes must be replaced.

The collection of scale and other sediment on the tubes will lead to overheating, which also causes leaks and burned tubes. No doubt a great deal of your present trouble is caused by the feed water.

A gasoline driven engine, directly connected to a D. C. generator, 200 amperes capacity, provides a good means for electric welding. These outfits are portable, and built by several companies, whose names we will be glad to supply on request.

In the mud ring section, or in the legs of firebox boilers the circulation of water is slight, also the impurities in the water settle in this space. Unless the water legs are cleaned out frequently, the plate may burn away on the fireside sheets and deteriorate from corrosion, etc.

Patches on boilers may be applied by welding provided the strength of the patch is not based on the weld, in other words, the weld must not carry the load on the patch due to the steam pressure.

To advise you on reclaiming the junked boilers we would have to know their exact condition.

Flow of Water Through Pipe

Q.—I am writing to ask information on the following question which, while not pertaining to boiler making, yet has to do with boiler shops. The shop where I am employed purchases all water used on meter. How long will it take to use, or pass 4,000,000 gallons of water through this meter? Service pressure on main, 25 pounds; pipe to meter, and from meter, 1¼-inch size; length from meter to extreme distributing end of pipe, 250 feet. Thanking you for you attention in proper order. H.B.F.

A.—On account of friction, bends and length of pipe the flow of water through a pipe is considerably less than the theoretical flow due to the head.

The head is the vertical distance between the point of discharge and the level at the source, the pressure per foot of head in pounds per square inch is 0.434. For a pressure of 25 pounds per square inch the equivalent head of water

$$\text{equals } \frac{25}{0.434} = 57.6 \text{ feet approximately.}$$

The loss in the flow of water due to friction varies directly as the length of pipes and inversely as the diameter; in other words the friction in a pipe 200 feet long is two times as great as in a pipe 100 feet long, and the friction in a 4-inch pipe is only half as much as in a 2-inch pipe, when the velocity is the same in both cases.

In this example the size of pipe, the head and length of pipe are given, from which the discharge may be determined approximately from the following formula:

$$Q = .09445\, d^2 \sqrt{\frac{h.d.}{fl + \frac{1}{8}d}}$$

Q = discharge in gallons, per second.
d = diameter of pipe in inches.
h = head in feet.
l = length of pipe in feet.
f = coefficient of friction = 0.0205, approximately for the conditions in this example.

Then using the values given,

$$Q = .09445 \times 1\tfrac{1}{4}^2 \sqrt{\frac{57.6 \times 1\tfrac{1}{4}}{.0205 \times 200 + \tfrac{1}{8} \times 1\tfrac{1}{4}}} =$$

0.6 gallon per second.

$0.6 \times 60 = 3.60$ gallons per minute.
$3.60 \times 60 = 216$ gallons per hour.
$4{,}000{,}000 \div 216 = 1{,}852$ hours, nearly.

L. F. Kuhman has been appointed vice president and director of the Andrews-Bradshaw Company, Pittsburgh, Pa., sales managers for the Tracyfier (Tracy steam purifier and Tracyfier gas and vapor scrubber). Mr. Kuhman has been associated with the company for the past three and a half years. For eight years prior to that time he was engaged as sales engineer for the Ingersoll-Rand Company, in the Pittsburgh district.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

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

Steamboat Inspection Service of the Department of Commerce

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

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.

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

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

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.

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

Vice-Chairman—C. D. Thomas, Salem, Oregon.

Statistician—E. W. Farmer, Rhode Island.

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

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

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

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

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

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

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

Master Boiler Makers' Association

President—J. F. Raps, general boiler inspector, Illinois Central.

First Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.

Second Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.

Third Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.

Fourth Vice President—George B. Usherwood, supervisor of boilers. New York Central.

Fifth Vice President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington and Quincy.

Secretary—Harry D. Vought, 26 Cortlandt Street, New York.

Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.

Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—J. W. Kelly, National Tube Company, Pittsburgh, Pa.

Vice President—A. W. Clokey, American Arch Company, Chicago, Ill.

Treasurer—George R. Boyce, A. M. Castle and Company, Chicago, Ill.

Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie, Pa.

Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.

Secretary-Treasurer—A. C. Baker, 801 Rockefeller Building, Cleveland, Ohio.

Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; Owsley Brown, Springfield Boiler Company, Springfield, Ill.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Wroks, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

Cities

Chicago, Ill.	Memphis, Tenn.	St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Los Angeles, Cal.	Philadelphia, Pa.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Missouri	Pennsylvania
California	New Jersey	Rhode Island
Delaware	New York	Utah
Indiana	Ohio	Washington
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Nebr.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Memphis, Tenn.	Philadelphia, Pa.	Tampa, Fla.

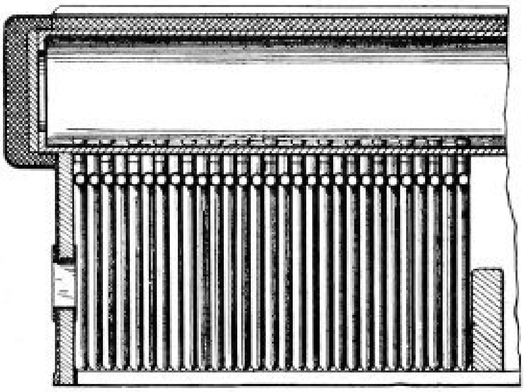
SELECTED BOILER PATENTS

Compiled by
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,576,807. JACOB BUCHLI, OF WINTERTHUR, SWITZERLAND. HIGH-PRESSURE STEAM BOILER FOR LOCOMOTIVES.

Claim 1. In a high-pressure steam boiler for locomotives, a water tube

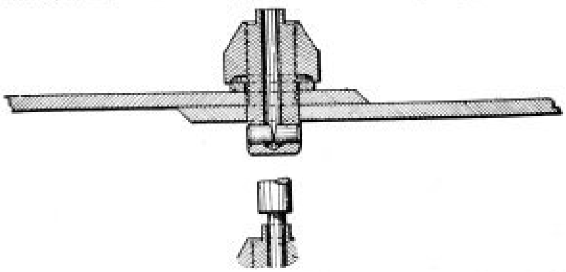


of substantially inverted U-shape for spanning the fire box and having an extension to its shanks bent substantially parallel to and protected by the shanks and a short tubular branch on said tube between the shanks.

4 Claims.

1,551,382. THOMAS MARTIN FOSS, OF MINNEAPOLIS, MINNESOTA, ASSIGNOR OF ONE-THIRD TO BERNARD L. GROGAN, OF MINNEAPOLIS, MINNESOTA. EMERGENCY RIVET.

Claim 1. A rivet comprising a hollow rivet body closed at its insertable end and provided with radially projectible anchoring lugs, a nut having

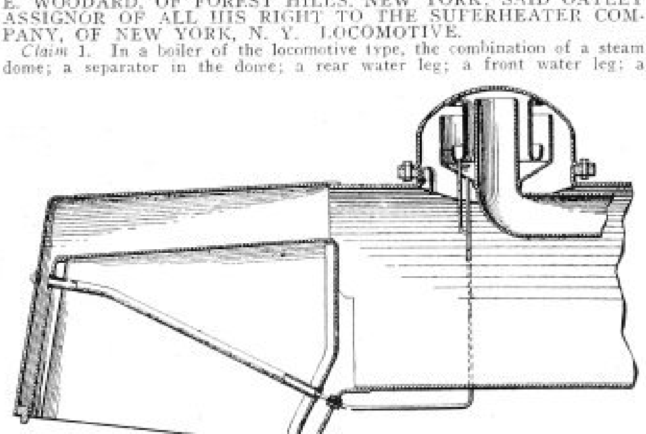


threaded engagement with the outer end of said rivet body and formed with a recessed working face, and a pliable washer applied around said rivet body and arranged to be upset and compressed within the recessed face of said nut.

5 Claims.

1,576,245. HENRY B. OATLEY, OF FLUSHING, AND WILLIAM E. WOODARD, OF FOREST HILLS, NEW YORK; SAID OATLEY ASSIGNOR OF ALL HIS RIGHT TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y. LOCOMOTIVE.

Claim 1. In a boiler of the locomotive type, the combination of a steam dome; a separator in the dome; a rear water leg; a front water leg; a

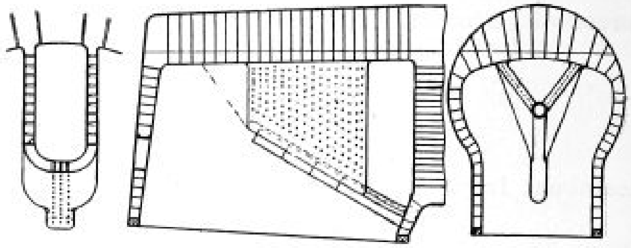


circulating tube connecting a high point of the former with a low point of the latter and extending through the firebox; and a pipe leading from the water collecting space of the separator through the outer sheet of the front water leg and a short distance into the circulating tube; said pipe being spaced from the walls of the circulating tube.

2 Claims.

1,575,050. CHARLES GILBERT HAWLEY, OF CHICAGO, ILLINOIS, ASSIGNOR TO LOCOMOTIVE FIRE-BOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE. LOCOMOTIVE BOILER.

Claim 1. In combination with a locomotive boiler and the firebox thereof, a water steaming and circulating element embodying a tubular inclined

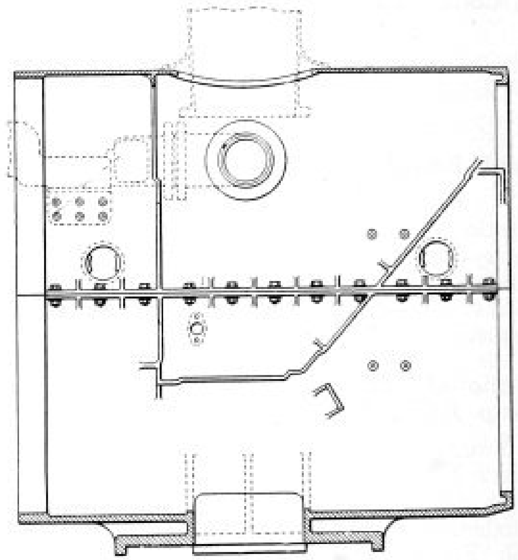


bottom portion connected at one end to the flue sheet of the firebox and flat tubular side portions connected at one end to said inclined bottom portion and opening at their top ends through the crown sheet of the firebox.

3 Claims.

1,549,899. WILLIAM L. BEAN, OF WEST HAVEN, CONNECTICUT. LOCOMOTIVE-SMOKE-BOX STRUCTURE.

Claim 1. A locomotive smoke-box structure comprising, in combination, two complementary castings abuttings in a plane extending lengthwise of

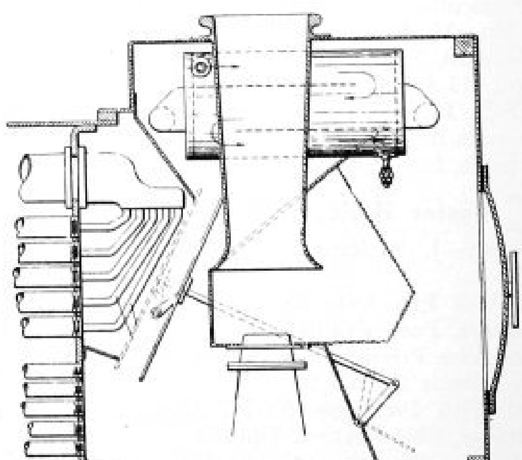


the smoke-box structure, and fastening elements securing said castings together.

15 Claims.

1,576,478. VIRGINIUS Z. CARACRISTI, OF BRONXVILLE, NEW YORK. COMBINED FEED-WATER HEATER AND ECONOMIZER.

Claim 1. A feed water heater for locomotives, comprising in combination with the locomotive smoke box, a feed water drum arranged within the upper portion of the smoke box, a damper controlling the products



of combustion from some of the fire tubes to allow the same to pass through said drum, a second damper, and connections between the same and said first damper whereby the second damper is closed by the opening of the first damper to cause the products of combustion from the remaining fire tubes to pass through the feed water drum.

11 Claims.

The Boiler Maker

Volume XXVI | September, 1926 | Number 9

Published Monthly by

SIMMONS-BOARDMAN PUBLISHING COMPANY

30 Church Street, New York, N. Y.

Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ave.
Mandeville, La.
Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.

Cable address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

Request for change of address should reach us two weeks before the day of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

Shop Kinks

THE value of exchanging practical ideas in boiler shop work was well demonstrated at the recent convention of the Master Boiler Makers' Association when the subject of shop kinks was given the prominence of a special committee report with a discussion from the floor of the devices presented in it. The report appears elsewhere in this issue.

There is scarcely a boiler shop in the country in which the men have not developed certain kinks of their own to speed up work, to make it easier or to amplify the tool equipment available. To a visitor at these shops, certain of the devices or methods employed stand out as radically different than those utilized in other shops. The men who are responsible for the application of ideas of this character, when questioned about them, in most cases disclaim any particular originality. Nevertheless they are original, if not in their entirety at least in their applications. No matter how familiar they may seem to the shop staff, the boiler makers in other shops know nothing about them but if they did could apply them with equal benefit.

Every thinking individual who is given a certain task to perform tries to discover how the methods and tools used can be improved upon to simplify the task. In some shops it seems to be the policy of the management to either discourage original work or to shelve devices that might prove real time and labor savers if they were developed properly. Fortunately, this latter condition is not at all general.

The thought has frequently been expressed in The Boiler Maker that the pages of the magazine are open at all times to descriptions of practical shop kinks developed by our readers. It is, however, true that too few take advantage of this opportunity to help out the men in other shops. Good drawings or photographs, similar to those appearing in connection with the Master Boiler Maker's report on shop kinks, go a long way toward an understanding of the tools or equipment described. An invitation is extended to our readers to collect information on some of the special kinks in their shops and to submit such material with photographs to this magazine for publication.

The Manufacture of Filler Rods

THE majority of those who are called upon to use filler rods in the course of their work are more or less unfamiliar with the manufacture of this essential adjunct to good welding. To these individuals the article in this issue on the "Properties of Steel Filler Rods" should particularly appeal. Probably no metallic material must be more carefully controlled in its manufacture than filler rods in order to insure the correct chemical and physical characteristics in the finished product upon which fundamentally depend the strength of the welds in which such rods are employed.

It is an axiom of the welding profession that good materials combined with good workmanship will produce satisfactory welds. In order that a welder may intelligently carry on his trade, it is essential that he be familiar with the tools and materials used. This knowledge should be broader than a mere understanding of the physical requirements of torches and filler rods—it should include a study of all the implements and materials from the raw state to the finished products.

For example, the reasons for the failure of welds are given as incomplete fusion, slag in the weld and blow holes. For the first of these the operator is responsible and can avoid the defect if he is competent and uses the proper filler rod and, in the case of gas welding, the proper size tip. The second defect—that of slag in the weld, can be partially avoided by the welder and partially by the rod manufacturer. With an understanding of how impurities become included in the metal during the process of manufacture and of how the presence of such impurities is to be avoided, a competent welder can in most cases float them to the top of the molten metal and in this way keep them from endangering the strength of the weld. In the case of gas welding, a large tip capable of heating the metal to a high temperature will usually bring the slag to the top of the weld where it is harmless. This defect does not generally occur in electric arc welding since the heat of the arc is sufficient to float any impurities to the surface. Blow holes, the third reason for weld failure, are entirely due to the manufacture of the rod and must be corrected in the production processes. Hydrogen is the gas most often found in filler rods and to its elimination manufacturers of this class of material have given a great amount of study.

It is with the thought in mind, that a proper understanding of the problems which occur in the manufacture of iron and steel filler rods for both gas and metallic arc welding will enable those of our readers who follow the profession of welding to advance the art, that this article is published. Further information on the physical and chemical properties of filler rods for all purposes will appear in later issues of the magazine.

Statistics of the Boiler Industry

THE need for statistical data in the field of boiler makers and boiler users has long been urgent. Until within the past two years no records of the number of boilers built, their power, the number of boilers in use, their location and like information were available in any form. At a meeting of the National Board of Boiler and Pressure Vessel Inspectors two years ago a report was presented by the statistician of the organization outlining what constituted a real basis on which a definite knowledge of the boiler industry for the future might be based. At the meeting this year E. W. Farmer, statistician for the organization, presented a second report which is concise and complete insofar as any records for a two-year period may be complete. This report appears elsewhere in this issue.

The National Board is to be highly commended in taking the initiative in this matter by not only maintaining the records of boilers built and used in accordance with A. S. M. E. requirements, but also of enlisting the cooperation of all states in keeping the board informed of boiler statistics on record in their respective inspection offices.

The point has now been reached when the assistance of every individual and organization interested in the boiler industry should combine with some authoritative body, such as the Department of Commerce, to survey, the entire field and from this basis work out a method of accurately maintaining boiler data for use in the future.

The American Boiler Manufacturers' Association at the last annual meeting evidenced its intention of working to this end. What this association can accomplish in the next year, combined with the efforts of the National Board, should give a great impetus to the movement so that within a comparatively short time the status of the boiler industry in this country can be as definitely known as that of many other of the industries where records have been maintained for years.

LETTERS TO THE EDITOR

Oswego, N. Y.—The Boiler City

TO THE EDITOR:

After reading the last issue of THE BOILER MAKER, the writer prepared the following article on a town that is well known to the boiler trade. I hope if it is worth attention we will hear from other cities, for personally I enjoy reading how other men work and like to know something of their surroundings.

You are quite right in assuming that any new method in laying out is of interest, but why not some of the old methods for the younger mechanics? There are plenty of shop kinks that work today as well as they did in the past.

Feeling that the readers of THE BOILER MAKER might be interested in knowing something of the activities in boiler making in this vicinity I am outlining the general status of the industry in Oswego.

THE BOILER INDUSTRY IN OSWEGO

Oswego with a population of approximately 25,000 people, located at the mouth of the Oswego River, shares with Rochester as being the only two American cities located on Lake Ontario.

At one time it was called the "Starch City" because of the fact that the largest manufactory of corn starch was located here. Due to the passing of the manufacture of starch in the eastern states and the location of plants nearer the producing center of the raw products, Oswego lost that distinction, but recent developments indicate that instead of starch it will be the center for the manufacture of boilers of many descriptions.

The Fitzgibbons Boiler Company, Inc., is building a new extension to its plant which will more than double the present output. Mr. Homer Addams, the president, plans eventually to make it one of the largest shops in the east building low pressure steel plate heating boilers. This company also builds many boilers for high pressures.

The Ames Iron Works also located here has installed boilers in every state and almost every foreign country. They build all types of boilers, tanks and stacks for working pressures from 15 pounds to 200 pounds per square inch. A great many of the heating boilers are of the Kewanee type. This firm also builds Unaflow engines that are equally as well known to the engineering field as are their boilers. A display is now on exhibition at the Sesqui Centennial in Philadelphia.

The Kingsford Foundry and Machine Works has for years built the highest class marine firetube boilers on the market and is now extending its activities to watertube construction. Possibly most people know that it was the Kingsford organization which controlled the starch industry here.

The Oil Well Supply Company of Pittsburgh manufactures all its boilers at the Oswego plant. All of the products of this firm are intended primarily for oil field work but they are equipped to handle other types.

One of the newer boiler plants in Oswego is the Otis-Sawyer Boiler and Foundry Company which manufactures a small type heating boiler suitable for homes and Pullman cars.

Oswego has been fortunate in these plants, which from small beginnings have grown to staple enterprises, each of them employing hundreds of skilled workers.

Boiler making requires men of good physical strength and climate is a big factor in that connection. With Lake Ontario sending forth cool breezes in the summer and diverting many storms in the winter men are able to enjoy clean fresh air. Contrast this condition with other places where one will gasp for breath in parks at night, and go into work fatigued in mind and body.

The labor turnover here is much less than is usually the case in iron producing centers, nearly all are home owners, contented, efficient and interested in their work.

The Oswego River Power Corporation is building a new plant costing over $1,000,000 which will be able to supply electric power in unlimited quantities.

Oswego is served by three railroad companies the N. Y. O. & W. of which it is also the northern and lake terminus, and through which lines Oswego is the western exit from New England; the D. L. & W., the city and port being the terminal of this line and the Lake Ontario outlet; and the N. Y. C. through which the city shippers have access to three divisions on shorter routes than any other central industrial point in the state. The city is the lake terminal of the New York State barge canal system and if the proposed ship canal project is carried out it will be on that route also. Few cities have the rail and water connections which offer bulk transfer from one to the other as easily as here. This makes possible shipments westward with the inner waterways of the Great Lakes and eastward to the water routes of the world through the city of New York.

Oswego with cheaper power, ideal climate, should continue to thrive and be joined by more and bigger industries making a constantly enlarging name in the boiler industry.

Oswego, N. Y. J. A. SHANNON.

New Marine Watertube Boiler

TO THE EDITOR:

The makers of the Woodeson land-type watertube boiler (Clarke, Chapman & Co., Ltd.) a well known and widely used steam generator, have recently introduced in Great Britain a marine boiler, known as the Woodeson marine boiler. In the past the firm has specialized upon land boilers—of which many hundreds are in use throughout the United Kingdom and Continental Europe—but it is only quite recently that they have directed their attention to the production of marine boilers.

As was to be expected, the new boiler closely follows the same general design as has been found satisfactory in the Woodeson land type boiler. The chief difference discernible in the marine boiler lies in the tubes. In the land boiler these are perfectly straight and are arranged almost vertically. A similar slight inclination from the vertical is given to the tubes in the marine type, but instead of the tubes being straight throughout their entire length, they are given a slight curvature where they enter the upper and lower drums.

The boiler is arranged in two similar sections, front and back, these being connected by means of suitable circulating tubes. Each section comprises an upper or steam drum and a lower water drum, the latter being arranged somewhat to the rear of the steam drum, thereby giving the tubes the inclination away from the boiler front, previously referred to.

The fire is arranged across the boiler, that is to say the firebars are at right angles to the longitudinal axis of the four cylindrical drums and the water drum of the front section of the boiler is located immediately behind the brickwork arch at the rear end of the firebars.

The gases pass upwards through the tubes of the front section of the boiler, across the brickwork baffle, through the tubes of the integral superheater (which is placed between the two sections of the boiler), downwards through the tubes of the back section of the boiler and so to the uptake.

The feed check valve is placed on one of the ends of the back upper or steam drum, and the feedwater passes down the tubes of the back section into the back water drum. The feedwater then passes along the circulating tubes, which connect the back and front water drums, and continues up the tubes of the front section of the boiler into the front upper or steam drum.

Circulating tubes, similar to those which connect the lower water drums, are arranged between the front and back steam drums, tubes passing between both steam and water sides of the two upper drums of the boiler. Thus the feedwater passes from the front upper drum back to the rear upper drum, and a circulation of the simple figure "O" type is completed. The steam which is generated in the steam drum of the front section passes across to the back steam drum by way of the circulating tubes, and all the steam then flows into a large steam drum attached to the upper drum before entering the superheater or the steam range.

It is claimed that the type of circulation induced in this boiler tends to precipitate the feedwater deposits into those tubes farthest away from the fire. In this way it is assured that the hottest tubes are fed with the purest feedwater, and hence freedom from tube trouble should be a feature of this boiler. In view of the potentialities of the new high pressure steam turbine and hence of the watertube boiler, for mercantile vessels, this feature is of prime importance if the watertube boiler is to have a wide application for merchant ships.

The Woodeson marine boiler has been designed so as to incorporate the well known L-type integral superheater, so often applied to land pattern boilers of this type. The superheater is accommodated between the two sections of the boiler and is so arranged that it may expand freely in all directions. The end box of the superheater is located outside the firing space and hence the box may be cleared of deposits in a very convenient manner. A drain valve is fitted to the end box. A safety valve is fitted to the back upper drum of the boiler end, and also to the steam dome carried over the drum.

The designers of this boiler state they are prepared to produce designs for working pressures of 500 pounds per square inch and over, and they are also prepared to furnish plans for pulverized fuel firing as an alternative to either coal or oil burning for ship work.

London, England G. P. BLACKALL.

Regulators Should be Handled Carefully

REGULATORS for oxygen and acetylene are obviously of such sturdy construction that the first thought when one gets out of order is to take it apart and try to locate the trouble. To realize the error of such action, it is only necessary to remind the oxwelder that regulators are precision instruments with two distinct functions: First, regulators act as reducing valves, bringing the high cylinder pressures down to the working range; second, when set for a given working pressure, regulators should maintain this pressure steadily, without variation. Even if they were simply reducing valves it would be unwise for the oxwelder to attempt repairs himself, but with the added function of accurate pressure regulation it becomes imperative to have all adjustments and repairs made by someone thoroughly familiar with the entire mechanism.

All reputable manufacturers of oxy-acetylene equipment maintain apparatus repair stations. Any regulator (or, for that matter, any other part of the apparatus) that is not functioning properly should be sent to the nearest repair station for reconditioning. These stations are not maintained to make money and their charges are consequently low. It is far better, safer, and in the end cheaper, to send a regulator to be repaired by one who makes that his business than it is for the oxwelder to attempt to "doctor" it up himself. The principle is identical with that which prompts anyone to take his watch to a jeweler when it needs attention.

From what has already been said of the functions of regulators, it should be evident that they are actually much more refined and precise than their outward appearance would indicate. By observing a few simple precautions, however, the inconvenience of having to send a regulator to the repair station can be entirely avoided.

Cylinders with regulators attached should be mounted on a two-wheel truck or securely fastened, so that they can not be knocked over.

Before opening cylinder valves, always make certain that the pressure adjusting screw on the regulator is fully released. Otherwise the sudden rush of high pressure gas may break the working pressure gage or rupture the diaphragm.

Broken gage glasses should be replaced without delay. The cost of a new glass is slight in comparison with the protection afforded. Exposed gage hands easily become bent or rusted, and the dial accumulates dirt, thus preventing correct operation.

Attaching the dust cap to the inlet connection when the regulator is not on a cylinder will keep out dust and grit that will clog up small passages in the regulator and mar the valve seat.

Should any part of the regulator mechanism seem to stick, never try to free it with oil or grease. This is extremely important with oxygen regulators, which, you will observe, carry a caution "OXYGEN—USE NO OIL." As oxygen under sudden pressure will set fire to oil or grease, even a drop of oil might completely ruin an oxygen regulator.

In short, reasonably careful handling will enable your regulators to function continuously at high efficiency. If, however, through accident or other cause, they require adjustment or repair, send them to the manufacturer's repair station maintained for that purpose.—*Oxy-Acetylene Tips.*

NEW BOOKS

THE ENGINEERING INDEX, 1925. *792 pages, 7 inches by 9½ inches. Bound in cloth. Published by the American Society of Mechanical Engineers, 29 West 39th Street, New York.*

The Engineering Index published each year by the American Society of Mechanical Engineers has for years been considered a necessary reference book by those who wish to keep in touch with current engineering literature. It is always a welcome edition to an engineering library. Even those who have occasion to consult it only occasionally appreciate its value and completeness when they find it necessary to investigate any of the numerous subjects covered.

The first volume of the Index appeared in 1892 and it has been published annually since 1906. Up to 1918 it was prepared and published by the Engineering Magazine Company, but since that time by the American Society of Mechanical Engineers. This volume, numbering nearly 800 pages, includes some 18,000 items which appear in engineering and other technical publications and more than 3,000 of these items are cross-references. Many 1924 publications received too late for inclusion in the 1924 Engineering Index as well as periodicals in 1925, which were received as late as February 1, 1925, are included in this volume. In the preparation of the index, the staff of the society reviewed more than 1,200 periodicals, reports and other publications regularly received during the year by the Engineering Societies Library, New York. The railway field, both steam and electric, is covered.

THE METALLURGY OF ALUMINIUM AND ALUMINIUM ALLOYS. *By Robert J. Anderson, B. Sc., Met. E., Consulting metallurgical engineer. Bound in cloth, 6¼ inches by 9¼ inches. 913 pages, illustrated. Published by Harry Carey Baird & Co., Inc., New York.*

This volume is an entirely new work and is said to be the only complete modern volume written on this subject. It contains 19 chapters and nearly 300 illustrations, supplemented by tables and charts. While the book is written primarily with a view to being practical, the more theoretical aspects have not been neglected. The average layman will find the introductory and second chapters to be quite interesting. These chapters give a historical survey of the aluminium industry and an account of where the various aluminium ores are found and how they are mined. Chapter three goes into the various phases of aluminium production. The remaining chapters explain the various processes used in making aluminium alloys, their uses and applications, aluminium-alloy melting practice, foundry practice and allied subjects.

PERSONAL

CHARLES F. PALMER, who was recently appointed manager of sales of the Pittsburgh Steel Products Company, has assumed his new duties at the company's general offices in Pittsburgh, Pa. Mr. Palmer has for about twenty years been active in sales and executive capacities in the railway supply business. Prior to his connection with the Pittsburgh Steel Products Company, he was with the Frank E. Palmer Supply Company, St. Louis, Mo., in an official capacity and previously was secretary of the J. W. Faessler Manufacturing Company, Moberly, Mo. For the past twelve years he has been manager of the Chicago office of the Pittsburgh Steel Products Company and two years ago was appointed manager of railway sales of the same company in connection with his managership of the Chicago office.

C. F. Palmer

C. H. Van Allen has been appointed manager of the Pittsburgh Steel Products Company's Chicago office to succeed Mr. Palmer. Mr. Van Allen served from 1893 to 1903 in various capacities with the Wabash, Pennsylvania and Lake Shore & Michigan Southern. Since 1913 Mr. Van Allen has been connected with the Chicago office of the Pittsburgh Steel Products Company.

C. H. Van Allen

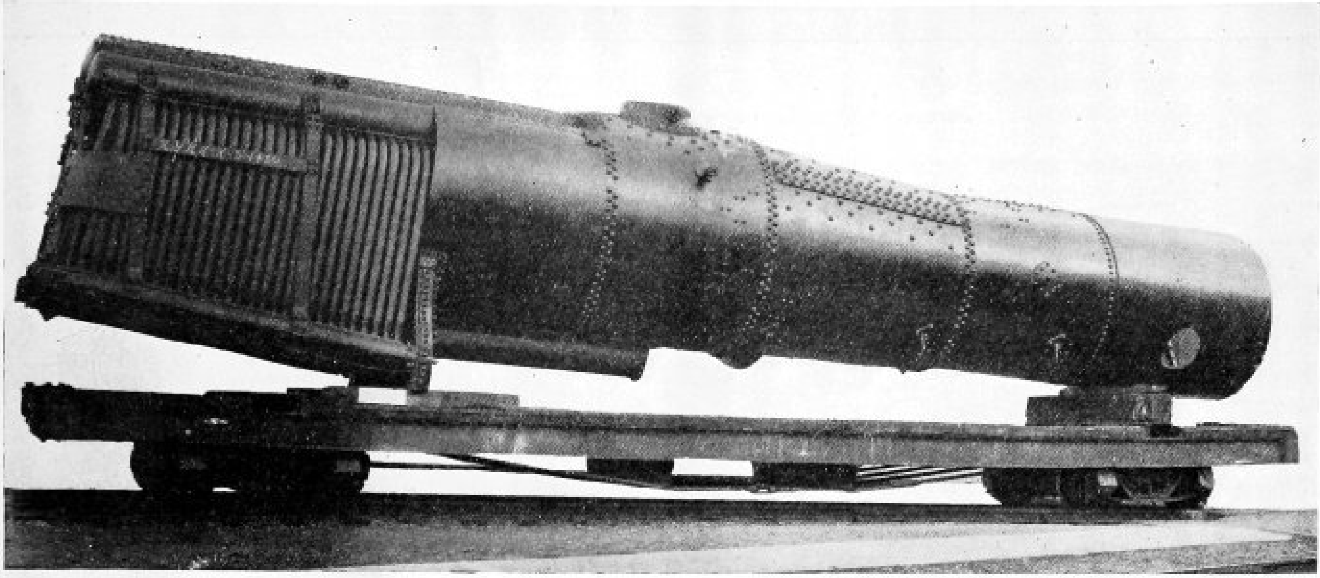


Fig. 1.—McClellon boiler ready for the test pit

Structural Changes in the McClellon Watertube Locomotive Boiler

Side watertube arrangement altered in recent order for ten locomotives for New York, New Haven and Hartford Railroad

THE American Locomotive Company, Schenectady, N. Y., has recently completed an order from the New York, New Haven and Hartford Railroad for the construction of 10 Mountain type locomotives equipped with the McClellon watertube boiler. An additional feature in the case of three of these engines is that they are of the three cylinder type.

Because of the outstanding features of this design and the interest which it created in the railroad field, a descriptive article giving the main details of the construction of the first Mountain type locomotive so equipped was published in the March issue of THE BOILER MAKER. A number of changes and modifications have been incorporated in the structure of the present order of McClellon boilers and in the following article these changes will be noted as well as certain methods of carrying out the work and precautions observed to make this boiler one of the finest in workmanship ever built.

In general the boiler, which is designed for 265 pounds working pressure, consists of a watertube firebox and watertube combustion chamber; that is, the sides, back end and the combustion chamber space are made up of single rows of watertubes. These are connected at the top to steam drums of which there are three running longitudinally. At the bottom, connection is made to a cast steel firebox ring in place of the conventional mud ring. The combustion chamber tubes are also connected at the top to the steam drums and at the bottom to a circulating chamber which will be described later.

CONNECTING THE WATERTUBES

In connecting the side watertubes to the steam drums, the first change from the previous engines occurs. In Fig. 1 and in Fig. 2 D, which show the boiler of the Mountain type locomotive as originally designed, it will be noted that the side tubes as well as the arch tubes enter the drums perpendicularly on the radius and are rolled and beaded. The side tubes enter the mud ring perpendicularly on the radius and are rolled and flared through the hand holes at the bottom of the firebox ring. The mud ring, which is a steel casting, is flat in section both inside and outside where the tube is inserted, while the bottom section of the mud ring where the plug is screwed in place is also flat.

In this first design the steam drums were made of ⅞-inch material planed down to ½ inch except for a section 4 inches wide which was left the original thickness at the point where the tubes entered. On the new boilers this planing has been eliminated and the entire drum is of ½-inch material. In order to maintain the efficiency of the construction, the side tubes are staggered where they enter the drum. The necessary strength is thus provided at the top by a double row of tubes which straighten at about one-third of the distance down and then enter the mud ring as a single row just as in the previous design. Figs. 3 and 4 show the mud ring and the steam drums assembled and connected by structural bracing.

An interesting feature of the drums is that it was necessary to cold flange them to meet the specifications of the railroad. The drums were made by the Riter-Connelly Company. The connections between the drums offered considerable difficulty in their fabrication since the flat sections at the joint had to be made absolutely tight—so tight in fact that a feeler 0.008 inch thick could not enter. In connection with the cast steel mud ring, hydrostatic tests were made before any holes were drilled. In this test the ring was subjected to a pressure of 350 pounds for the duration of one hour. The drums are connected by screw rivets. Should there be any opening between them the hot

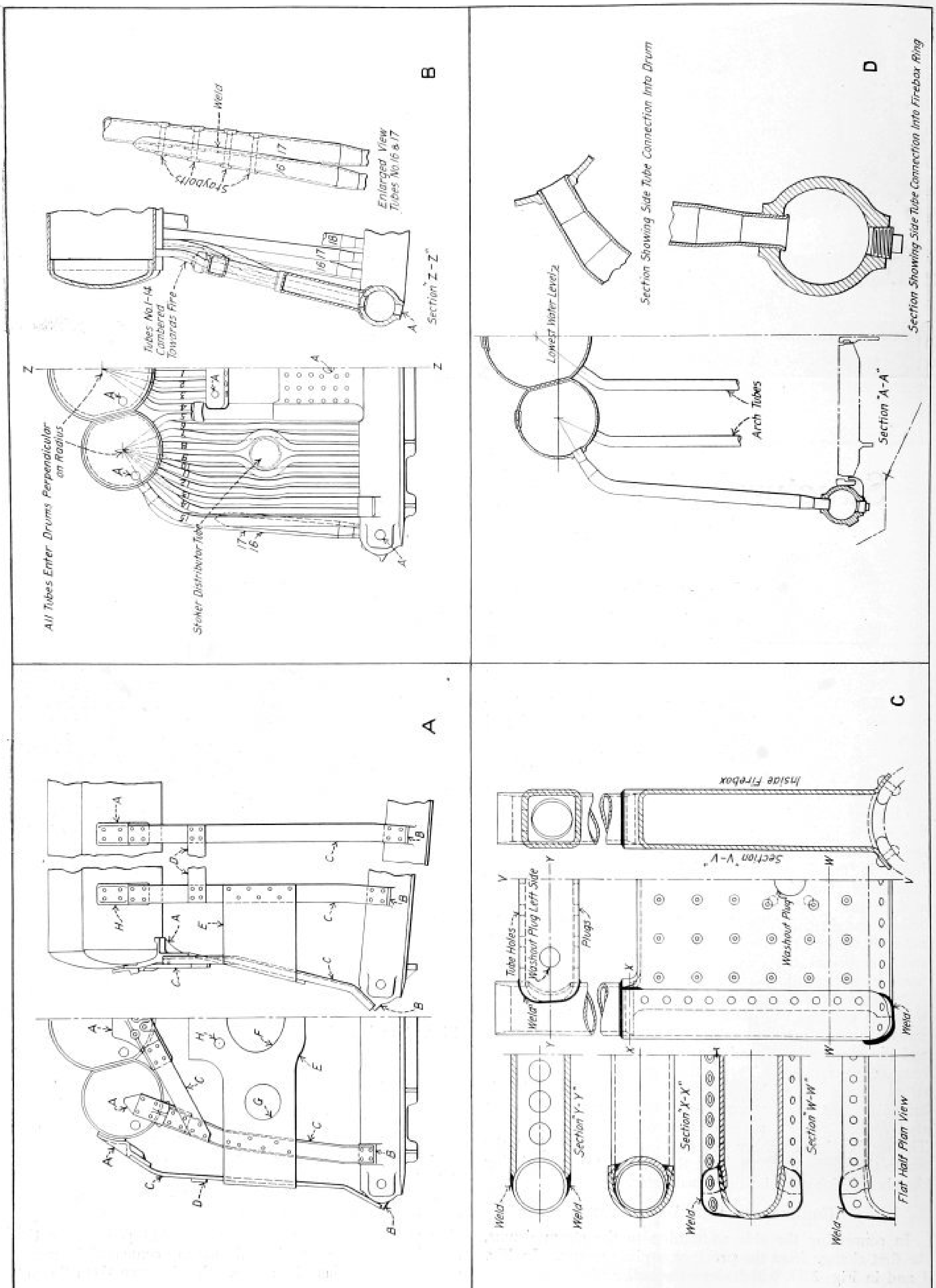


Fig. 2 A.—Firebox bracing. B.—Backhead tube arrangement. C.—Detail of backhead at firedoor. D.—Side tubes and arch tube details.

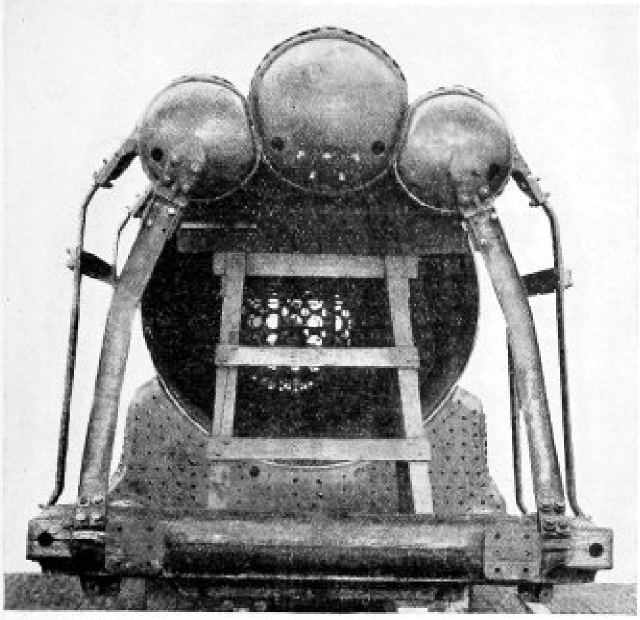


Fig. 3.—Steam drums and corner bracing

gases of combustion would destroy the lagging and, in addition, combustion efficiency would suffer.

Structural Bracing Between Drums and Mud Ring

Figs. 3 and 4 also indicate the method of bracing the steam drums and mud ring. Fig. 2 A shows the side bracing in detail. By means of this system of structural support all firebox tubes are independent of loads other than those imposed upon them by carrying hot water under pressure. The method of erection, referring to Fig. 2 A, is given in detail as follows: Castings A are applied to the drums and similar provisions made for castings B and the cast steel mud ring. Vertical members C are applied at these connections by means of fitted bolts. The joints between cast connections A, B and braces C embody the use of shoulders and lips to relieve bolts of all shearing action and to prevent working. Horizontal stiffness is obtained through braces D and E; the latter brace plate not only forms part of the firebox bracing, but also carries all heavy fittings and appliances formerly carried on the back head. The fire door opening is designated at F. On the first locomotive of this type the stoker distributor tubes entered through G. These openings are also shown in Fig. 5. Access to the washout plug on the left side of the fire door section of the back head is provided for through opening H. In the new locomotives, the openings in the back plate have been eliminated since underfeed stokers are now being installed.

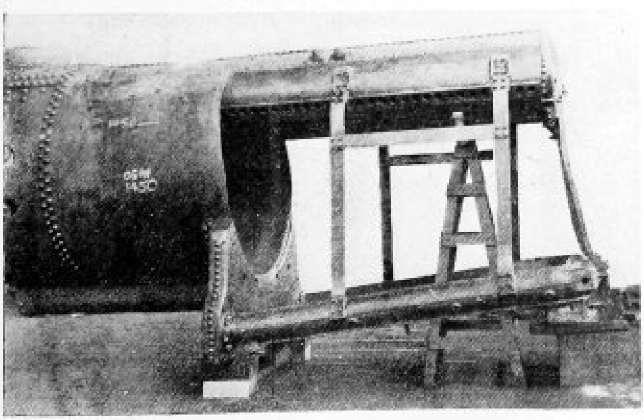


Fig. 4.—Back end in place ready for tube installation

The fire door opening shown in Fig. 2 C is built up of tubing and plate. The bottom section is in three pieces riveted and stayed together. The top section consists of tubing flattened to the required shape with tube holes on the top and plugs on the bottom. The sides are large tubes welded into the top and bottom sections.

In fitting up the bracing, the members are ground to the correct contour and then connected with bolts and lock nuts in order to provide for ready removal in case of repairs. The greatest care is exercised in obtaining correct alinement and contour of all braces for the accuracy of the entire firebox assembly of drums, mud ring tubes and back end all depend upon the accuracy of the work at this point.

Changes Made in Firebox Corner Tubes

The next variation in the building of the present engines over the original is demonstrated in Fig. 2 B which shows the back head tube arrangement. This drawing demonstrates the original design in which tubes numbers 1 to 14 are of 2-inch outside diameter and number 15 is 3-inch outside diameter for their entire length. Then numbers 16, 17, 18, etc. for the side tubes are 4-inch outside diameter swedged to 3 inches at the top and bottom. In this case tubes No. 16 and No. 17 which were formerly 4 inches outside diameter were joined about halfway up, as shown on the enlarged detail, by welding and staybolts. With the new design, these tubes have been changed so that this joint is eliminated. Tube No. 15 is 3 inches in diameter, tube No. 16 is 2 inches in diameter, tube No. 17 is 3 inches in diameter and then with No. 18 the 4-inch side tubes begin.

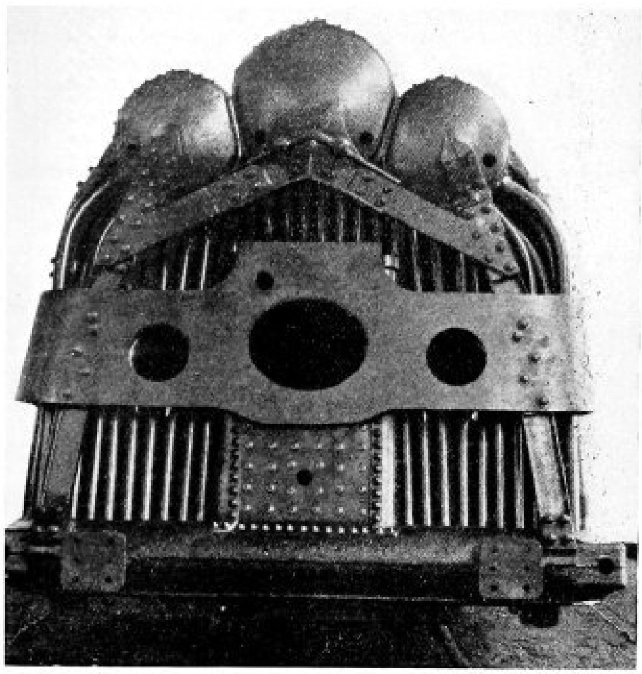


Fig. 5.—Furnace bearing plate-support for rear end

In Fig. 3 where the front flange of the throat sheet is connected to the dry shell all rivets are countersunk and ground off to a smooth finish so that they do not interfere with the application of the combustion tubes. When these tubes are in place they lie directly over the rivets. Fifteen combustion tubes are installed on each side of the dry shell.

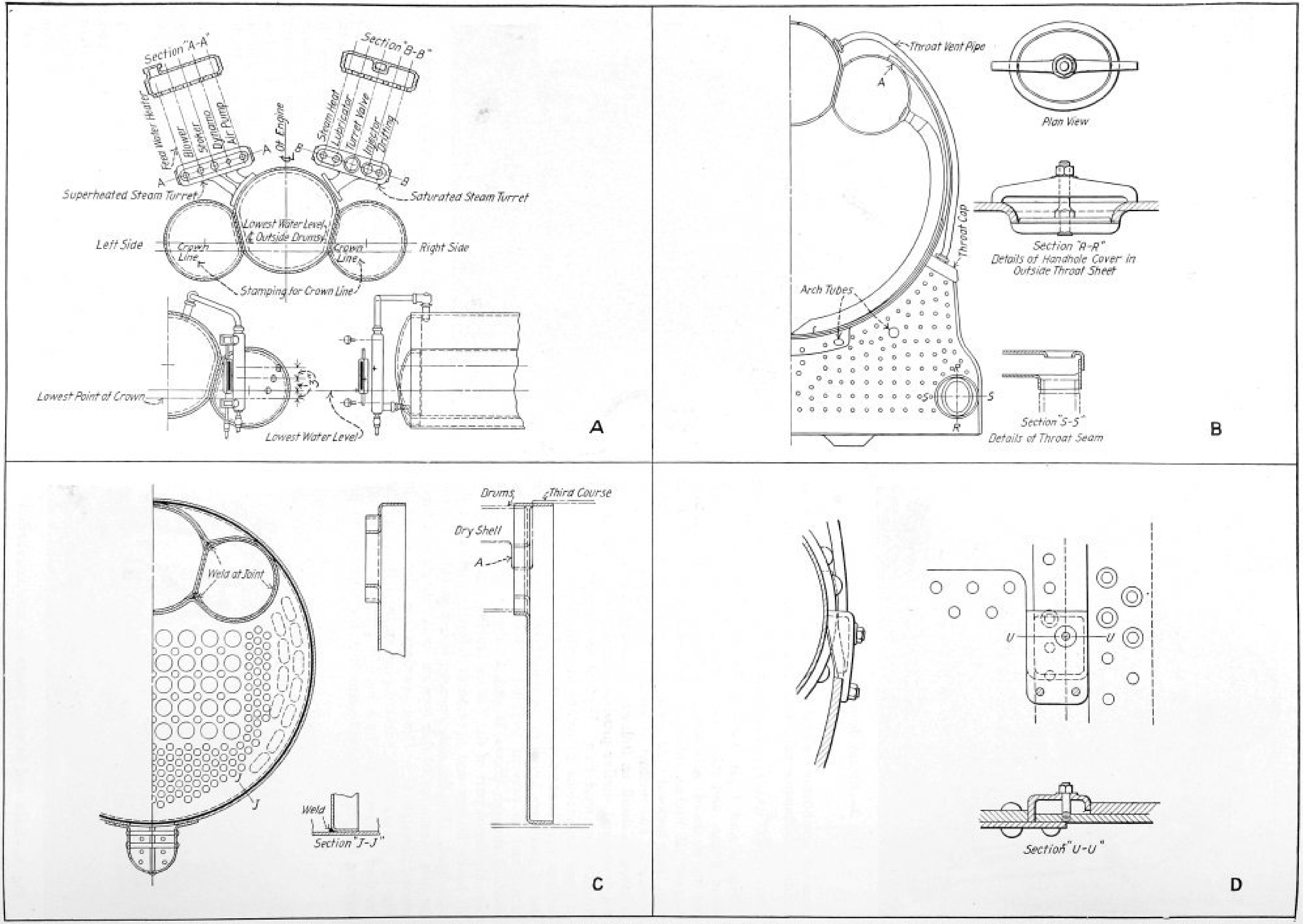


Fig. 6 A.—Arrangement of turrets, water columns and water glass. B.—Combustion chamber and inside throat sheet. C.—Back tube sheet arrangement. D.—Cover plate application, third course and dry shell

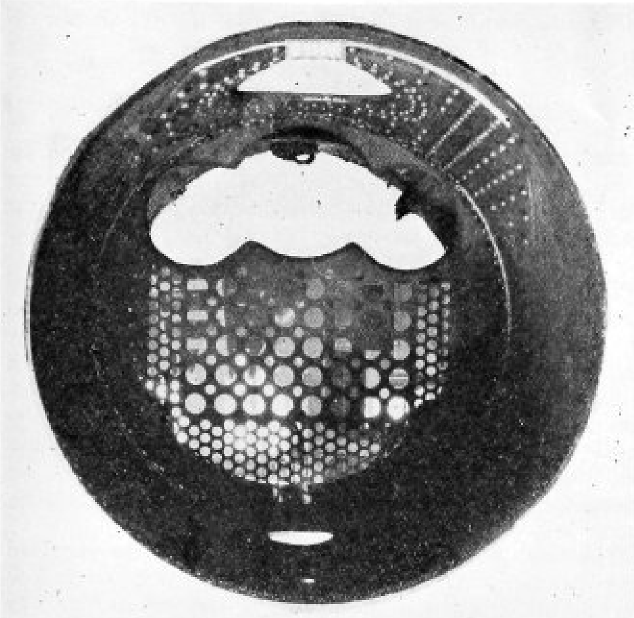


Fig. 7.—Back tube sheet looking from front end

In both the former and most recent designs these tubes are of 4 inches outside diameter swedged down to 3 inches at each end. The third course or dry shell is carried back to the throat to provide strength for the combustion chamber as well as for protection to the combustion chamber tubes. Fig. 6 B shows the original combustion chamber and inside throat sheet. In both designs the dry shell is riveted to the side drums at A. In this design also the tubes enter the side drums in exactly the same manner as the firebox tubes. They are bent to the contour of the third course with clearance for expansion and contraction. In the recent order, however, the combustion tubes are staggered at the top where they enter the steam drums in exactly the same manner as the side tubes in order to compensate for the change in the thickness of the drums.

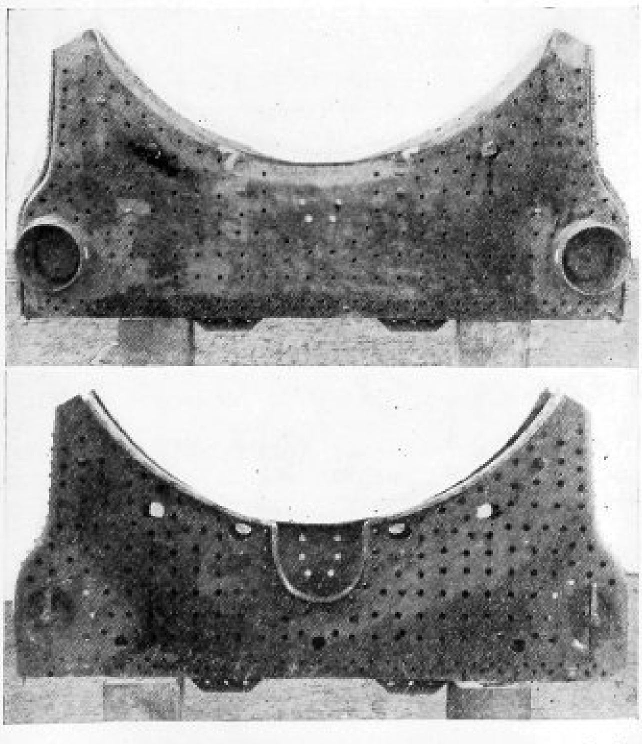


Fig. 8.—Inside throat sheet, showing openings for mud ring (top), and outside throat sheet (bottom)

Forming the Watertubes

In the application of all watertubes both in the firebox sides and the combustion chamber the tubes were first swedged at the ends and formed to shape. They were then lined up correctly in the boiler and removed again so that excess stock could be cut off. Each tube was marked for its proper place and then all were placed in the annealing furnace, after which they were re-applied. As noted previously, the tubes were rolled and beaded where they entered the steam drums and rolled and belled to a 45-degree angle in the mud ring. This method of tube installation applied to the new order as well as to the first engine.

In bending the watertubes requirements demanded that there be no flat spots in their entire length. In order to guard against inaccuracies each tube was bent to shape from its own template. A complete set of tube templates is furnished the railroad to ensure accuracy in replacing tubes.

In the first boiler, the back tube sheet of which is shown in Fig. 7, the fire tube installation consisted of 5½-inch flues and 2¼-inch tubes, a type A superheater being installed. The boilers for the new locomotives are fitted with a full installation of 3½-inch size tubes and flues,

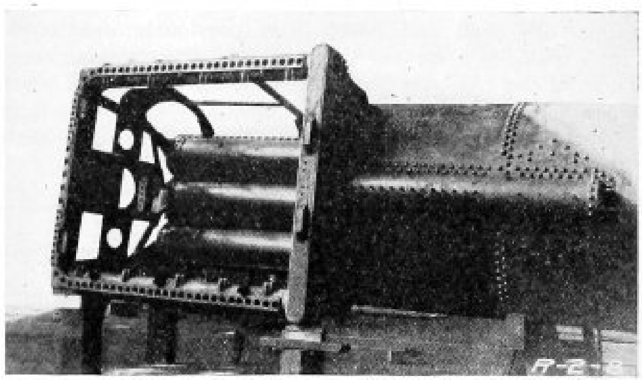


Fig. 9.—Boiler on side, showing location of circulation chamber

33 of these being tubes and 172 flues which accommodate the type E superheater.

Throat Sheet Construction

The throat sheet is exactly the same in each case. Illustrations, Fig. 8 and Fig. 6 B show both the inside and outside throat sheets assembled with their structural details. The throat is made up of two pieces with a lap seam at the sides. The inside throat is flanged out for the mud ring and the outside throat is flanged in for hand hole covers. The top corners of the throat are each provided with a copper pipe to vent any steam that may collect to the center drum.

In the newer engines, however, the method of closing the throat sheet corners has been slightly changed. In the case of the former type the plate was first welded in the opening between the inside and outside throat sheets. This plate has now been entirely eliminated. From this point on, however, the two locomotives are similar. The lap of the sheets at the end of the throat is smoothed by welding and scarfing and a flange cap is fitted in place while hot. After this fitting it is secured by screw rivets and welded to the dry shell and to the inside plate at the edges of the vent opening. The opening is then reamed and the studs applied. The original cap and vent pipe is shown in Fig. 6 B. In addition, the newer caps are flanged at the dry shell and connected by patch bolts and then welded.

Circulating Chamber

One extremely interesting feature for both the first design and the later construction is the method of attaching the combustion chamber tubes to the circulating trough. This trough or chamber is shown in Fig. 9. The combustion tubes are flattened and curved to fit the dry shell at the bottom and their ends are cut away at an angle. A hole through the flattened wall of the tube fits over a nipple applied through a hole in the dry shell and rolled, beaded and welded before the circulating chamber is put in place. The upper end of the nipple is rolled, beaded and welded in the tube, the work being done through the open or box end of the tube. Each tube end is then closed and made steam tight by a 1/4-inch cover plate over which the edges of the tube are flanged and welded. A space block is applied between the right and left tubes of each pair to relieve the nipples of shearing action. Stresses in the circulating chamber are provided for by vertical and horizontal staybolts and stay rods which extend from the combustion chamber cap to the throat sheet.

Application of Dry Shell

Fig. 6 D details the method of applying the third course, dry shell and cover plate previously mentioned. Fig. 7 which is a view of the back tube sheet looking from the front end indicates the flanges formed in the tube sheet where the steam drums are fastened. At this point it is essential that all joints be accessible for calking. Such calking is readily possible except where the dry shell overlaps the tube sheet flanges at the right and left sides where the drums enter the tube sheet. To facilitate maintenance, the dry shell is recessed to permit calking this seam externally and directly. This recess would open the combustion chamber and permit the direct escape of the gases against the lagging except for the fact that the cover plate, as shown in Fig. 6 D, effectively seals the opening.

Flanged Sheets

In all flange work on this boiler great care was observed in preventing any misalinement. All sheets were flanged and fitted to profiles laid out on boiler plate before any holes were driven. The plates were also fitted up as a check before the drilling operation. The holes were drilled from jigs, particular care being exercised in drilling tube holes in the steam drums and cast steel mud ring, as the slightest deviation in location would affect the bridging or area between the tube holes thus reducing the allowable safety factor which was 5 throughout the entire boiler.

The shell flanging and assembly followed the standard shop practice. All circumferential seams were riveted on the bull under a hydraulic pressure of 100 to 125 tons. In order to safeguard against leaks these rivets were all held at least 8 seconds under pressure.

The only other changes in the present order of New York, New Haven and Hartford locomotives is the application of a modified form of the M-K-T type smokebox having a table plate through the smokebox on which the throttle pipes are mounted and a cut-out in the shell on either side so that the steam pipes lie outside the smokebox proper.

A Superior type soot blower is mounted through open-

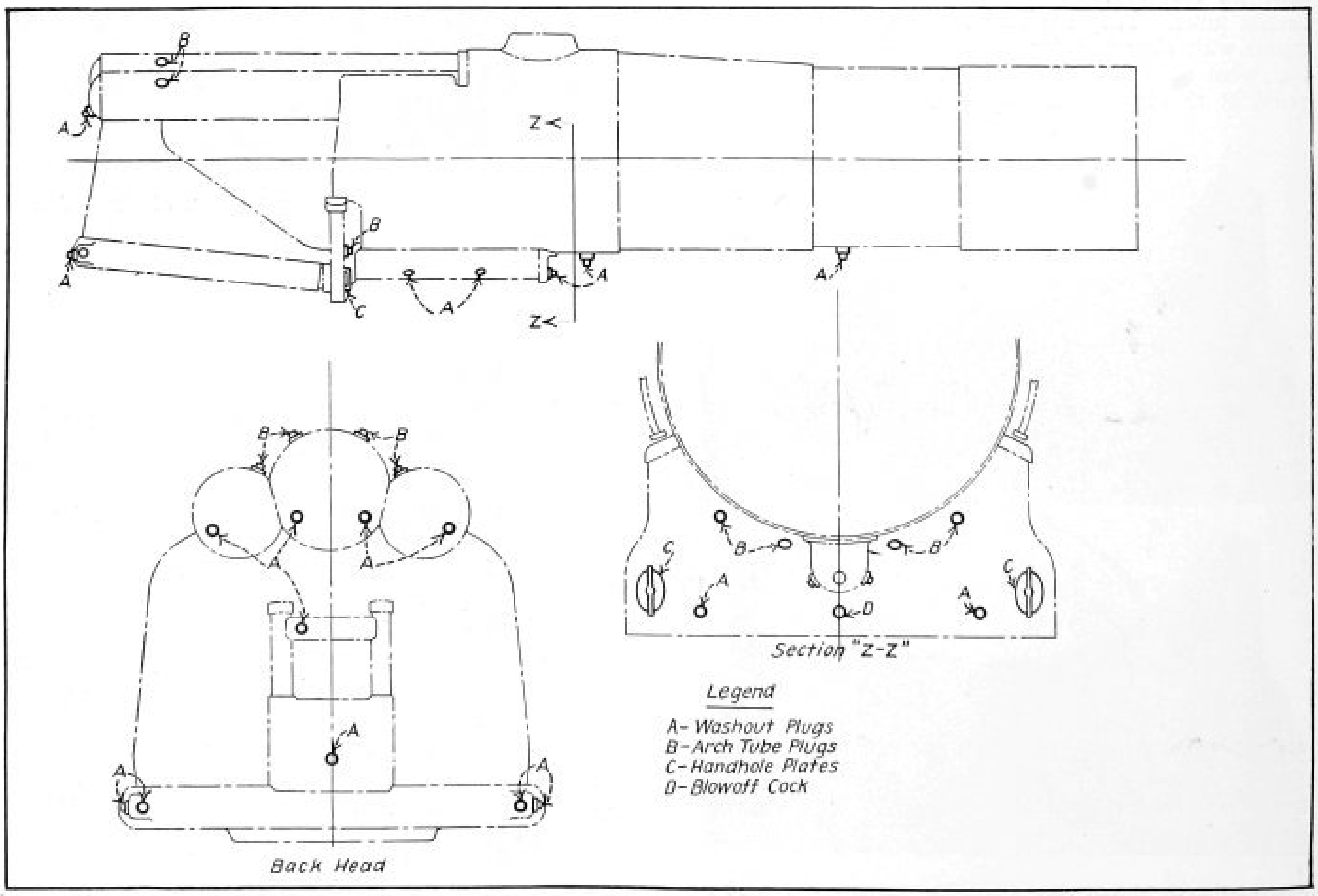


Fig. 10.—Location of plugs and openings for washing out boiler

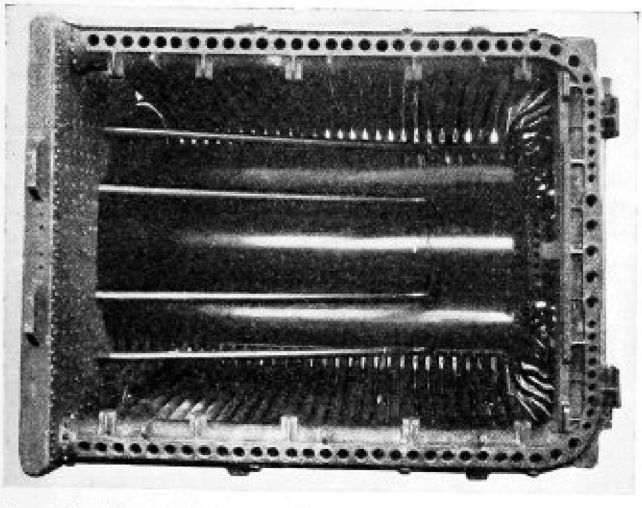


Fig. 11.—View looking into firebox, showing arch tubes and side vertical tubes

ings in the rear end of the dry shell so that they can be controlled readily from outside the boiler.

Before completing the boilers each was given a hydrostatic test with warm water at 331 pounds pressure and three fire tests.

All engines of this type in service on the New York, New Haven and Hartford Railroad are giving excellent performance and have in every way met the requirements of the designers.

Doubling Boiler Capacity

At the Fordson power plant of the Ford Motor Company, on the River Rouge, an important problem came up some time ago. The plant, originally laid out for 65,000 kilowatts, was increased first to 100,000 and then to 240,000 kilowatts capacity. In the boiler room there were eight units and practically no space for any more. These units were designed for continuous running at 250 to 300 percent of nominal rating when burning simultaneously blast-furnace gas and powdered fuel. The problem of how to make the furnaces do added duty was solved in the following manner.

On the first furnace to be remodeled the number of powdered coal burners was increased from six to twelve on each side, giving a coal-burning capacity of 72,000 pounds per hour, and to permit operation up to 660 percent of rating, water cooling for the side walls and a water screen across the bottom of the furnace were provided. Forced- and induced-draft and primary air fans of adequate size, plate-type air preheaters, and an elaborate system of controls were added features in the furnace-rebuilding program. The work on one furnace has been completed recently, and the installation is being given a thorough trial before the remodeling of the other seven is undertaken. Up to the time of this writing, the unit had been running continuously, 24 hours a day, at 500 percent of the original rating of the boiler.

An unusual feature is the arrangement of the side-wall cooling surface and the water screen at the bottom of the furnace into complete circulating systems independent of the boiler proper, in which steam is generated, passed through radiant superheaters behind the side-wall tubes, and delivered under the same conditions, 225 pounds gage pressure and 200 degrees F., as the steam from the boiler.

The radiant superheater was installed so that it is protected from excessive temperature by the side-wall surface and at the same, owing to the omission of the fins on the side wall, tubes at this point may absorb the radiant heat from the fire. The convection superheaters in the first bank of boiler tubes on either side were retained and the radiant superheaters installed in addition, as it would have been impossible to add sufficient convection surface to take care of the increased output of steam without undue pressure drop.

In addition to the water-cooling surface previously mentioned, it was considered desirable to protect the arches guarding the lower boiler drums. In front of each of the two arches are thirty-four 3¼-inch tubes spaced on 7½-inch centers, which connect into a header at their lower ends and into the boiler drum at their upper ends. Loose-fit tubes continue through the drum into the last row of tubes in the center bank, so that the circulation is positively directed toward the upper boiler drums. The headers are supplied with water from the lower boiler drums through four 4-inch tubes at both ends of the drums. In the two arch screens there is 750 square feet of heating surface, this being distinct, however, from the other cooling surface, as it is connected directly into the boiler circulation.

Air preheaters are of the plate type and are enclosed in a heavy casing, outside of which is 3 inches of insulation covered by light-gage panel plates. In the preheaters the air is raised in temperature to a maximum of 519 degrees F.

Air is supplied to the feeders at a temperature of 200 degrees F., which means that under certain conditions such as at maximum rating it was necessary to lower the temperature of this air before it entered the feeders, of which there are six at each side of the boiler, each driven by an individual motor capable of handling 6,000 pounds of coal an hour. To do this cooling, a specially designed damper box was provided at the intake of the fan which has one side open to permit drawing in air at room temperature. At the side of this box there is connected to the damper shaft a thermostat control with a spring balance regulating the amount of cool air drawn into the fan and keeping the temperature at approximately 200 degrees F.

By these methods the amount of coal that can be burned per boiler has been raised to 72,000 pounds per hour and the boilers made to operate at over 600 percent of rating.—*Power.*

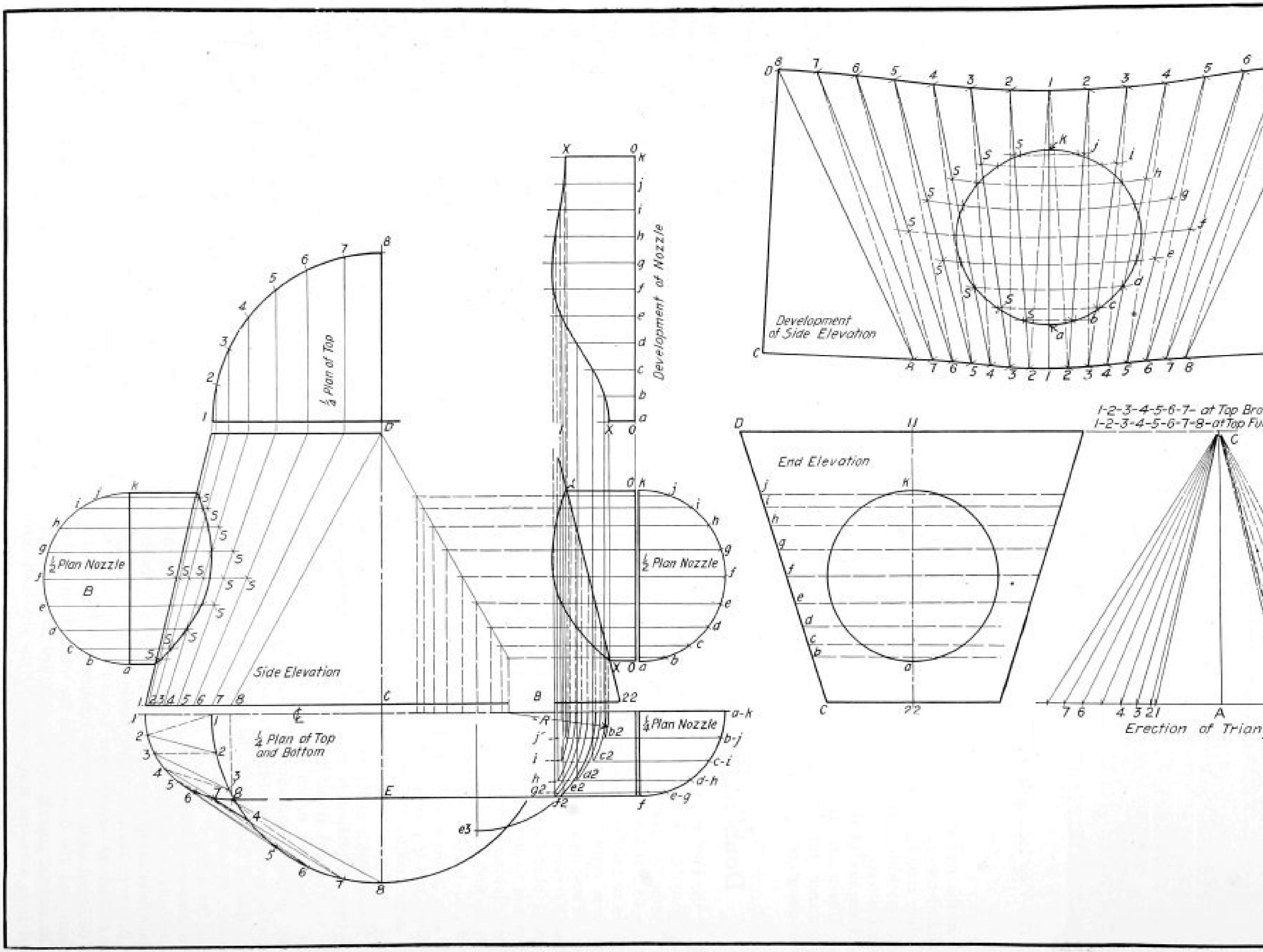
Trade Publications

Expansion Reamer.—The No. 717 spiral flute expansion reamer is fully described and illustrated in a four-page circular being distributed by the Morse Twist Drill & Machine Company, New Bedford, Mass.

Welding and Cutting Apparatus.—The Purox Company, Denver, Colo., has issued catalogue No. 6 descriptive of its apparatus for welding and cutting metals. The oxygen-acetylene welding process is briefly described, also the points and principles used in the design and construction of the Purox equipment. An apparatus and supplies price list accompanies this catalogue.

Machine Tools.—Four circulars descriptive of the construction and operation of the Niles 90-inch quartering machine, the Niles car wheel borer, the Niles 90-inch journal turning lathe and Time-Saver planers, respectively, have been issued by the Niles Tool Works Company, Hamilton, Ohio.

Hoisting and Hauling.—A 16 page booklet entitled "Handy hoisting and hauling," has been issued by the Sullivan Machinery Company, 122 South Michigan avenue, Chicago. The service rendered by the Sullivan Turbinair steam and electric portable hoists is described in this booklet which shows many of the uses to which these hoists have been adapted.



Details of side nozzle and stack base intersection.

Intersection of a Side Nozzle With a Stack Base

Explanation of methods for solving this problem including a solution by triangulation

By J. E. Bossingham

IN the development of this problem you will note that there are two stages by which the desired result may be obtained, viz., one by triangulation and the other by the extension of lines from the intersection of converging lines.

The triangulation method will be first described. On the quarter *Plan of Top and Bottom* first draw line *C/L* a little longer than the required distance to make the full length of the stack base plus the length of the nozzle and the quarter plan of the nozzle, that is from point 1 at the extreme left on the *C/L* to the point *a—k*. Then with point 8 on *C/L* as a radial center draw a quarter circle, from point 1 to 8 and from point 8 extend a line parallel to *C/L* and to point *f*. With point *C* as a center draw a quarter circle from point 1 to 8. Draw line 1—*C*—22 on the side elevation equal to the full length of the stack base. At point *C* on this line erect a perpendicular line equal to the required height of the stack base. At point *D* draw a horizontal line 1—*D*—11 equal to the diameter of the stack base at the top. Connect points 1 and 11 at the top to points—1 and 22 at the bottom; this gives the full lines *Side Elevation* and the quarter *Plan of Top and Bottom*.

Divide the quarter circles of the top and bottom plan each into the same number of equal parts, as points 1, 2, 3, 4, 5, 6, 7 and 8. Connect points 1 to 1, 2 to 2, 3 to 3, 4 to 4, 5 to 5, 6 to 6, 7 to 7, and 8 to 8 with solid lines, then draw broken lines from 1 to 2, 2 to 3, 3 to 4, 4 to 5, 5 to 6, 6 to 7 and 7 to 8.

Now make the *Erection of Triangles* by drawing horizontal line *B* about twice the length of solid line 8 to 8. At point *A* on this line erect a perpendicular line at point *C* making this the same height as shown on the *Side Elevation* from point *C* to *D*. Set the dividers to the different lengths of the solid lines on the quarter *Plan* of 1 to 1, 2 to 2 and up to 8 to 8. Transfer these lengths from point *A* as shown on the drawing by points numbered 1, 2, 3, 4, 5, 6, 7 and 8 on the line *D*. Likewise set off the lengths of the broken lines from the quarter plan (1 to 2, 2 to 3, and up to 7 to 8) on line *B*, as shown by points 3, 4, 2, 5, 6, 7 and 8.

With the dividers set from these numbered points on line *B* to the point *C* we arrive at the development of the side elevation, as follows: First draw solid line 1 to 1 (on *Development of Side Elevation*) equal to *C* to 1 from *Erection of Triangles*. Now with the dividers set at the same spacing as 1 to 8 on quarter *Plan of Bottom*, draw a short arc each side of point 1 at the bottom. Then set the dividers equal to the distance *C* to 2 and with one point of the dividers on 1 at the top draw a short arc through the short arc from point 1 at the bottom. This gives us the broken line from point 1 at the top to point 2 at the bottom. Set the dividers equal to the solid line 2 to *C* from *Erection of Triangles* and with one point of dividers on point 2 at the bottom draw through the short arc from point 1 at the top and draw the solid line from point 2 at the bottom to point 2 at the top.

Proceed in like manner with alternating solid and broken lines until you have laid out all the lines up to points 8 to 8 on each side of lines 1 to 1. Set dividers *C* to 8 on the side elevation and with one point of the dividers on point 8 of *Development* cut a short arc, then with dividers equal to *D C* on the end *Elevation*, cut the short arc just drawn from point 8. This gives us point *C* and with straight lines from points 8 and *D*—8 to *C* gives us the full half development of the stack base as shown by the *Side and End Elevations*.

To secure the development of the nozzle, first draw at the right hand of *Side Elevation* the half *Plan* of *Nozzle A*. Space the half circle into an equal number of spaces *a—k*, extend horizontal lines from these points to slant line 11—22 and on over to slant line *D B*. Where horizontal lines *b, c, d, e, f, g, h, i, j* intersect line 11—22 drop perpendicular lines to *C/L* of *Plan*. Likewise the lines *b* to *j* should be extended to line *D—B* and thence dropped to *C/L* at points marked *j, i, h, g, f, e, d, c, b*, and with these points as a radial center (see b......R......b2) draw arcs, *b2, c2, d2, e2, f2, g2, h2, i2*, and *j2*, intersecting horizontal lines *a—k, b—j, c—i, d—h, e—g* and *f*. From these intersecting points extend up perpendicular lines to the lines *a, b, c, d, e, f, g, h, i, j, k*. These points of intersection are the true points of contact of the nozzle with the *Stack Base*.

Nozzle Development

To develop the nozzle extend the line *O—O* up to *Development of Nozzle*, spacing this line into the same number of equal spaces as appears on the half *Plan* of *Nozzle A* viz., points *a, b, c, d, e, f, g, h, i, j* and *k*. From these points extend indefinite horizontal lines to the left of line *O—O*. Now extend perpendicular lines from the intersection of *b2* with *b*, *c2* with *c*, *d2* with *d*, *e2* with *e*, *f2* with *f*, *g2* with *g*, *h2* with *h*, *i2* with *i*, *j2* with *j*, *x* with *a* and *x* with *k*, up to horizontal lines *a, b, c, d, e, f, g, h, i, j* and *k*. These points of intersection give us the layout of one-half of *Nozzle A*. To secure the lines of intersection of the *Nozzle* on the *Stack Base*, draw the half *Plan of Nozzle B* extending these lines from the division of the half circle (same as half *Plan Nozzle A*) over to the solid lines 1, 2, 3, 4, 5 and 6 of the *Side Elevation*. Where these lines intersect, as shown on line *f* and others by the mark *S*, take the actual distance from the bottom line of the *Side Elevation* up to these points of intersection on the lines 1, 2, 3, 4, 5 and 6 and transfer to the corresponding numbered lines on *Development of Side Elevation* as shown by the mark *S* to the left of line 1—1 and also to the right of line 1—1.

To secure the actual measurement of the several lines *a, b, c, d, e, f, g, h, i, j* and *k* (note: points *a* and *k* are negative points of distance on the line 11—22 of the *Side Elevation*) from the *C/L* take the actual length of the arcs *b2, c2, d2, e2, f2, g2, h2, i2* and *j2*, and set these distances off on each side of line 1—1 and with these several points of contact of the nozzle with the stack base you have the true layout.

On the quarter *Plan of Top* of the *Side Elevation* the points of division on the quarter circle which are dropped down to the line 1—*D*—11 and the points 1, 2, 3, 4, 5, 6, 7 and 8 extended up from the bottom plan to the bottom line of the *Side Elevation* are connected by solid lines from top to bottom, as shown on the side elevation. These are used to obtain the development of the nozzle with the stack base, which has just been explained in detail.

The *End Elevation* is really unnecessary in the development of this problem, but is of assistance in proving that the lines of intersection are accurate. For instance, take the line *e* on the *End Elevation*, from 11—22 to line *D C* is equal to line *e* from line 11—22 *D B* on the *Side Elevation*. This is proved by dropping line *e* on the *Side Elevation* down to and intersecting the continuation of arc *e2* and this intersection gives us point *e3*. This point is the actual half circle on the line *e* either on the *Side* or *End Elevation*. The line *D C* as shown on the drawing is the true length, but can be secured by triangulation. With the distance *E* to 8 as a base line and the height *C* to *D* set at right angles to the line *E* to 8, the length of the hypothenuse is equal to *D C* on the development of the *Side Elevation*.

Blowoff Tank Explosions

THE rather common belief that blowoff tanks are never subject to any serious pressure is disproved every once in a while by an explosion of one of these vessels. It is true that they are not continuously under pressure when they are properly installed and vented and all the connections are kept free and clear; but conditions often arise which cause heavy internal loads to be thrown on them for short periods. Under these circumstances the tanks are likely to burst if the material is unsuitable or the construction is weak.

A case in point is the explosion of a blowoff tank which occurred a short time ago. In this instance the lower part of the tank gave way, and the remainder, which comprised the greater portion, ascended like a skyrocket and then fell back into approximately its original position.

At the time of the accident the fireman was blowing down No. 2 boiler of the battery, which was directly in front of the blowoff tank. The force of the explosion threw him away from the spot where he was standing, and he was unable to return to the blowoff valve to close it on account of the escaping steam. He immediately went to the front of the boilers, however, and drew the fires. He was scalded to some extent, and his hip was injured. The property damage was small.

This was a cast iron tank 36 inches in diameter and 48 inches long. The thickness of the shell varied from 13/32 of an inch to ½ of an inch. The discharge pipe from the boiler to the tank was 2½ inches in diameter. A vent pipe of the same diameter led from the tank to the open air above the boiler room, and there was also an overflow pipe 2½ inches in diameter leading from the tank to the sewer.

So far as these facts go, it would appear that the piping and connections had been properly installed; and an examination of the wreckage after the explosion, failed to disclose any evidence of stoppages or obstructions in the pipes. It seems possible, therefore, that the explosion was caused by opening the blowoff valve too quickly while the tank was already nearly full of water, and thereby causing the tank to become completely filled, quite suddenly, by the additional water that rushed out of the blowoff pipe under boiler pressure. The overflow and vent pipes would ordinarily relieve the pressure sufficiently, if the blowoff valve were opened slowly and cautiously; but if it were opened suddenly it is quite possible that these pipes might become choked with water, so that sufficient pressure would be imposed on the tank, before they could be cleared, to cause it to burst.

Another possible theory is that water-hammer action might have been set up when the hot water and steam from the boiler came in contact with the comparatively cool water in the blowoff tank. It is a well known fact that violent shocks and strains may be caused by water hammer, and that pipes, fittings, and vessels of various kinds are often ruptured by them.

The two theories here advanced as to the cause of this explosion are merely speculative, and are suggested because of the lack of definite information concerning this particular case. Perhaps the actual cause was of an entirely different nature. However, the accident furnishes additional proof of the danger of using cast iron blowoff tanks. We have repeatedly urged the use of of boiler plate for the construction of blowoff tanks, and recommended that the tanks be built strong enough in all respects to withstand the maximum pressure allowed on the boilers to which they are connected. The difference in cost would not be excessive, and the greater resulting safety would be an important consideration.

In every case, the area of the overflow pipe, and also the area of the vent pipe, should be equal to at least three times the area of the boiler blowoff pipe. There should be no valve in either the overflow pipe or the vent pipe, and care should be taken to keep both of these pipes clear, and to prevent them from freezing up in cold weather. Furthermore, if the tank must be set below the floor level it should not be buried in the ground but should be placed in a pit, and sufficient space should be left on all sides of it to allow thorough inspections to be made. A manhole should be provided in the tank (or a large handhole, if the tank is of small size) to make it possible to examine the interior.

The accident here described also affords an appropriate opportunity to speak another word of caution concerning the manipulation of blowoff valves. These should invariably be opened slowly and carefully otherwise dangerous shocks and strains are likely to be produced, which may rupture the blowoff pipes or their fittings, or may cause even more serious trouble. When blowing down a boiler the attendant should "stand by" the blowoff valve, preferably during the entire operation, and some other competent person should keep careful watch of the gage glass to make sure that the water is not drawn down below the safe level. If any unusual noise or disturbance is noted when the blowoff valve is first opened or during the blowing-down operation, the valve should be closed at once and an investigation made to discover the cause of the anomalous behavior.

On account of the tremendous amount of energy stored up in a steam boiler, it is absolutely imperative that every possible precaution be observed not only in connection with the boiler itself but also with regard to all its auxiliary equipment, attachments, and connections. The greater the amount of attention given to these things, the more infrequent will become the accidents and explosions that endanger lives and property.—*The Travelers Standard*.

Keeping Up With the Procession

THE higher pressures required in many types of vessels by modern demands mean not only heavier plates and machinery, but larger and truer size rivets as well. The fabricator of such products cannot afford to overlook this detail and even though he installs a high power hydraulic riveter, he must also look for "high power" rivets to use it on.

The Champion Rivet Company of Cleveland announces the installation of the heavy improved machinery for the manufacture of accurate rivets up to and including 2½ inches in diameter.

Champion "True Tolerance" rivets for high pressure work are furnished accurately round within .0156-inch (1/64-inch) and within .0156-inch (1/64-inch) of the nominal size ordered. By using them it is claimed that the fabricator can maintain a smaller clearance than ordinarily and can turn out his work with practically no calking.

This announcement should prove of interest to those turning out high pressure work made to exacting specifications, as ordinary boiler quality rivets will not ordinarily give the results and satisfaction desired for high grade products of a special character.

Properties of Steel Filler Rods for Welding*

Manufacture and study of iron and steel filler rods for gas and metallic arc welding

As this article deals exclusively with iron or steel and its alloys, a clear understanding of these terms is necessary, especially as much confusion as to the meaning of both words exists in the welding industry.

One reason for this confusion is because the terms "Iron" and "Steel" have different meanings to chemists, who are chiefly concerned with the composition of materials, and to manufacturers who consider mainly the processes by which these materials are made. To the chemist, any of the common iron and steel commodities are iron, the chemical element, because this element is predominant in their composition.

The manufacturer of these commodities, however, makes a distinction between iron and steel based upon the method by which the pig iron is refined to the workable materials of modern commerce. When the pig iron is refined by the old-fashioned puddling process, which is now almost extinct, it is called "iron." When it is refined by the modern melting methods in an open hearth furnace or Bessemer converter, it is called "steel."

Another reason for the confusion is because welding rods used in the early days of the new art came from Europe and were made by the puddling process so were properly termed "iron welding rods." These rods contained very little carbon or manganese. However, they were not only expensive but were also notably lacking in uniformity as the puddled iron could not be freed from ruinous inclusions of furnace slag, so they were discarded in favor of welding rods made by the basic open hearth process. In fact, most carefully written specifications on welding rod definitely exclude material made by the puddling process.

In recent years, the term ingot iron was devised to denote an open hearth steel having the low carbon and manganese contents of puddled iron.

As all the popular brands of welding rods on the American market are made by the melting process, they will hereafter in this booklet be referred to as steel for the sake of brevity.

The terms Norway and Swedish iron as applied to the great majority of welding rods on the American market today are misnomers.

Method of Manufacturing Filler Rods

In order that the reader may understand some of the later points in this article, a brief description of the various manufacturing processes through which the welding rod passes is necessary.

The steel is poured molten from the furnace in which it has been refined into an ingot mold holding several tons. After it has solidified in the mold, the ingot is rolled hot into a billet and this billet is in turn rolled hot to a round shape of one-half to one-quarter inch diameter and a length of several hundred feet. When coiled up, the material is called a wire rod and is the raw material from which the welding rod is drawn in the wire mill.

The wire mill first removes the hot mill scale from the wire rods by pickling them in hot sulphuric acid. After the pickling operation is completed, the rods are allowed to stand until they have accumulated a slimy rust or sull coat which acts as a lubricant in the drawing operation, after which they are dipped in a tub of hot lime, which also acts as a lubricant. The lime coating is baked on in an oven and when the baking is completed the rods are ready to be drawn.

The drawing consists of passing the wire rod cold through a die which reduces the diameter and increases the length of the material. Naturally not much reduction can be made on a single pass through the die, so the wire is passed time and again through smaller and smaller dies until the desired size is attained.

The displacement of metal that occurs in this cold drawing process naturally requires lubrication of a rather unusual sort. Lime has been referred to and is always used in the first few passes.

Another method of lubrication, however, is employed in the wet process of drawing which follows the dry or lime drawing. Some other metal usually copper, is deposited on the wire and furnishes the lubricant. The copper, however, can only be deposited on a chemically cleaned coil of wire from which all the lime coating has been removed.

Therefore a copper coated filler rod will have a chemically clean surface while a bare rod will have considerable amounts of lime adhering to the surface.

Rods for Gas and Electric Welding

Many welders have asked why filler rods for oxy-acetylene welding were furnished copper coated and for electric welding they were left bare. The idea that there is a radical difference between the two is quite prevalent but as a matter of fact the difference is only in the surface.

In electric welding the lime adhering to the bare rods has a marked steadying influence on the arc and is therefore very desirable; in fact, usually essential to good welding. The heat of the arc seems, except under freak conditions, to be always sufficient to float the arc-passed lime to the top and out of the weld metal so there are no detrimental occlusions.

Copper Coated Rods

In gas welding this is seldom the case, so the use of a copper coated rod, the surface of which is free from lime, is highly desirable. If a bare rod is used for gas welding the lime will sooner or later become entangled in the weld and cause trouble. On the other hand, if a coppered rod or even a bare rod from which all the lime has been removed with emery is used by the metallic arc welder the arc is so wild that it is difficult to do good work. These are the facts back of the popularity of coppered rods for gas welding and bare for electric, and this surface difference is the only real one that the welding rod manufacturer makes.

The above remarks refer especially to the low-carbon steels. In the case of high-carbon and alloy steels, somewhat different conditions obtain. These wires are generally so hard that practically all the lime is scraped off passing through the die and virtually none remains on the filler rod when it is down to finish size. It is therefore customary to supply the high-carbons and alloys in the same bare finish for both gas and electric welding. When these rods are used for metallic arc welding they are notorious for the wildness of the arc which is chiefly caused by the absence of lime on the surface, "flux coating" makes these rods much more controllable.

Causes of Weld Failures

In low-carbon steel welds there are three general reasons for the weld metal falling short of its maximum strength.

*Published through the courtesy of the Chicago Steel and Wire Company, Chicago, Ill., from data compiled by this company.

These reasons are:

1—Incomplete fusion.

2—Slag occluded in the weld.

3—Blow holes in the weld.

In the case of high-carbon or alloy steels, "heat treatment" must also be added.

Considering first gas welding, incomplete fusion is almost entirely due to the lack of manual skill of the operator in the handling of the torch, and the selection of proper size of filler rod and tip bore is secondarily important.

Slag, or sonims, occluded in the weld can be partially controlled by the operator and partially by the rod manufacturer. The word "sonim" is a contraction of the words "solid non-metallic impurities." Usually these sonims are bits of refractory lining from the steel furnace, slag which has been drawn off into the ingot mold with the molten steel, or, if bare rod is used, they are lime particles. It is rather rare to find them as occluded slag drawn off with the metal as this slag floats to the top in the steel furnace and does not readily mix with the metal. Furthermore, if present in particles of appreciable size, this slag causes breaks in the wire mill preventing the successful drawing of the steel into filler rod.

If the gas welder, who is not usually heating the filler rod far above its melting point, notices unusually bright specks floating on the molten weld metal under the torch, the presence of sonims is to be suspected. They can sometimes be floated to the top of the weld metal and thus kept from endangering the strength of the weld by using a larger tip capable of heating the metal to a very high temperature.

Blow holes are practically out of the welders' control as they are caused by gas or gas-forming ingredients in the filler rod. They constitute a problem for the filler rod manufacturer.

Surveying the same three reasons for weld failure from the standpoint of the electric welder, incomplete fusion is still up to the operator. However, his manual skill is secondary to his judgment in selecting the proper grade and size of filler rod and in using the proper current. If he uses good judgment in these matters, his skill is much less essential.

Sonims or occluded slag in the weld metal are very rare in metallic arc welding as the heat of the arc is practically always much more than sufficient to float them to the surface.

Blow holes are due to the electrode, the same as in gas welding, and are out of the operator's control.

Hydrogen and gas forming materials are the causes, and along with blow holes they also are the causes of irregular flow and sputtering both in gas and electric rods. A full understanding of these matters is probably as important as any item to the welder if good welds are desired.

Gas in Filler Rod

Gas in filler rod is the most difficult trouble maker to eliminate, the most difficult to identify or measure quantitatively and yet is a major factor in determining the quality of the rod. The subject of the presence and its importance of nitrogen in steel seems to alternately rise to commanding attention, then fall into oblivion. So far as the welder is concerned, a study of the effect of nitrogen might be of interest only in the instance of such rare freaks that it is hardly justified. This seems equally true of all gases except hydrogen.

There are two gas forming materials always present in filler rod which must be considered. These are carbon and sulphur. Under some circumstances water becomes entrapped in what might be called the surface pores of filler rods and changes to superheated steam during welding. It then must be classed as a gas forming material. Some ingredients occasionally met with in the materials used in flux coating electrodes are essentially gas forming and should be considered.

Hydrogen Gas in Filler Rods

The first place that this gas is encountered is in the steel furnace during the refining process. As the steel comes from the furnace it contains much gas but, before it cools in the ingot mold, this has for the most part either escaped or been artificially removed by the addition of certain degasifying materials. Until recently this "degasification in the ladle" as it is called was considered a sufficient precaution against the presence of hydrogen in the finished filler rod, and so it probably would be if the steel was not again exposed to hydrogen forming chemicals in its subsequent stages of manufacture.

Earlier in this article it was stated that the ingot and then the billet were rolled hot in the steel mill. During this hot rolling a layer of iron oxide called scale forms on the surface as it aways does on all red hot iron exposed to the air. This scale is glass hard and must be removed before the wire rod can be drawn through a die. About the only successful commercial method ever developed for accomplishing this removal is pickling the rolled rod bundle in hot dilute sulphuric acid solution. A chemical reaction takes place here, iron sulphate being formed which is soluble in the pickle solution and at the same time free hydrogen is liberated from the acid. Hydrogen as well as many other elements is far more active chemically at the moment it is liberated from some compound than it is later. Chemists have long recognized this fact, and given it the name of nascent hydrogen from the Latin meaning "being born."

Practically all metals have a strong tendency to absorb hydrogen, or at least to condense it on their surfaces, and this is especially true of nascent hydrogen. It has been found that iron under certain conditions will absorb two hundred and fifty times its own volume of hydrogen. It is difficult to conceive of what appears as a cubic inch of solid steel absorbing two hundred and fifty cubic inches of hydrogen as a sponge might water. It is not intended to give the idea that all steel always absorbs this amount which is probably the maximum. Mention is made of this to show that steel has tremendous absorbing power for hydrogen and that all steel filler rod is in contact with large quantities of nascent hydrogen during its process of manufacture. If nothing were done to remove at least some of the hydrogen absorbed during the pickling operation the filler rod would be so brittle it could not even be drawn in the wire mill. The removal of enough of this hydrogen to permit drawing is a comparatively easy matter by merely baking at oven temperature, but there usually is enough left to seriously interfere with welding.

The prevention of hydrogen absorption by steel and its removal when absorbed is a matter of fairly wide interest, and scientists, who in many cases probably have never been familiar with fusion welding, have made a deep study of it. It furnishes the basis for an explanation of something which every welder has experienced. Fence wire sometimes makes perfect welding wire and at other times regular filler rod of a popular brand cannot be made to do satisfactory work.

Without going too deeply into the technique of pickling, a few remarks on the subject should make this clear. When the molten steel cools in the ingot mold even the small amount of sulphur allowed in filler rods may or may not segregate towards the center. No particular attention is usually given to this segregation by the steel maker so he may make a type having this sulphur segregation at one time and not at another. The methods of some steel makers, without any conscious attention on their part, will usually tend toward producing one type or the other.

It so happens that when the sulphur is segregated to the center an outer shell is produced on the rod which is very nearly immune to the action of the wire mill pickle. Such steel has a very fair chance of being good welding rod although the manufacturer may turn it into fence wire not knowing how he made this sulphur segregated steel or even that he had made it at all. The outer shell of such steel peculiarly resistant to hydrogen absorption and occluded hydrogen constitutes the major factor in determining good and bad filler rod. Steel makers the world over have been quite generally ignorant of just how they produced *Weldite* type steel even when they did make it. If a line of filler rod was to be marketed under these circumstances, with the assurance that it would be uniformly *Weldite* type, it could be done only by selection and this is just what the manufacturers of *Weldite* did. A definite test was required and one was developed.

A piece of rod, one end of which has been ground fairly smooth, is put into a glass of dilute acid maintained at a temperature just below the boiling point. After prolonged immersion, the outside shell of *Weldite* type rod will scarcely be affected by the acid while the center core will be eaten away. Non-*Weldite* type steel will be eaten away irregularly.

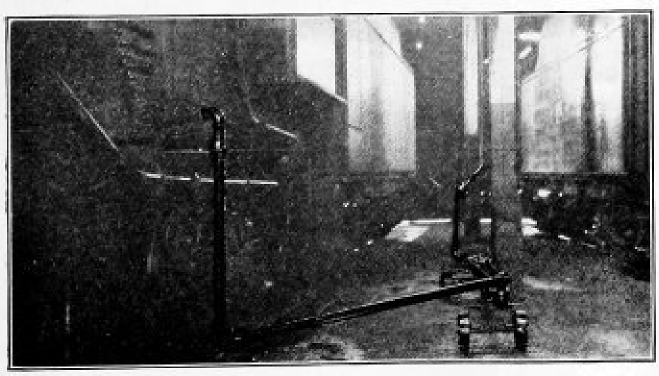
The practice, hitherto referred to, of sull coating which is indulged in by wire mills may load an otherwise good filler rod with gas to the point of rendering it unusable. Rust itself is not especially detrimental to filler rod and in the case of electrodes, may, under certain circumstances, even be desirable. The method of producing the rust, or sull coat as it is called, usually loads the rod with hydrogen, however.

Certain colloidal substances have the power of absorbing immense quantities of hydrogen and, when present even in small quantities in the pickle solution, the hydrogen goes to these colloids instead of the steel. Certain metals will deposit from their salt solutions on steel without the aid of an electro-plating current. When so deposited they prevent further action of the acid on the steel and when there is no action there is no hydrogen formed. It so happens that at times either these colloids or the proper metal salts or both appear as natural impurities in the commercial sulphuric acid used by wire mills. When they do, filler rod pickled in such acid will contain far less hydrogen than otherwise. Wire mills as a rule pay no attention to these matters. Only in *Weldite* will be found a deliberately complete scientific control of hydrogen through the use of *Weldite* type steel, colloids and metallic inhibitors in the pickle solution and elimination of the practice of sull coating.

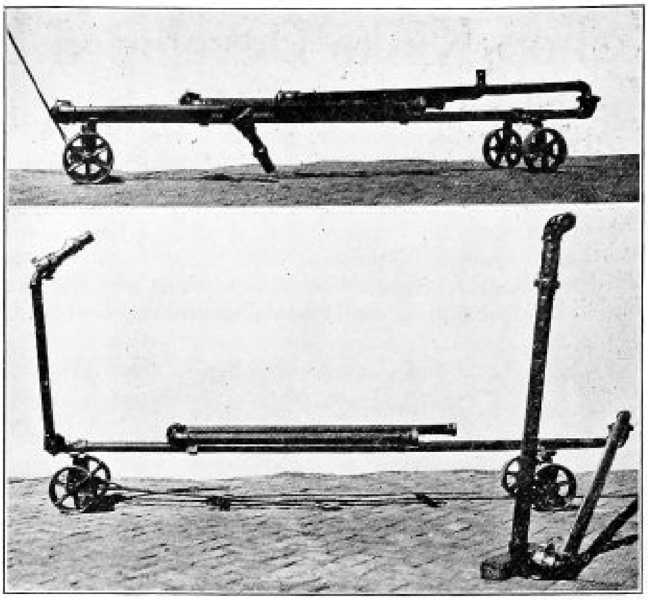
(*To be continued*)

Flexible Pipe for Locomotive Blow Back Operation

Improvements have recently been made in the Cumberland, Md., shops of the Baltimore & Ohio in the operation of locomotive boiler washing, by providing a better method for the coupling up or connecting of the boiler with the enginehouse piping system, for the blow back operation.



How the apparatus is used



The upper view shows the apparatus folded and ready to be wheeled where needed, while the lower view shows the device extended and in shape to be attached to a boiler and enginehouse piping system

In the past, hose of various makes, types and construction had been used for this operation. Since hot water and steam at high temperature and pressure pass through this apparatus, the management provided the best and most reliable hose obtainable, such as a specially constructed armor-covered hose.

This hose is safe, but not sufficiently durable, for under the most favorable conditions the inside fabric soon deteriorates and collapses under the hot water and steam and the outer metallic armor construction is also of short life, for in a busy shop many things happen that tend to nick, dent, crush and finally cause the armor to collapse. While not of frequent occurrence, cases have been known of hose being cut in two by being run over by the wheels of a locomotive. These special hose are costly, averaging $55.50 each and the average life is 33 days and, as they are especially fitted up by the manufacturer, when any part is injured it is practically unreclaimable in the local shop.

Further, in the handling and transporting of the hose from one point of operation to another, it requires the services of two men, as they are too heavy and cumbersome for one man to handle.

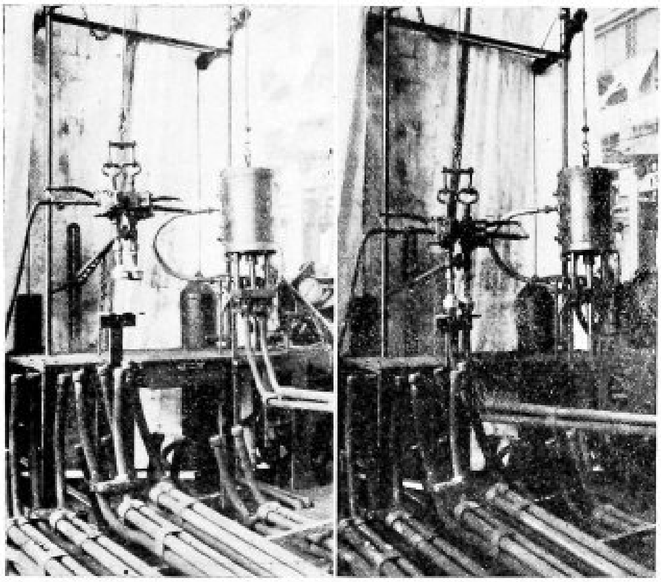
To provide a better, safer and a more economical means of carrying out this operation, a method has been designed, as shown in the accompanying illustration, by Master Mechanic F. W. Fritchey and developed by C. M. Kennedy, pipefitter foreman, of the Cumberland shops. This device has been in service for over three months and is giving excellent results.

It will be observed that it is constructed of a system of piping and metallic flexible joints and is mounted on a set of four small wheels. It is easily handled, transported and coupled—in fact, all operations are performed by one man. It is practically indestructible and if any part should be damaged, it can be repaired or reclaimed locally. The initial cost of this device was $64.94, which includes labor and material.

The description of this device was secured through the courtesy of the Baltimore and Ohio magazine.

Shop Kinks Developed by Boiler Makers to Speed Up Work in the Boiler Shop*

NUMEROUS items have been received with which no doubt some are familiar and to others I hope it will be of interest. Numerous blue prints have been received which, if I attempted to have tracings made so that all could have report in the Official Proceedings, I would be quite busy, so I will try to explain a few of which photographs or tracings were not received in time.



Figs. 1 and 2

Tell-Tale Holes in Staybolts

Holes that become closed with paint rust, etc., can be readily opened by using high speed steel ⅛-inch square, three inches long with end beveled to 45 degrees used in small motor.

Device for Testing Boiler and Superheater Units

In place of crude method of using jack and rubber for blocking exhaust pipe. A bolt 1¼ x 9 inches diameter over top of nozzle with a packing nut in center this plate to have hole at edge ⅜-inch diameter, approximately 3 inches deep with opening in exhaust pipe to apply test gage, a three legged crab. Eight inches outside and 3 inches high is used to prevent leakage, this is being used on the B. & O. R. R. and found to be a labor saver.

* Report presented at annual meeting of Master Boiler Makers' Association.

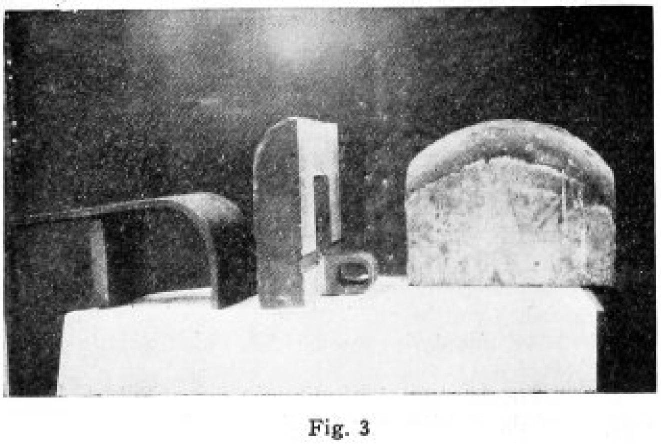


Fig. 3

Testing Superheater Units in Shops

See Figs. 1 and 2. The unit is first clamped by air to the water inlet and filled, then subjected to hydrostatic of 350 pounds, and thoroughly hammer tested. When the pressure is released air is turned into the unit forcing out all water and all accumulation of scale or dirt. If the unit is found O. K. it is then ready for grinding.

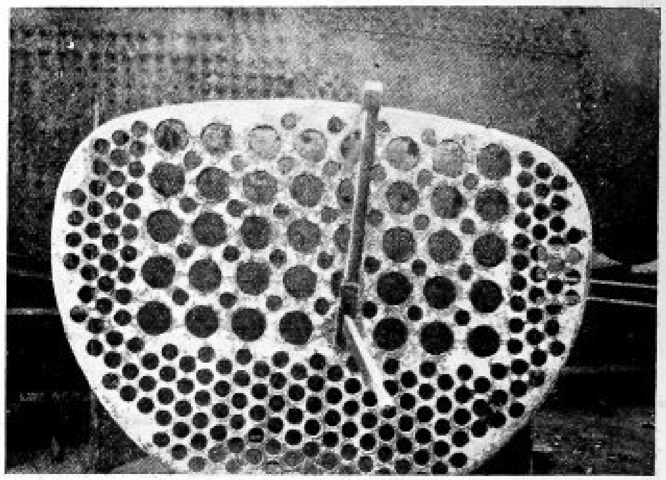


Fig. 4

Flanging of Backheads

See Fig. 3. This can be accomplished on a flanger by the addition of these two dies which can be made at any foundry equipped to make cast steel. It is not necessary to change the flanging die. Merely put in or take out liners as needed.

Rivet Holding Bar

See Fig. 4. Device for holding on rivets in tube sheets which is speedy and does not injure tube holes. A very use-

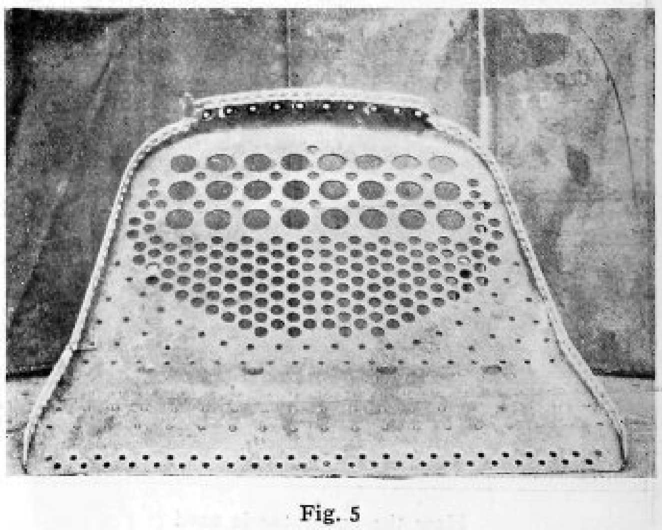


Fig. 5

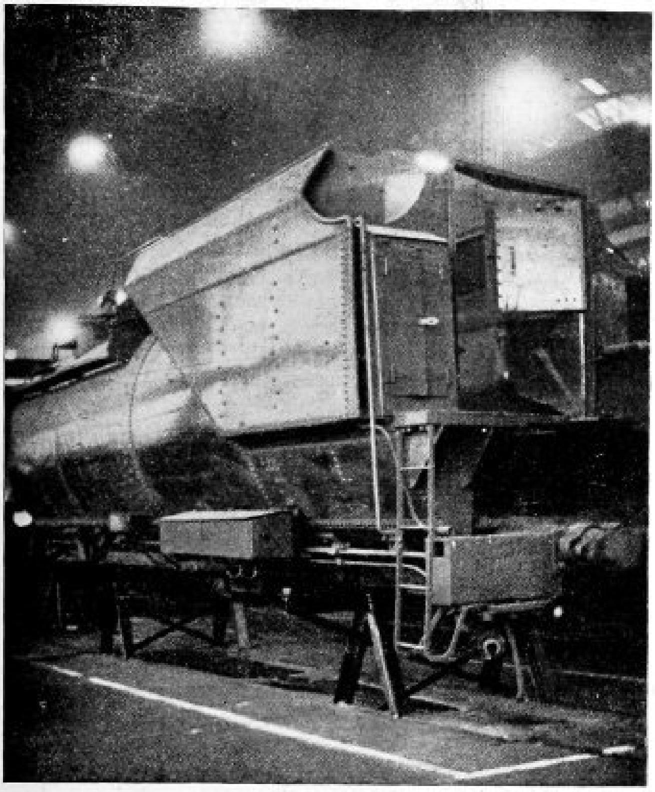


Fig. 6

ful tool. Rivets in tube sheets from throat braces up readily held on.

EXTENSION FLANGE TUBE SHEET

Fig. 5. On certain types of locomotives, especially those with wide fireboxes, a great deal of trouble is experienced with the crown sheet giving out at the first row of crown bolts.

The common practice has been to patch the crown sheet, which, at its best, is poor practice.

We have adopted an extension flange tube sheet (of which a cut is shown) to overcome the patched crown sheet.

No change whatever is made in the tube sheet, except that the flange at the top of sheet is 9 inches long. This allows the crown sheet to be cut between the first and second rows of crown bolts and the tube sheet is then riveted to the crown and the first row of crown bolts is placed in the flange of the tube sheet.

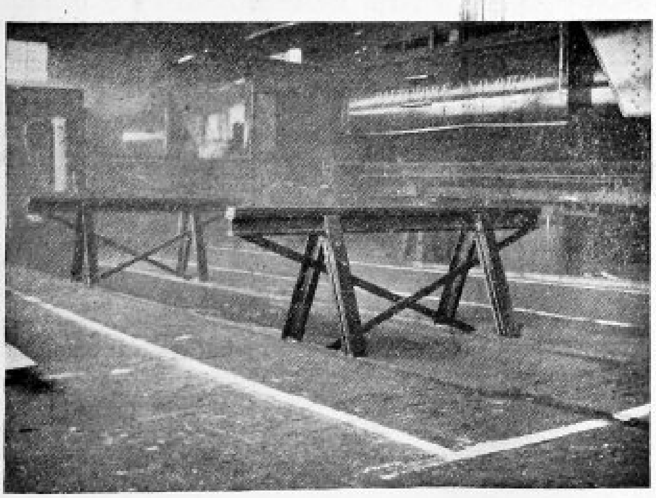


Fig. 7

We find that the four crown bolts on each side of the center of the crown sheet is where the crown sheet first gives out.

The same principle can be used on the door sheet also.

Note scarfing which increases life of sheet eliminating fire cracks, which is good practice on all firebox seams, all holes countersunk and flat countersunk rivets applied.

These sheets can be flanged with a hydraulic press or flanger, which is very economical for this purpose.

STEEL TRESTLES

Figs. 6 and 7. Shows steel trestles used in tender shop which are welded to tracks. The safety feature of these trestles is a big improvement over the old method.

ARRANGEMENT USED FOR DRIVING CROWN BOLTS

(See Figs. 8 and 9)

This rigging is very flexible and allows free swing of hammer for driving the bolts. A great deal of hard work is

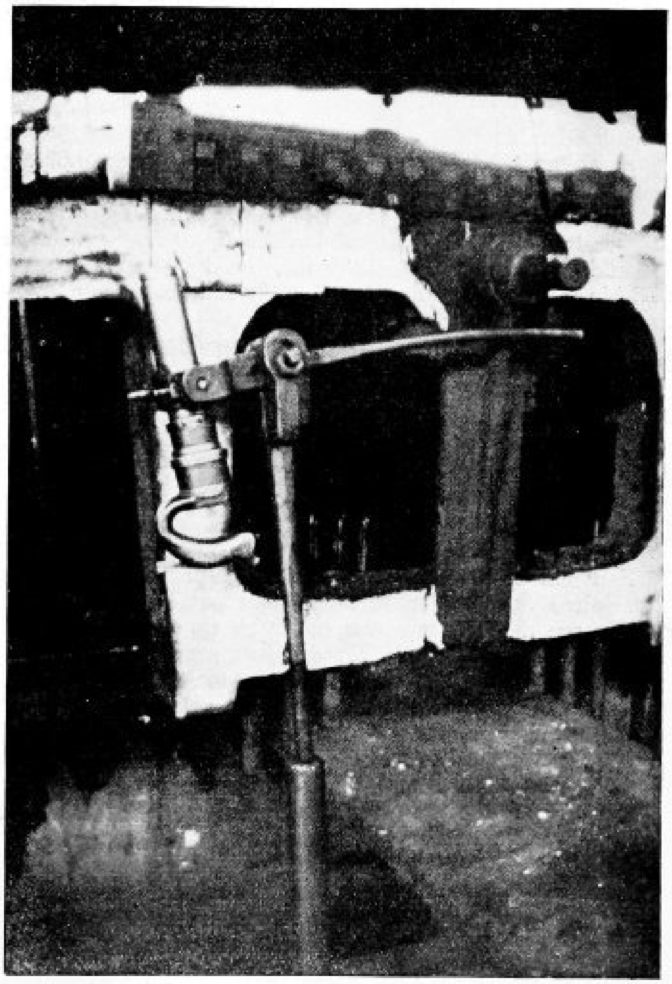


Fig. 8

eliminated in this operation as heretofore the men were compelled to hold overhead the weight of the hammer and together with the recoil all bolts were not driven up tight. The usefulness of this "kink" can be readily observed.

REMOVAL OF CAPS FROM FLUSH, FLEXIBLE STAYBOLTS

This is a job in which considerable energy is lost. Some success is noted by use of socker wrench and air hammer, but we have had better success by applying heat from acetylene torch of approximately 30 seconds and cool with water, applying heat to cap in center. Special care to be noted

Fig. 9

is that graphite and oil are applied properly upon reapplying caps.

TAP FOR REPLACING BROKEN SLEEVE ON EXPANSION STAYS WITHOUT REMOVING CROWN BOLT

Considerable time can be saved by having hole drilled through tap 1 3/16-inch diameter. When used for applying sleeve, first remove the cap. Care should be taken in removing the round nut from crown bolts, that thread on bolt is not destroyed and then remove bushing by cutting out. Care should be taken not to destroy the thread in the sheet after bushing is removed. Retap and apply new bushing and proceed the same as on new installation.

This report was prepared by a committee composed of C. J. Baumann, chairman, C. H. Browning and Ira J. Pool.

Fireboxes of Mild Steel—American Versus German Practice

By M. A. Brünner

IF I am correctly informed, fireboxes are made in the United States of mild steel almost exclusively, but in Europe their absence was noticeable up to the beginning of the war. The German State Railways made repeated experiments with mild steel but, contrary to American practice, always using thicker plates, bolts, etc., as the safety factor in European countries, especially in Germany, is much higher than in America. The experiences collected during the war with these mild-steel fireboxes are not favorable and we would probably not have made any trials if our copper supply was not cut off, at that time. Our railway ministry has given orders to return again to the copper fireboxes. It is hard to find out whether the impure coal, much mixed with earth, requiring larger grate areas, or other causes influenced this action.

Our engineers are somewhat astonished as to why in North America, a country rich in copper, mild steel is used almost exclusively for fireboxes, while we in Germany produce only very little copper and must import the greater part to meet requirements at high cost. The replacing of fireboxes and the manufacture of new ones within the domain of our Imperial state railways requires no less than 25,000 to 30,000 tons of copper yearly. In the summer of 1922 we had to pay 123,000 marks per ton of copper or 3.6 million marks for the yearly demand; but prices have since gone up not only steadily but at unprecedented jumps. We come to a figure of roughly 10 millions a year.

As we know, the thermal conductivity of iron or steel is less than that of copper. Steel fireboxes to give the same results must therefore be made larger. Certainly the best available material for the firebox of a locomotive is just good enough as, this portion has to undergo great stress, and we should therefore employ the flexible, tough, easily-to-be-calked copper having a good thermal conductivity which remains valuable even if worn out, while the steel firebox presents many dangers as to cracks, is hard to be managed, has smaller heat conductivity and has no value after replacing except as scrap iron. We know that the sizes of American engines are generally larger than those in Europe, consequently there are larger iron walls and grate areas. This means that the relative stress, viz.: per square yard heating surface, is smaller, compared with copper fireboxes. Our state railways have installed a so-called G-12 Standard engine which is fitted with mild steel fireboxes of larger dimensions than the copper ones. But this type exists only in small numbers.

After the outbreak of the war our railway administration was not in a position to alter at once our designs and drawings, thus mild steel was mostly substituted and the dimensions for copper adhered to, hence the unfavorable results. The back walls of the fireboxes and those of the pipes, also the covers of the boxes stood the tests quite well, while the side walls within the fire zone were gradually destroyed. We found that even with copper fireboxes the side walls, the flanges and bars of the front tube sheet are the vulnerable points and manufacturers should pay attention to them.

The necessity of long life for fireboxes in the United States does not seem to be as great as in Germany. Although some railways boast of fireboxes having a life of 5 years, we know that that of the majority is much shorter. One reason why American railways prefer mild steel for fireboxes is probably the fact that locomotives are kept under steam for longer time than here, in order to save the boiler metal. We have in Germany far more engine sheds and extinguish the fire immediately if an engine is not needed for several hours. This frequent change of course is detrimental to the metal. It favors the formation of cracks, renders bolts and seams untight. We found that we had more cracks in winter. They occur when the locomotive is cold, especially when the staybolts or seams are hammered to tighten them. This shows that we must reckon with tensions in the side walls when the firebox has cooled. Our advice is not to do any hammering at the walls when the engine is cold, and wait until it is warmed up.

We found that faulty metal has a great influence upon the life of a firebox. Either the material is unfavorably composed, heated from one side only, has no good thermal conductivity, the ready cut sheets are unsufficiently annealed or oxidized iron is used. It may be that the design of the boiler has some influence too. It is strange that nearly no cracks appeared at the boilers of our engine type T-14 where great care is taken for unrestricted rising of steam bubbles and to correct position of the staybolts while the boilers of type P_8 and G_8 showed many cracks. The thicknesses of the side walls and of the firebox crown sheet of American locomotives as well as the tube sheet are less than in German locomotives.

Of course much attention must be paid to purity of the feedwater. We purify by means of filters and chemically. It is a wrong economy to make savings in this respect.

The Locomotive Firebox Company, Chicago, has opened an office at 30 East Forty-second street, New York, in charge of George N. De Guire, assistant to the president.

H. H. Pleasance, vice-president and sales manager of the United Alloy Steel Corporation, Canton, Ohio, has resigned that position to become affiliated with the Bourne-Fuller Company, and George H. Charls, president, has resigned following the merger of the United Alloy Steel Corporation with which he was connected, with the Central Alloy Steel Corporation.

The Stamping of Boilers, Proper Handling of Data Sheets and Keeping of Boiler Records*

By C. J. Manney

IT will be my purpose in this paper to outline a method for the proper keeping of boiler records in a state or municipal boiler inspection department. My experience in this work consists of fifteen years of record keeping of boilers in the State of Ohio and I have found that one of the most important functions of a state or municipal boiler inspection department is that of establishing a simple system for the keeping of records of all boilers which come into or are operated in a certain locality. I believe that we have tried out most every conceivable way to simplify record keeping without affecting accuracy until finally we have secured a system which assures us of absolute accuracy of the records of all boilers in the State of Ohio.

Considerable detail work is required to accomplish this, and in working out a system there are several important points which must be borne in mind. First, simplification; second, checking manufacturer's data and field inspector's reports; third, recording reports and filing them; fourth, where fees are charged, a simple system of bookkeeping. The system should be so arranged that each operation will check against the other which acts as a means of reducing errors.

It will be my object to try to outline as clearly as possible in a general way the sequence of the operation from the construction of a boiler to the issuing of the certificate of inspection, and the necessity of proper identification marks on the boiler from the time it is constructed until it is placed into operation.

The A. S. M. E. boiler code covering the construction, which has been adopted as a uniform code of boiler rules for the construction of boilers, gives us in detail the necessary requirements for the construction and installation. The Code Committee has handed to us a wonderful piece of work in this Code, and it is the duty of the state and municipal departments, who have adopted it, to provide every means at their command to retain the high standard set forth in this Code by properly interpreting and enforcing it. In order to do this efficiently it is necessary to secure competent men for shop inspectors and the National Board, as I understand it, has a very efficient means of keeping record of shop inspections.

After a boiler is constructed that has been inspected during its construction by a qualified National Board inspector, or a state inspector, it is stamped either "NATL BD" or with the state standard, and a number is stamped on it. This boiler should be known thereafter until the time of its installation by its "NATL BD" or state standard number. The data report of this boiler is filed in duplicate with the secretary-treasurer of the National Board and when the boiler is installed in a certain locality, a copy of this data is sent by the secretary-treasurer of the National Board to the state or municipal department where the boiler is to be operated.

At this point the state or municipal department assumes responsibility for its operation, and as a means of permanently marking it for the purpose of keeping its record thereafter, there should be, on the first inspection, a serial number assigned and stamped upon it. Each state or municipality should have a symbol such as a star, triangle, arrow head, or some other identification mark which should be placed before and after the serial number, so that the department can readily identify its own serial number, and no two states or cities should adopt the same emblem, as to do so would defeat the very purpose for which it is intended. The use of a symbol prevents fraud as it makes it impossible to alter the number.

A Satisfactory Method of Record Keeping

The serial numbering of boilers is a very simple matter, but is one which requires a system whereby the numbers cannot be duplicated or transposed, which is sometimes done by the inspectors, and the system which is adopted should be such that these errors will be caught when the inspection reports are checked. The state or municipal inspection department should assign all serial numbers to field inspectors. These numbers can be assigned to insurance companies in blocks in proportion to the number of boilers insured by them. A system of accurately keeping record of them and to whom they were assigned is very important. We have tried out various ways of taking care of this and can highly recommend the following outlined policy as being complete, simple and efficient in preventing errors; as an example, serial numbers from 1 to 50, inclusive, may be assigned to the chief inspector of an insurance company who has a number of inspectors and he can reassign them to the individual inspectors. Where only one inspector represents an insurance company a few numbers may be assigned to the individual inspector. When these numbers are assigned each number should be stamped upon an individual card.

In the first instance, there would be fifty cards. These cards should be retained in the office as a record and marked to whom assigned. The field inspector should carry a set of dies with him and upon his first inspection should stamp one of these numbers on any boiler which has not been previously numbered. This number should be placed upon the inspector's report to the department and when received by the department, the card bearing this number should be taken from the pack and destroyed. Should the inspector duplicate a number at any time, it will be instantly caught when his report is checked, as there will be no card in his pack for this number. A number cannot be transposed as it will not be among the numbers which were assigned to an insurance company or an individual inspector. It is practically impossible to beat this system of keeping record of serial numbers, and as stated before we can highly recommend it for any state or municipal department.

After this operation the report should be entered upon a card record and this card record should consist of an individual card for each boiler, as this works most efficiently. Upon this card should be placed the information necessary in issuing the certificate of inspection, such as the name and address of the owner or user, the location of the boiler, owner's number, state or municipal number, state standard or National Board number, the type, size, the name of builder and date built, the name of the inspector, date of inspection and pressure allowed. Reference to inspection reports may be made for all other details, which are not on the record card. These record cards should be filed alphabetically so that all the boilers owned or operated by one concern or individual will be filed together regardless of the location of the boilers or dates of inspection. It should be remembered that the fundamental rule in any

*Presented at annual meeting of National Board of Boiler and Pressure Vessel Inspectors.

filing system is to have only one place for a thing and to have that thing in its place at all times.

Arranging the Filing System

With this system of serial numbering of boilers and keeping a card record of each boiler it is possible to so arrange the filing system that the inspectors' reports on boilers are filed numerically by the serial numbers and the cards filed alphabetically under the name of the owner or user of the boiler. We have found that this is very convenient, as in numerous cases where the name of the former owner cannot be obtained and the boiler number is known the record can easily be found. When these two systems of filing are put into effect it is always possible to locate the record from one or the other.

A card signal system is a very efficient way of taking care of various conditions reported by the inspectors. As an example, an inspector reports a certain boiler should have a number of repairs made upon it before the certificate may be issued. This inspection is entered upon a card and a red signal placed on the top of this card, which indicates that repairs are necessary before the certificate can be issued. At fixed intervals a repair report can be sent to owner of a boiler whose card has a red signal on it. When it is reported back that repairs have been made, the red signal is removed and the certificate is issued. Different colored signals may be used for other conditions which may arise.

Data Reports

On the first internal inspection made upon the boiler by an insurance company or state inspector, it is well to require a long form data report giving all the dimensions of the boiler and for repeat inspections we recommend the use of a short form report with only enough information on it to properly identify the boiler, such as state serial number, diameter, length and type. This reduces clerical work for the inspector. When the insurance on the boiler is changed, it is advisable to require a new long form report. This furnishes a means of checking up on the inspector and in some cases you will have a number of long form reports on a certain boiler which should compare with one another, and which will all be filed numerically and will be found at the same place. The short form reports should be filed separately by state serial number and after two or three years they may be discarded, but in no case should the long form data report be destroyed, as it should be kept as a permanent record of the boiler. The card record should likewise not be discarded. When a boiler is taken out of service it is well to place the card in an out of service file.

Responsibility for Boiler Operation

The responsibility of the operation of a boiler required to be inspected in any state or municipality lies upon the offical charged with this duty as conditions are continually changing, boiler being put into service and out of service. It is necessary that the system, in order to be complete, be so devised that the department will know when the boiler goes out of service or when one that is out of service is put into service and also that there is a report of inspection from the insurance company or state inspector when the inspection is due, and to take care of these conditions, a special form should be furnished to inspectors to report to the department when a boiler goes out of service, which may be called a no inspection report. When this report is received it should be entered on the record card and the card taken out of the live file and put in the dead file. This will always keep your card filing system up to date.

It will not be our purpose to criticize in any respect the efforts of the insurance inspectors to make inspections regularly when they are due as we realize that conditions which are unavoidable sometimes cause delay in making inspections and reporting them to the state or municipal department when they are due, but with everything considered the state or municipal department should have a report on file for every boiler under its jurisdiction at intervals provided by law.

We have found, after trying a number of ways to get inspections regularly, that the most effective way is to provide a special form headed with the words "Legal Notice of Boiler Inspection Past Due" and quote the section of the Law providing for such inspections and mail this notice to the owner or operator of the boiler. This is the most direct and effective means of securing inspections as in the last analyses the department holds the owner or operator of the boiler for compliance with the Law, and the insurance comance company or inspector is only a medium to assist the department in the enforcement of the Law.

A card signalling system may be effectively used for the purpose of determining when inspections are overdue and for sending out legal notices of inspections past due as cards can be gone over at regular intervals and signalled with black or other colored signal and the notice sent out. Provision can be made on this notice for the reason why inspection was not made. This assists the inspectors greatly in securing a boiler when it is due for inspection.

National Board Statistical Report*

By E. W. Farmer, Statistician

In presenting the second annual report of statistics of accidents, etc., of boilers and pressure vessels, I feel that I have only made a slight advance over last year's report owing to the fact that many of the members have not made any reply and a few say that they have no records and cannot give the information asked for in the questionnaire sent out. While members may not be able to answer all the questions, if they could give the number of boilers as far as they know of them and the number of accidents, it would help in the work greatly.

I hope the members of the Board will realize that the more information they can give on the subject the better it will show a higher standard of efficiency of the department to their states and to the non-code states the effectiveness of a state boiler law with uniform regulations of construction and inspection. If the members do not have a record themselves, they might apply to the insurance companies for the number of boilers they have until some time in the future they may be able to compile figures making a record of all boilers uninsured as well as those insured. Some of the members have responded nicely and have given me much valuable information for statistics, especially whether the boiler is of code or non-code construction.

The statistician sent out letters whenever he received information of a boiler accident and in nearly all cases received a reply and in every case found that where an explosion took place, the boiler was not built to any code regulations, but was an ordinary stock boiler of ancient vintage; and of the accidents to boilers, only three were of code construction—one in Rhode Island and two in Pennsylvania—and the cause of these accidents were in each case due to gross negligence.

In making inquiries into accidents and explosions, I have not found that one stationary boiler that exploded was a code boiler even in non-code states. Where I got replies, it was to the effect that the boiler was not of code construction. Mr. Thomas of Oregon sent the best report this year with information in detail of accidents, stating

* Presented at annual meeting of National Board of Boiler and Pressure Vessel Inspectors.

the fact whether it was a boiler or pressure vessel and the nature of the accident, the damage, the list of casualties and the type of construction, that is, code or non-code.

Many of the answers from non-code states were very interesting as some expressed regrets that there were no records on the subject available and no means of procuring them. Two or three states admitted that they should have a boiler law and two indicated that they have tried several times to get a law with A. S. M. E. code regulations but failed. Also two states have attempted to give me such help as was possible from reports of departments which gather information on industrial statistics. I tried to gather some information of boiler accidents and explosions by the use of the Luce Newspaper Clipping Bureau, but found it very unsatisfactory as there were quite a number of boiler accidents, accounts of which were printed in the papers but no clippings of the same were received by the statistician.

The State of Rhode Island had a serious accident or disaster when a boiler on the Steamer Mackinac had a rupture of the cross drum permitting the steam and water to escape and scald 53 persons to death and injure over 60 others.

Another accident came to my attention when a new boiler which was built to the A. S. M. E. Code was destroyed by being overheated without any water in the boiler whatever. The attendant opened the blow-off valve to blow the boiler down while the fire was burning and forgot to close it until the boiler was red hot and the tube sheet bulged. The tubes pulled out of tube holes in the sheet and the whole boiler was only fit for junk.

The statistician has divided the statistics into three classes:

First, including power boilers for industrial use under state supervision in many states.

Second, including boilers on steamers under the Department of Commerce and under steamboat inspection.

Third, including boilers on locomotives on railroads and under the Interstate Commerce Commission and the Locomotive Inspection Bureau.

The number of accidents to industrial boilers as reported from all sources as far as is known for the year 1924 is as follows:

Total number of accidents, including number of explosions of boilers, pressure vessels and appurtenances	360
Explosions of stationary boilers	28
Explosions of stationary boilers, oil wells	12
Explosions of stationary boilers, saw mills	20
Explosions of stationary boilers, miscellaneous	14
Explosions of stationary boilers, low pressure	14
Total	88
Accidents to boilers and pressure vessels	272
Grand total	360
Total killed	90
Total injured	222
Explosions of flywheels	36
Number of persons killed	9
Number of persons injured	21
Centrifugal dryer exploded	1
Number of persons killed	2
Number of persons injured	1

The figures which have been compiled from the reports from code states and cities are as follows for the year 1925:

13 states filling out questionnaire as far as records permitted.
4 states answered but have no record.
1 state making no reply.
4 cities out of 15 filling out questionnaire, 11 making no reply.

Number of boilers in code states	172,319
Number of boilers in code cities	7,112
Total	179,431
Number of boilers insured	107,565
Number of boilers uninsured	71,866
Number of new installations	3,759
Number of boilers found unsafe to operate	896
Number of boilers found defective and repaired	1,449
Number of explosions	24
Number of accidents	21
Number of pressure vessel explosions	3
Number of pressure vessel accidents	10
Total	58
Number of persons killed	13
Number of persons injured	27
Number of state inspectors	129
Number of insurance inspectors	822
Number of boiler manufacturers	280
Number of boilers manufactured	6,182

7 boilers oil well, 3 saw mill, 2 misc.

This record of code states does not include the State of Massachusetts as it did last year as the code states relate only to those using the A. S. M. E. Code.

The report of explosions and accidents of boilers on vessels of the merchant marine and inspected by the Steamboat Inspection Service, Department of Commerce, for the fiscal years of 1924 and 1925 were as follows:

Fiscal year 1924	
Number of explosions	16
Number of lives lost	10
Property loss	$30,490
Fiscal year 1925	
Number of explosions	19
Number of lives lost	10
Property loss	$425,703

The report of accidents on locomotive boilers and appurtenances operating on railroads and railways—1924:

Total accidents	393
Total loss of life	54
Total injured seriously	447
Of this total there were boiler explosions	43
Of this total there was a loss of life from boiler exp.	45
Of this total there were injured from boiler explosions	59
Total number of accidents—same cause—1925	274
Total loss of life	13
Total seriously injured	315
Of this total there were boiler explosions	28
Of this total there was a loss of life from boiler exp.	12
Of this total there were injured from boiler explosions	49

I wish to express my thanks to Mr. D. N. Hoover, supervising inspector of the Steamboat Inspection Service, and Mr. A. G. Pack, Chief Inspector of the Locomotive Inspection Department, both of Washington, D. C., for their courtesy and co-operation and ask the secretary of the National Board to send them a copy of our report.

The figures as compiled from the latest statistics of industries and divided into code states and non-code states show the amount of horsepower generated in the few states having code regulations as compared with states not having regulations and taking these same figures and striking a comparison of the few accidents and casualties with the same in non-code states:

	Code States	Non-Code States
Population	53,819,781	52,032,839
Establishments	109,090	64,590
Total primary HP	20,478,256	12,360,319
Internal combustion engines		
Number	9,355	7,425
Horse power	878,971	345,291
Steam engines and turbines		
Number	50,921	39,827
Horse power	10,414,593	6,616,395
Water turbines		
Number	4,562	3,769
Horse power	762,547	850,578
Electric motors		
Number	415,825	200,598
Horse power	6,085,620	2,737,020
Tone of coal		
Anthracite	11,324,150	1,779,442
Bituminous	151,144,017	65,337,618
Barrels of Oil	52,935,754	36,040,786
Numbers of boilers	179,431	41,609

Uniform Examinations for Boiler Inspectors

Discussion of necessity for uniform inspections and reports to provide for acceptance of boilers in all Boiler Code States

By C. D. Thomas*

THOSE of you here who were at our meeting in Milwaukee last year will undoubtedly remember the words of our good friend Charles E. Gorton, chairman of the American Uniform Boiler Law Society, when he spoke of uniform inspections, uniform registration, uniform examination, uniform rules, uniform stamping and uniform interpretations of the Boiler Code. We already have uniform rules for the construction, inspection and installation of new boilers and I firmly believe that uniform rules for the inspection of existing installations could be obtained if the various states were not so fearful of losing their identity. In fact it appears to me that some think their individuality of more importance than the regulations they are required to enforce. I make this statement because of the fact of little technicalities of no consequence which cause a difference in the various states.

I believe that you will all agree with me when I say that an inspector who is efficient and capable of intelligently inspecting a boiler which has been in use several years and who can after determining the working pressure for which the boiler was built estimate its true value, due to its depreciated condition, is capable of inspecting boilers in any state in the union, but as conditions now exist this inspector is required to pass another examination before he is permitted to inspect boilers in several of the states now operating under the Code. I believe that it is possible to so standardize and protect these examinations as to meet the objections of all concerned. You will note in the Preamble printed at the head of the program for this session, these words: "To maintain uniformity in the construction, installation, and inspection of steam boilers and other pressure vessels and their appurtenances and to secure interchangeability between political sub-divisions of the United States." No one is more heartily in accord with the sentiments here expressed than I. I believe in it thoroughly but in order to obtain this interchangeability it is absolutely necessary to have uniformity in determining the qualifications of the inspector, and I believe this uniformity can be obtained through the National Board of Boiler and Pressure Vessel Inspectors. I do not mean by this that they shall conduct all examinations but I do mean that all examinations conducted by the various political subdivisions shall meet with their approval and that certificates of competency be issued by the National Board to those only who have successfully passed this examination and have had a certain required amount of experience.

I admit, however, that shop inspectors who have had no field experience are, as a rule, not capable of examining installed boilers. These examinations, however, can be such as to cover questions relating to both shop and field inspections. That is the kind we endeavor to have in the State of Oregon. After an inspector has secured his commission to inspect boilers from the National Board it does not mean that he may promiscuously roam from one state to another inspecting boilers, but he should be required to appear before the officials of the state whose duty it is to enforce the boiler laws in order to satisfy them as to his ability and to file a facsimile of his commission with the state. At the same time he should familiarize himself with the local conditions before authority would be granted to inspect boilers in any state. I hope that all here present will not think that I am trying to formulate a rule of procedure for the National Board. I have merely tried to explain the manner in which the qualifications of inspectors are determined in Oregon, with a hope that some definite rule of procedure may be had in order to establish uniformity in the various states and cities.

Much was said at the meeting in Detroit in 1921 concerning uniform inspection laws and the advantages of interchangeability of certificate of competency and some progress has been made along these lines since that time. I believe, however, that a better understanding of this matter should be had among the various cities and states operating under the Code. True the laws of some states and the ordinances of some cities define definite procedure as to conducting examinations but even so a little diplomacy upon the part of the powers that be can readily change this method of procedure to conform to regulations required to standardize these examinations and yet comply with the law or ordinance. I do not believe that any examiner should be permitted to examine a single individual alone for the reason that accusations of partiality will be made at times and there is no way in which such charges can be successfully denied, whereas if two or more are in the examining room prompt denial of partial methods may be made and proof will be had for fair treatment to all concerned.

Not long ago I received a paper on Labor and Industry published by one of the eastern states in which this paragraph appeared:

> "That all boilers stamped with the symbol of the A. S. M. E. and the stamp of a state other than *this state* may be permitted to be installed and operated *in this state* provided that the inspector who witnessed the construction of the boiler was an approved boiler inspector of this state and provided further that a shop data report is filed with the department at the time of petition for installation. Petition for permission to install and operate such boilers shall be made to the Secretary of Labor and Industry in every individual case and such boilers shall be inspected before approval is given."

Please note all boilers stamped with the A. S. M. E. symbol and the stamp of a state other than this, may be installed provided the inspector who witnessed the construction of the boiler was an inspector approved by this state. Does this mean that no boiler can be installed in this state even though it complied with all the code requirements unless such boiler was shop inspected by an approved inspector of this particular state? Does it mean that a Code boiler manufactured in Ohio, Illinois, Missouri, California or elsewhere cannot be installed in this state unless an inspector of this state made the initial inspection? Is the inference to be drawn from this paragraph that no inspectors are qualified to inspect boilers but those who are approved by the officials of this state? Do such rules and regulations promote harmony, instill confidence or make for uniformity? When the question was asked at our last meeting by the secretary as to whether states would issue commissions to inspectors holding National Board commissions for inspectors of existing installations without a re-examination this state answered "No," and from this paragraph I take it that they will not accept shop inspections from others than those who have been commissioned

* Vice-Chairman of National Board and Chief Inspector State of Oregon. Paper presented at recent meeting of National Board.

to make such inspections by this state. I hope I am wrong in this but from the wording of this paragraph I am led to believe that this is so. Should all states follow this procedure manufacturers would be compelled to keep the boilers in the state where manufactured.

There is one other matter which I wish to call to your attention and that is the manner in which manufacturers' data reports are sent out. It may be that states located near the manufacturing center of the United States have no difficulty in receiving the reports before boilers are installed, but with us it is different, for we often find boilers installed before the manufacturers' data report is received. The fault perhaps is in a measure our own for we have no law requiring an operator to report to our department that he is installing a new boiler or any other machinery. However, we have had several instances where new boilers were installed and no manufacturers' data report had been filed with our department. These reports were either in the hands of the secretary of the National Board or the manufacturer had neglected to forward them to us. In each instance however, we always called for the report from the secretary of the National Board or the manufacturers. Understand this is no reflection on the secretary for when the manufacturers sent the report to him they failed to state where the boilers were being shipped. Now what I want to get at is this—our only check on the manufacturer to see that he is complying with all parts of the Code, is the manufacturer's data report and if this is not received before the boiler is installed and a boiler does not comply with the Code, trouble is sure to be the result, with dissatisfaction to all parties concerned. I have a case in mind where a manufacturer shipped a boiler into the state of Oregon. This boiler was 54 inches in diameter and it had a dome 36 inches in diameter, attached. This boiler was installed before the manufacturers' data report was received, in fact our first report of this boiler was from a state inspector. I immediately wrote to the manufacturers for the data report which was sent. After receiving this report, I called their attention to this error but have never received a reply from them.

I don't wish to be tedious but I wish to call to the attention of those present that Oregon has adopted Section 8 of the A. S. M. E. Boiler Code known as the rules for the construction of unfired pressure vessels. This action was taken shortly after Mr. Gorton visited our state last year, when he and the commission discussed the advisability of such action. Twenty-four hours after Mr. Gorton left our state, a pressure vessel of welded construction, 20 inches in diameter exploded in the city of Salem doing about $3,000 worth of damage and within a month two more air tanks exploded in the state. This together with Mr. Gorton's visit caused the commission to take action. We are now just getting this part of the work in some kind of order, and before long hope to have the unfired pressure vessel Code under as good a control as we now have the boiler Code.

High Speed Boiler Shell Drilling Machine

By F. G. Bailey

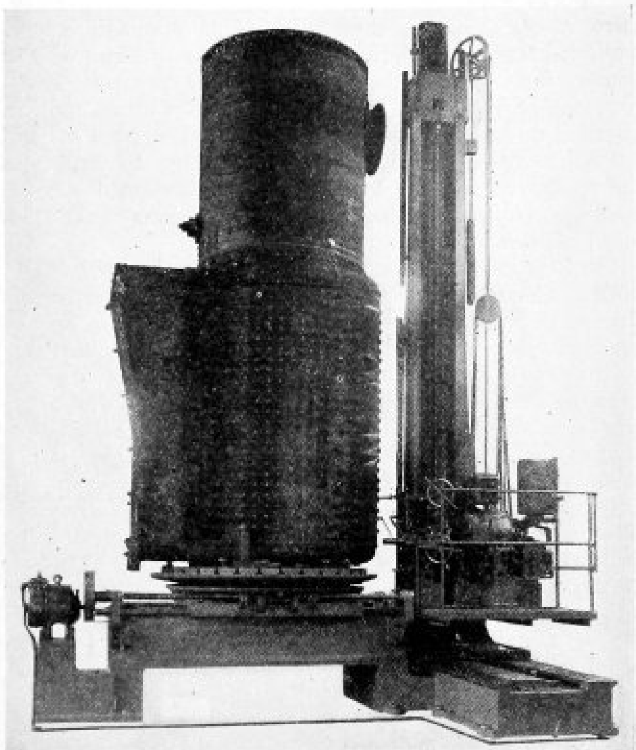
HEREWITH is illustrated a machine that has recently been patented to meet present demands in the drilling of boiler shells in England. In the construction of this machine the makers have carefully studied the question of efficiency and speed essential in modern boiler shop practice.

Dealing with the construction of the machine, the bed is of strong section, on which is mounted a rigid column, having a longitudinal traverse. The column is of box section reinforced at regular intervals by cross braces, and carries on its front face a balance spindle slide and operator's cage, actuated by a central screw. The spindle slide carrying a steel spindle of large diameter is rotated by a directly connected variable speed motor running in a sleeve, brass bushed at both ends and fitted with ball thrust washers.

The operator's platform is attached to the spindle slide, and carries the whole of the control gear.

As regards the traverse bed and circular table, this is made of durable section, mounted on rigid standards and carries a large diameter circular table having a cross adjustment to suit various sizes of work; it also has a rotary movement for locating. The top surface of the table is amply provided with "T" slots for clamping work.

The electrical equipment consists of one shunt wound,



British development in boiler shell drill

variable speed non-reversible motor directly geared to a drill spindle with three series wound variable speed reversible motors operating the circular table. The cross traverse is upright, and the vertical traverse is of spindle slide; being complete with collectors, leads, cables, junction boxes, circuit breakers, safety switches, and liquid controllers.

A small motor mounted on a tank operates the plunger pump and delivers cutting lubricant to the drill point through a telescopic steel tubing.

For the information and interest of readers we would mention the following:

Largest diameter drilled	1 inch
Cross adjustment to circular table	3 feet 11 inches
Diameter of circular table	7 feet
Top speed for 1 revolution of table	2 minutes
Vertical traverse of spindle slide	15 feet
Top speed of spindle slide vertical traverse	9 feet per minute
Horizontal traverse of spindle slide	13 feet
Automatic and hand traverse of spindle	1 foot 6 inches
Revolutions of spindle per minute	250-500
Feeds in cuts per inch	80 to 106

This machine has been patented and put on the English market by Sir W. G. Armstrong Whitworth & Company, Ltd., of Manchester.

Explosion of a Blow-Down Tank at Bradford, England*

IN accordance with the provisions of the Boiler Explosions Acts, 1882 and 1890, a preliminary inquiry has been conducted by the Board of Trade surveyor at Hull, with reference to an explosion from a blow-down tank, which occurred on February 27 last, in the boiler house of Messrs. Joseph Dawson's Cashmere Works, Bradford, England.. The tank which failed was used to receive the drainage from the waste steam pipes from the safety valves, and the hot water discharged from the boilers through the blow-out valves, before being run into the sewer. It was rectangular in shape, 9 feet in length, 3 feet in width, and 3 feet 6 inches in depth, and was constructed of steel plates 5/16-inch thick. The boiler plant at the Cashmere Works comprises three units of the Lancashire type, having safety valves adjusted to lift at a pressure of 140 pounds per square inch; each boiler is approximately 30 feet long and 9 feet in diameter. The blow-down tank in question rested on a brickwork foundation in front of, and below, the firing floor of No. 3 boiler. Over the tank was the reinforced concrete firing floor; this contained suitable openings, covered by steel plates, giving access to the tank and blow-down valves.

On February 27, it was ascertained that the safety valve of No. 3 boiler was leaking, and orders were given for the fires to be drawn in order that the valve should be opened up and repaired. This was carried out; the ashes were shifted away from the boiler front and the stokehold plates covering the blow-down valve removed. A short time afterwards, when the boiler pressure stood at 80 pounds per square inch, the blow-down valve was, it is thought, opened slightly. Almost immediately afterwards the foreman mechanic approached the valve and opened it to its full extent. The immediate result was that the blow-down tank burst with a loud report and steam filled the stokehold. The side of the tank opposite the inlet from No. 3 boiler blow-down valve was forced outwards, and the welding of the cover of the tank failed. The top was blown off, and, after wrecking the concrete floor forming the stokehold platform, came to rest in a vertical position against the side of the stokehold. Various portions of the mechanical-stoking arrangements were damaged and some brickwork in front of the boiler displaced. The windows of the building were shattered by pieces of flying concrete and the contents of the boiler were discharged into the stokehold. Unfortunately, two men, the foreman mechanic, who is said to have operated the blow-down valve, and a fitter who was standing beside him, were killed. Three other workmen were scalded.

The tank was evidently unable to withstand the severe stresses to which it was subjected on the rapid opening of the blow-down valve, whereby water at a great velocity and pressure was admitted into it. The report states, that while definite instructions were not issued in regard to lowering the boiler pressure before opening the blow-down valve, it seemed to be generally understood by the firemen that boilers should not be blown down at a pressure exceeding 35 pounds per square inch. In order to prevent a recurrence of the disaster, notices to the effect that under no circumstances must boilers be blown down at more than 20-pound pressure, have been affixed in the boiler house. In the course of his observations, the engineer surveyor-in-chief makes the remark that it is the duty of owners not only to see that the internal pressure is reduced to 20 pounds per square inch before a boiler is blown down, but also that the tank into which the water is discharged, is fit to resist safely that pressure, and that it is maintained in a proper state of repair.

* Published through the courtesy of *Engineering*.

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

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

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

Below are given interpretations of the Committee in Cases Nos. 526 to 529, inclusive, as formulated at the meeting of June 4, 1926, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

Case No. 526. *Inquiry:* Is it intended that the deduction of 100 square inches for a manhole in the head of a horizontal return tubular boiler, shall apply in the 1924 revised edition of the Code only to the portion of the head below the tubes as was the case in the 1918 edition, or is it applicable to the portion of the head above the tubes also? In the 1924 edition of the Code the sentence has been so divided that the statement of exemption does not appear to be limited to any particular portion of the head.

Reply: The reduction of staying allowed by the second sentence of Par. P-218 was intended to apply only under the conditions specified in the first sentence, namely, to the portion of the head below the tubes.

Case No. 527. *Inquiry:* Assuming that a 6-inch hole is permitted by Par. P-258 of the Code, in the shell or drum of a boiler without reinforcement, inquiry is made as to whether there will be any objection to the use of a 7-inch hole without reinforcement in shells or drums 2 inches and over in thickness, with a diameter of 48 inches, provided the concentration of stress at the edges of the hole does not exceed that experienced with a 6-inch hole, namely, between 16,000 and 17,000 pounds per square inch? With the construction contemplated, the normal stress in the shell would be from 5,000 to 6,000 pounds per square inch.

Reply: The restriction in the Code of 6 inches as the greatest opening in a shell or drum without reinforcement, was not intended to apply to shells of thickness of 2 inches or over, and for the case in question, it is the opinion of the Committee that a 7-inch opening is permissible without reinforcement, provided the construction otherwise meets all the requirements of the Code.

Case No. 528. *Inquiry:* Will it meet the requirements of Par. U-53 of the Code, that calls for a handhole in a compressed-air tank 16 inches in diameter or over, if 16-inch air tanks are fitted with 2-inch threaded openings to be closed with standard 2-inch pipe plugs and suitably located so that light bulbs can be inserted to facilitate inspection of all parts? Attention is called to the fact that 16-inch pneumatic reservoirs as used for street-car airbrake purposes are too small to accommodate the usual type of oval handhole openings.

Reply: It is the opinion of the Committee that if, under the conditions named, the vessel is fitted with plugged openings of 2-inch pipe size, so located as to admit electric-light bulbs and facilitate inspection of the entire interior, the intent of the requirement in Par. U-53 may be considered as fully met.

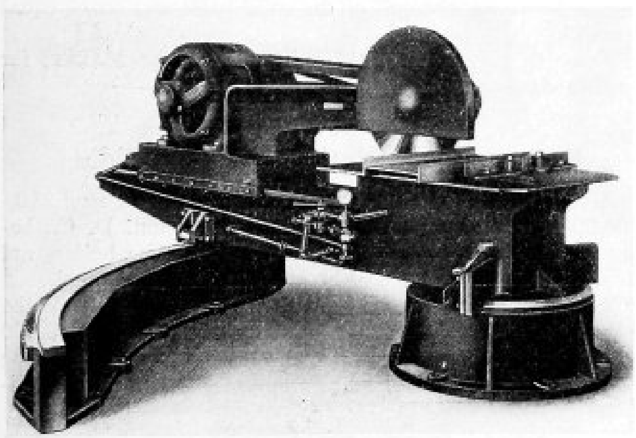
Case No. 529. *Inquiry:* Will a steam-actuated fusible-plug device for indication of low-water level in boilers, come under the rules for the fire-actuated fusible plugs given in the Code?

Reply: The requirements and recommendations in the Appendix of the Code for fusible plugs, if used, are for fire-actuated fusible plugs and do not refer to those of the steam-actuated type. There is nothing in the Code to prevent the use of steam-actuated fusible plugs.

Hunter High-Speed Metal Cut-Off Saw

The No. 2 Hunter high-speed metal cut-off saw was developed especially for the rapid cutting off, mitering, and coping of the new Junior Beams, and other similar sections, such as pressed and rolled metal sections.

The machine is mounted on a turn-table which permits it to swing to any desirable angle, which is convenient when making angular cuts on beams of 50 feet or 60 feet lengths. The table is rotated by a crank handle, which is not shown, at the front end of the machine, through a pair of reducing bevel gears and a spur pinion meshing with the gear on the outer edge of the track. After the table is set to the desired angle it can be clamped rigidly by giving the crank handle, shown above, one-quarter turn.



Hunter No. 2 high speed saw

Twenty-four Inch Saw Used

The machine is equipped with a 24-inch diameter toothed saw, belt driven directly off the motor. The motor and saw are mounted on a carriage which is equipped with rollers. The power feed is of the motor driven hydraulic type. The piston rod of the hydraulic cylinder is attached directly to the saw carriage. The hydraulic pump and the motor are mounted on the machine, making it entirely self contained. Both motors are push button controlled and the push buttons are located so that the operator has absolute control of the machine at all times.

The saw arbor is mounted on double-row deep-groove ball bearings in oil-tight and dust-proof housings. The belt and saw blades are fully protected by steel guards to conform with safety specifications. Belt guard can be quickly removed and an endless belt applied without dismantling other parts of machine. The motor support is provided with an adjusting screw to give the belt the desired tension.

The saw is driven by a 15 horsepower motor and can be equipped with a motor of almost any current.

Testing Pipe Lines and Pressure Vessels

Small, Inexpensive Pumps Are Available for Hydrostatic Tests in Shop and Field

It is of course necessary to test pipe lines and pressure vessels for tightness and strength after they are completed. Furthermore it is customary to use a considerably higher pressure for testing than the one regularly used in service, in order to show up any defects that may exist, and to make sure that the service pressure may be used without failure of any kind.

All building codes and standard specifications for such equipment require the "hydrostatic" test, meaning that the test is made by water at rest. ("Hydraulic" refers to water in motion.) The reasons for using water are three—first, it does not need a large pump, as water can be compressed but slightly; second, if a break should occur, there is not much reaction or "kick" from the slight expansion occurring when the pressure is suddenly released; and third, high pressures can be obtained by it more easily than in any other way.

Water is so slightly compressible that at the depth of a mile a cubic foot of it only weighs half a pound more than at the surface. At this depth the pressure is 2,270 pounds per square inch. From these data it may be figured that water decreases in volume only about three ten-thousandths of one percent per pound pressure. Consequently at 250 pounds test pressure (which is not at all unusual) the volume of water would be reduced less than one-thirteenth of one percent. Therefore when a break occurs, the expansion due to the release of pressure is very small, and the distortion of the vessel being tested is very slight.

On the other hand, using air for testing is a dangerous proceeding because it is highly compressible, its volume decreasing proportionately to the pressure. That is, one cubic foot at atmospheric pressure (or at about 15 pounds per square inch), will occupy only about one-seventeenth of a cubic foot at 259 pounds so that if a break occurs, the air in the container would expand to 1,700 percent of its volume, or over 22,000 times what water would, and the blast would probably cause serious damage if not personal injury. In fact a number of fatal accidents have occurred when air was used for testing a defective vessel, so it should never be employed until the hydrostatic test has previously shown the vessel to be safe.

The equipment necessary for the hydrostatic test is very simple, consisting of a small pump, a pressure gage, and the necessary pipe connections. One of these connections should be in the top of the system, so all air can be removed from the vessel and connections. This is evidently necessary for safety.

Suitable pumps small enough to be easily carried in one hand are made by several manufacturers and sell at moderate prices.

They are largely used by boiler inspectors in their routine work of testing boilers. Of course larger ones can be obtained, but small ones are suitable for a small shop, or for one doing much work in the field, as pressures up to 6,000 pounds per square inch are readily obtained.

When such a convenient and cheap device is available, it is certainly foolish to use air pressure.—*Oxy-Acetylene Tips.*

R. F. Stubblebine, railway sales engineer of the Hale-Kilburn Company, Philadelphia, Pa., has been appointed eastern sales manager with headquarters at 30 Church street, New York, succeeding A. F. Old, deceased.

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Pressure Required for Forming Metal

Q.—Will you please tell me the pounds per square inch it takes to upset hot metal. For instance, suppose I had a 4-inch by 4-inch wrought steel bar heated to a bright red; if I wanted to upset the bar there would be two ways, first to bump it, second hydraulic pressure. How many pounds per square inch does it take to upset the metal? Would appreciate an early reply. C.E.S.

A.—The resistance of a metal to forging determines the force required to form it. The resistance, or strength decreases with an increase of temperature, but for steel or wrought iron the reduction in strength is small, below 375 degrees F. The force required is also greater than the tensile strength of the metal, because the density of the metal increases during the process of upsetting or forging.

The tensile strength of steel when heated to from 800 degrees to 1,000 degrees F. is approximately 30,000 pounds per square inch and at 1,400 degrees F. the tensile strength may be figured at 10,000 pounds per square inch.

Let $R =$ resistance in pounds per square inch.

$T =$ tensile strength at forging temperature, pounds per square inch.

$A =$ area of surface, square inches.

$C =$ constant found from experience, equals 10 for quick acting hammer forging:

1.4 to 2 for slow acting presses or machines.

$P =$ total forging pressure, pounds per square inch.

$R = T C$

$P = A T C$

The work expressed in foot-pounds in forging equals $W = \frac{dP}{12}$, in which d is the distance traveled by the die in inches.

Theory and Design of Riveted Joints

Q.—(1) I am attaching hereto a print showing the back course of a locomotive boiler and detail of longitudinal seam for same and would greatly appreciate it if you would advise me in detail (that is just give me the theory and formulas) either by mail or through the columns of THE BOILER MAKER, just how that portion of the longitudinal seam over the combustion chamber is designed, how the lead is determined, tension on plate, shear on rivets. I would also appreciate it if you would advise me in detail how to determine the factor of safety of the crown sheet and wrapper sheet of a locomotive boiler (just give the theory and formulas).

(2) Please refer to the October, 1915, issue of THE BOILER MAKER, page 312, which gives a formula for finding the factor of a diagonal seam and on the same page next to the last paragraph states that the formula is only approximate. I would appreciate it if you would advise me the correct formula and theory for determining same. L.W.D.

A.—To cover the theory and design for the above problem, would involve more space than is available for this column. You should review the subjects of the design of riveted joints and staying. Refer to the rules for the construction of locomotive boilers, A. S. M. E. Boiler Construction Code. A copy of these rules can be had by writing the American Society of Mechanical Engineers, 29 West 39th street, New York.

The *factor of safety* is the ratio of the ultimate strength of the material to the allowable stress. For new construction the factor of safety shall not be less than 5.

The efficiency of a riveted joint is the ratio of its strength to the strength of the solid plate. The strength of the joint must be figured separately for each possible method of failure, then divide the lowest strength value so found by the breaking strength of the solid plate section of equal length.

Refer to July issue, 1917, of THE BOILER MAKER, for further data on diagonal seams.

Boilers for the National Press Building

Five firetube boilers are being installed in the new $10,000,000 National Press Building, Washington, D. C., being erected by the National Press Club. The boilers are so arranged that either coal or oil may be used as fuel.

The boilers were built and assembled at the plant of the Oil City Boiler Company, Oil City, Pa. Two 10,000 gallon oil tanks were lowered into place in the building recently. Oil will be used as fuel for the sake of cleanliness.

Tool Steel Handbook

The second edition of the Tool Steel Handbook of The Ludlum Steel Company, Watervliet, N. Y., is just off the press. It describes in detail carbon, alloy, rust and heat resisting steels—their use—methods of treating, etc. It is a very complete work and worthy a place in the library of any and every one using steels.

Business Notes

The Reading Iron Company, Reading, Pa., has opened an office at 721 Pioneer Trust building, Kansas City, Mo., and will be directly represented by O. R. Lane.

The Ludlum Steel Company, Watervliet, N. Y., is planning to change over the remainder of its melting furnaces from manual to automatic electric control. This company uses electric furnaces of its own patented design, featuring a movable hearth with a consequent increase in production per furnace.

Charles C. Phelps, 473 Getty Avenue, Paterson, N. J., has been appointed to handle the Marley Superheater in New York City and northern New Jersey. This superheater is made by the Power Plant Equipment Company, Kansas City, Mo., and is especially designed for use with horizontal return tubular boilers and other boilers of the firetube type.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

Steamboat Inspection Service of the Department of Commerce

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

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—C. D. Thomas, Salem, Oregon.
Statistician—E. W. Farmer, Rhode Island.

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

J. A. Franklin, International President, suite 522, Brotherhood Block, Kansas City, Kansas.
William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.
Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.
James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.
H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.
International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C. Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Avenue, Columbus, Ohio.

Master Boiler Makers' Association

President—J. F. Raps, general boiler inspector, Illinois Central.
First Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.
Second Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.
Third Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.
Fourth Vice President—George B. Usherwood, supervisor of boilers, New York Central.
Fifth Vice President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington and Quincy.
Secretary—Harry D. Vought, 26 Cortlandt Street, New York.
Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.
Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—J. W. Kelly, National Tube Company, Pittsburgh, Pa.
Vice President—A. W. Clokey, American Arch Company, Chicago, Ill.
Treasurer—George R. Boyce, A. M. Castle and Company, Chicago, Ill.
Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie, Pa.
Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.
Secretary-Treasurer—A. C. Baker, 801 Rockefeller Building, Cleveland, Ohio.
Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; Owsley Brown, Springfield Boiler Company, Springfield, Ill.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Wroks, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

Cities

Chicago, Ill.	Memphis, Tenn.	St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Los Angeles, Cal.	Philadelphia, Pa.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Missouri	Pennsylvania
California	New Jersey	Rhode Island
Delaware	New York	Utah
Indiana	Ohio	Washington
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Nebr.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Memphis, Tenn.	Philadelphia, Pa.	Tampa, Fla.

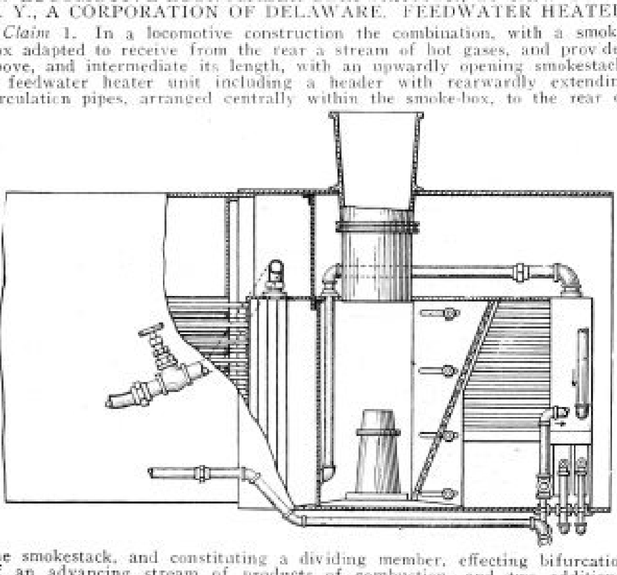
SELECTED BOILER PATENTS

Compiled by
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,595,932. GUY T. FOSTER, OF DAYTON, OHIO, ASSIGNOR TO LOCOMOTIVE ECONOMIZER CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE. FEEDWATER HEATER.

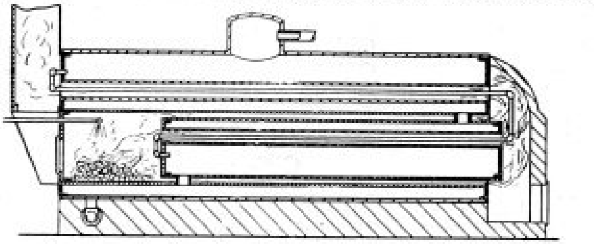
Claim 1. In a locomotive construction the combination, with a smoke-box adapted to receive from the rear a stream of hot gases, and provided above, and intermediate its length, with an upwardly opening smokestack, a feedwater heater unit including a header with rearwardly extending circulation pipes, arranged centrally within the smoke-box, to the rear of



the smokestack, and constituting a dividing member, effecting bifurcation of an advancing stream of products of combustion, and two additional units including each a header with rearwardly extending circulation pipes, symmetrically arranged within the smoke-box on either side and at its forward end, the circulation pipes of the two last-named units extending into the branches of the bifurcated stream.
Four claims.

1,589,162. JAMES S. HILLYER, OF DULUTH, MINNESOTA. BOILER.

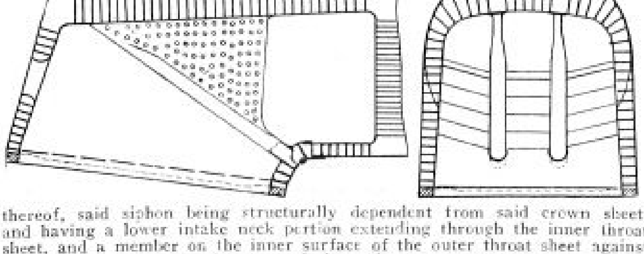
Claim 1. In a boiler, the combination of an exterior tank, an interior tank extending into said exterior tank and spaced therefrom, connecting means for permitting the circulation of water from one to the other of said tanks, a fire flue extending through one of said tanks, another fire



flue extending through the other of said tanks, and a water circulation pipe extending through both of said flues, one end of said circulation pipe communicating with the interior of one of said tanks and the opposite end of said circulation pipe communicating with the interior of the other of said tanks.
Three claims.

1,575,051. CHARLES GILBERT HAWLEY, OF CHICAGO, ILLINOIS, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE. LOCOMOTIVE BOILER.

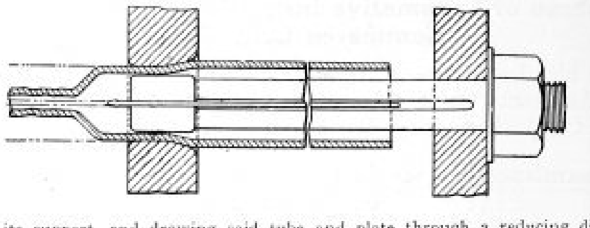
Claim 1. A locomotive boiler firebox in combination with a substantially triangular thermic siphon or water-steaming wall forming a water passage between the throat of the firebox and the space above the crown sheet



thereof, said siphon being structurally dependent from said crown sheet, and having a lower intake neck portion extending through the inner throat sheet, and a member on the inner surface of the outer throat sheet against which said neck portion has an end thrust bearing engagements as and for the purpose specified.
4 Claims.

1,591,116. JAMES H. DUNBAR, OF BELLEVERNON, PENNSYLVANIA, ASSIGNOR TO PITTSBURGH STEEL PRODUCTS COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA. METHOD OF FORMING TUBES.

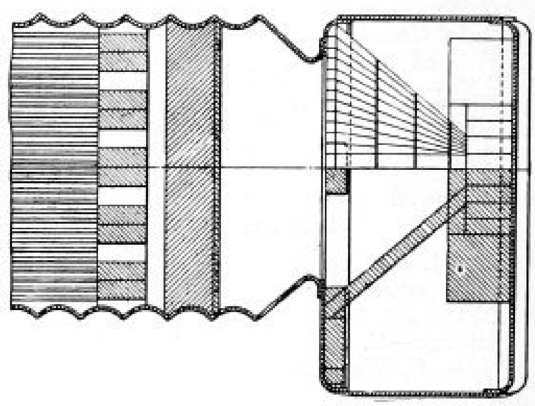
Claim 1. The method which consists in supporting a partition plate throughout substantially its entire length, placing a tube over said plate



and its support, and drawing said tube and plate through a reducing die, to compress said tube against the edges of the plate.
Three claims.

1,580,028. WILLIAM S. FANDREI, OF ASHTABULA, OHIO, FURNACE.

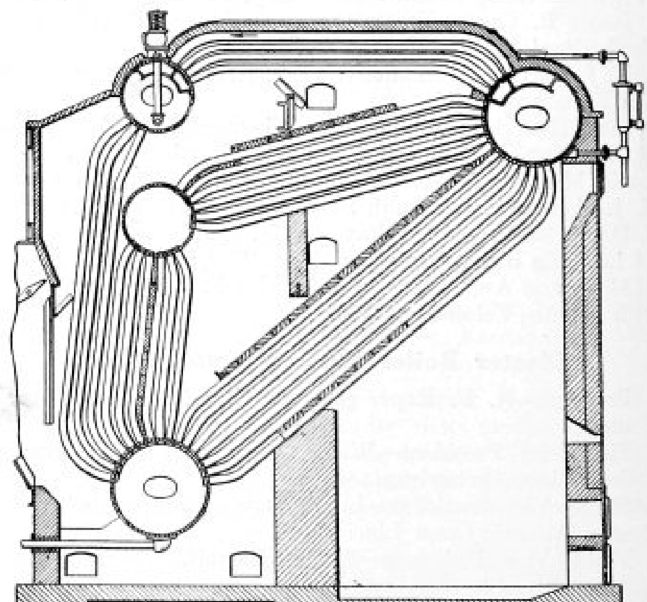
Claim. In a furnace including grate bars having a solid bridge wall extending across the rear ends thereof, a supplemental solid bridge wall resting upon said bars and extending transversely thereof against the face of said first mentioned bridge wall, said supplemental bridge wall having



a recess in, and extending throughout the length of the back, said recess being of less height than the wall and opening through the grate therebeneath, and said supplemental wall further having a series of transverse passages therethrough opening at one end through the front of the wall and at the other end into the upper part of said recess.

1,592,818. RALEIGH J. ADAMS, OF CHICAGO, ILLINOIS. BOILER.

Claim. In a boiler, a drum having a plurality of compartments therein, one of said compartments having an outlet through which steam may be withdrawn from the boiler, a second drum having a single compartment therein, none of said compartments having direct communication with



the interiors of their respective drums, tubes independent of the compartments in the two drums for connecting the first drum to the second drum, tubes independent of the compartment in the second drum for connecting the second drum with a compartment in the first drum, tubes connecting said last mentioned compartment to the compartment in the second drum, and tubes connecting the compartment in the second drum to the compartment in the first drum provided with said outlet.

The Boiler Maker

Volume XXVI — **October, 1926** — **Number 10**

Published Monthly by

SIMMONS-BOARDMAN PUBLISHING COMPANY

30 Church Street, New York, N. Y.

Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ave.
Mandeville, La.
Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.

Cable address: Urasigmee, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

Request for change of address should reach us two weeks before the day of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

Machine Tools in the Boiler Shop

During the past few months a number of heavy production type machine tools of advanced design for use in the boiler shop have been described in the pages of The Boiler Maker. Two machines coming under this category—a mud ring and flue sheet drill, and a boiler shell drill appear in this issue. It should be gratifying to the boiler manufacturing industry in all its branches that thought and study on the part of machine tool builders are being devoted to the production problems that exist in the boiler shop and advantage should be taken of the savings in manufacture made possible by the use of these machines.

Practically every other industry has adopted a policy of installing time and labor saving machinery as it has become available. In many cases such machinery has been charged off in the overhead at a rate that would permit the renewal of equipment at more or less frequent intervals as newer and better devices were produced. Because of the comparatively limited number of machine operations in boiler making the life of machine tools may well be extended over a longer period than is usual in some other industries. At the same time attention should be given to modernizing equipment by easy stages. The field for such modernization in boiler work is rather extensive for with the exception of a few new plants the average boiler shop is equipped with practically the same heavy tools today that were functioning 30 years ago.

Some tools, such as bending rolls, shears and the like, are possibly as usable now as they were when in their prime but punches, drills, riveting machines, presses and other tools which have come down from a former industrial period, are more or less wasteful in the light of later developments. In fact, the punching of rivet holes in boiler sheets is now considered unfavorably by most builders. With the decrease in rivet hole punching, drilling machines have been developed in the form of gang drills and multiple sheet drills with movable tables, both automatic and semi-automatic, that not only give the advantage of accuracy but also provide greater ease and speed in the fabrication of boiler and heavy plate work.

Another way in which production may be increased and costs proportionately lessened is by speeding up shop machinery to a point approaching its capacity. In some plants there seems to be a tendency to operate boiler fabricating machines at a speed that is neither economical nor conducive to long life of the equipment. By the use of high speed steel tools it will be found that machine tool speeds may be increased 20 to 30 percent with excellent results from a production standpoint and without causing any undue wear on the tools.

On the question of new tools, as for example, the boiler shell drilling machine described in this issue, many of the developments in boiler shop machinery have been the direct result of the experience, ingenuity and hard work of the men in the boiler shops themselves. The editors of The Boiler Maker will welcome any information on new equipment for heavy operations or for hand work, that are developed to speed up boiler production, whether they are used in an individual shop or are available to the entire industry. It will be the object of this magazine in the coming months to feature descriptions of such equipment in the effort to bring to the attention of our readers the fact that this phase of the industry has entered a new and progressive era.

Questions and Answers

ONE way in which The Boiler Maker is able to render a valuable service to its readers is through its Questions and Answers department. Any reader may use this service at any time and as often as he desires without cost or obligation of any kind. All that is necessary is to write out the question, with the name and address of the inquirer; mail it to our office and the answer will be forthcoming within a reasonable time. Needless to say anonymous questions cannot be answered nor can information be given which does not pertain to boiler shop work. If the answer contains information that is of interest only to the inquirer, it will simply be mailed to the name and address given with the question; but if it contains information of general interest to other readers, it will also be published in The Boiler Maker. The name and address of the inquirer, however, will not be disclosed unless the editor is given permission to do so.

The department of Questions and Answers is conducted by a man who has worked his way up through all the grades in the boiler shop and is now in active charge of one of the prominent boiler shops in the east. He has also had extensive experience in charge of the course in boiler making offered by one of the largest correspondence schools in the country. Any reader, therefore, who desires assistance in solving practical boiler shop problems may have for the asking competent advice from an authoritative source.

The Watertube Locomotive Boiler

ALTHOUGH the practical application of watertube boilers to locomotives is a relatively new development and so far has been limited to only a few installations, nevertheless the results indicate that such boilers are giving an excellent account of themselves in service and that further progress may be looked for in this direction in the future. Aside from the complications that arise in working out the mechanical details of this new new type of construction, the fact remains that by means of a watertube firebox the heating surface of the locomotive boiler can be materially increased and that at a point where heating surface is most effective. That the possibilities for improvement in this direction have long been recognized is shown by the fact that early in 1908 the late Mr. Robert Joy, formerly head of the boiler department of the Kingsford Foundry and Machine Company, Oswego, N. Y., designed a watertube locomotive boiler in which the side walls of the firebox consisted of vertical watertubes connecting a water box at the bottom in place of the mud ring to steam drums at the top comprising the crown of the firebox. Patents covering this design, which were applied for in 1917, were granted in 1919 and but for the untimely death of the designer an experimental boiler of this type would have been built. This design resembles in many respects the McClellon type of firebox recently successfully developed by the New York, New Haven and Hartford Railroad and described in our March and September issues of this year. In view of the inherent advantages possessed by this type of boiler, it is to be hoped that further opportunity may be found for its development and practical application.

LETTERS TO THE EDITOR

Boilers Used in European Electrical Steam-Raising Plants

To the Editor:

Steam-raising by electricity is making particular progress throughout France, especially in those districts where water power is abundant and coal expensive. What is believed to be the first plant of this description, and of commercial size, was installed at Bussi, in Italy, in 1914-15. At this plant seven boilers were utilized to generate steam for the requirements of a 5,600 horsepower plant. At the present time there are several hundreds of these boilers in operation in Italy, and all of them are giving quite satisfactory results.

The largest French installation of the kind is probably that in the Fredet works at Brignould, in the Isere department. It has been working very successfully for the last five years. These works are of a very general description and manufacture various chemical products, besides having large repair sheds for railway trucks. The boilers actually in use were specially designed, the water being heated by electrodes working on a three-phase current of 6,500 volts, with a frequency of 50 cycles. The boilers are of the horizontal type, with six vaporizing chambers in each. In each of these chambers there is an electrode carried on a specially constructed insulator. The steaming capacity of each boiler is 4,800 to 5,000 kilograms of steam an hour. Steam passes through a separator to the dome and is then taken for paper-making. There are two of these boilers installed in this works, and the current consumption of each is about 78,000 kilowatts in 24 hours, so that the current consumption per kilogram of steam raised is about 0.7 kilowatt.

Although the installation was an expensive one, it is estimated that the capital has been recouped several times over, as the cost of current is exceedingly low—1 centime per kilowatt hour during the periods when water for the prime movers is abundant, which is practically all the year round.

It is not proposed to utilize this method of steam generation except in conjunction with electricity generated by water power and then only in cases where it would not interfere with other users. In other words, it is the utilization of power that would otherwise run to waste. The success of this installation, however, has brought in a large number of inquiries, particularly from the mountainous districts such as the Pyrenees, Jura and Central Plateau, where water power is available in abundance, but where, up to the present time, no industries requiring steam for process work have been established. A number of boilers are under construction and will be in operation shortly, chiefly in paper and chemical manufacture.

The same method of steam-raising has been applied to a shunting locomotive in the Fredet works, but in this instance a stationary boiler is used for the generation of the steam, which is fed into an accumulator which takes the place of the locomotive boiler. The stationary boiler is heated by three-phase current at 500 volts, with a periodicity of 50, while the capacity of the accumulator is 5,000 liters. The locomotive weighs 20 tons, and works for from three to four hours without being recharged. The current consumption is about 1,500 kilowatt hours per day of eight hours, while the coal consumption of the locomotive before conversion was 700 kilograms of briquettes, valued at 250 francs per ton.

London, England. G. P. Blackall.

Sections of Cones*

To the Editor:

On page 221 of the August issue of The Boiler Maker you have a development which seems to me is wrong, due to an error in basic principles of conic sections wherein Mr. Haddon states that the section of a cone is a true ellipse and proceeds to use the methods of a right cone for the development of the conical part. There is no section of a right circular cone that is a true ellipse or that will coincide with one cut from a cylinder. If you wish me to do so, I would be glad to submit the correct layout, using the same condition as to angles, etc., that Mr. Haddon has used and, if desired, I will superimpose Mr. Haddon's layout on one of my prints to show the difference.

The correct development of the conical part must be triangulated because it will not be a right cone as it will be necessary to find the true elliptic contour and warp the elements of the conical part to fit. R. C. Harding.

Cleburne, Texas.

An Easily Made Sand Blasting Machine

To the Editor:

The inclosed drawing of a sand blasting device may prove of some interest to your readers.

We have found in the sandblasting of flues preparatory to welding that the manufactured outfit that we have used has been too cumbersome and expensive to operate due to the rapidly cutting out of various cast iron parts. These faults of construction were principally all caused by the rapid flow of sand around the base of the container and through the valve and seat within the tank. This soon resulted in a nearly uncontrolled flow of sand. This was so great as to be wasteful and so rapid and heavy as to generate a considerable amount of electric current within the hose that made it very difficult to handle.

The apparatus illustrated was designed to eliminate the conditions mentioned and is a very satisfactory assembly. As will be seen all parts, with the possible exception of the 12-inch pipe and No. 9 mesh screen are readily obtainable from stock in most any shop and can be replaced with little trouble and expense when the sand cuts them out.

The piping arrangement gives a moderate flow of sand at high velocity. It has been found that about two cubic feet of sand will clean the flue ends and sheet of a locomotive boiler with 36 superheater flues and 236 2¼-inch flues.

We use nothing but locomotive sand. With other grades of sand the interior sand holes might have to be changed. The entire labor cost on the job should not exceed ten dollars.

Hilton Village, Va. C. E. Lester.

*On page 293 will be found Mr. Haddon's reply to these readers, as well as a complete explanation of the points in question.

Should Rivets that Sweat Be Calked?

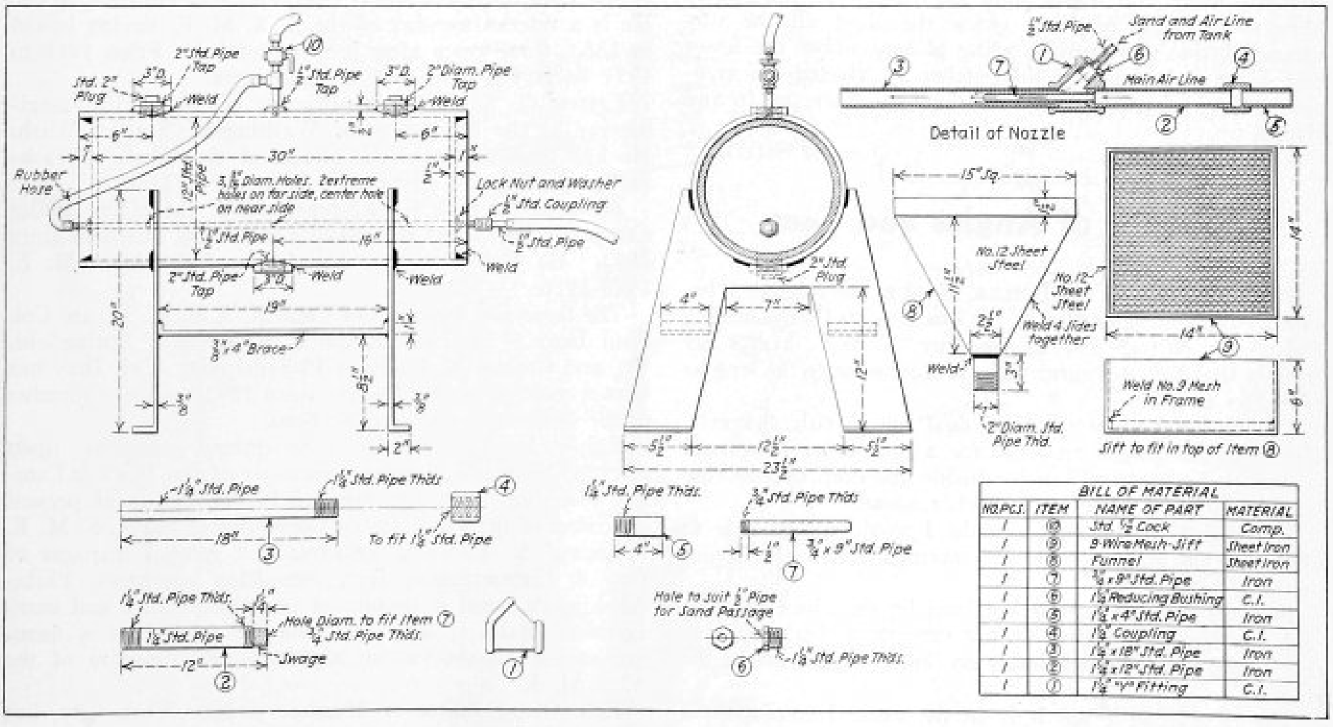
To the Editor:

The July issue of The Boiler Maker contains a request from "T. F. S. J." for the opinion of authorities as to whether rivets that "sweat" should be calked. While not considering myself as an authority on the subject, experience gained from 33 years in the business may be of some help.

The standing instructions from the boiler foreman under whom I was fortunate enough to learn the trade were "never mind the sweats, get the trickles and the squirts." A close compliance with these instructions and the subsequent checking upon various jobs in service prove to my satisfaction that calking a sweating rivet or seam is unnecessary. Apart from other considerations there are two distinct reasons for leaky rivets and seams. These can be eliminated by the proper driving of the rivet, by which is meant the complete filling of the hole and the careful laying up of the sheets as the riveting progresses.

Welding Flues in the Flue Sheet

In the same issue "E. N." requests information as to the advisability of welding flues to back flue sheet without beading. We understand that superheater flues have been applied in this manner, but up to this time no data as to results have been published. The accepted theory of what



BILL OF MATERIAL			
NO. PCS.	ITEM	NAME OF PART	MATERIAL
1	10	Std. ½" Cock	Comp.
1	9	9-Wire Mesh-Sift	Sheet Iron
1	8	Funnel	Sheet Iron
1	7	¾" x 9" Std. Pipe	Iron
1	6	1¼" Reducing Bushing	C.I.
1	5	1¼" x 4" Std. Pipe	Iron
1	4	1¼" Coupling	C.I.
1	3	1¼" x 18" Std. Pipe	Iron
1	2	1¼" x 12" Std. Pipe	Iron
1	1	1¼" "Y" Fitting	C.I.

Details of a shop-made sand blasting machine part a flue plays, apart from its function as heating surface, is that the flue acts as a stayrod between the two flue sheets, a properly expanded and beaded flue has vast holding power. Eliminate the bead and we find ourselves depending upon the weld practically for holding power and, from my observation of welded flues in service, I should hesitate in placing my entire dependence upon the weld.

Another factor which we will have to consider is, in applying flues in this manner would it not be necessary to discard the copper ferrule? The copper ferrule acts as an equalizer between flue and flue sheet, or, in other words, aids in giving a more equal distribution of expansion and contraction due to the varying temperatures, therefore it follows that in eliminating the ferrule we would lose a valuable agent in the upkeep of flues. The average cost of welding 1⅞-inch flues should be between 3 and 3½ cents per flue, as a welder at 78 cents per hour can average 25 flues per hour; that is, for labor only, welding wire and overhead must also be considered.

Boiler Troubles

In the August issue, "G. G." gives a list of boiler difficulties. Taking the case of his marine dryback which gives trouble through flue leakage after washout: He is experiencing the same kind of trouble which came under the writer's observation for several years with the same class of boiler which was used in connection with a car-dumping machine. At washout periods the boiler was blown off rapidly then washed and filled with cold water and fired up rapidly; the flues had been worked over carefully but would still leak. Finally, another boiler was installed, making it possible at washout periods to blow down the one boiler slowly; then allow the other boiler to go cold, wash and steam up slowly and our flue troubles disappeared.

Flues are not welded. Welding of flues in combustion chamber may help, but I fail to see the benefit of welding in both ends. Are combustion chambers airtight? Air leaks into chamber will cause the flues to leak. In the case of junked boilers, if the boilers are in good condition and will pass inspection, it has been found practical and economical where boilers were of the "ogee" type of mudring to cut that away and apply solid mudrings. If the boilers have solid rings, why not renew the sheet all the way around, inside and outside, going at least above the lower row of staybolts; then if the patches are riveted the mudring can be left out until this is done and then put in and riveted up.

Lorain, Ohio. Joseph Smith.

Lengths of Angles and Tees

To the Editor:

In looking over The Boiler Maker for August I became very much interested in the question on Channel Ring Calculation on page 241, as asked by "N. W." May I say frankly that I do not agree with the answer as to the lengths of angles and tees.

I have not had occasion to deal much with channels. However, the length required for a 6-inch by 8.2-pound channel to be bent to 77 inches inside diameter, outside ring is 244.784 or 20 feet 4 13/16 inches, about.

If I had a similar ring to make I would not hesitate at all to use the above length and layout any holes to be put in the same.

Inasmuch as the figures obtained by the given formula and the figures I present do not vary only about ⅜-inch, this would not cut much figure on the circumference of the ring.

The trouble as I see it is in the method employed in rolling the channel. To roll channels or angles, after having been layed out before rolling, great care should be taken in the process of rolling not to reduce the size of the flange.

As the flange plays the important part in obtaining the required length of circumference and *not* the line of gravity as is commonly referred to. You doubtless know that in rolling a channel in plate rolls the channel section comes out with the edges of the flanges stove up, thereby reducing the true section of the flange.

I feel sure that this is where "N. W." went wrong in the bending. I hope this may be of some help to you. I am still grateful for the hints given from time to time in your Questions and Answers Department. Wishing you continued success.

Canton, Ohio. James McMurray.

New Officers Elected by the American Society of Mechanical Engineers

The tellers of the annual election of officers of The American Society of Mechanical Engineers announced this morning that Charles M. Schwab had been elected president of the Society for the coming year. Mr. Schwab is already well known to the 18,000 members of this national engineering organization, having been elected an Honorary Member in 1918 as a recognition of his great part in the upbuilding of the steel industry and his ability as an industrialist, a financier and as an organizer of men.

Mr. Schwab will formally assume his new office as A. S. M. E. President at the annual meeting of the Society in New York early in December, at which time he will succeed William L. Abbott of Chicago. Mr. Schwab has accepted the responsibility with his characteristic enthusiasm and it is certain that his organizing power and charming personality will go far toward promoting the cause of organized engineering effort in the United States.

Other new officers announced by the tellers at this time are three Vice-Presidents, three members of Council, and a Treasurer. The Vice-Presidents are: Messrs. Charles L. Newcomb, Everett O. Eastwood and Edwards R. Fish. Mr. Newcomb is manager of the Deane Works of the Worthington Pump and Machinery Corporation at Holyoke, Mass. He is a veteran member of the A. S. M. E. having joined in 1883, three years after it was founded. From 1918 to 1921 he served as one of the managers.

Everett O. Eastwood is professor of Mechanical Engineering at the University of Washington, Seattle, Wash. He has been active in the affairs of the Western Washington Section and served as a Manager 1923-1926.

Edwards R. Fish is vice-president of the Heine Boiler Company, St. Louis, Mo., having been with this firm since 1893. He also served as a manager of the A. S. M. E. 1923-1926.

The three new members of Council, A. S. M. E., are Col. Paul Doty of St. Paul, Ralph E. Flanders of Springfield, Vt., and Conrad N. Lauer of Philadelphia. Col. Doty has been a member of the Society since 1891 and is a member of the Committee on Local Sections.

Ralph E. Flanders is a recognized authority upon machine tools and is general manager of the Jones & Lamson Machine Company, Springfield, Vt. He is at present chairman of the Publications Committee of the A. S. M. E.

Conrad N. Lauer is treasurer and general manager of Day & Zimmermann, Inc., consulting engineers, Philadelphia, Pa., and is prominent in public utility and management affairs. Since 1922 he has served as a member of the Committee on Meetings and Program of the A. S. M. E.

Erik Oberg, editor of *Machinery*, New York City, has been re-elected Treasurer of the Society.

A Boiler Shop Built by Boiler Makers

Employees of the Union Iron Works build highly efficient modern plant at Erie, Pa., to replace original shop destroyed by fire

IN March, 1922, the boiler shop of the Union Iron Works at Erie, Pa., was totally destroyed by a fire of unknown origin. The plant had been in operation since 1890 when it was founded by William Hardwick, president of the Erie Engine Works, and LeGrand Skinner, president of the Skinner Engine Works. As both of these manufacturers were producing engines for small power plants, their boiler requirements were practically identical and hence their united enterprise under the name of the Union Iron Works was a logical development to meet a common need for the economical production of steel boilers. In the course of time, as the demand for small boilers gradually diminished the scope of the work of the Union Iron Works was enlarged and special types of both watertube and firetube boilers were developed for general industrial use.

Fig. 1.—Exterior view of boiler shop

Faced with the difficult situation created by the disastrous fire in 1922, the company immediately turned to its own organization for a way out of its difficulties with the result that before the end of the year a new and highly efficient shop was in full operation on the site of the old plant, all of which had been accomplished by the company's own organization. That a force of trained boiler makers under competent management should build good boilers efficiently is to be expected but that the same organization, thrown upon its own resources, should create from the ruins of a disastrous fire one of the most efficient and best equipped boiler shops in the country speaks volumes for the loyalty, resourcefulness and progressiveness of the members of the organization.

Location of the Plant

The plant of the Union Iron Works is built on a plot comprising about 5¾ acres located on the south side of the New York Central Railroad tracks between Cascade and Raspberry streets with spur tracks entering the plant from the main line of the New York Central. As shown in Fig. 2, the plant comprises the main boiler shop, which is 335 feet long by 158 feet wide; a flange shop, 174 feet long by 50 feet wide; a blacksmith shop, 58 feet long by 51 feet wide; a stack or sheet metal shop, 174 feet long by 117 feet wide; a warehouse, 202 feet long by 71 feet wide; a power house, 58 feet long by

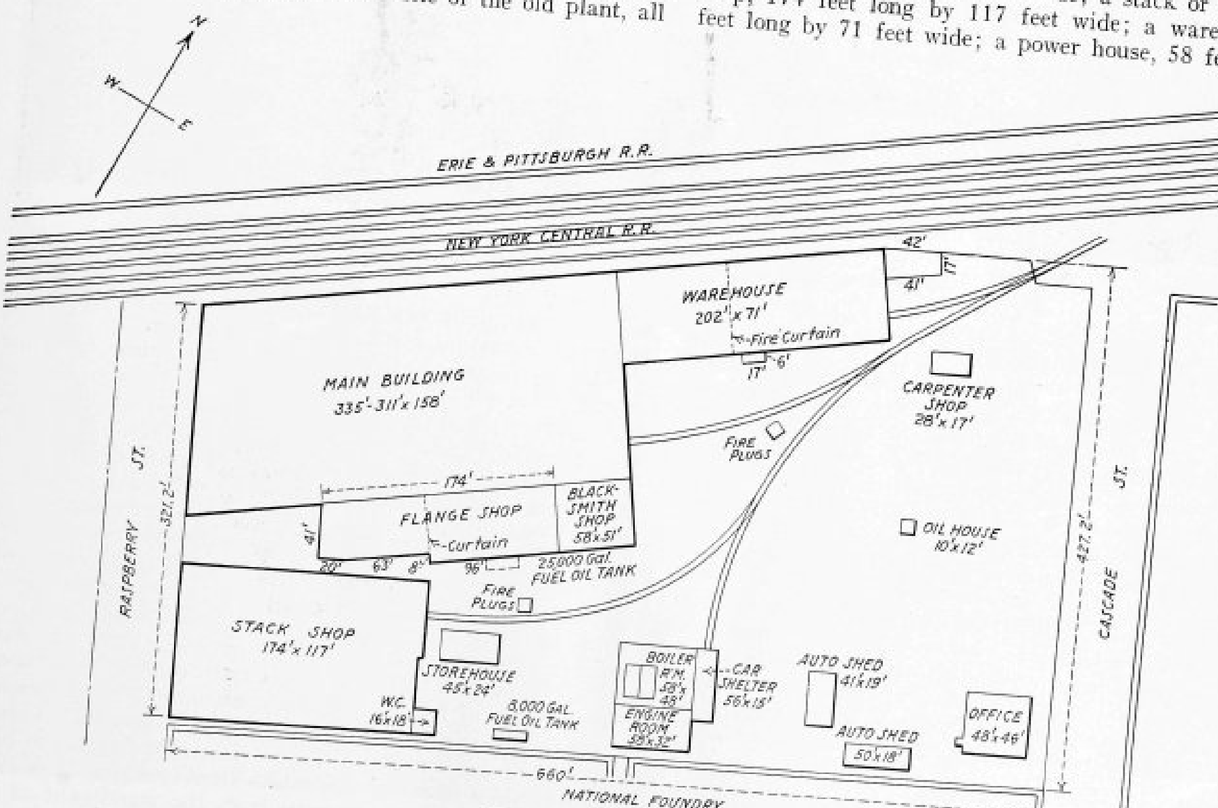


Fig. 2.—Layout of plant

80 feet wide and a two-story office building, 48 feet long by 46 feet wide. In addition, several smaller buildings are scattered through the yard. The main boiler shop, flange shop, blacksmith shop and warehouse are joined together. As the present buildings cover only about half the property owned by the company there is ample room for future expansion of the plant.

As previously stated, both watertube and firetube boilers are built in the plant as well as an extensive line of general plate work. The watertube boilers are of either the horizontal drum or bent tube types and are built in sizes ranging from 150 to unlimited horsepower. The firetube boilers include not only horizontal return tubular boilers but also small vertical boilers for steam shovels, locomotive boilers for geared locomotives in the logging industry and a small horizontal tubular boiler of special construction called the Universal type boiler which is made in sizes ranging from 25 to 250 horsepower for power and heating purposes.

An average of 110 men are regularly employed in the boiler and stack shops. The men in the boiler and stack shops form two separate organizations and those who work on the light work (¼ inch or lighter) in the stack shop never work on the high pressure work in the boiler shop.

The main offices of the company, located in a two-story brick building facing on Cascade street, are thoroughly modern in every respect. On the main floor are the executive and sales offices and the auditing department while on the second floor are the engineering department and drafting room and the time-keeping and progress department.

Power Plant

Electricity for operating and lighting the entire plant is generated in the company's power house which is typical of the latest practice in design and equipment. Steam is supplied at 200 pounds per square inch pressure by two 300 horsepower Union horizontal drum watertube coal-burning boilers equipped with Detroit mechanical stokers and mechanical coal and ash handling appliances. The electrical plant comprises a 125-kilowatt direct current generator direct connected to a single cylinder Skinner non-condensing engine and a 55-kilowatt Keystone generator also direct connected to a Skinner single cylinder engine. Compressed air at 115 pounds per square inch pressure is supplied by two Bury steam-driven air compressors. Power for operating the hydraulic machinery is supplied by an accumulator in the power house operated by a Snow pump. The plant is thoroughly equipped with automatic recording instruments necessary for its efficient operation.

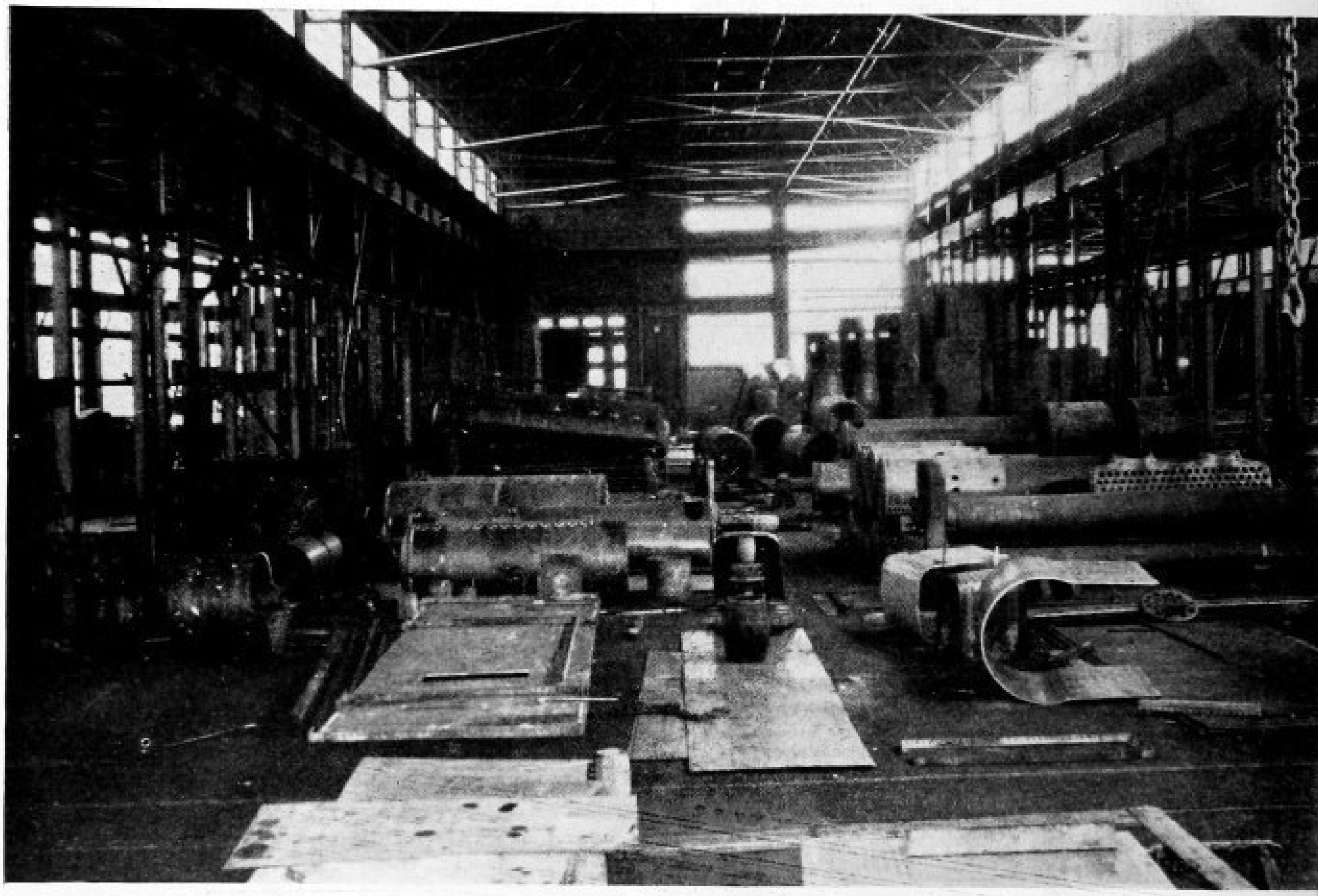


Fig. 3.—General view of center bay of the boiler shop, looking east

The buildings are all heated by exhaust steam from the power plant.

The Boiler Shop

The main boiler shop, as shown by the exterior view, Fig. 1, is a fine example of modern steel, brick and glass factory construction. As the walls are almost entirely of glass and the roof of monolithic construction, every part of the shop is thoroughly lighted. For artificial illumination at night, a lighting system, designed by engineers of the General Electric Company, was installed which is so effective that there are no shadows in any part of the shop.

An innovation in boiler shop construction is to be found in the floor of the shop which consists of a solid concrete foundation on which is laid wood block flooring. This is said to be the first boiler shop in the United States to have a wood block floor and the results after four years' use fully justify its adoption not only from the standpoint of the

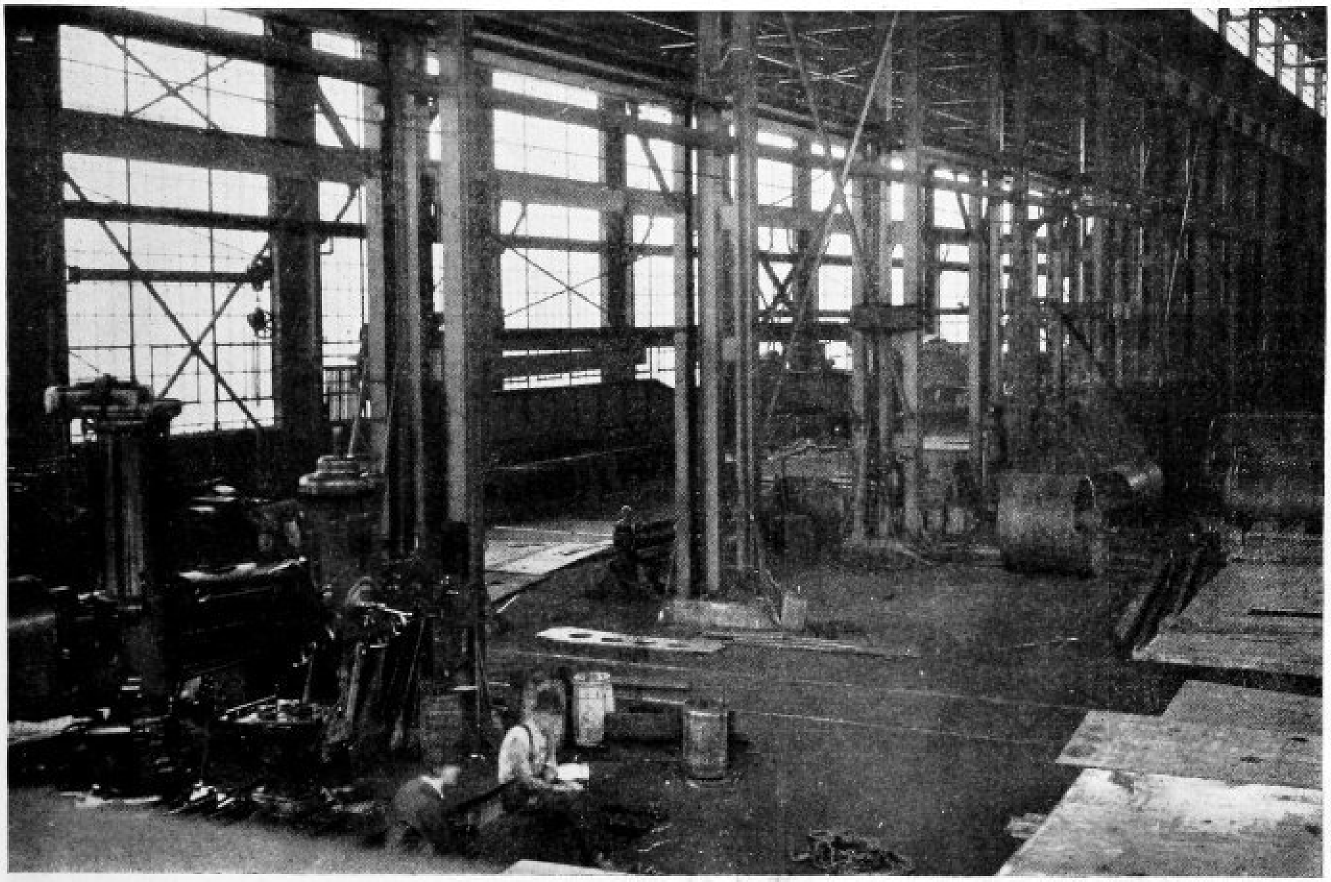


Fig. 4.—Looking towards north bay from riveting tower

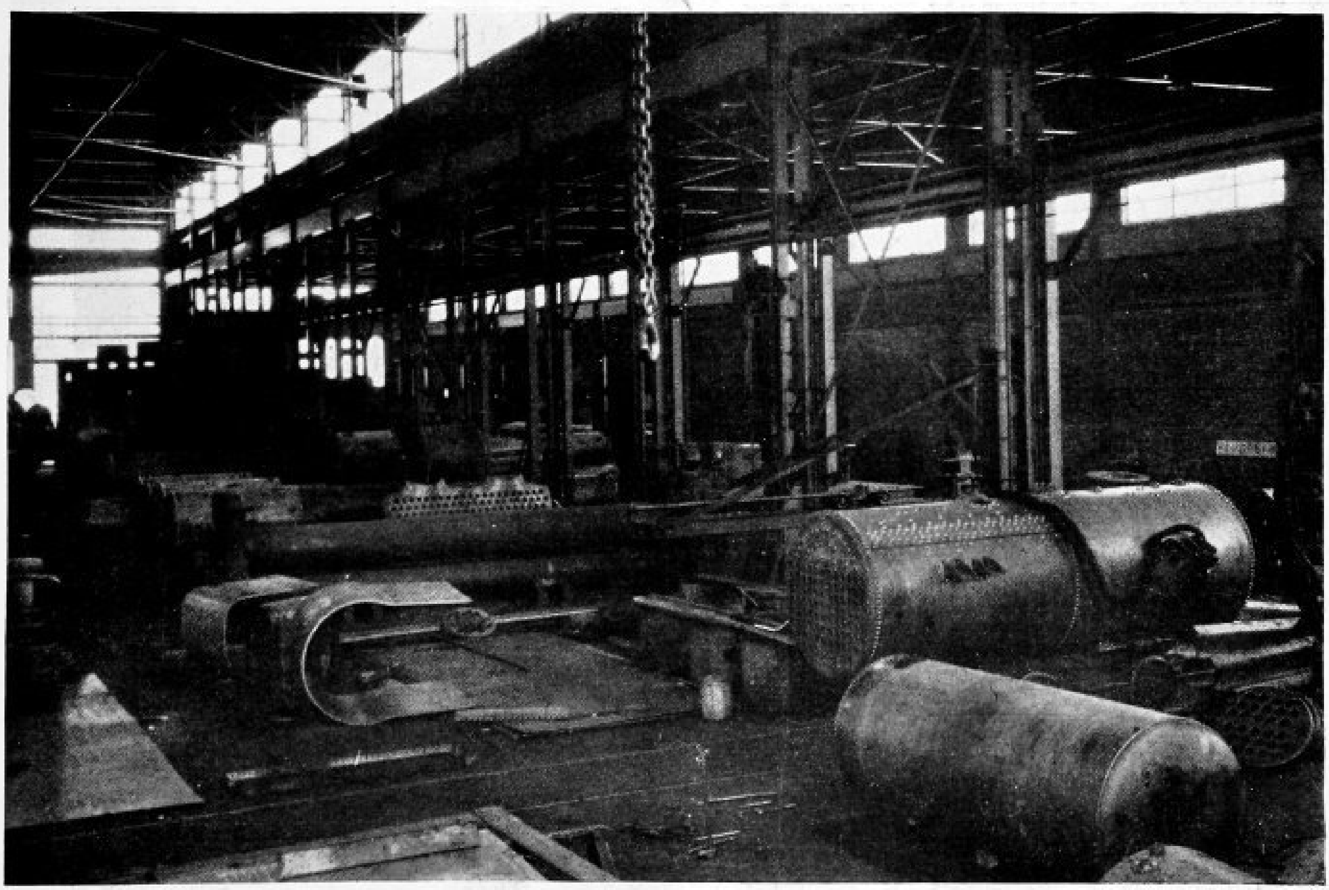


Fig. 5.—Looking towards south bay from riveting tower

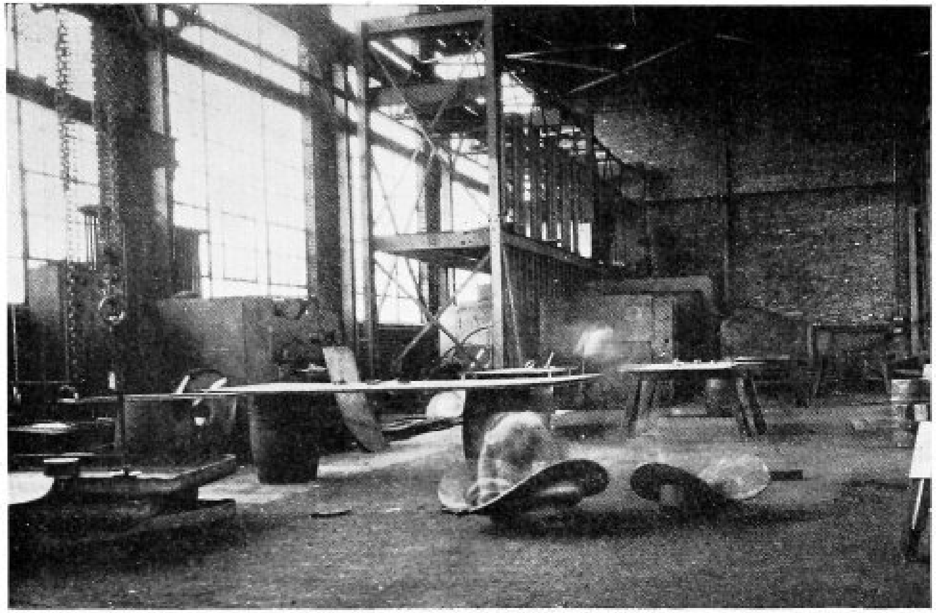


Fig. 6.—Laying out space, showing double-deck vertical plate racks in background

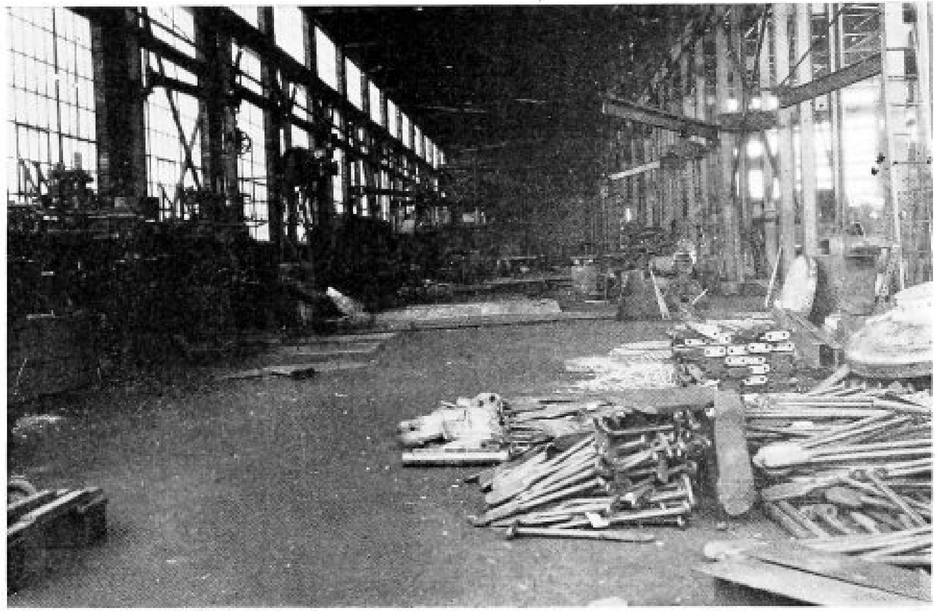


Fig. 7.—Looking east in north bay, showing fabricating department

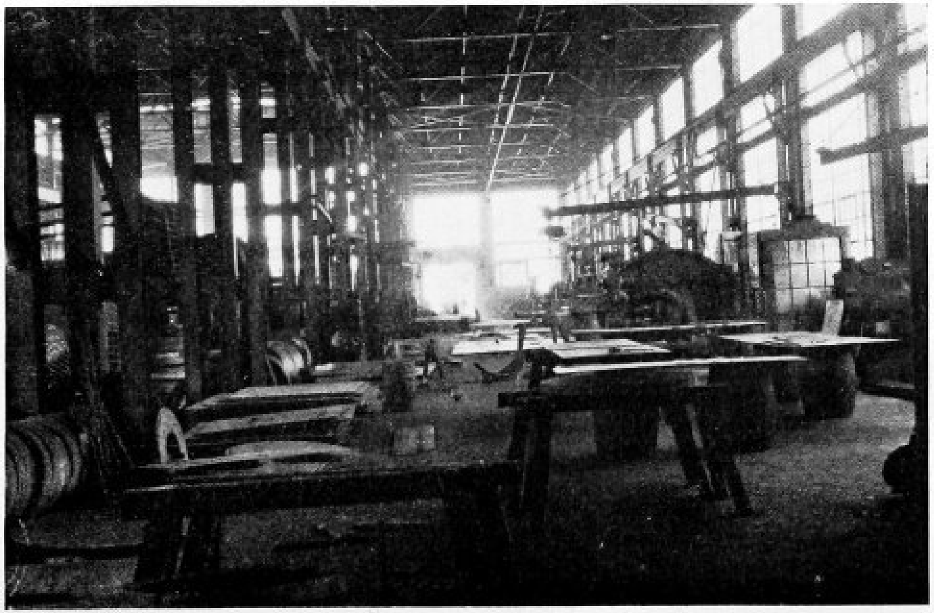


Fig. 8.—Looking west from laying out space in north bay

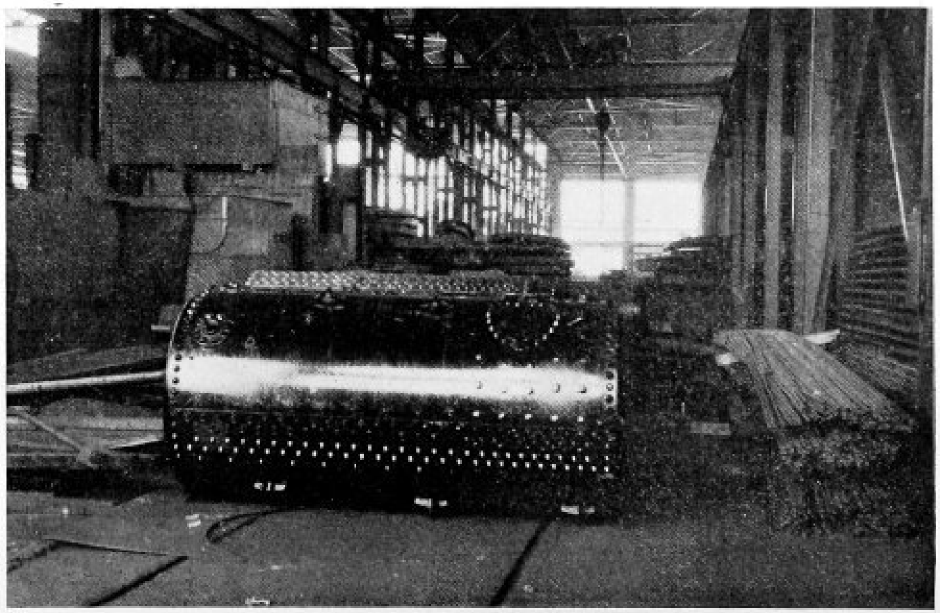


Fig. 9.—Looking west in south bay, showing finished work in foreground

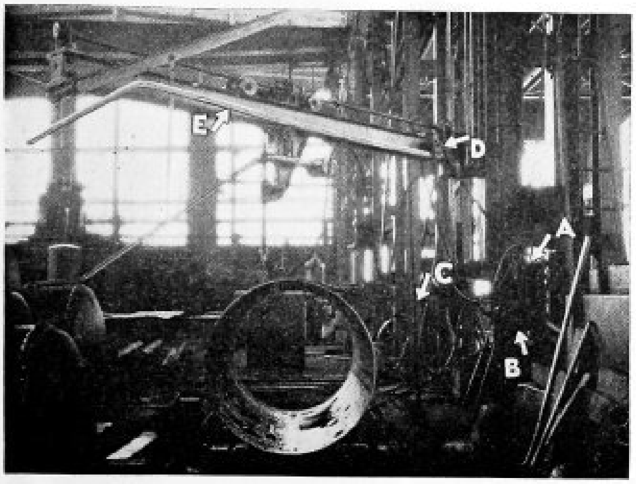


Fig. 10.—Wall drill fitted with special device for turning work

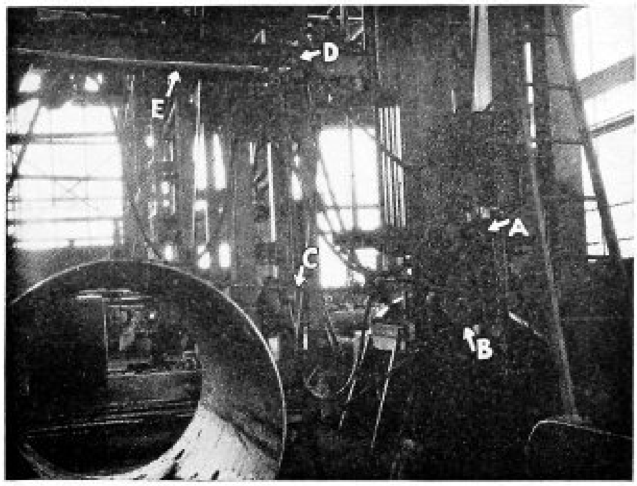


Fig. 11.—Rigging for turning work at wall drill

reduction in cost of maintenance but also in providing an ideal surface to withstand the hard usage in handling heavy weights. It is also easy on the men.

Another innovation is found in the construction of the roof which consists of gypsum blocks supported by steel trusses. This innovation was adopted after a careful study of the problem had been made not only with regard to its fireproof features but also with regard to the acoustic properties of the structure. Experience shows that this type of construction has materially lessened the noise usually encountered in a boiler shop.

As shown in the plan, Fig. 12, the boiler shop is divided into three bays. Each bay is equipped with electric overhead traveling cranes ranging in capacity from 10 to 35 tons. At each of the machine tools material is handled by a Yale electric hoist of from 2 to 3 tons capacity operated on a jib crane. All of the machine tools are operated by individual electric drive and an unusually complete and efficient system of guards is provided to protect the workmen at the machines. In locating the machinery in the shop the assistance of experts in each department was sought to secure the most efficient location of the tools.

The material enters the shop on a spur track at the east end of the north bay where the plates are stored according to size in a double-deck steel plate rack. The tubes and other supplies are stored in the warehouse which forms an extension of the north bay but is separated from it by a fireproof wall. The material is laid out at the east end of the north bay in a space adjoining the storage racks and then goes to the fabricating department where the various operations of punching, shearing, planing and drilling are performed successively until the fabricated material reaches the west end of the north bay when it is transferred to the fitting up floor at the west end of the center bay adjoining the riveting tower.

After being bolted up and riveted, the material progresses down the center bay to the assembling space where the boilers are assembled, the tubes set and the calking, chipping and welding operations completed. Finally, the boilers reach the testing floor at the east end of the center bay where they are given the hydraulic test and then painted and prepared for shipment from another spur track entering the shop at the east end of the south bay. In the south bay the staybolts are cut, threaded, installed in the fireboxes and riveted. Here also a double electric welding outfit is installed for the necessary welding. At the west end of the south bay is a machine shop equipped with lathes, shaper, planer, milling machine and drill press for the

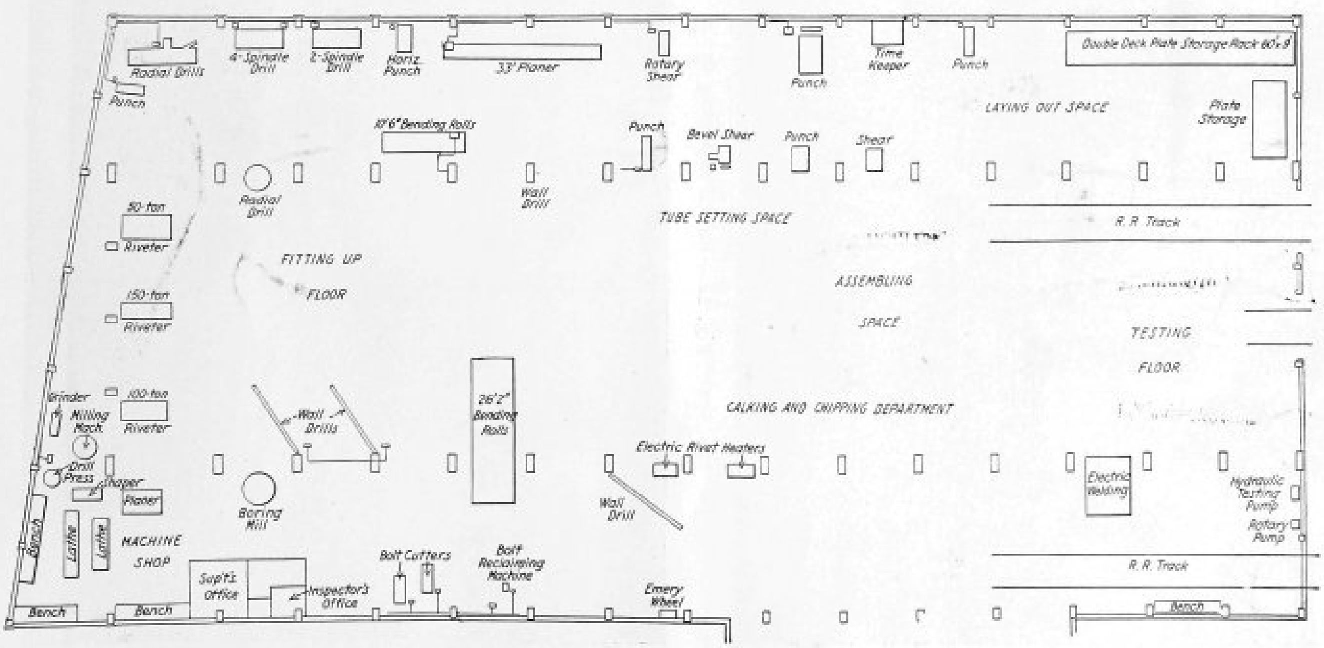


Fig. 12.—Plan of boiler shop, showing location of machinery

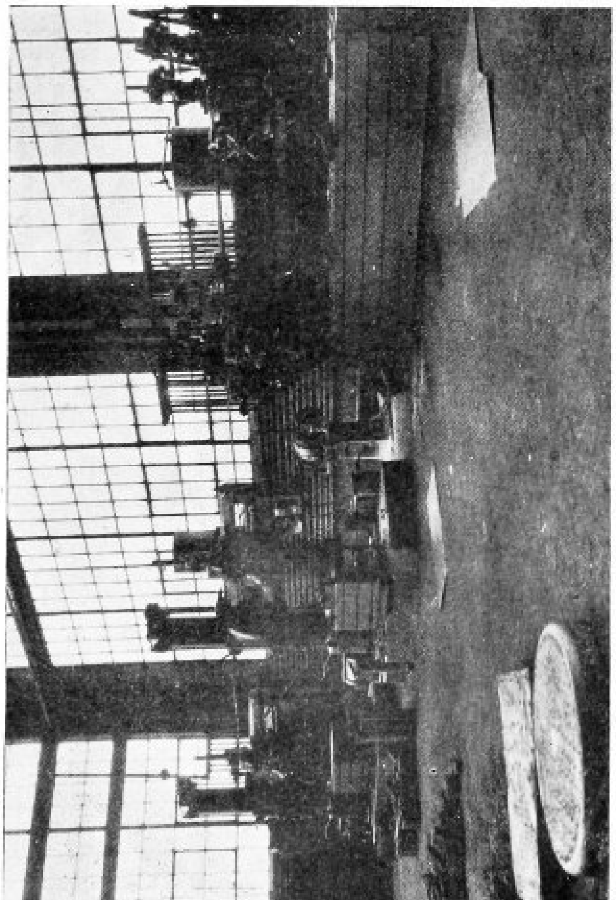


Fig. 13.—Radial and gang drills

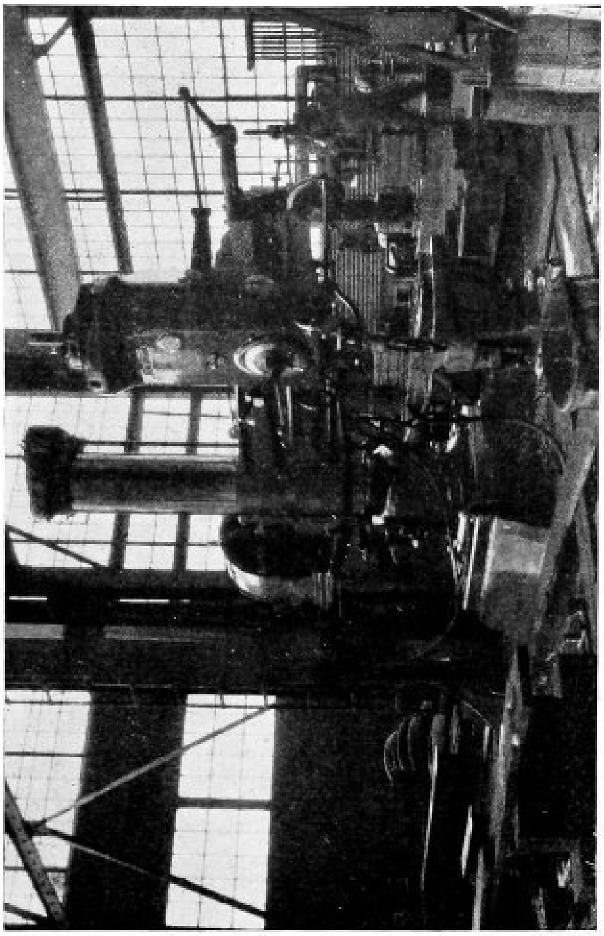


Fig. 14.—Large radial drill

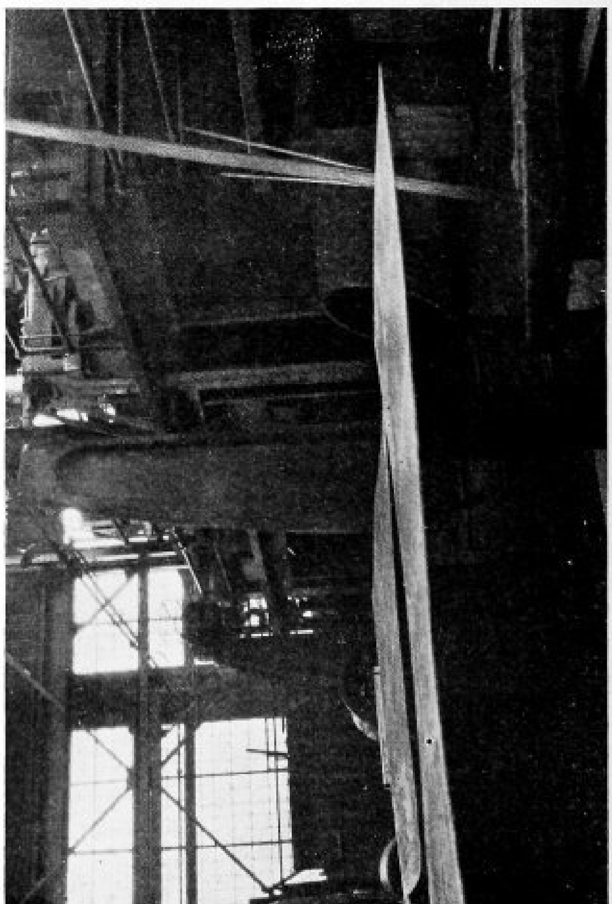


Fig. 15.—"Bull" riveting machines

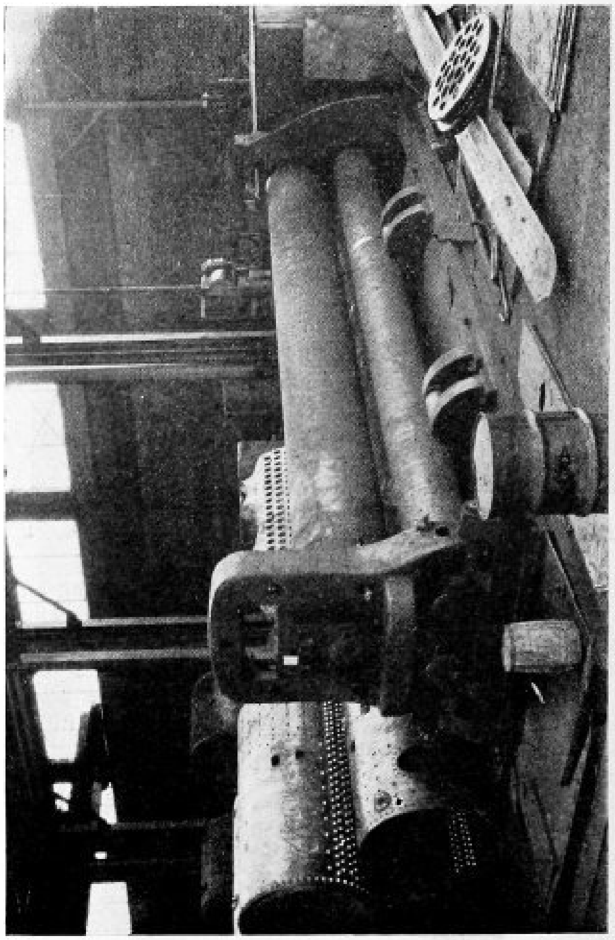


Fig. 16.—26-foot bending rolls

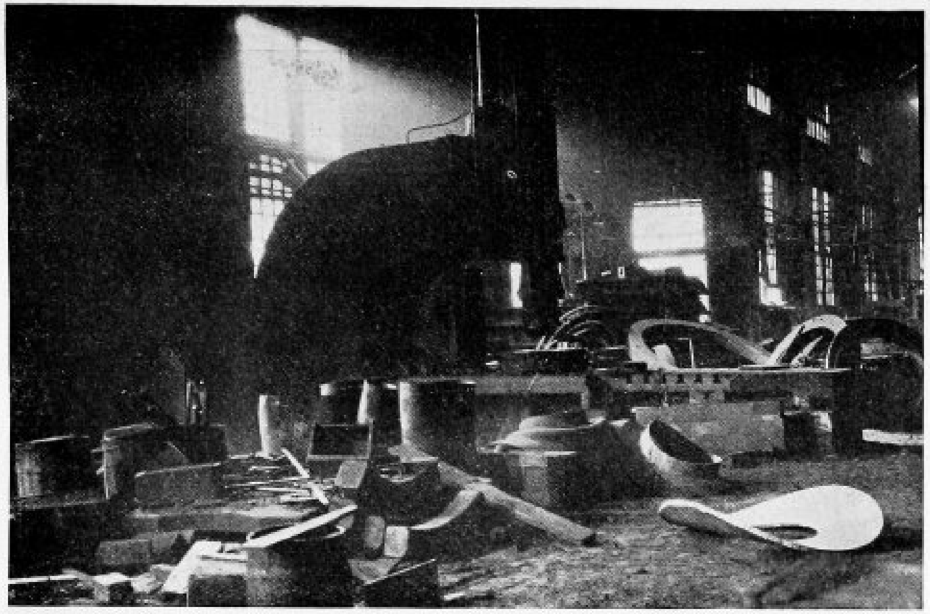


Fig. 17.—200-ton sectional flanging machine

Fig. 18.—550-ton flanging press and furnace

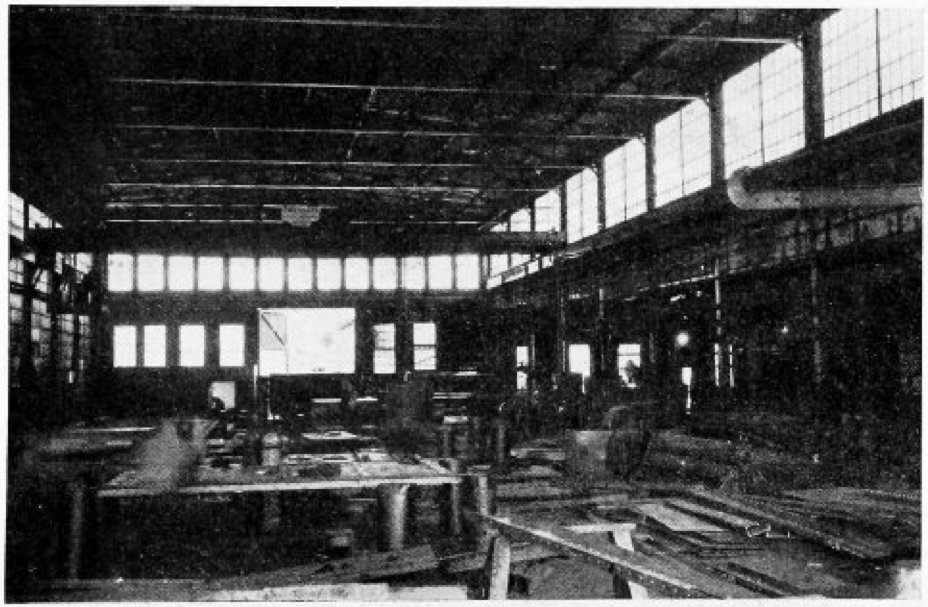


Fig. 19.—Interior of stack or sheet iron shop, looking east

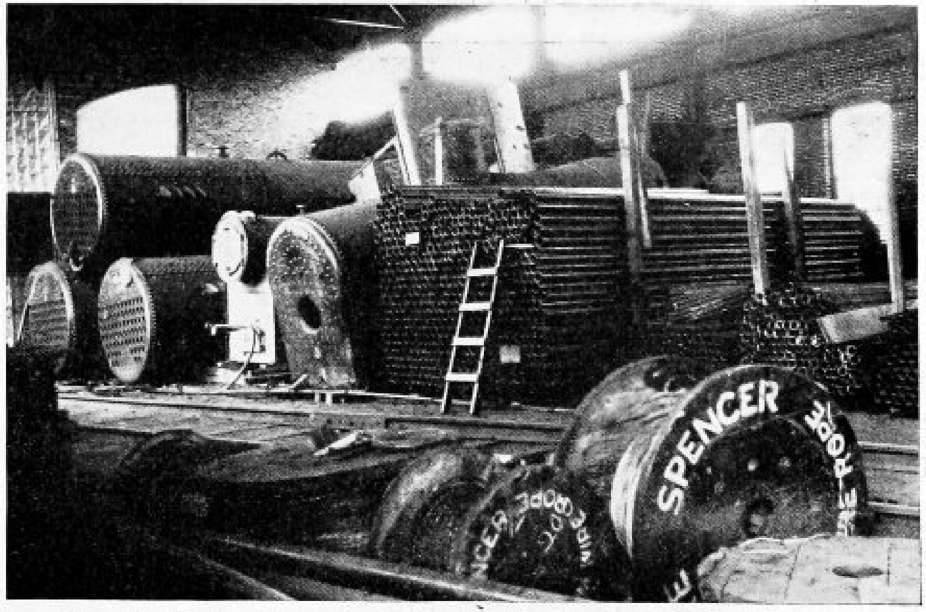


Fig. 20.—Interior of warehouse, showing tube storage and finished boilers

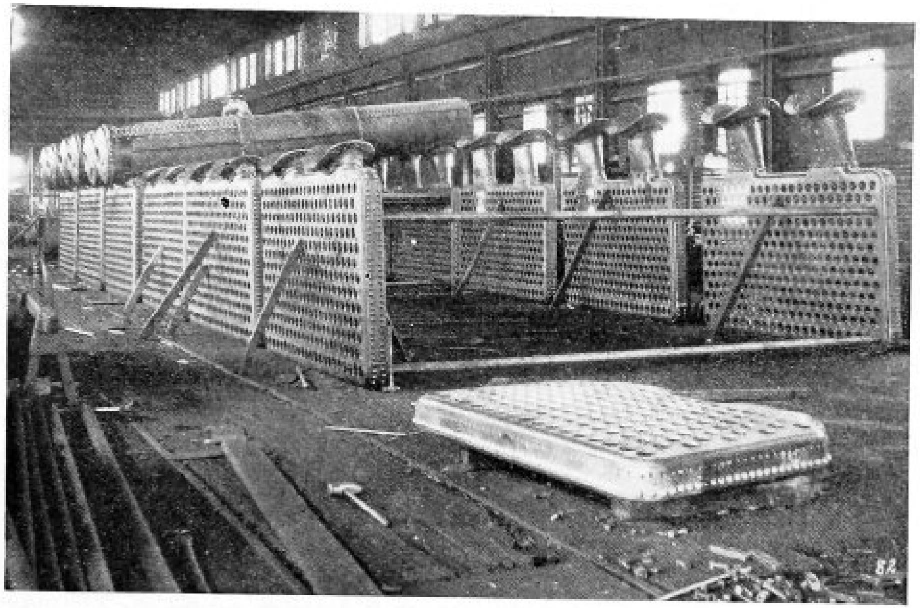


Fig. 21.—Assembling six 625 horsepower watertube boilers

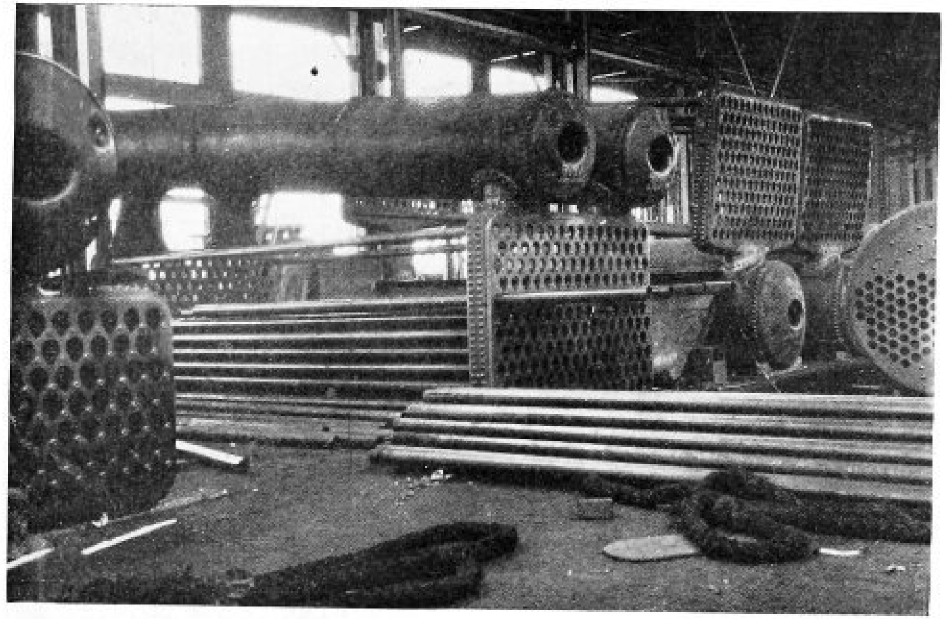


Fig. 22.—Installing tubes in horizontal drum watertube boilers

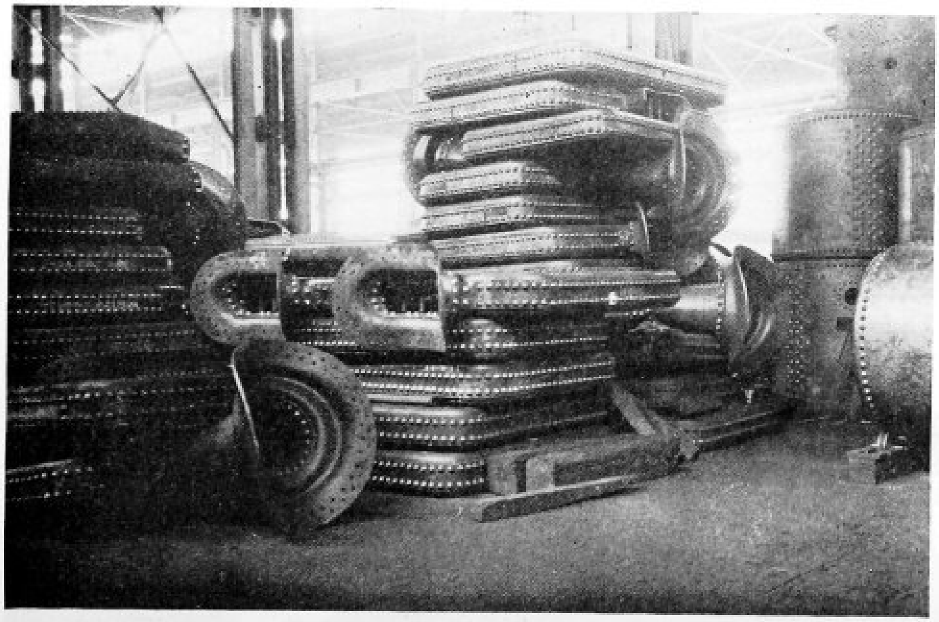


Fig. 23.—Finished headers for watertube boilers

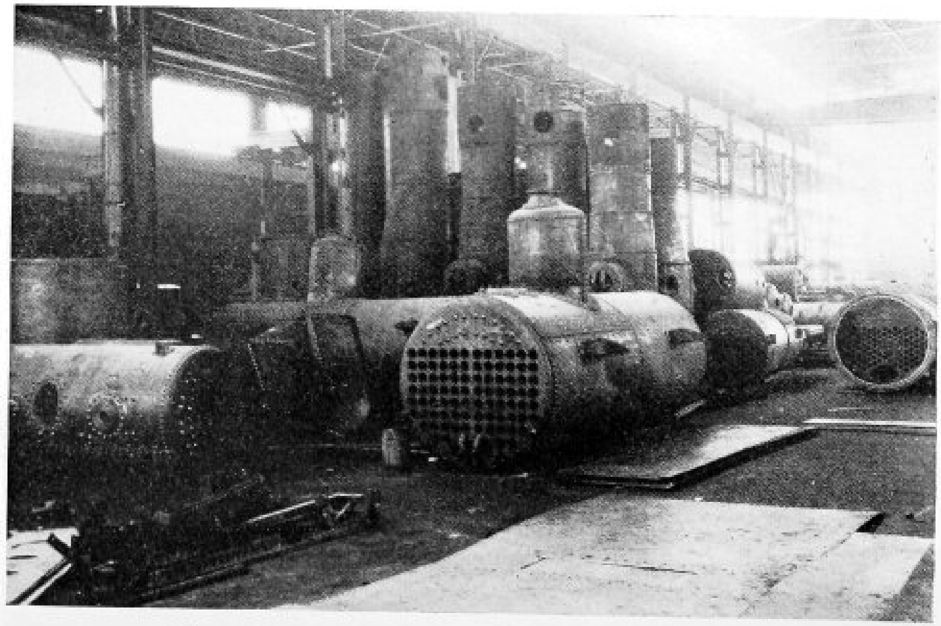


Fig. 24.—Various types of boilers awaiting shipment

maintenance of the plant. Adjoining the machine shop is the office of the superintendent and of the resident inspector of the Hartford, Steam Boiler Inspection and Insurance Company.

Material Handling Appliances

The warehouse is served by a 25-ton Shaw crane; the north bay by a 10-ton Northern crane; the center bay by a 35-ton Northern crane and a 10-ton Erie crane and the south bay by a 10-ton Northern crane. On the crane serving the north bay, or fabricating department, the operator's cage is located in the center of the crane instead of at the end as is usual. With the cage at the center of the crane, the operator has an unobstructed view of the entire floor at all times and all interference with the jib cranes at the machines on either side of the bay is thereby eliminated.

The riveting tower at the end of the center bay is 72 feet high and is equipped with 15-ton electric cranes controlled by the riveters at the bull machines. The cranes have a maximum lift of 45 feet.

Equipment

The arrangement of the machinery is shown by the plan of the shop, Fig. 12, and also by the photographs showing general views in the shop. The equipment of machine tools includes the following:

North Bay

1 Cleveland punch, 28-inch throat; capacity, 1-inch hole in 1-inch plate.
1 Cleveland punch, 32-inch throat; capacity, 1-inch hole in 1-inch plate.
1 Hilles and Jones punch for hand holes; capacity, 4-inch holes in 1¼-inch plate.
1 Cleveland horizontal punch; capacity, 1-inch hole in 1-inch plate.
1 Cleveland shear, 24-inch throat; capacity, ¾-inch plate.
1 Quickwork rotary shear; capacity, ¾-inch plate.
1 Lennox bevel shear; capacity, ¾-inch plate.
1 Cleveland plate planer, length 33 feet; capacity, 1½-inch plate.
1 Wickes bending rolls, length 10 feet 6 inches; capacity, ¾-inch plate.
1 Prentiss 4-spindle gang drill.
1 Prentiss 2-spindle gang drill.
2 Cincinnati Bickford radial drills.
1 American Tool Works radial drill, radius 7 feet; height, 6 feet 6 inches.

Center Bay

1 Southwark 150-ton hydraulic riveter; height of stake, 12 feet 6 inches.
1 Chambersburg 100-ton hydraulic riveter; height of stake, 10 feet 6 inches.
1 Morgan 50-ton hydraulic riveter.
3 Cleveland wall drills.
1 Southwark bending rolls; length, 26 feet 2 inches.

South Bay

1 60-inch Baush boring mill.
1 Cleveland wall drill.
1 Acme bolt cutter.
1 Landis bolt cutter.
1 bolt reclaiming machine.
1 emery wheel.
1 Burke double electric welder.

Special Kinks

Among the special appliances devised by the Union Iron Works is an arrangement for controlling the work at the drilling machines where the rivet holes in the shells are drilled or reamed. This arrangement as applied to a wall drill is shown in Figs. 10 and 11. The boiler shell is mounted on rollers in blocks on the floor so that it is free to rotate on its axis. The shell is rotated in either direction by chain *C* wound around the shell and driven by a spur gear *B* which is mounted on the post or wall and actuated through a worm gear by an air motor *A*. The operation of the motor is controlled by a 3-way cock *D* mounted on the arm of the drill. The cock is opened or closed by a rod *E* extended along the arm of the drill to a point within easy reach of the operator. By this means the operator can move the drill with one hand and rotate the work with the other thus materially reducing the time and labor required for the operation.

This device is used for handling the work at all the wall drills and a further development of this arrangement has been worked out for drilling the tube holes in the drums of the bent tube type watertube boilers. This work is done on the large radial drill shown in Fig. 14. Here the drum or shell is placed on a movable table, improvised from a former punch table, located in a pit, 34 feet long, 5½ feet wide and 4 feet deep in front of the machine. The table has a travel of 10 feet and is driven at a speed of 3 feet per minute by a long worm underneath the table which in turn is driven through a pinion and large gear by a 3-horsepower motor running at 150 revolutions per minute. The maximum capacity of the table is a drum 78 inches diameter by 24 feet long.

Flange Shop

The principal items of equipment in the flange shop consist of a 550-ton W. H. Wood 4-column flanging press and a 200-ton R. D. Wood sectional flanging machine. Located opposite the 4-column flanging press is a Rockwell oil fired furnace, 12 feet wide by 14 feet 6 inches long, for heating the plates and also for annealing the flanged

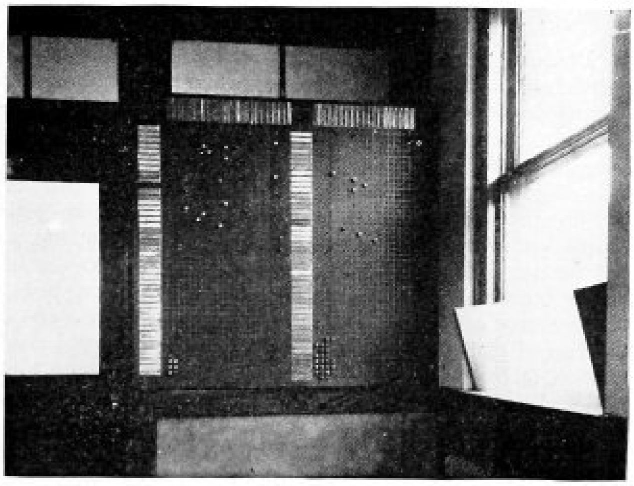


Fig. 25.—Progress board in office

work. On the opposite side of the furnace is a set of straightening blocks, 13 feet 6 inches by 20 feet long.

The ends of the drums of the watertube boilers are flanged in one heat. The plate is first dished and the offset made for the water column; then the manhole is flanged in the center and finally the flange formed around the edge of the head.

The flange shop is also equipped with a special 100-ton Southwark hydraulic riveting machine, a W. H. Wood ogee flanging machine and a McCabe flanging machine capable of handling ½-inch plate.

Material in the flange shop is handled by electric hoists of 2 and 3 tons capacity operating on jib cranes. Seven men are employed in the flange shop.

Blacksmith Shop

Heavy work in the blacksmith shop is forged on an 800-pound Erie foundry hammer. The lighter work is handled at two hand forges. The equipment of the shop includes a tube welding and swedging machine and a Tate-Jones tempering and annealing furnace. Four men are employed in the blacksmith shop.

Stack Shop

The stack or sheet metal shop, which is housed in a separate building, is divided into two bays. The larger bay, in which the work is fitted up and riveted or welded is served by a 5-ton Erie Steel Company crane while the smaller bay, which is used for fabricating angle iron and other bars, is served by a 1-ton monorail trolley. The work here consists of stacks, breechings, tanks, boiler fronts, suspension frames and the like. Seventeen men are regularly employed in this department, including two layer-outs.

The machinery in the stack shop includes the following:

1 bending brake; capacity, 3/4-inch plate.
1 Buffalo splitting shear; capacity, 3/8-inch plate.
1 Cleveland punch, 24-inch throat; capacity, 3/4-inch hole in 3/4-inch plate.
1 Wickes bending rolls, length 10 feet 6 inches; capacity, 1/2-inch plate.
1 Quickwork rotary shear; capacity, 1/4-inch plate.
1 Cleveland punch, 18-inch gap; capacity, 1-inch hole in 1/2-inch plate.
1 Long and Allstatter horizontal punch, 1-inch hole in 3/4-inch plate.
1 Lincoln electric welder.
1 General Electric electric rivet heater.
1 wall drill.
1 Cleveland angle punch and shear; capacity, 4-inch by 4-inch by 1/2-inch angle.
1 Amplex angle bending machine; capacity, 3-inch by 3-inch by 3/8-inch angle.
1 Union Iron Works rolls; capacity, 2 1/2-inch by 2 1/2-inch by 5/16-inch angles.
1 bending rolls, length 6 feet; capacity, 1/4-inch plate.
1 drill press.
1 emery wheel.

A spur track enters this shop for delivery of material and for shipping finished products.

Organization

Production in the shops is under the direct charge of the superintendent. In the superintendent's office is a progress board on which a record is kept of the progress of each separate contract or order as it goes through the shops. A duplicate of this board, shown in Fig. 25, is also kept in the executive offices.

The progress board is divided by horizontal and vertical lines into squares. Across the top of the board at the head of the vertical columns are printed the names of the successive operations through which the work must progress before reaching the final testing and shipment. At the left hand end of each horizontal column is a metal clip in which is inserted a card bearing the order number and a brief description of the job. The progress of work is indicated by moving pegs along the horizontal line opposite the contract number as each successive operation is completed. The progress board gives at a glance the status of the work in the shop at any time and as the shipping date is entered in the last column when the job is begun any delays can be quickly detected and provision made for speeding up the work if necessary.

Group insurance for all employees is carried by the company ranging in amounts from $500 to $1,500 depending upon the length of service. The company is a member of the National Safety Council and a safety committee, consisting of the general manager, superintendent and department foremen, meets each week to consider ways and means of improving the safety and sanitary conditions in the shops. Each employee is provided with a metal locker and the equipment includes shower baths and a system of sanitary drinking water fountains.

Neatness and cleanliness are at once apparent upon an inspection of the plant. This is in keeping with the policy of the company which adheres strictly to the rule that the first requisite in efficiency and quality in workmanship is orderliness and cleanliness in the shop.

Personnel

F. F. Curtze is president of the company; George W. Bach, vice president and general manager; E. E. Knobloch, treasurer; E. H. Brevillier, secretary; M. E. Smith, chief engineer; F. Griggs, superintendent, and D. C. Kennedy master mechanic.

Mr. Bach, the general manager, has been active in boiler engineering for over 30 years, the last 15 of which have been with the Union Iron Works. Mr. Bach is now serving a second term as president of the American Boiler Manufacturers' Association. Mr. Knobloch has been with the company 31 years; Mr. Brevillier over 20 years and Mr. Smith, who is a Cornell graduate, over 10 years. Mr. Griggs came to the Union Iron Works as foreman and layerout in 1916, was made assistant superintendent in 1918 and superintendent in 1923. Over 80 percent of the employees have been with the company over 5 years and many of them for much longer periods—all of which gives some indication of the spirit of cooperation and loyalty which exists throughout the organization and which was strikingly shown in the rebuilding of the plant—to say nothing of the skill and competency of the men as shown by the quality of the work turned out by the shops.

Improvement of the Steam-Boiler Industry

At present, American boiler manufacturing is passing through a trying period, which might be called the Period of Elimination because of excess of boiler manufacturing capacity in this country.

In analyzing conditions, we find the causes for this excess to be centralization of power plants with consequent use of fewer and larger boilers operating at very high percentage of rating and high efficiency, also prime movers of high efficiency and better use of steam in process work. Other factors are development of water power and use of oil and gas engines as prime movers, so that increase of boiler output has not been proportionate to growth of population or industries. These natural developments must be faced.

We should, however, follow the example of other industries in development of potential markets by trade extension; engineers should be shown that steel boilers are better than cast iron for heating, especially in larger plants such as institutions, factories, and apartments. Modernizing of industrial power plants should be pushed in the interest of fuel conservation, for it is well recognized that, in 75 percent of the boiler plants now operating, efficiency could be raised by amounts up to 30 percent by replacing obsolete equipment with modern apparatus.

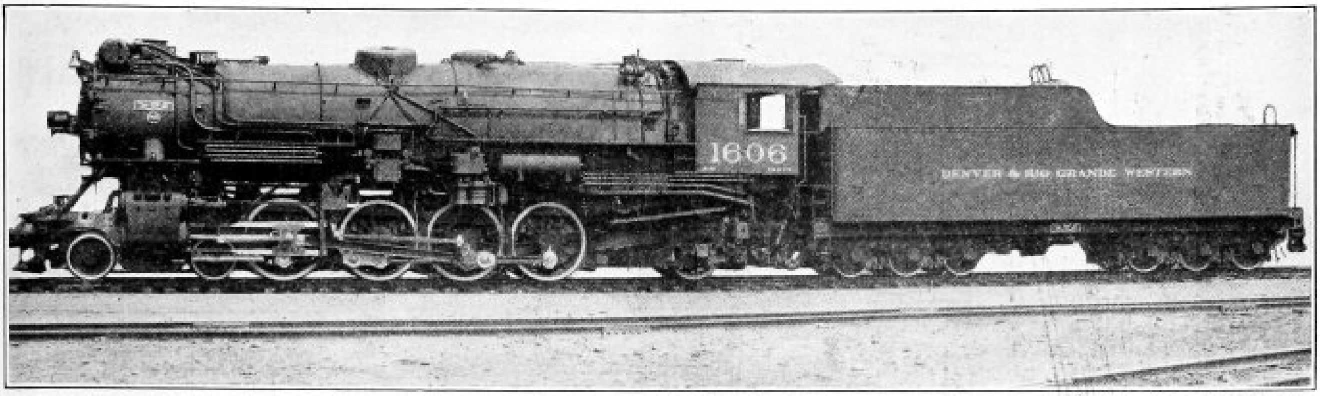
As to the future, I believe that there will be, before long, radical changes in boiler design and installation for central station and large industrial plants, necessitating changes in shop equipment. Centralization of power is here to stay and superpower is more than a phrase. Whether this will continue exclusively in the lines of public-service corporations or as centralized plants for a block, of neighboring industries, supplying power, light and heat for those industries and leaving general public service for the central station is a question for the future but, in my opinion, the latter is a logical development. (George W. Bach, *Power Plant Engineering*, August, 1, 1926.)

BUSINESS NOTES

The Oakley Chemical Company, New York City, has changed its name to Oakite Products, Inc.

H. E. Graham has been appointed an assistant vice-president of the American Car & Foundry Company and will be associated with the sales department at New York. Mr. Graham was formerly connected with the Pressed Steel Car Company and later was vice-president in charge of sales of the Standard Tank Car Company.

Col. Leonard S. Horner has resigned as vice-president and manager of sales of the Acme Wire Company, New Haven, Conn., and has been elected president of the Niles-Bement-Pond Company, New York, succeeding James K. Cullen who has resigned to devote his entire time to his activities as president and general manager of the Niles Tool Works. He is also a director of the Crocker-Wheeler Company, the Acme Wire Company, and the Pratt & Whitney Aircraft Company of Hartford, Conn.; vice-president of the New Haven Chamber of Commerce; a counsellor of the United States Chamber of Commerce, and a member of the Board of Aviation.



Three-cylinder Mountain type locomotive built for the Denver & Rio Grande Western Railway

Three-Cylinder Mountain Type Locomotive

Built for Denver & Rio Grande Western for heavy passenger service at the Baldwin Locomotive Works

THE Baldwin Locomotive Works has recently completed an order for ten three-cylinder Mountain-type locomotives for the Denver & Rio Grande Western. These locomotives, one of which was exhibited during the recent convention of the Mechanical Division of the American Railway Association at Atlantic City, are designed to meet the demands of unusually severe operating conditions over a road where the maximum grades are three percent and the sharpest curves are 16 degrees. They develop a maximum tractive force of 75,000 pounds which is exceptional for an eight-coupled design, giving these locomotives a hauling capacity that is exceeded by comparatively few locomotives in freight service.

It was the aim of the designers to obtain maximum capacity in a coal-burning unit of the 4-8-2 type, without exceeding certain specified weights and clearance limits. To accomplish this it was essential that all superfluous weight be omitted and the detail parts are consequently as light as is consistent with the required strength. The total weight of one of these locomotives is 419,310 pounds of which 290,530 pounds is distributed over the drivers, 67,880 pounds on the engine truck and 60,900 pounds on the trailing truck. All three cylinders are 25 inches by 30 inches and the outside diameter of the driving wheels is 67 inches. The boiler working pressure is 210 pounds per square inch.

A novel feature in the design is the construction of the cylinders. The three cylinders are of cast iron and cast separate from each other, the center cylinder being cast in one piece with the saddle. Both sides of the center cylinder casting are flanged to receive the two outside cylinders which are cast from the same pattern. The front frame rails are single, measuring 6 inches in width by 13½ inches in depth. The outside cylinders are bolted securely to the rails and also to the center cylinder casting.

The Boiler

The boiler, apart from its large dimensions, represents no unusual features of design. It is of the conical type, 92 inches outside diameter at the first course and 104 inches outside diameter at the dome course. The firebox is of corresponding size and volume, having a length of 126⅛ inches and a width of 108 inches which makes a grate area of 95 square feet. The depth from the crown sheet to the grate surface at the front of the firebox is 96 inches; it is 73¾ inches at the back. There are 244 flues 2¼ inches in diameter and 64 tubes 5½ inches in diameter, the distance over the tube sheets being 19 feet 6 inches. The total evaporative heating surface is 5,093 square feet of which 402 square feet is in the firebox and 5-feet combustion chamber, 4,581 square feet in the tubes and flues and 25 square feet and 85 square feet in the arch tubes and thermic syphons, respectively. The superheating surface is 1,495 square feet.

The boiler accessories include a superheater having 64 elements, two thermic syphons and du Pont-Simplex stokers. The brick arch is supported on the two syphons and three arch tubes. Five of the locomotives are equipped with Worthington feedwater heaters and the other five with the Elesco. The water level is shown by a Sargent three-face water gage. Barco joints are used in the connections between the engine and tender.

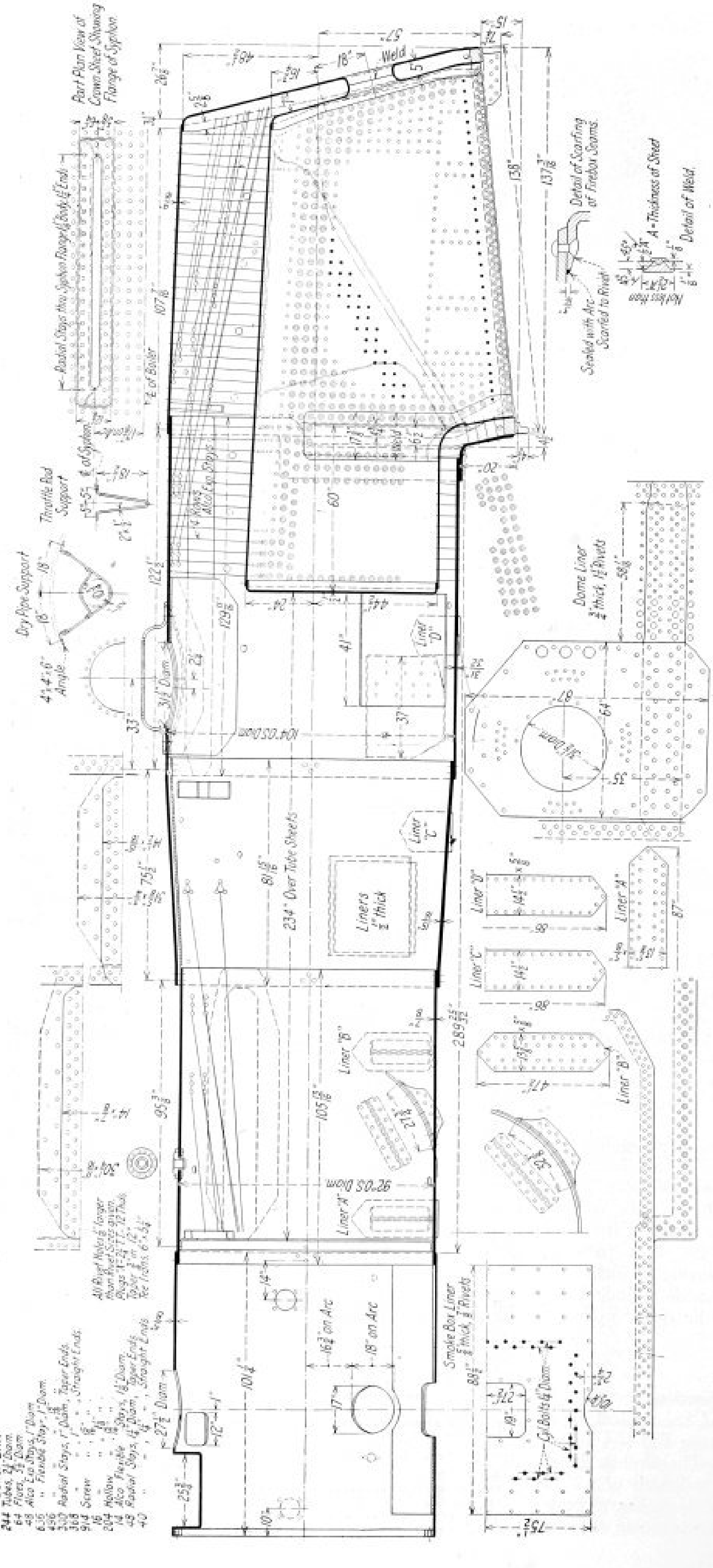
The Tender

The stoker engine is mounted on the forward end of the tender instead of on the locomotive, as is the usual practice. The tender, which weighs 297,090 pounds in working order, has a capacity for 15,000 gallons of water and 25 tons of coal. The tank is of rectangular or water leg construction. The trucks are of the six-wheel type, having 36-inch diameter wheels and 6-inch by 11-inch journals.

The builders were assisted in the design of the locomotives by collaboration on the part of J. S. Pyeatt, president, and W. J. O'Neill, general mechanical superintendent of the Denver & Rio Grande Western.

Table of Dimensions, Weights and Proportions

Railroad	Denver & Rio Grande Western
Builder	Baldwin Locomotive Works
Type of locomotive	4-8-2
Service	Heavy passenger
Cylinders, diameter and stroke	(3) 25 in. by 30 in.
Valve gear, type	Walschaert
Valves, piston type, size	12 in.
Maximum travel	6¾ in.
Outside lap	1⅛ in.
Exhaust clearance	¼ in.
Lead in full gear	¼ in.
Weights in working order:	
On drivers	290,530 lb.
On front truck	67,880 lb.
On trailing truck	60,900 lb.
Total engine	419,310 lb.
Total engine and tender	716,400 lb.



Longitudinal section of D. & R. G. W. boiler and structural details

Wheel bases:	
Driving	18 ft. 3 in.
Rigid	11 ft. 10 in.
Total engine	41 ft. 6 in.
Total engine and tender	86 ft. 5 in.
Wheels, diameter outside tires:	
Driving	67 in.
Front truck	36 in.
Trailing truck	49 in.
Journals, diameter and length:	
Driving	11½ in. by 14¼ in.
Front truck	7 in. by 14 in.
Trailing truck	9 in. by 16 in.
Boiler:	
Type	Conical
Steam pressure	210 lb.
Fuel, kind	Bituminous
Diameter, first ring, inside	90¼ in.
Firebox, length and width	126⅛ in. by 108 in.
Combustion chamber, length	60 in.
Tubes, number and diameter	64—5½ in.
Flues, number and diameter	244—2¼ in.
Length over tube sheets	19 ft. 6 in.
Grate area	95 sq. ft.
Heating surfaces:	
Firebox and comb. chamber	402 sq. ft.
Arch tubes	25 sq. ft.
Thermic syphons	85 sq. ft.
Tubes and flues	4,581 sq. ft.
Total evaporative	5,093 sq. ft.
Superheating	1,495 sq. ft.
Comb. evaporative and superheating	6,588 sq. ft.
Special equipment:	
Feedwater heater	Worthington (5) Elesco (5)
Stoker	du Pont-Simplex, Type B
Tender:	
Water capacity	15,000 gal.
Fuel capacity	25 tons
Journals, diameter and length	6 in. by 11 in.
General data estimated:	
Rated tractive force, 85%	75,000 lb.
Factor of adhesion	3.88
Cylinder horsepower (Cole)	3,547
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	69.4
Weight on drivers ÷ tractive force	3.88
Total weight engine ÷ cylinder horsepower	118
Total weight engine ÷ comb. heating surface	63.8
Boiler proportions:	
Comb. heating surface ÷ cylinder hp. per cent	1.85
Tractive force ÷ comb. heating surface	11.4
Tractive force X diam. drivers ÷ comb. heating surface	763
Cylinder hp. ÷ grate area	37.4
Firebox heating surface ÷ grate area	5.4

Accident Prevention

"Accident Prevention on a Railroad" is the title of a booklet issued by the Metropolitan Life Insurance Company, 1 Madison avenue, New York. The report in this booklet contains the story of an accident-prevention survey carried out by the safety engineers of the Policyholders' Service Bureau for a Class I railroad—a group insurance policyholder of the Metropolitan Life Insurance Company. It illustrates the method used in making such a study and the type of information deemed essential. An outline of the recommendations made to the railroad company is also included.

Care and Maintenance of Locomotive Boilers

By P. G. Tamkin

THE locomotive boiler which is designed to give high steam raising power without undue weight needs considerable care in use, because the steam and particularly the water spaces are reduced as far as possible, consistent with power required.

Good water should invariably be used, so that scale is reduced to a minimum, feedwater which might be quite suitable for the Lancashire type of boilers would probably choke up the narrow waterspaces of the locomotive boiler with disastrous consequences. It is, therefore, very necessary that this class of boiler should be frequently opened up (say every 100 working hours) and thoroughly washed out. This should be done with a hosepipe on which is a nozzle, the idea of this being to have a good velocity of water which will remove most of the scale. It is of course essential that the boiler be allowed to cool down before washing out with cold water, otherwise there is sure to be trouble with leaky seams and tubes.

When washing out this class of boiler, special attention should be directed to the firebox crown, both firebox and smokebox tubeplates, and narrow waterspaces, also over the top portion of the firehole. Thick scale left on the crownplate means serious trouble. This can readily be seen by the fact that if conditions of a fire are such that a ½-inch plate, if clean, would acquire a mean temperature of approximately 5 degrees F. in excess of that of the water, then by adding a layer of scale 0.04-inch thick this excess temperature would be doubled. A film of oil 0.004-inch thick would have the same effect, so it is necessary that oil should be rigidly excluded.

After the boiler has been thoroughly washed out it should be examined by the shed boiler maker, externally and internally for defects.

If the tubeplates are not kept clean there will be trouble with leaky tubes and also cracking between the tube holes. I have known cases in which it has been necessary to retube this class of boiler owing to leaky tubes due to dirty tubeplates.

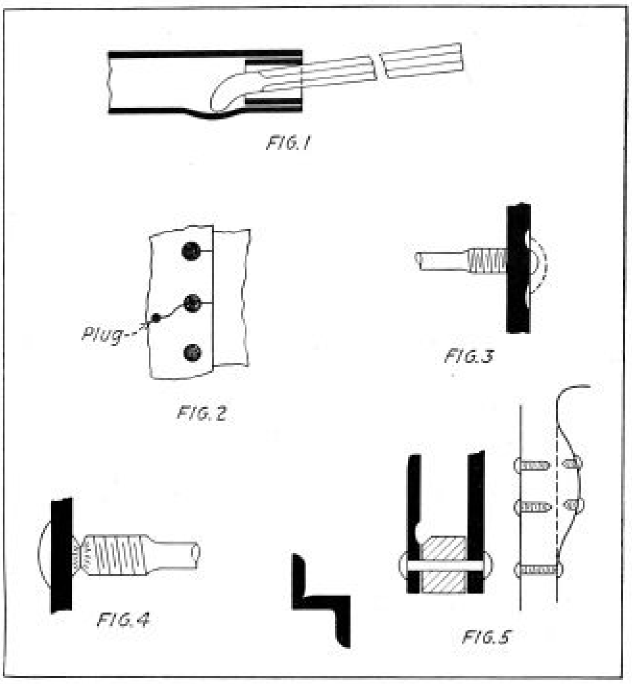
Stopping Up Pitted Tubes

Tubes that are leaky through pittings perforating the metal should be "stoppered" by a longitudinal bolt of ample strength passing through the defective tube, this being threaded at each end and a nut and cap fitted. The projecting end of the tube should be cut flush with the tubeplate. The practice of "stoppering" defective tubes by tapered plugs is dangerous as these frequently blow out and a number of lives have been lost through this cause.

It is of course unwise to run a locomotive boiler with a considerable number of tubes "stoppered" owing to loss of efficiency. Another important point which should not be overlooked is that tubes should be regularly withdrawn so that the barrel can be thoroughly inspected, this of course applies particularly to the older type of boiler in which the longitudinal seam of the barrel is of the lap joint type and in the waterspace, as grooving is liable to take place at this seam. This is a particularly dangerous defect.

Smoketubes again are subject to wasting on the fireside at the firebox end just beyond the ferrule, this is very pronounced when hard coal is used and the tubes are of brass or copper. Defective tubes of this type can be detected by a prodding lever, see Fig. 1.

Again the projecting ends of tubes very often become considerably thinned and burned. So long as they keep tight this is not important but as soon as these tubes give trouble by leakage, they should either be renewed or new



Sketches showing boiler troubles

ends brazed on to the old tubes (if they are good otherwise) and replaced for further service. The smokebox tubeplate should be kept clear of all soot and ashes, etc., particularly at the lower parts, for if these are allowed to accumulate they become damp from the exhaust steam and consequently the lower parts of this plate are found to be considerably wasted, due to this cause.

As this type of boiler is a quick steam raiser damage may soon be done by shortness of water, it is, therefore, good policy to inspect and also renew the fusible plug at frequent intervals, as the alloy in these plugs deteriorates. In England it is the rule to renew these plugs at least every 12 months. In the firebox externally a lookout should be kept for leaky seams, stayheads, and tubes. Any patches of wasting should be noted and if deep and extensive, the defective part should be cut out and a patch fitted.

Lap Cracks in Vertical Seams

Lap cracks are also found at the vertical seams, these are not important unless they extend beyond the rivet, in which case the end of the crack should be drilled and plugged (see Fig. 2), to prevent its extension. If there is considerable leakage from such a crack, it could quite easily be repaired by electric-welding. The heads of copper stays should also be noted, as these get burned, consequently considerably reduced in size and since copper stays rely on their heads for staying strength this is an important point. This is not so important with steel stays as this type of stay is able to rely on the thread for staying strength. Copper stays with considerably reduced heads should be renewed, particularly if there are a number affected together. These defective stays are generally found about the firebar level on all plates, and in most rows on the firebox tubeplate.

One point I must mention before passing to the waterside of stays, etc., and that is leaky stayheads in the firebox should be promptly checked, otherwise this leakage will cause grooving of the plate in the vicinity and also wasting of the stayhead. Fig 3.

On the waterside stays should also be carefully examined periodically particularly in the upper rows and at the firebar level. In the former case the stays frequently fracture due to the continual expansion and contraction of the firebox. These stays can often be seen but if they cannot, "sounding" will detect them. In the case of a number of broken stays together it is generally found that the firebox plate in the vicinity will be bulged as in Fig. 4.

Referring to defective stays about the firebar level, it is found that these very often groove in the neck against the firebox, so much so that their strength is greatly reduced. Defective stays of both classes require to be renewed.

We now continue to the casing and firebox on the waterside. Special note should be made of the casing plates adjacent to the foundation ring, as these frequently channel here (Fig. 5). This defect can readily be repaired by welding also, or as shown in the sketches. Needless to say the welding can only be done if the firebox is taken out of the casing, and this is a costly business, so that if it becomes absolutely necessary to repair this defect it may be cheaper to repair by one of the patching methods. If the base ring is of the angle type this also gives trouble by grooving, particularly at the corners as shown in Fig. 5. Although not dangerous this defect should be repaired before it penetrates the plate, otherwise it may cause great inconvenience.

Boilers of this class frequently suffer considerable deterioration arising from leakages at mudhole doors, plugs and other joints. These parts should receive careful attention and any leakage should be immediately checked.

In conclusion I would venture to say that I do not pretend to have touched on every defect found in locomotive boilers, but have confined myself more particularly to the main and most important defects which are always cropping up when an engine comes into the shed for its periodic overhaul and inspection during washing out time.

Suggested Rules for the Care of Power Boilers

ENGINEERS, operators of steam boiler plants, and all engaged in the boiler industry generally, will be interested to learn that Section VII of the Boiler Code of The American Society of Mechanical Engineers, which has just been issued after four years of intensive work, is the first work relating to steam power boilers that tabulates the various causes of boiler derangements, explosions, etc., and attempts to show how they may be avoided. This work embraces a very comprehensive analysis of boiler operating conditions generally, and is intended to offer suggestions to those in charge of boiler operation that will assist in maintaining their steam generating equipment in safe operating condition. In being issued as Section VII of the Boiler Code, it is a logical sequel to Section I on Power Boilers, as the latter offers rules for the *construction* of safe boilers, whereas Section VII offers rules for their *care* which will ensure that they are maintained in safe working condition.

The rules in this new section of the Boiler Code have been formulated with particular reference to the principles and standards of steam boiler construction covered in Section I on Power Boilers, namely, those to operate at a steam pressure exceeding 15 pounds per square inch. The rules are compiled primarily to assist the operators of steam boiler plants in maintaining their equipment in as safe condition as possible, the subject of economy receiving only incidental consideration. The Committee has, of course, recognized the difficulty in formulating such a set of rules that may be applied to all sizes and types of plants, and therefore the rules in this section are offered as suggestive only and the advisability of departure therefrom in certain cases is recognized.

The rules in Section VII of the Code are divided into five parts and an appendix. The rules in the first division cover routine operation and are elementary, governing the proper procedure in performing the ordinary duties of operating and maintaining steam boilers. The second division covers the operation and maintenance of boiler appliances and is also elementary in character. The third division contains rules for inspection which are intended to apply to the procedure necessary by the operatives in the plant to give proper supervision to all parts and details of the steam boiler equipment.

The fourth division embraces rules for the prevention of direct causes of boiler failures and is intended as a guide and assistance to those who desire to make a more comprehensive study of this subject. The rules in this division are wider in scope than those in divisions 1 and 2 and take up the causes of boiler failures under the headings of overpressure and weakening of structure. The fifth division is devoted to partial rules for installation, inasmuch as they treat with some conditions which are not encountered in Section I of the Code pertaining to the construction of power boilers. These rules are necessarily not complete inasmuch as there are definite requirements in Section I of the Code pertaining to installation. The appendix to these rules pertain to feedwater analysis, treatment and control, and pertain to improved methods of investigating and reporting of analysis treatment and the control of feedwater with a view to standardizing methods and forms. It is not intended so much for the operating engineer as for those specializing in the chemistry of feedwater.

The interest manifested in these suggested rules was indicated at the public hearings held during the time the preliminary reports thereon were under consideration. Rules of this sort appeared to be not only greatly needed but of extreme value to the entire boiler industry. Since Section VII of the Code has been issued early in the year there has been a large demand for the copies and the continued inquiries indicate thoroughly that the Suggested Rules are of such a character as to apparently answer the needs of the operatives in modern boiler plants where upkeep and proper maintenance are essential to ensure economy in operation.

New York State Boiler Requirements

THE following letter is being sent out by the Department of Labor, Division of Boiler Inspection of New York State at Albany, N. Y., to manufacturers of boilers and prospective buyers:

"We are again compelled to call attention to the requirements of the New York State Boiler Code, adopted by the State Industrial Commission June 25, 1917, in accordance with the requirements of sections 51-a and 52 of the Labor Law.

"The Boiler Code requires that all boilers installed in this state shall be of New York standard construction and that they shall be stamped accordingly, and it further requires that they shall be installed as required by the Code, in Paragraphs 268 to 328, inclusive, regarding fittings and settings.

"Under the provisions of Paragraph 334-b of the Code, the department may accept and permit the installation of a boiler built according to the standard construction of another state, if such construction is equivalent to the New York standard, and if the boiler is stamped as required by said state.

"Before such boiler can be brought into the state or approved an application requesting permission for its installation must be forwarded to the Division of Boiler Inspection, Department of Labor, Albany, New York, with a copy of the manufacturer's data report covering the construction of the boiler.

"A boiler which does not meet with these requirements must not be brought into this state, unless it has been operated here at some previous time. For such a boiler, an affidavit must be furnished setting forth this fact; application requesting permission for reinstallation must be forwarded, and a report of inspection must be filed, showing the present condition of the boiler. The inspection must be made by an inspector holding a certificate of competency issued by this department. The boiler must not be installed until permission has been granted by this department.

"James A. Hamilton,
"Industrial Commissioner."

Principles of Conic Sections Applied to the Layout of a Cone and Pipe Intersection

By I. J. Haddon

AFTER reading the letter (see page 277) re my problem in THE BOILER MAKER of August, the thought that passed through my mind was, "Where ignorance is bliss 'tis folly to be wise," and I had almost decided to take no more notice of it, but seeing that I am the originator of this method, and it is published in a book of which I am joint author, I thought that I should reply.

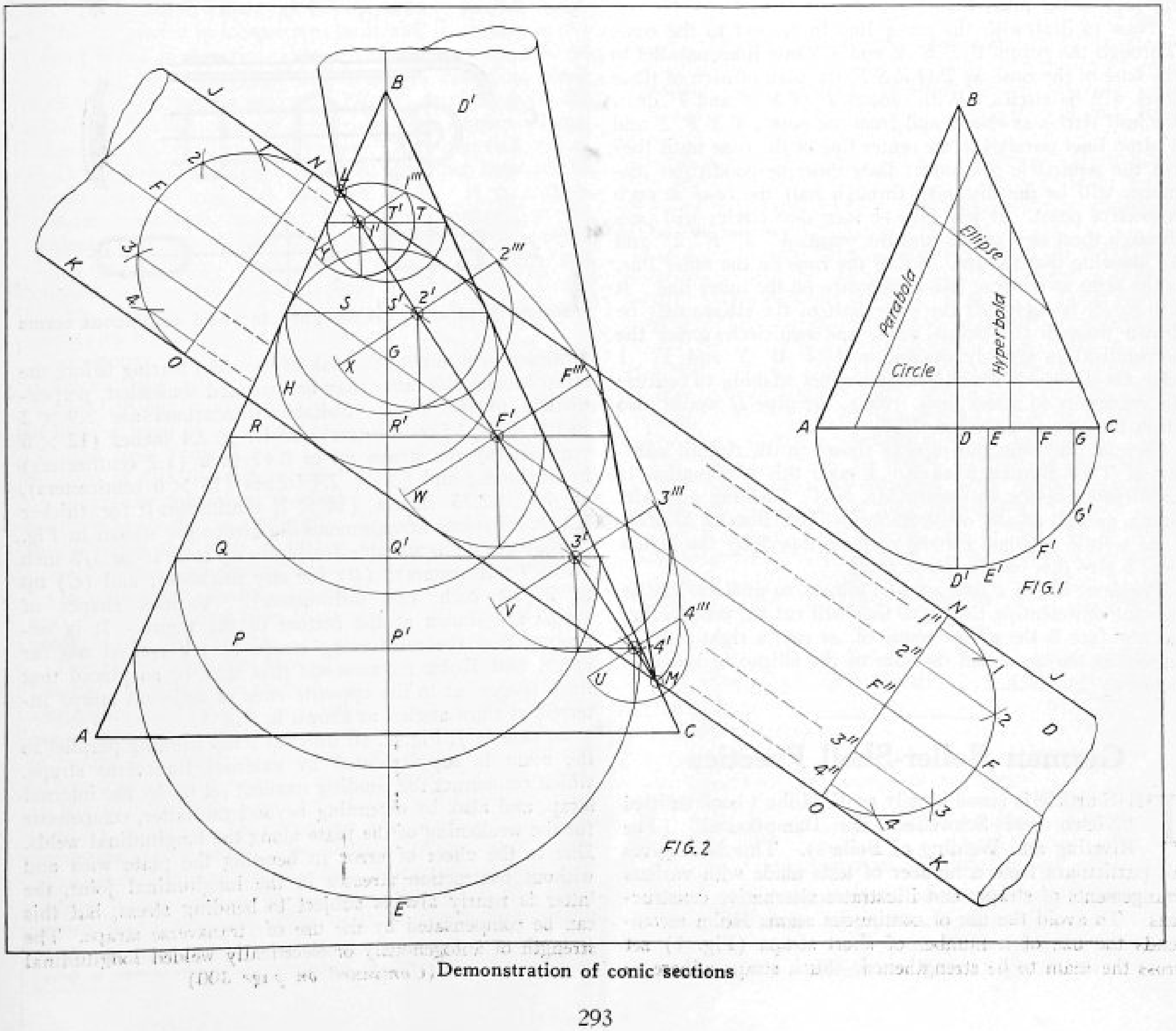
In the first place I would ask Mr. R. C. Harding to look in any dictionary for the word "ellipse" and he will read: "An ellipse is a conic section, etc., etc." I may tell Mr. R. C. Harding that the conic sections are: the circle, ellipse, parabola and hyperbola, *any of which* may be cut from *any cone*.

A triangle may also be cut from a cone by a plane passing through the apex perpendicular to the base, but a triangle is *not* a conic section, because *any* triangle cannot be cut from *any* cone. I would advise Mr. R. C. Harding and Mr. Gumz to read a little more on Conic Sections before writing to THE BOILER MAKER as critics. I am enclosing a couple of sketches showing the true face of the ellipse on the cone made by the cutting plane, also the true face of the ellipse, made by the plane on the pipe.

A B C, Fig. 1, is the elevation of a cone and the semicircle *A D' C* is a half plan. *Any line* drawn parallel to the base *A C is a circle*, and *any circle* may be cut from *any cone*.

Any line drawn parallel to the *side* of the cone *is a parabola*, and *any parabola* may be cut from *any cone*. *Any line* drawn perpendicular to the base *is a hyperbola*, and *any hyperbola* may be cut from *any cone*.

Any line drawn obliquely as shown is *an ellipse*, and *any ellipse* may be cut from *any cone*. These are the four conic sections. Half the distance through the cone at *D* is equal to *D D'*; half the distance through the cone at *E* is equal to *E E'*; half the distance through the cone at *F* is equal to *F F'*; and half the distance through the cone at *G* is equal to *G G'*. I am explaining this now because I am going to show that the distance through the cone where the



Demonstration of conic sections

miter line of the pipe engages with the cone is the same as the pipe, therefore making a *perfect connection.*

In Fig. 2 you will notice I have drawn the pipe and cone at a greater angle to each other than what was shown in the August number of THE BOILER MAKER, just to show that they can be at any *angle* to each other.

To construct, draw the lines *A C, B E,* being the base and center lines of the cone; draw the center line *F F* of the pipe at the angle the pipe has to be with the cone and crossing *B E* at *G*. With *G* as a center and radius equal to half the diameter of the pipe, describe the circle *H*. Draw lines tangent to the circle *H* from *A* and *C* and meeting at *B;* then *A B C* will be the *only cone* that will make a connection with the pipe as shown.

Draw the lines *J K* crossing the cone at *L M,* join *L M.* This will be the miter line. Divide the semicircle *N O* into any number of parts (not necessarily equal) as *N* 1 2 *F* 3 4 0; draw lines from these points parallel to *J J* and cutting the miter line in 4′, 3′, *F*′, 2′, and 1′. The small circles shown will represent the holes on the miter line of the pipe *D* with the cone.

Draw lines perpendicular to the miter line from the points 1′ 2′ *F*′ 3′ and 4′ as shown. Now as explained in Fig. 1, the distance half through the pipe at the points 1″, 2″, *F*″, 3″, and 4″ will be equal to 1″ 1, 2″ 2, *F*′ *F*, 3″ 3 and 4″ 4. Set out from the miter line of the pipe these respective distances as shown in 1‴, 2‴, *F*‴, 3‴ and 4‴; draw a fair curve through these points, and that curve will be *half an ellipse,* and is the true view of half the face of the pipe at the miter line.

Now to deal with the miter line in respect to the cone. Through the points 1′ 2′ *F*′ 3′ and 4′ draw lines parallel to the base of the cone, as *P Q R S T,* the plan of each of these lines will be circles. With centers *P*′ *Q*′ *R*′ *S*′ and *T*′ draw the half circles as shown and from the *points* 4′ 3′ *F*′ 2′ and 1′ drop lines parallel to the center line of the cone until they cut the semicircle as shown; then these perpendicular distances will be the distances through half the *cone* at each respective point. It will also be seen that circles will pass through these new points and the points 4‴ 3‴ *F*‴ 2‴ and 1‴ showing that the true face of the *cone* on the miter line, is the same as the true face of the pipe on the miter line. It will easily be seen that the other half of the ellipse may be drawn through the points where the semicircles cross the perpendiculars already drawn, in *U V W X* and *Y*. I have not drawn in the elliptic curve, not wishing to confuse the reader by so many lines. Note, the pipe *D* would also fit on the cone as shown at *D*′.

Develop the cone and pipe as shown in the August number of THE BOILER MAKER. I hope this explanation is sufficiently explicit to satisfy Mr. R. C. Harding and Mr. Gumz, as well as any other reader of THE BOILER MAKER.

As a little problem for the readers, especially the layout men, I give this one for their study:

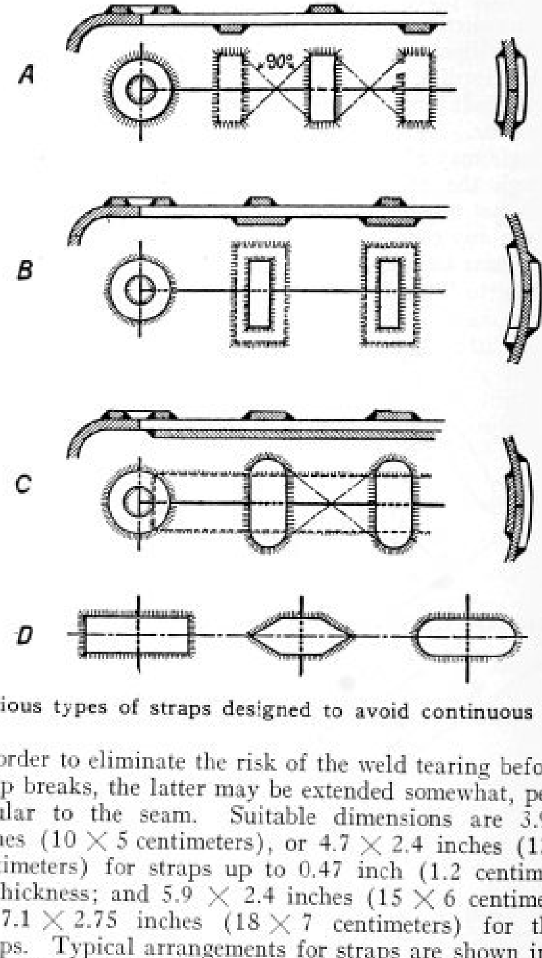
Problem: Given a cone and an ellipse, to find the line on the cone representing the plane that will cut the cone so that the true face is the ellipse required, as say, a right cone 30 degrees at the apex and the size of the ellipse to be say 6 inches by 2¾ inches.

German Boiler-Shell Practice

THIS article is based largely on E. Höhn's book entitled "Nieten und Schweissen der Dampfkessel" (The Riveting and Welding of Boilers). This book gives full particulars from a number of tests made with various arrangements of straps, and illustrates alternative constructions. To avoid the use of continuous seams Höhn recommends the use of a number of short straps (Fig. 1) set across the seam to be strengthened. Such straps adhere so firmly that they break through the center before they can be drawn from the plate. Incidentally the author states that it is impracticable to transmit adequate stresses with riveted straps, but that the welded strap is both technically and commercially well suited to the work.

Investigations concerning the elasticity of welded straps show that in all cases the strap connections are elastic, and when the strap is welded all around the variations in the stress at different sections are regular. The welds themselves participate in the elastic extension.

It being established that even thin square straps of the type considered break centrally, and not by tearing adrift, when welded all around, it is evident that such straps reinforce a seam—e.g., the longitudinal seam of a pressure vessel— by the full strength of the total section of straps.



Various types of straps designed to avoid continuous seams

In order to eliminate the risk of the weld tearing before the strap breaks, the latter may be extended somewhat, perpendicular to the seam. Suitable dimensions are 3.9 × 2 inches (10 × 5 centimeters), or 4.7 × 2.4 inches (12 × 6 centimeters) for straps up to 0.47 inch (1.2 centimeters) in thickness; and 5.9 × 2.4 inches (15 × 6 centimeters), or 7.1 × 2.75 inches (18 × 7 centimeters) for thicker straps. Typical arrangements for straps are shown in Fig. 1; that at (*A*) is suitable for plates up to 5/16 or 3/8 inch (8 to 9 millimeters); (*B*) for any thickness; and (*C*) up to 25/32 inch (20 millimeters). Various shapes of straps are shown at the bottom of the figure. It is important that the reinforcing straps be not spaced too far apart, and Höhn recommends that they be so placed that lines tangential to the opposite ends of adjacent straps intersect at right angles, as shown in Fig. 1.

In case (*C*), Fig. 1, an internal strap running parallel to the seam is supplemented by external transverse straps, which counteract the bending moment set up by the internal strap, and also, by extending beyond the latter, compensate for the weakening of the plate along the longitudinal welds. Due to the effect of error in bending the plate with and without contraction stresses in the longitudinal joint, the latter is nearly always subject to bending stress, but this can be compensated by the use of transverse straps. The strength of autogenously or electrically welded longitudinal

(*Continued on page* 300)

Railway Shops of the British Isles

Interesting results of a foreign tour and observations on British locomotive boiler shop practice

By Thomas Lewis*

IN the year 1923 the railways of England were amalgamated into four different consolidated systems, as follows:

First. The London, Midland & Scottish Railway, which serves the Midlands and west of England.

Second. The London & South Western, which serves the south of England.

Third. The London & North Eastern, which serves the Midlands and eastern counties. Both this and the Scottish Railroad come through to the north of Scotland, all the Scottish Lines being incorporated in these two companies.

Fourth. The Great Western, which serves the south and west.

Other railway systems have not yet been taken into these consolidations, but are operated and controlled by joint committees. English railroads, however, are very largely represented by the four consolidations. The London, Midland & Scottish railway first. Let me say that the English built locomotive must not be compared in size or weight or tractive power to locomotives built and in service in the United States of America, although since the years 1825 to 1925 some very remarkable improvements have been made in their design, so that today the English machine gives the speed and hauling capacity desired by their owners. I saw locomotive No. 4417 at the Wembley Exhibition in London, which their owners claimed made 70 miles per hour on the longest non-stop run that was ever made. It is a three cylinder locomotive, built at Doncaster, England, at the Company's plant, and had made 21,269 miles before being placed on exhibition. It hauls heavy trains, especially The Scottish Express, which for 63 years has left King's Cross, London station, at 10 A. M. every day, on its 395-mile journey to Edinburgh.

Locomotive No. 4417 was built in 1923, and is known as Pacific type 4-6-2, with four leading truck wheels, six coupled driving wheels and a two wheel-trailer. It has handled a train of 20 corridor cars (Pullman cars) weighing 610 tons, from King's Cross station to Grantham, a distance of 105½ miles, at an average speed of 52 miles per hour, the maximum reached being over 70 miles per hour. The engine is equipped with brick arch resting on square ended stud bolts in firebox side sheets, Detroit lubricator, and has superheater tubes. Total heating surface is 3,445 square feet; boiler working pressure, 180 pounds per square inch; distance from front tube sheet to center of exhaust, 2 feet, 5⅞ inches.

The main shops for locomotive and car repairs of the London, Midland & Scottish, are located at Derby in Derbyshire, and Crowe, in Cheshire. The Crowe plant is one of the most extensive in the country, covering 139 acres of ground with shops on 41 acres, employing 8,000 men. It is here that all steel rails are manufactured. Another plant at Horwich employs 3,903 men. Derby Locomotive Plant occupies 80 acres, 18 of which are covered with shops employing 4,590 men. The Derby Carriage and Wagon Works occupy 128 acres, of which 38 acres are covered, and employ 5,534 men. The Carriage Works at Wolverton, employ 4,143 men and other outlying places have engine sheds and wagon repair shops. The estimated number of men employed in all shops on repairs to locomotives and cars and other equipment is 26,089.

Equipment for Amalgamated Railways

The total equipment given in the Railroad Year Book of 1925, combined in this Amalgamation, is as follows:

London, Midland & Scottish Railroad Equipment of all kinds, for all kinds of service: 10,246 steam locomotives, 6,855 locomotive tenders, 28 steam rail motor cars, 2 electric locomotives, 272 electric motor coaches, 353 trailer coaches, 14,095 carriages of uniform class, 4,577 composite carriages, 204 restaurant cars, 113 sleeping cars, 110 post office cars, and 7,349 other coaching vehicles, making a total, including electric, of 27,073 coaching vehicles.

Freight: 167,436 open cars, 39,894 covered cars, 76,363 mineral wagons, 2,194 special wagons, 7,138 cattle trucks. 9,821 rail and timber trucks, 5,254 brake vans and 327 miscellaneous vehicles making a total of 308,427.

Street Traffic Equipment: 4 passenger motor vehicles, 25 tram or street cars, 22 omnibuses, 1,321 parcels motor vehicles, 19,259 horse wagons and carts, 9,870 horses for road vehicles, 351 horses for switching, 549 miles of canals.

Houses and Dwellings Owned: 1,938 laboring class dwellings, 11,892 houses for employees, 11,783 other houses and cottages, a total of 25,613.

London & South Western, Consolidation: Locomotive Equipment—2,266 locomotives and tenders; main repair shops at Eastleigh, located near Southampton, employing about 7,000 men on locomotive and car repairs.

London & North Eastern Railway, in 1924: 7,471 locomotives and tenders; main shops at Darlington and Manchester, employing an estimated number of 9,000 men on locomotive and car repairs. It was at this shop that Locomotive No. 1 was built by George Stephenson in 1825, drew the first passenger train between Stockton and Darlington. It has two cylinders 10 by 24 inches with a boiler pressure of 50 pounds per square inch. The total weight of engine and tender in working order is 11¼ tons.

The Great Western in 1924: 3,996 locomotives and tenders; main shops at Swindon, near Bristol, employing 13,000 men on locomotive and car repairs.

The total number of locomotives in the four or in the Amalgamation is 23,979, with 15 percent locomotives undergoing repairs, leaving 20,383 in actual service.

Total number of engine miles, including piloting and light:

London & North Eastern	167,054,909
London, Midland & Scottish	231,310,904
Southern	64,078,413
Great Western	96,793,512
Total engine miles for the four systems	559,237,738
Average per engine mile for 1924	27,432

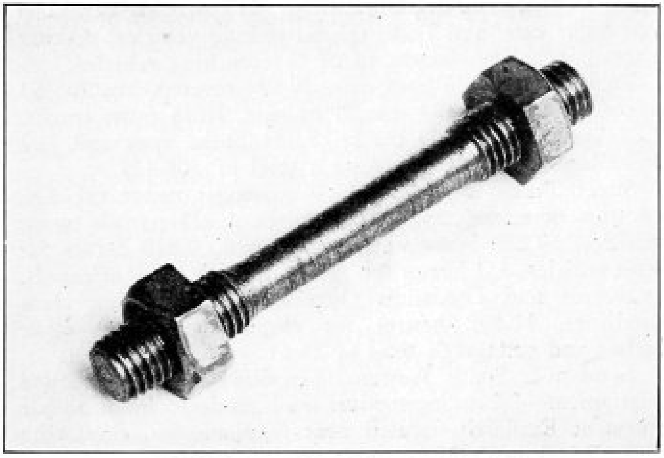
Locomotive Boiler Design

The general design of the locomotive boiler chiefly used is of the Belpaire type, although there are others of the Wagon Top style. The boiler shell is boiler steel, with copper fireboxes, copper staybolts, and in nearly all in-

*Chief Boiler Inspector of the Lehigh Valley Railroad. Paper presented at seventeenth annual convention of the Master Boiler Makers' Association.

stances copper flues. Some of the later built engines have been equipped with superheaters, and in a few cases, brick arches are being used. With these exceptions, engines do not have any accessories—nothing in comparison with the many in service on locomotives used in the United States. However, it appears from my observation that emphasis is laid on the quality of the work done, so that when an engine is placed in service it is expected that all parts are in 100 percent condition, and finished in a workmanlike manner.

It was my privilege to visit four of the largest railroad shops in England—at Eastleigh, Swindon, Crowe and Derby. These are the most representative railroad repair shops in the country, and when I speak of one I speak of them all and of the methods of doing the boiler work, with one or two small exceptions. The boiler departments in all these shops were well equipped with machinery for doing the best work. For rolling plate work there were horizontal rolls, also vertical rolls for rolling wrapper sheets standing on edge that were too wide to pass through the horizontal rolls, flange presses for doing all kinds of flanging, punch presses and shears, drill presses and hydraulic riveting machines. Despite the size of these shops and the large amount of work done, there appeared to me to be a lack of compressed air tools, such as air drills, air hammers, etc.



Iron staybolts used in British boilers

Flue work is done similarly to the way we do it in the United States, except that their prosser tools have not as many sections. Where we have eight for 2-inch and 2¼-inch flues, they have four and six sections. Flue rollers are about the same.

For the safe ending of flues, an oil furnace was being used with a hammer similar to ours. In one shop I was introduced to a method of lengthening flues instead of applying safe end. The flue was clamped at each end, vise like, and then pulled until it was brought to its original length to go back into the boiler. This did not appeal to me as being proper, as it reduced the thickness of the tube below standard, and would not be permitted in the United States.

I also found that iron staybolts were applied in firebox side sheets, in the flat surface, which might be termed the non-breaking zone. These were what we call reduced center bolts. (See accompanying illustration.) They were reduced in the center to ½-inch diameter. The ends were ⅝-inch diameter threads cut and hexagon nuts applied at each end. A copper firebox wrapper sheet ½-inch thick was placed in the furnace and brought to a cherry red heat, and rolled to shape in vertical rolls. This made a perfect job, and required no sledge hammer work.

Why are copper flues and copper firebox sheets used in place of steel, as in the United States? Because copper is a better conductor of heat than steel; because it does not crack in service as steel does. It will, being more pliable than steel, withstand expansion and contraction better than steel. Copper staybolts do not break as iron staybolts do, thereby being safer than iron.

What, then, are the conditions to cause copper fireboxes and flues to be renewed? The reduced thickness of the material. Sheets when applied new are as follows: Back flue sheet, ½-inch thick at bottom half, ¾-inch at top half; door sheet, ¼ inch thick; firebox wrapper sheet ½-inch thick.

The sheets, from contact with the fire, will wear down to 5/16 inch after a certain number of years. The average time is seven years, and $\frac{5}{16}$-inch thickness the limit. Before this limit is reached, staybolts begin to give trouble on account of leakage on the fire side, and must be either renewed or re-riveted in the fire zone. The iron reduced center staybolts are only used on engines overhauled at one of these shops, and are not approved at any of the other shops.

I saw one boiler in a shop for new firebox. It was of steel and the reduced center staybolts had been applied in flat surface in side sheets. All other staybolts were 1 inch in diameter. On making inquiry as to why this box was to be removed, the reply was that the side sheets were cracked around the staybolt holes, and being of steel, it ought to come out anyway. It had been in service 3½ years. I was told that the average life of their copper fireboxes is seven years. Our locomotives will average seven years' service. I said, "It must cost your railroads a lot of money if you only get seven years' service out of your copper boxes, as it is much more expensive than steel." My guide said, "No, it doesn't, please explain." I told him. "We have an average of 65,000 locomotives in the United States. I don't know of one that has a copper firebox, and I think I am safe in saying that the average life of the fireboxes would average seven years. You are worse off than we are, because it must cost you more for copper than for steel." "Oh, no," was the reply. "When we take out that copper firebox and those copper staybolts, we get the same price as we paid for the metal when put in, only, of course, it is lighter. But per pound we get the same price." He argued that he was getting money back for his copper fireboxes, and we were getting nothing. And that counterbalanced the difference—what we were paying and what he was paying. I had to keep quiet. I couldn't say anything.

Meeting the Shop Manager

It was time for me to go too. I had a conductor going through with me, and as I was going, he said, "Would you like to see our shop manager?" I said, "I have no objections. I would like to meet one of them." "Well," he said, "he is our shop manager, the chief man in this plant.

The manager was sitting at his desk—these men are always busy when you go in to see them. "Oh," he said, "you come from the United States do you?" "I do." "Well", he said, "you people over there have more privileges on your boilers than we have." "I don't get you; what do you mean by that?" "Well, you do lots of welding over there." "Yes, we do some welding, true, but, maybe you don't know it—in the United States our Interstate Commerce Commission has a Locomotive Inspection Bureau, and this Bureau has laid down certain rules which we must live up to in making locomotive repairs. If we don't, they have about 75 men traveling around the country and they will come in and put the kibosh on us if we are not doing things right." "Oh, oh!" Well, you know I couldn't let the man get away that way. "Now, Mr. ———," —I can't recall his name—I said, "I didn't come here to criticize your shop.

Now, you have all been very good to me, but since you sprung the welding, let me say now I did see a job in your shop that we would not be permitted to do in the United States." "What was it?" he asked. He began to wake up. "Well, now," I said, "I don't want to get your foreman into trouble. I talked to him about it. He knows. You better speak to him." "Tell me what it was." He wouldn't let me go. "Now, if you want to know, I will tell you, but your foreman knows about it, anyhow. You had a lot of boilers under repairs, some getting fireboxes and some patches, and some big patches on the boiler shell. Among all the bunch, you had one boiler that your foreman told me the belly of the boiler was pitted badly. I didn't see it because he had a patch over it, but he told me himself it was pitted badly and he had to put that patch on it. That is the patch that would not be allowed in our country." "Why, what is the matter with it?" "Well, they didn't even cut out the old part on the bottom of the boiler, but took a piece of boiler steel and put it on lengthwise almost from the front flue sheet near to the throat sheet, and longitudinal seams were put in that patch. They didn't even cut out the bottom."

He said, "What is the matter with it?" "Well, I will tell you what the matter is. Our Interstate—or our Boiler Inspection Bureau, takes this ground on jobs like that: They say that no chain is stronger than its weakest link, and those two seams on that patch wouldn't come up to much more or not quite 70 percent of the solid sheet, and they wouldn't stand for it." "What would they do with it?" "We would have to cut out the bottom of that boiler. If it was a three-course boiler we would have to put in either three new courses or three new half courses, and the longitudinal seams in those three new half courses would have to be strong enough and keep the boiler as it was when first made." He said, "Are you coming here tomorrow?" "No," I said, "I am going home tonight." "Why," he said, "I never heard anything like that. If you come here tomorrow I will drop everything and go with you." I said, "I have to go back to the United States. Good-bye."

(To be continued)

Part Played by Personnel in Developing Railroad Facilities*

By Frank M. Barker†

BUFFALO has the second largest railroad terminal in the country, with some 14 railroads serving 3,200 industries, and in this Buffalo-Niagara frontier territory there are some 1,500 miles of railroad trackage, or practically enough to build a four-track railroad from Buffalo to New York.

Being a transportation city, we are particularly interested in transportation conventions, because the people here very largely understand the railroad language—better perhaps than in a good many cities where transportation is not such a big factor.

Being a railroad man, I know what the Master Boiler Makers' Association means—I know the extremely important part that the boiler makers take in the operation of railroads, because the locomotive is one of the very important parts of the railroads' operation.

This is Railroad Anniversary Year. A hundred years ago the first railroad was started in a very feeble way. Those men back there, little dreamed that in one century, through their foresight, and the courage and industry of the men who have followed in building and developing these great railroads, that the happiest, greatest and most prosperous empire the world has ever known would be settled and developed, as the United States is today.

If it had not been for the railroads, the settlements in this country would very largely have been confined to the waterways, the seaboard, the lakes, the rivers and the great sections of inland country would still be virgin, so that this is a particularly fitting year for railroad conventions.

The general railroad situation, considered from all sides, is the best it has ever been. Service is at a high peak of efficiency and this is largely the result of the millions of dollars that have been poured into railroad property during the past few years, the money for which was obtained by borrowing, and not from earnings.

The railroads have not only brought their facilities up to a high state of efficiency, but the men and women who work for, and operate the railroads, have also kept pace, bending every effort to operate them in the interest of the shipping public. As a result, the state of view of the shipper has changed completely. He is being given the prompt and quick service that enables him to keep his stocks and supplies down to the lowest possible minimum, and he has used the money thus saved to buy better machinery and otherwise develop his business. Shippers all over the country are telling us in no uncertain terms, that they appreciate what the railroads are doing, and that they are with us.

As I said a few minutes ago, this happy situation is largely due to the greatly increased facilities which have been bought during the past few years on borrowed money.

There is another side to this railroad picture; that is, the compensation that the railroads receive for this service. There is constant pressure to compel the railroads to increase their expenses through increased taxes, the elimination of grade crossings, increased wages, etc. Railroad taxation has increased 130 millions of dollars per year comparing 1919 with 1925 and there is a constant demand from every quarter for the elimination of grade crossings without carrying with it the means for increased earnings or any other provisions to enable the railroads to get the money—coupling with this situation, the tendency to always adjust freight rates downward decreasing the income of the railroads brings about a situation generally not understood by the public.

I am saying this to you men, because we as railroad men have the very definite obligation of bringing this situation to the attention of the public, showing them just where the railroads are headed.

While the shipping public is well served, and the men and women operating the railroads are working under the most satisfactory conditions, and receiving the best wages they have ever had, there is, it seems to me, a very serious financial problem facing the railroads. If the railroads are to continue to adequately meet the demands of the public of the future they must do it by the spending of huge sums of money for new engines, new cars, and keep on increasing their facilities in every direction. They cannot go on doing this, as they have done in the more recent years, through the borrowing of money by placing mortgages on their property. Last year something like 99 percent of the money secured for the development of railroads was gotten through the sale of bonds.

My experience is that the public when concerned at all about rates, are concerned about the inequality of comparative rates, and are not so much concerned about the general rate level. They are keenly alive to their interests that nothing be done to adversely affect the high grade service that is being given by the railroads.

The Transportation Act of 1920 set up definite machinery for the making of freight and passenger rates, empowering the Interstate Commerce Commission to make rates that would give the railroads a fair return on the value of their property used in transportation service, specifically providing

*Abstract of paper read at seventeenth annual convention of Master Boiler Makers' Association.

† Vice President, Buffalo Chamber of Commerce, and Superintendent Lehigh Valley Railroad.

that in making such rates they will take into consideration the amount of money required for future upbuilding of the properties to provide for the growth of the country.

For the five full years since the Transportation Act went into effect the net earnings of all the railroads has been an average of 4.6 percent. In 1925 the railroads in this country earned about 5 percent, which is not return enough to furnish money required for the proper upkeep of the property and to pay the interest on their stocks and bonds each year.

If we railroad men study this situation and bring ourselves to a thorough understanding of it, and then use the information to spread the gospel of good service by the railroads, and a fair return to them by the public, we will, it seems to me, not only aid in placing our own business on a firmer foundation, but it will also be to the best interest of the country as a whole.

An Unusual Boiler Drilling Machine

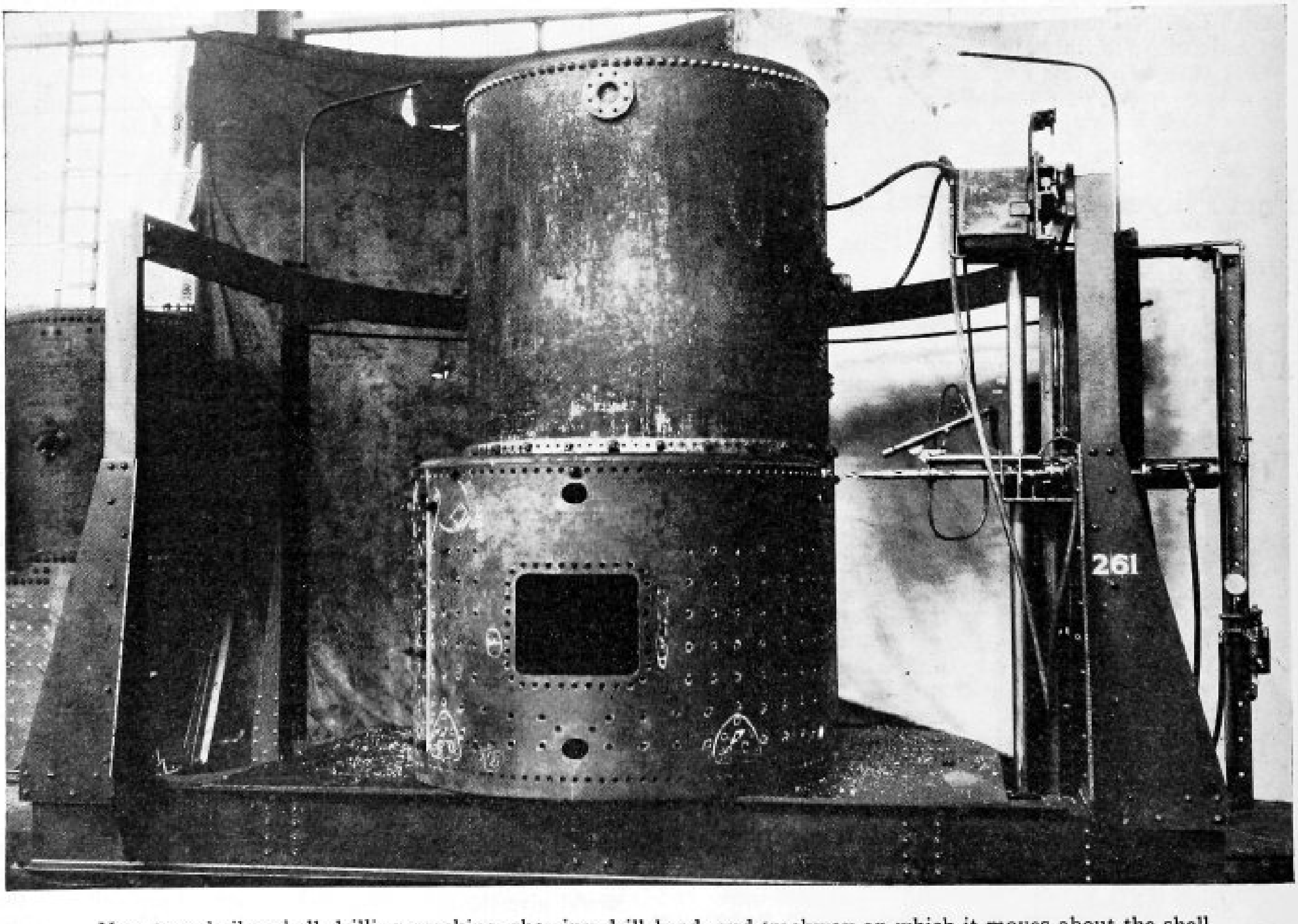
A NEW departure in boiler shop drilling equipment has recently been invented and patented by J. W. Doyle, who has charge of boiler and structural steel construction at the Washington Iron Works, Seattle, Wash. This machine is designed as a labor saver. Being comparatively inexpensive, it nevertheless is universal in its application, in that it can be made to handle drilling of plates either flat or curved.

The invention consists of a platform on which a frame structure is mounted and arranged so as to form a trackway for the drilling apparatus. The first machine for this purpose had a semi-circular platform and trackway straightening cut at both ends of the semi-circle to form a straight trackway. On this trackway an air motor is mounted so as to operate either in a fixed horizontal plane or any angular plane within certain limits. The feed mechanism is arranged so as to feed at any speed or pressure through the motor without causing any strains on the motor other than the usual torsional strains generated from the drill in doing its work. The motor and its swivel head are balanced so that the operator may swing the drilling apparatus into place quickly and easily.

The exhaust air from the motor is run through a flexible hose terminating in a nozzle, this nozzle at all times pointing to the drill point. Another smaller pipe used for introduction of water is attached to the air pipe and arranged with a shut-off. Water, however, does not seem necessary with the exhaust air coming from the motor and striking the drill point. The air, when expanding from 100 pounds pressure at atmospheric temperature, drops considerably below the freezing point and keeps the drill and material cool, blows out chips and gives a cleaner operation than if water is used.

The construction of the drill feed mechanism is such as to eliminate any stresses on the motor, as the drill spindle is carried through the motor and into ball thrust bearings before entering into the feed cylinder which has a feed piston

(*Continued on page 302*)



New type boiler shell drilling machine, showing drill head, and trackway on which it moves about the shell

Necessity of Improving the Steam Locomotive*

By R. B. McColl†

YOU are all aware that oil electric and straight electric locomotives are being thought of now to a greater extent than heretofore. This is especially true of the oil electric, which is a comparatively new development, and so far is giving a very good account of itself.

Unless we keep improving the steam locomotive in every particular your very existence as an association and as master boiler makers will be threatened.

It has been said, and truly, that "necessity is the mother of invention" and I venture to say that the necessity for improving the locomotive steam boiler is now with us.

Suppose we agree that it can be improved by at least three different methods, namely:

1—Improved design—including materials.
2—Improved workmanship when building.
3—Better care and maintenance.

Regarding improved design, as you know, many of the railroads are placing orders for sample engines with more or less radical departures in design. After thorough trials, many of these engines are proving highly satisfactory and roads are placing orders in larger numbers.

This will result in raising the standard of locomotive efficiency throughout the country and will gradually bring to the front newer and more improved power.

In addition, many designers are taking even longer steps toward the goal and in such engines as the "Horatio Allen," now being operated by the Delaware and Hudson Railroad, you find a very radical type of watertube boiler with a working pressure of 350 pounds.

In Europe designers are taking even more radical steps and in Germany we find an express locomotive with a special boiler built for two working pressures, namely, 853 pounds per square inch in the rear and 199 pounds per square inch in the boiler barrel proper. This also is a watertube boiler and perhaps some modification of these experimental locomotives will be the locomotive of the future.

After well ordered research and experiment some roads are getting excellent results by the use of a double articulated staybolt.

Many other devices such as superheaters, feedwater heaters, syphons, etc., have taken their place in adding to the greater efficiency of the steam locomotive boiler.

Regarding the second way, that of the maker building a better boiler: As with the design, the makers have improved greatly the past few years but we still feel there is room for improvement and you can rest assured we intend to progress.

You gentlemen can help the builders by telling them, when they are building your boilers, what troubles you are having and suggesting better ways of doing your work.

I can assure you the locomotive builders are only too glad to get your advice and to have you visit their boiler shops because you can show us in a few hours where improvement can be made which would take endless numbers of letters to explain.

Another way in which you could be of untold service to us would be to send us samples of parts of boilers that have failed; for example, small sections of pitted sheets, bolts, etc., with a short explanation of their location and type of boiler so that we can have that much more material to work on in our research.

We now come to the third way of improving the locomotive boiler, that is, better maintenance.

* In the absence of Mr. McColl, A. F. Pitkin read the address prepared for presentation at the convention of the Master Boiler Makers' Association.
† Manager, Schenectady Plant, American Locomotive Company.

It is a fact that if the design is excellent, and the original workmanship good, that the maintenance will be less on the life of the boiler, but it does not follow that the maintenance, or the methods of maintenance cannot be improved.

I feel that you agree with me that it can. I believe that if you men issue instructions that whenever a repair, be it large or small, is done on a boiler, that it is to be done right, that quality comes before quantity; then you will find your steam boiler living longer and maintenance costs reduced.

I am of the belief that the only substantial claim our electrical friends can make for the electric locomotive over the steam locomotive is less maintenance cost.

So you see, gentlemen, a great responsibility is yours. You must find ways and means to reduce maintenance costs.

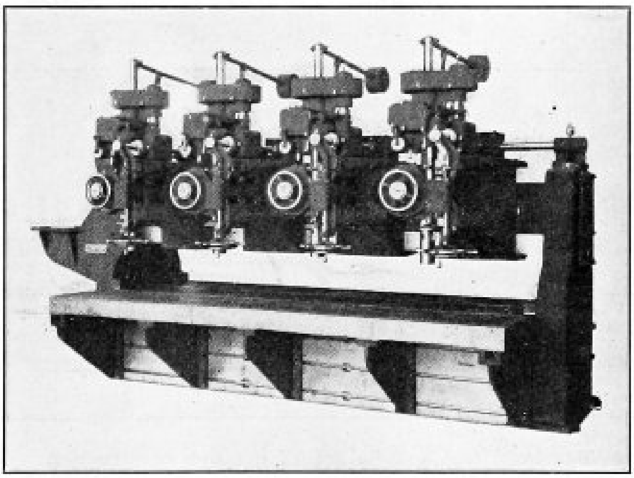
The designers and builders are willing to share the responsibility with you; they are willing and anxious to have suggestions from you; they are willing to make experiments for you.

Again, before closing, I want to emphasize that the designer, the builder and all of the steam locomotive boiler makers must work in harmony and together devise ways and means so that the electric people cannot say that the maintenance of the electric locomotive is less than a steam locomotive.

Mud Ring and Flue Sheet Drilling Machine

TO meet the demand of the railroad shops for heavier equipment required in the building of the modern type locomotive, the Foote-Burt Company, Cleveland, Ohio, has recently designed a drilling machine, which is called the No. 3 mud ring and flue sheet drilling machine, regularly equipped with four No. 30 heads. The long travel of the table, the back and forth, as well as the in and out adjustment of the spindles, allows the drilling of large flue sheets in one setting.

The spindles overhang the finished edge of the base so that mud rings can be bolted to this finished edge by means of three T slots running horizontally, for drilling the rivet holes. The two further outside knees that sup-



The Foote-Burt No. 3 mud ring and flue sheet drilling machine

port the table are fixed, but the three center knees are adjustable in case they interfere with the clamping of mud rings. When drilling flue sheets all knees are securely doweled in position to form the bearing for the table.

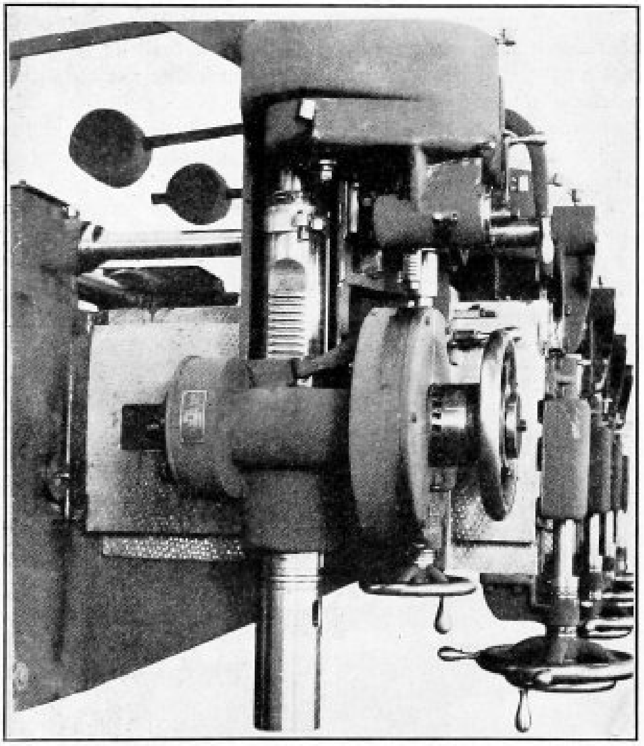
Arrangement of Machine

This machine is so arranged that a pit can be placed in the floor flush with the front finished edge of the base to allow the mud rings to project down in it for drilling the rivet holes. The size of the pit is governed by the size of the mud ring.

The machine can be arranged for either belt or motor drive. The power is transmitted through a heavy horizontal shaft where the drive is taken for each head, through bevel gears. From there power is transmitted through a vertical shaft in each head through spur gears direct to the spindle. All gears subject to heavy duty are made of high grade steel and all shafts are mounted on bronze bearings.

Each head has a drilling capacity of 3½ inches in solid steel, or 7 inches using a flycutter. Each head is adjustable along the rail, the minimum center distance between the spindles being 24 inches; the maximum distance between the two outside spindles is 123 inches. The spindles also have an in and out adjustment of 18 inches. All hand wheels controlling the adjustments of the heads are located at the front of the machine within easy reach of the operator. This also includes the hand wheel which controls the spindle itself. Each head is equipped with three quick feed changes independent of each other. The speed changes are accomplished by the cone pulley and back gears when the machine is arranged for belt drive, or by a variable speed motor when arranged for motor drive. The speeds in each head cannot be changed independently.

The spindles are made of high carbon steel and have long bronze bearings in the spindle sleeve. The spindle sleeve is also made of steel. The double rack is cut from



The head and spindle are of massive construction

the solid. This double rack feature is a "Foote-Burt" patent, and is said approximately to double the strength of the down pressure, which is enormous when large sized drills are used.

Great care has been taken in the design of this machine to make it as rigid as possible, the uprights being securely bolted to the base in an L-shaped pad.

The table has a working surface of 75 inches by 144 inches, and is provided with an in and out adjustment of 60 inches.

PERSONAL NOTE

JOHN R. BLAIR has been appointed manager of sales of Pittsburgh Steel Products Company, Pittsburgh, Pa., succeeding Charles F. Palmer, who resigned. Mr. Blair was educated in the common schools in Scotland, and was with the Millom and Askam Hematite Iron Company, in the Northwest of England from 1895 to 1902. He came to live in Pittsburgh in 1902, and was in the purchasing department of the Pressed Steel Car Company from that time until 1907. For the past eighteen years Mr. Blair has been connected with the sales department of the Pittsburgh Steel Products Company, and its predecessor, the Seamless Tube Company of America, and for several years has been acting as assistant to the general manager of sales.

John R. Blair

German Boiler Shell Practice

(*Continued from page 294*)

seams is generally from 65 to 80 percent that of the plate itself, but by adding transverse straps (welded all around) of a total section equal to 35 percent of the longitudinal section of the plate, the resultant strength of the seam equals or exceeds that of the plate. This claim is proved by the fact that vessels with such reinforced seams burst in the solid plate when tested to destruction.

At the Mulheim Works of A. Thyssen and Company, welded drums are being made up to 4 feet 1 inch in internal diameter and 31 feet long. These drums are rolled all in one plate, including the drum ends, i.e., with one longitudinal seam and no circumferential seams.

The edges of the plate are machined before welding, which helps to insure a homogeneous and close weld. It is also very necessary, as the strain set up in the plates during shearing is considerable and extends some 5 or 6 inches from the edge of the plates, the latter being 2 inches thick. After machining, the plates are annealed at a temperature of 910 degrees Centigrade.

After water-gas welding, the cylinder is again annealed to remove all strains set up during the welding process; from the annealing furnace and while red hot, the cylinder is threaded on a bending-roll mandrel, where it receives its truly cylindrical shape. It is kept revolving on the rolls while cooling, thus avoiding distortion. The ends are then trimmed off and the shell tested to 1.5 times the working pressure as a preliminary test; if this is withstood satisfactorily, the manufacture is proceeded with.

The hemispherical ends are now formed under pressure, leaving an opening for manholes. During this operation the thickness of the metal increases naturally, strengthening the end around the manhole opening. The final operation consists in machining the drum where required.

Among other things, it is stated that the ordinary formula for calculating the thickness of boiler plates cannot be relied upon for high-pressure work.—(W. S. Findlay in *Power Engineer*).

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Blowing Down Boilers

Q.—I would appreciate it if you would advise whether it is advisable to blow down a hot boiler and immediately fill with cold water. One party claims this will loosen scale and mud; another party claims it is injurious to the boiler and staybolts.—A. B. DuB.

A.—A boiler should not be blown out under full steam pressure, as the sudden reduction of pressure will produce excessive strains in the boiler parts. The pressure should be reduced to about 15 or 20 pounds per square inch before opening the blow-off cock. Allow the boiler to cool off before refilling with cold water because sudden contraction of the metal will otherwise result in leaky tubes, rivets and stays.

Some engineers blow the boilers, under pressure, to get the mud out before the mud has had time to settle; this is not good practice. It is better to reduce the pressure, as explained, then allow it to cool ready for washing it out.

Factor of Safety and Boiler Construction Rules

Q.—I would like to know how the factor of safety is given? As I understand it, say the factor is 5, do you multiply that figure by the given steam pressure, say 5 × 210 = 1,050 pounds that the boiler should stand?

I also would like to know if the railroads are exempt from state or the A. S. M. E. Code, if there is one on stationary and portable boiler inspections, as wrecking crane, hoisting and ditches? Boilers that do traveling and work in different states?

Is the book entitled "A Study of the Locomotive Boiler" a useful book in my line as an inspector, or are there any other books you know of as useful?—A. W. G.

A.—The *factor of safety* is the ratio of ultimate strength to working stress. The factor of safety of a boiler is the ratio of the stress at which rupture would occur to the allowable working stress. Thus in your example the calculated stress at which rupture would occur is 1,050 pounds per square inch and the allowable working stress is 210 pounds per square inch. The factor of safety equals $\frac{1,050}{210} = 5$. This factor of safety specified by the A. S. M. E. Boiler Code is 5 for new boiler constructions.

Locomotive boilers are built in accordance with rules fixed by the mechanical department of the respective railroads. Each railroad company is held responsible for the general design and construction of such boilers under their control by the Interstate Commerce Commission, Bureau of Locomotive Inspection. In general the rules adopted by the A. S. M. E. Code are now used for power boilers.

Stationary and portable boilers must be built and operated in accordance with the respective laws of the state in which they are used. Many states have adopted the A. S. M. E. Boiler Code.

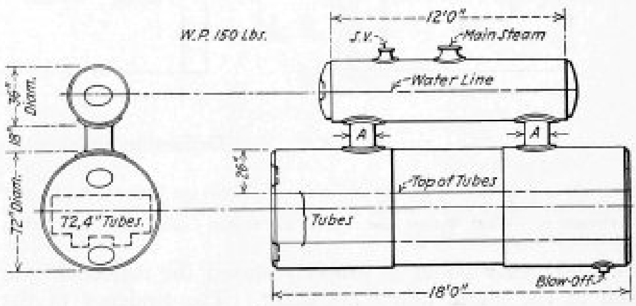
The book to which you refer is very useful in the study of locomotive boilers. Procure the rules and instructions governing the inspection and testing of locomotives from the Interstate Commerce Commission, Division of Locomotive Inspection, also the A. S. M. E. Boiler Construction Code. Address The American Society of Mechanical Engineers, 29 West 39th Street, New York.

Steam Drums and Nozzles

Q.—In the design of a firetube boiler having steam drum on top of same, connected to boiler proper by riser necks as shown on the accompanying sketch, the writer has been requested to give a logical method of calculating the diameter of connecting necks "A-A," as indicated, so as to give proper circulation. Can you give me any information that could help me arrive at this?—R. C. W.

A.—The diameter of a steam dome or drum for locomotive and tubular boilers should not exceed 0.6 of the diameter of the shell or barrel of the boiler.

The nozzles connecting the steam drum with the shell



Calculation of steam drum connections

should be of sufficient diameter so as to provide free circulation of the water and steam. The combined cross sectional area of the nozzles being from 60 to 90 percent of the cross sectional area of the drum.

Comments on Laying Out for Boiler Makers—Fourth Edition

Q.—I purchased the Fourth Edition of Laying Out for Boiler Makers. It is a good book but prints are entirely too small, especially on spiral plans and flange corners of locomotives; also the boilers, Figs. 1, 2, 9 and 10, and Figs. 23, 24 and 25 have no instructions as referred to. Kindly let me know if you have any plans and instructions on two tapered pipes intersecting at center, also ashpan for boiler, Figs. 9 and 10.

Do you know of a book of instructions for direct reading slide rule?—C. J. H.

A.—The purpose of the problems, given in the book referred to, is to illustrate the application of projection, triangulation and the radial methods in laying out patterns. The details such as flanges, laps, etc., are matters of design, depending on the type of joint. Therefore, the main object is covered in the treatise and if the layerout understands the principles given, the allowances for lap and flange can be readily made, direct on the pattern.

A number of tapered pipe connections are also given, refer to Figs. 69, 73 and 78 of Chapter III. If you will furnish a sketch of your problem, we will show a complete development. We do not have drawings of the ash pan referred to.

Write McGraw-Hill Publishing Company, New York, N. Y., for a treatise on reading the slide rule by J. J. Clark.

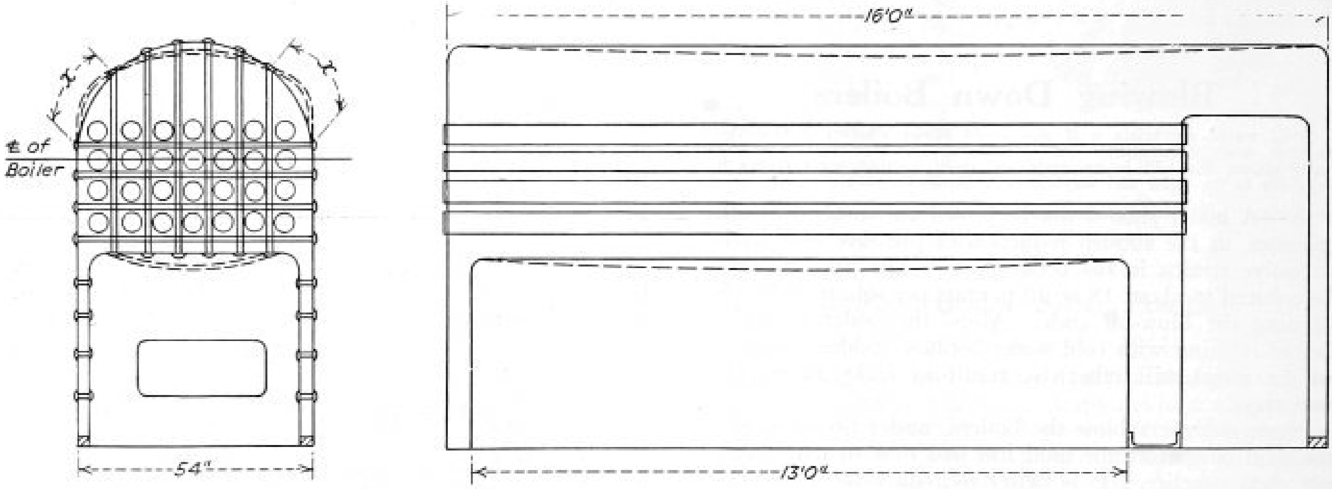
Deflection in Boiler Sheets

Q.—I am sending you a sketch of a boiler with which we have been having considerable trouble, and I would appreciate very much your opinion on what is the cause of it. It is an experimental boiler which we are developing, having built it only for low pressure before, but now we want to build it for pressure to 100 pounds and possibly more.

The boiler is of the doghouse type built of 5/16-inch steel and for 100 pounds working pressure, 1-inch staybolts about 7 inches center to center.

You will notice the extremely long firebox (the sketch is not drawn to scale, but the dimensions are given) and the flat crown sheet; also that the last upper row of through-staybolts is above the center line of the boiler.

Now when pressure is applied, the crown sheet is forced down. I have drawn in with dotted lines the contour of the boiler under pressure, exaggerated, of course, but to show which way it is going. We tested the boiler to 150 pounds per square inch, and we found the crown sheet was down about 1 inch. Now what the reason is I cannot figure out. I must admit I am baffled and I would thank you very much for your opinion on this matter. What causes the boiler to change form that way when pressure is applied?—E. J.



Deflection in sheets of doghouse type boiler

A.—If your boiler is properly stayed the deflection you find in the plates would not occur. The tendency of the pressure is to force the plate outward in the form of a sphere; therefore that section of the boiler marked x on your sketch which is unstayed has bulged outward, causing the deflection in the crown sheet and outer wrapper sheet.

If our readers have other ideas on this subject, please express them.

Coefficient of Friction in Calculation for Flow of Water

Q.—Please refer to page 242 of The Boiler Maker, article "Flow of Water Through Pipe." What is the general coefficient of friction which will cover all cases? 0.0205 was given for the conditions in this example. Thanking you for this information.—F. C. H.

A.—To determine the coefficient f of friction in straight pipe of uniform diameter it is necessary to find first the mean velocity of discharge v, in feet per second, from the formula:

$$v = 2.315 \frac{hd}{fl}$$

h = head in feet.
d = diameter of pipe, in inches.
l = length of pipe, in feet.
f = 0.025, trial coefficient.

The final value for f may then be found from the formula:

$$f = 0.014392 + \frac{0.01756}{\sqrt{v}}$$

Unusual Boiler Drilling Machine

(Continued from page 298)

head and an opposed thrust head leading with a spindle to the strong back posts. The drill spindle is fed or withdrawn from the hole simply by the turning of a two-way air throttle. This control is very close. The drill spindle can be fed slowly or quickly as desired or withdrawn in the same manner. A special patented control valve regulates the feed pressure with such accuracy that any size drill from the smallest to the largest within the capacity of the motor can be used with equal success without breakage.

The illustration (page 298) shows a vertical boiler with an oblong firebox after it had been drilled. The firebox was drilled and tapped for staybolts and 3/16-inch telltale holes were drilled in each stay after riveting. All drilling was done with this machine without breaking a single drill. No reamer was used as all holes are bound to be true and fair and may be drilled full size. Staybolt holes are not laid out separately on the firebox only on the outer shell.

Speed of Drilling

This boiler had 754 holes averaging 1 inch diameter and was drilled in 13 hours with one man, an average thickness of 1.2 inch or over 900 inches of metal removed. Staybolt holes were drilled in 1/3 the time formerly necessary for drilling and reaming. Three-hundred and eighty-one—3/16-inch diameter telltale holes were drilled 1⅜-inch deep all with one drill and no breakage. This has been one of the greatest nuisances heretofore. It is understood that the inventor has several patents pending on this machine and negotiations for the manufacture and marketing of this machine in its various fields of application are now being carried out.

Business Note

J. T. Stephenson of the Munsey Building, Washington, D. C., now is selling the manufactured products of the Logan Iron and Steel Company (Philadelphia, Pa.) in Baltimore and the territory south of it, and in the territory as far south as Atlanta, Ga., and Wilmington, N. C.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

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

Steamboat Inspection Service of the Department of Commerce

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

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.

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

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

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.

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

Vice-Chairman—C. D. Thomas, Salem, Oregon.

Statistician—E. W. Farmer, Rhode Island.

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

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

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

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

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

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

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

Master Boiler Makers' Association

President—J. F. Raps, general boiler inspector, Illinois Central.

First Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.

Second Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.

Third Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.

Fourth Vice President—George B. Usherwood, supervisor of boilers, New York Central.

Fifth Vice President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington and Quincy.

Secretary—Harry D. Vought, 26 Cortlandt Street, New York.

Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.

Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—J. W. Kelly, National Tube Company, Pittsburgh, Pa.

Vice President—A. W. Clokey, American Arch Company, Chicago, Ill.

Treasurer—George R. Boyce, A. M. Castle and Company, Chicago, Ill.

Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie, Pa.

Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.

Secretary-Treasurer—A. C. Baker, 801 Rockefeller Building, Cleveland, Ohio.

Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; Owsley Brown, Springfield Boiler Company, Springfield, Ill.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Wroks, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

Cities

Chicago, Ill.	Memphis, Tenn.	St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Los Angeles, Cal.	Philadelphia, Pa.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Missouri	Pennsylvania
California	New Jersey	Rhode Island
Delaware	New York	Utah
Indiana	Ohio	Washington
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Nebr.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Memphis, Tenn.	Philadelphia, Pa.	Tampa, Fla.

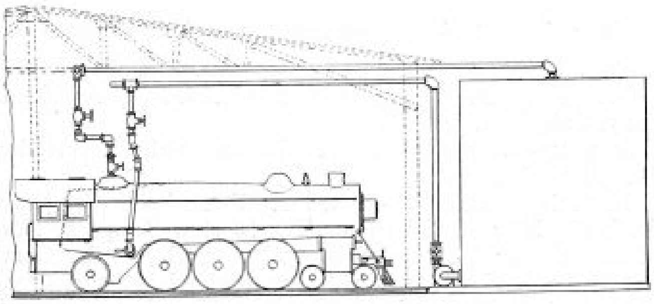
SELECTED BOILER PATENTS

Compiled by
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,588,782. CHARLES W. STURDEVANT, OF SAN FRANCISCO, CALIFORNIA. METHOD OF CLEANING LOCOMOTIVE BOILERS AND SUPPLYING WATER TO REFILL THE SAME.

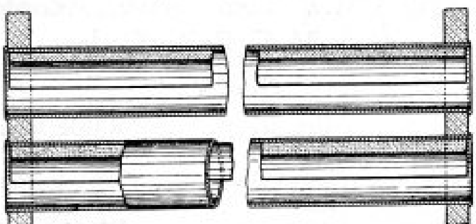
Claim. The method of cleaning a locomotive boiler and supplying water to refill the same comprising discharging the steam from the locomotive initially at substantially working pressure of the locomotive from a point above the water level of the locomotive boiler, into a container at sub-



stantially atmospheric pressure without the addition of water to the steam prior to its delivery into said container, with consequent evaporation and discharge as steam of a portion of the water initially liquid in the boiler, discharging sediment and the remaining water from the boiler by gravity at substantially atmospheric pressure and utilizing the stored hot water of condensation at the temperature found in the container in refilling the boiler.

1,598,184. FREDERICK G. WILCOTT, OF SAN QUENTIN, CALIFORNIA. BOILER-TUBE CONSTRUCTION.

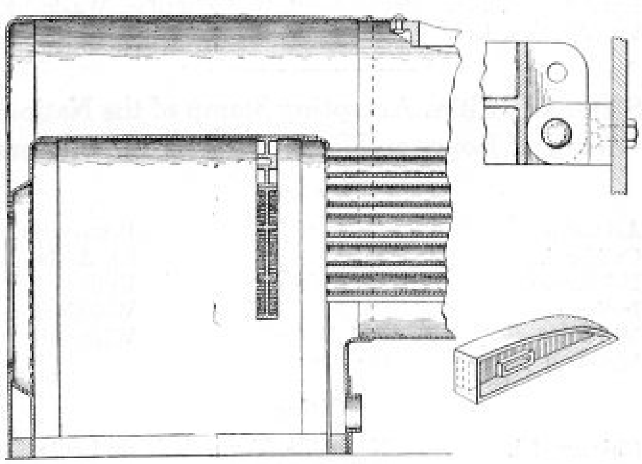
Claim 1. In a boiler tube construction, a liner comprising a body



segmental in cross-section and having thin, flared edges adapted to hold the liner tightly in contact with the inner wall of the tube.
Five claims.

1,597,158. CARL E. JOHNSON, OF CHICAGO, ILLINOIS. BOILER FIREBOX.

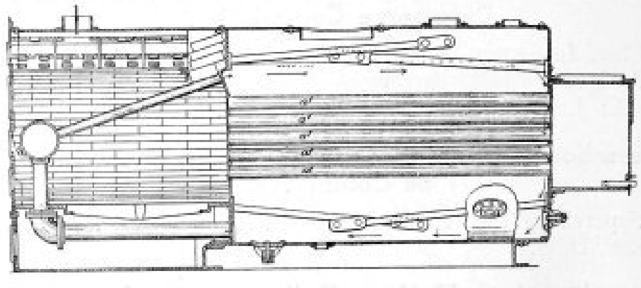
Claim 1. The combination with a boiler of a fire box therefor, a plurality of flues extending from said firebox, through said boiler, a



movable baffle positioned between the fire in said firebox and said flues and a section removably carried by said baffle for baffling said firebox from said flues.
Eight claims.

1,597,872. JAMES B. STANWOOD, OF CINCINNATI, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE STANWOOD CORPORATION, OF CINCINNATI, OHIO, A CORPORATION OF OHIO. STEAM PLANT.

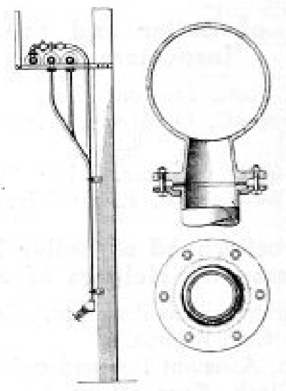
Claim 1. In a steam plant, the combination of a down draft furnace, a horizontal fire tube boiler the water space of which is substantially all back of the furnace and the fire tubes of which communicate at their



front ends directly with the furnace, a water outlet extending from the lower part of the boiler through the furnace, a water tube grate in the furnace which opens into the upper part of the boiler, and means for distributing the water from said outlet to the tubes of said grate.
Fifteen claims.

1,598,388. SPENCER OTIS, OF BARRINGTON, ILLINOIS. DROP PIPE FOR BOILER-WASHING APPARATUS.

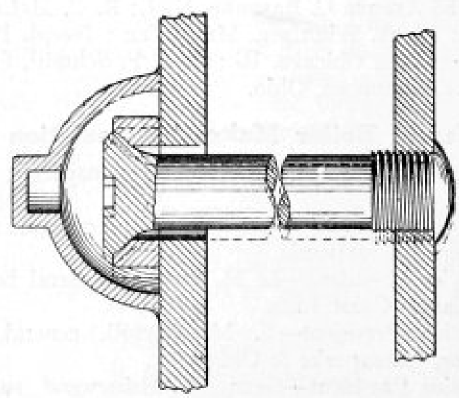
Claim 1. In a boiler washing system for locomotive terminal houses, a locomotive stall post, a series of main pipes supported in an upper level adjacent to and extending past said post, said pipes having, at points therein adjacent to said post, vertically presented transversely flanged branches, flanged drop pipes supported from the respective main pipes, having upper ends coaxial with and opposed to the ends of said branches,



clamping rings opposed to the flanges of the branches embracing the flanges on the drop pipes and assembling the drop pipes with the branches with freedom of the drop pipes to rotate, said drop pipes having bends which offset them respectively from the main pipes by which they are supported laterally to the stall post, and said drop pipes extending beyond their bends downwardly along said post to their points of service; said clamping rings and branch-flanges adapted to tighten the connected ends of the drop pipes after the drop pipes have assumed the positions described.

1,586,921. FRANK W. SHUPERT, OF SANFORD, FLORIDA. STAYBOLT CONSTRUCTION.

Claim 1. In combination with spaced inner and outer firebox sheets, a staybolt construction comprising a bolt including a shank, a screw threaded portion at one end of the shank, fixed in screw threaded engagement to the inner firebox sheet, and a relatively shallow button-like head



integral with the opposite end of the shank and disposed exteriorly of the outer firebox sheet with the shank freely movable laterally in an opening of said last mentioned sheet and the face of the head confronting the outer sheet being convex in shape; and a mounting for the headed end of said bolt comprising a ring like member slidable over the face of the outer sheet and having a concaved annular seat for the convex faces of said head.
Two claims.

The Boiler Maker

Volume XXVI **November, 1926** **Number 11**

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Edward A. Simmons, *Pres.*
L. B. Sherman, *Vice-Pres.*
C. R. Mills, *Vice-Pres.*
Roy V. Wright, *Sec'y.*
Henry Lee, *Vice-Pres. and Treas.*
Samuel O. Dunn, *Vice-Pres.*
F. H. Thompson, *Vice-Pres.*
George Slate, *Business Manager*

Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ave.
Mandeville, La.
Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St.
Westminster, S. W. 1.

Cable address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

Request for change of address should reach us two weeks before the day of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

Master Boiler Makers' 1927 Convention

THE announcement has been issued by the secretary of the Master Boiler Makers' Association that the executive committee has selected the period of May 3 to 6 inclusive for the 1927 convention of the association. This convention is to be held at the Hotel Sherman, Chicago, in accordance with the decision reached at the convention last spring. It will be well for members of the association to make their plans for attending the meetings somewhat earlier than usual because of the advance in the dates of the convention by nearly three weeks. It is understood that the reason for this advance is to avoid conflict with meetings of other associations and particularly for the convenience of the members of the Boiler Makers' Supply Men's Association who wish to exhibit their products at other conventions during the months of May and June.

This change from the customary time of meeting most vitally affects members of topic committees who have reports to prepare for presentation at the 1927 convention. To make the subject matter of any report of utmost value, a great deal of time and study of the problems involved must be devoted to their preparation. After each individual member of the committee has to the best of his ability prepared his report, it must be forwarded to the chairman whose duty it is to compile the findings of the individual members into a composite report that will represent their opinions. This procedure must necessarily be extended over a considerable period. So, in order that all reports may be submitted to the secretary for preparation in time for the next convention, it is essential that committee members arrange their reports on schedule.

Since these reports are the most important feature of the convention, too much emphasis cannot be placed on the work of the committees. With this work done as adequately as it has been carried out in the past, the convention will prove to be a banner one.

Inefficiency in Industry

"HOW many machinery builders could stand a government investigation into their methods of conducting their companies?" K. H. Condit, editor of the *American Machinist* asks this question in an editorial contained in a recent issue of that publication. Whether it is in the machinery building industry or in the boiler manufacturing industry, his analysis of the causes of the present unprofitable situation existing parallel each other closely. He points out that the investigation in question should not be of the snooping variety which has characterized so many conducted by the government but rather of the kind to which Owen D. Young referred in a recent address before the National Industrial Conference Board. At this meeting Mr. Young went on record as follows: "Industry should be profitable. It would be a good idea if the Government should change its policy. I have noticed for a number of years that whatever investigation was to be made, was of a concern that made some profit. Suppose we reverse the policy. I know of no way concerns can make profits unless they render service, and, conversely, if they do not make profits they cannot render service."

Mr. Condit applies the suggestion noted above to an investigation of the machinery industry in a manner that is highly illuminating. The same lesson may be applied to the boiler manufacturing or any other industry which is laboring under the weight of destructive competition. As Mr. Condit points out, an investigator of a company operating under such conditions would find "a group of machinists of more than ordinary skill, under the direction of foremen above the average in ability. Something more than half the shop equipment would be less than ten years old.

"The engineering department, on investigation, would produce technical talent second to that of no other industry, with perhaps one exception. It is possible, although not inevitable, that he would find the technical talent engaged in adapting the ideas of other designers to the needs of their employer. And why? Because there was no research in progress to reveal new physical facts that they might utilize in solving their own problems. The investigator might find a certain lack of enthusiasm in this department engendered by too much worry over personal financial problems, brought on in turn by inadequate salaries.

"What of the sales department, and sales methods? The situation here would depend on the policy of the company, selling direct or through agents. In either case our investigator would probably discover sales efforts spread too thin over a line of product that had outgrown reasonable bounds. Too many of the salesmen would be found to be mere order-takers, unable to answer the searching questions of prospective customers adept in the latest shop practice. He would find attempts being made to get business that might much better be left alone because of the small profits.

"He would surely unearth free mechanical service impossible to justify on any ground other than pure fright, and free engineering service that bordered on charity, depending in extent on the rapacity of the customer. He might discover an unpleasant willingness to believe anything said about the size of a competitor's bid by an unscrupulous purchasing agent.

"Having discovered these facts any good investigator would naturally search for the reasons of their being. And, being an experienced man, he would head straight for the general manager or the president, depending upon which official exercised final authority. What would he find?

"The chances are about three to one that in and around the executive offices there would be an atmosphere of apprehension. Apprehension as to what the company's competitors might be doing in the way of new designs or clever selling stunts. . . . Fears of an impending slump in business, induced by all too recent memories of the narrow escape from failure during the last depression.

"What effect do they have on business policy? Just this —a weakening of morale that is evident in prices for the product that are entirely too low, and, to make matters worse, a general tendency to shade even these low prices when sufficient pressure is brought to bear.

"The margin between cost and selling price is not sufficient to permit of the establishment of adequate reserves to take care of dull periods, or to conduct vitally necessary research and investigation, or to pay wages and salaries high enough to hold valuable men when some one tries to hire them away. The margin is inadequate to cover the cost of proper selling effort."

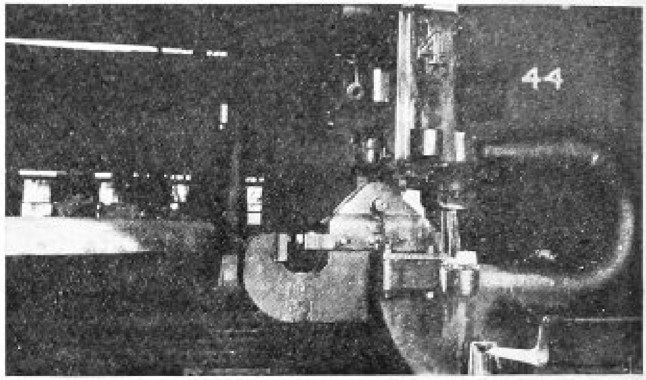
It might prove extremely profitable to members of the boiler manufacturing industry both singly and collectively to turn the light of a similar investigation on their own companies and from the results discovered endeavor to correct the difficulties that stand in the way of the prosperity to which their efforts entitle them.

LETTERS TO THE EDITOR

A Punching Machine for Flanged Heads

TO THE EDITOR:

I noticed in your last issues some very interesting shop kinks. I am sending you a picture of an attachment I made for the punch in our shop. The idea so far as I know is absolutely original. In traveling around I have



Attachment for punching machines

found shops that have dug pits trying to punch flanged heads without a flange punch. The attachment shown herewith is not an expensive outfit and costs very little more than a pit, but will do ever so much more work. I would be glad to send any one, so desiring, a drawing of it. Hoping some other fellow may be benefited by this kink.

Hilo, Hawaii. H. LINDGREN,
Boiler Shop Foreman, Hilo Iron Works.

Staying Crown Sheets

TO THE EDITOR:

In the October issue of THE BOILER MAKER we have an interesting problem before us in E. J.'s description of the deflection of wrapper and crown sheet in his experimental boiler when under pressure. As you state in your reply, it is evident that there is lack of sufficient staying and as there are no definite measurements given of these parts, we are forced to surmise a good deal. Now I would like to suggest to E. J. that the length and shape of his crown sheet are such as to offer no great resistance to pressure when it is handicapped, as we might say, by the insufficient staying of the wrapper sheet.

Would it not be a good policy to apply the crown sheet with a radius to it, even at the expense of shortening the side sheets, so that in raising the height of the crown sheet along its central line we would not lessen the area between the crown sheet and the bottom row of flues? This would give us the advantage of a surface with more resistance to pressure and also a surface that would not accumulate scale and mud as readily as a flat surface.

In the area between the top row of cross stays and the outer row of radials, I would suggest leaving out the top row of cross stays, also the outside flue in the top row on each side. Apply the tee irons to the shell in this space at a distance apart of not less than two rows of cross stays and apply cross braces with jaws securely bolted to the tee irons. Removing the two flues would give us clearance for the tee iron and also preclude the possibility of an accumulation of scale between the flue and the shell, which we so often find at these points. Also the added circulation would more than offset the presumed loss in heating surface.

The fire door shown calls for improvement. Here we have another flat surface at the top of the door. This type of fire door is known as a mud catcher. Would it not be better to have it of circular or elliptical design thus affording a better opportunity of keeping it clean and free from mud blisters?

Lorain, Ohio. JOSEPH SMITH.

New Design of Lancashire Boiler Flues

TO THE EDITOR:

In submitting this article the writer anticipates the same volume of criticism that usually follows the appearance of anything new. In the interest of the trade this is more than welcome provided of course that it is constructive and instructive.

As most of us know, the existing arrangement of Lancashire boiler flues consists of a number of cylindrical sections flanged up at the ends, drilled at about 2-inch pitch and joined together with a calking liner in between the flanges. These sections (measured over the flanges) rarely exceed 4 feet in length, and the number of sections are generally 10 or 11 in a boiler 30 feet long. This method which is known as the Adamson "flanged joint" is the best known and is superior to the "bowling hoop," the "lap joint," "two-angle rings," or the "tee bar." The bowling hoop permits of expansion, but the rivet heads are in the path of the flame, which is bad practice. The lap joint does not permit of expansion, is not sufficiently rigid and the rivet heads are in the path of the flame. The two-angle rings and the tee bars, make the joint rigid but do not permit expansion and the rivet heads are in the path of the flame or hot gases.

The Adamson flanged joint permits expansion in harmony with the expansion of the shell, the rivet heads are in the water space and the flanges make the tube rigid and come into calculations as a point of substantial support.

The object of the new design is to dispense with a considerable amount of planing, flanging, drilling, turning, making calking rings, riveting and calking. To do this we procure from a tube maker two long lengths of lap welded tubes, one corrugated section and a short section; if you can make them in your own works so much the better, provided they are equally as good.

The next process is to make (as in this example) 4 solid welded tee bars of substantial thickness and about 3 inches by 3 inches; shrink these onto the tubes and electrically weld them to the tubes, after which flange up the ends of the long tubes, drill the holes, insert calking rings and rivet up. By following this line of action we have dispensed with 4 Adamson joints, which means 8 processes of flanging per flue; that is 16 flanged per boiler and the necessary joint rings and all the consequent drilling, turning, riveting and calking. We must admit at once that we have reduced just the expansion that the four Adamson joints would give; but to overcome this we have inserted a corrugated section and finished the flue length with a making up piece. The corrugated section could have a more convenient position or a better position according to opinion, or could be extended to the back end plate thus making a flue length in 3 sections.

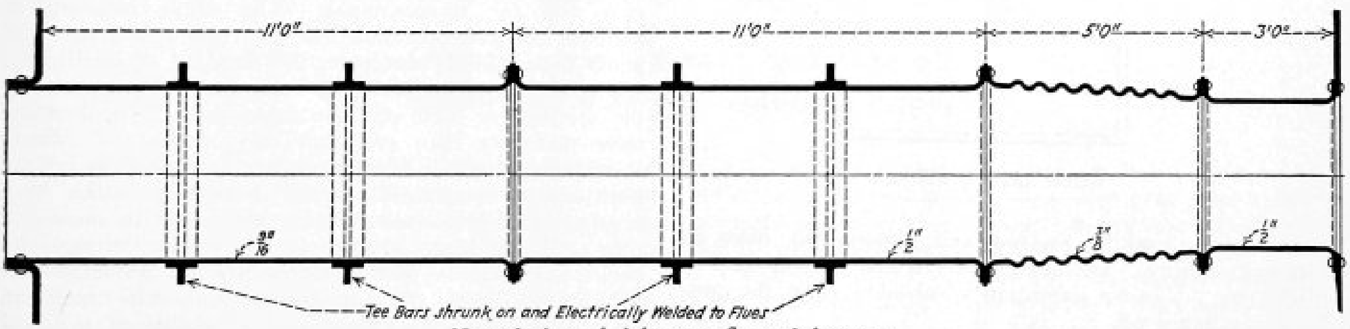
The point at issue is this: Have we produced a flue length equal in strength and expansion to the Adamson flue and at what difference in cost?

Well now, how do we stand with the governing bodies for passing the job? The B. O. T., that is the Board of Trade of Great Britain, will not have electrically welded joints that are in tension, or depending on their own structure for support. We have I think overcome that, for the tee bar stiffeners are not in tension neither does the electric welding which binds them to the flues depend on its structure to support the flues against collapse.

The tee bars are there to give the points of substantial support to the cylindrical tube which is subjected to external pressure and these of course must be pitched to meet the requirements of the formulæ of the B. O. T. and A. S. M. E. Further advantages of this design are obvious; (1) No rivet heads either in the water space or the path of the flame to burn or waste away. (2) Number of riveted joints which leak at times reduced to a minimum. (3) More heating surface at the back end where the temperature of the gases are lowest i. e. in the corrugated section.

This design may not be perfect but if it gives any boiler makers or engineer an idea for further development it has achieved something for our mutual benefit.

Yorks, England. JOHN GORDON KIRKLAND.



New design of Adamson flanged furnace

Unstayed Flat Surfaces

TO THE EDITOR:

The sketch enclosed gives a rough idea of a mild steel vessel which was built to work at 5 pounds per square inch and hydraulically tested to 10 pounds per square inch. The flat bolted cover plate was specified 1/4-inch thick with bolts at 2 feet 3 inches centers. During the hydraulic test the following deflections were noted:

5-pound pressure.	1/2-inch deflection.
7 1/2-pound pressure.	3/4-inch deflection.
10-pound pressure.	1-inch deflection.

The point under consideration will be the difference between technical calculations and the actual results.

The following formulæ is applicable for flat unstayed surfaces not exceeding 2 feet 6 inches diameter or equal area.

Working pressure of flat ends up to and including 2 feet 6 inches in diameter and 1-inch thick.

$$\text{Working pressure} = \frac{C \times t^2}{S}$$

where t = thickness in sixteenths.
C = 300 for mild steel
S = area of the circle between points of substantial support in inches.

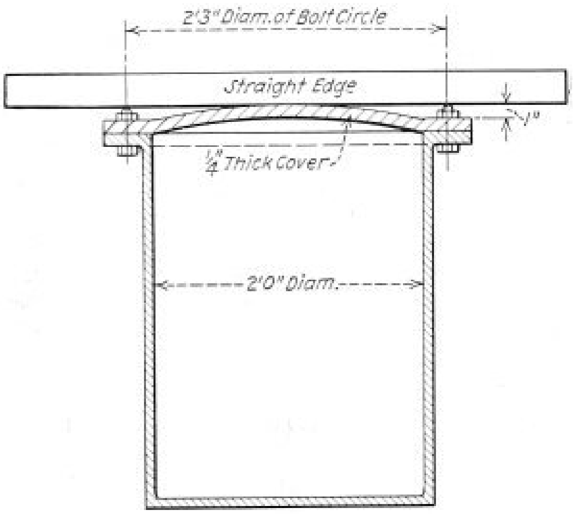
Working this formula out to apply to this problem we have:

$$\text{Working pressure} = \frac{300 \times 16}{573} = 8.38 \text{ pounds per}$$

square inch.

ALLOWABLE WORKING PRESSURE

Therefore, according to the formula, the flat cover plate of the vessel should be suitable for about 8 pounds per



Cover plate problem

square inch working pressure and consequently more for its test pressure. The deflections given at 10 pounds pressure (viz., 1 inch) immediately subsided when the pressure was taken off.

The gage was in good condition and the test was reliable. For the purpose of comparing notes my friends and I would be glad to see the American formula worked out which is applicable to an unstayed flat surface.

Yorks, England. J. G. KIRKLAND.

Good Methods Make Good Welds

SLOW acceptance of welding as a satisfactory fabricating process has been noted on the part of a good many who are nevertheless quick to accept it as a repair process in an emergency. For a long time the cry has been that there is no way to test a weld without destroying it. However, the steady progress of the art has caused the cry to become somewhat fainter. The perfectly rational argument that other methods of construction cannot be definitely tested except by destructive methods is gaining a little recognition. And along with it the idea is gaining recognition that competent workmen can be obtained, and systematic procedure followed in welded construction, which combination may quite safely guarantee the sort of result which needs no further testing.—*The Welding Engineer.*

Death of Charles B. Rowland, Vice-President of the Continental Iron Works

CHARLES BRADLEY ROWLAND, civil engineer and vice president of The Continental Iron Works, Brooklyn, N. Y., died at his home on Brookside Drive, Greenwich, Connecticut, November 1, 1926.

Mr. Rowland was born in Greenpoint, Brooklyn, on May 22, 1863. He was the son of the late Thomas Fitch Rowland and Mary Eliza Bradley Rowland and a descendant of the last Colonial Governor of Connecticut.

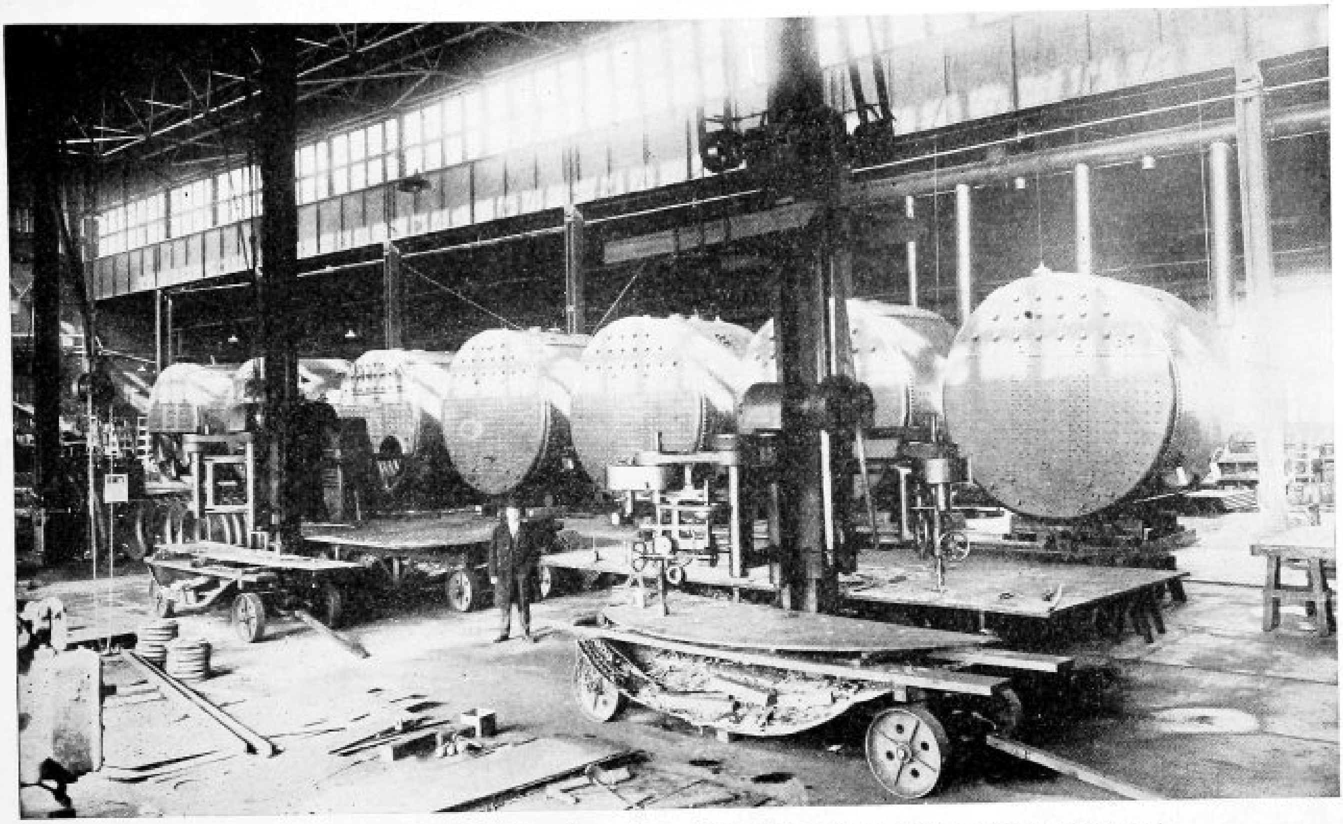
He was graduated from the School of Mines, Columbia University, Class of 1884 with the degree of civil engineer.

Directly thereafter he joined with his father in the business of The Continental Iron Works. His father founded these Works in 1859 and was its president for many years. Here was constructed the original Monitor in 1862. He devoted his entire business career to The Continental Iron Works, and for the last twelve years had been its vice president.

The Reading of Books

ASTONISHING advances have been made all along the line on the railways in this country during the years which have elapsed since the close of the world war and particularly since the return of the railroads to their owners after the period of federal control. This advance is particularly noteworthy in the mechanical department in the improvements in the design of cars and locomotives, the better maintenance and utilization of the equipment and the finer spirit of teamwork, and cooperation between the men and the managements. The whole standard of management and operation has been raised to a new and much higher level; moreover, the standard of intelligence and education of the boys and young men who are entering the service has been steadily improving. It is therefore more necessary than ever that the foremen and officers should make special efforts to better fit themselves for the positions of responsibility and leadership which they occupy. It is important that they give a certain amount of time to the reading and study of the technical papers and books which can be of the greatest practical value and inspiration to them. One progressive shop superintendent, recognizing this need, has taken a number of technical books from his own personal library and placed them in a bookcase in the general foreman's office as a nucleus for a circulating technical library for the use of the foremen and workers in the plant. The outcome of the experiment will be awaited with much interest. Will the men make good use of this facility unless some enthusiast gets behind it and encourages the men to make use of it? Will the men become sufficiently interested to cooperate in enlarging the collection to make it comprehensive and also of more particular value to some of the special groups in the organization? Has anyone made a similar experiment? To what extent has it succeeded?—*Railway Mechanical Engineer.*

AUTOMATIC ARC WELDING.—The principles of "Stable-Arc" automatic welding are diagrammatically illustrated in the 24-page bulletin on welding equipment published by the Lincoln Electric Company, Cleveland, Ohio. The carbon electrode process is used with the "Stable-Arc" equipment, a filler rod of mild steel being placed along the seam prior to welding to supply additional metal to reinforce the weld. The time required to make different types of welds on metal of various-gages is given in tabular form.



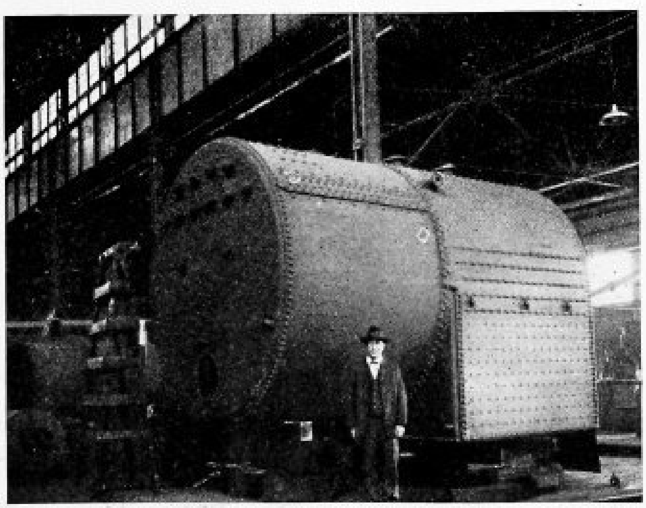
Looking across the Kingsford shop from the west bay, showing wall drills in the foreground

The Kingsford Boiler Shop

Oswego firm builds both Scotch marine and stationary watertube boilers

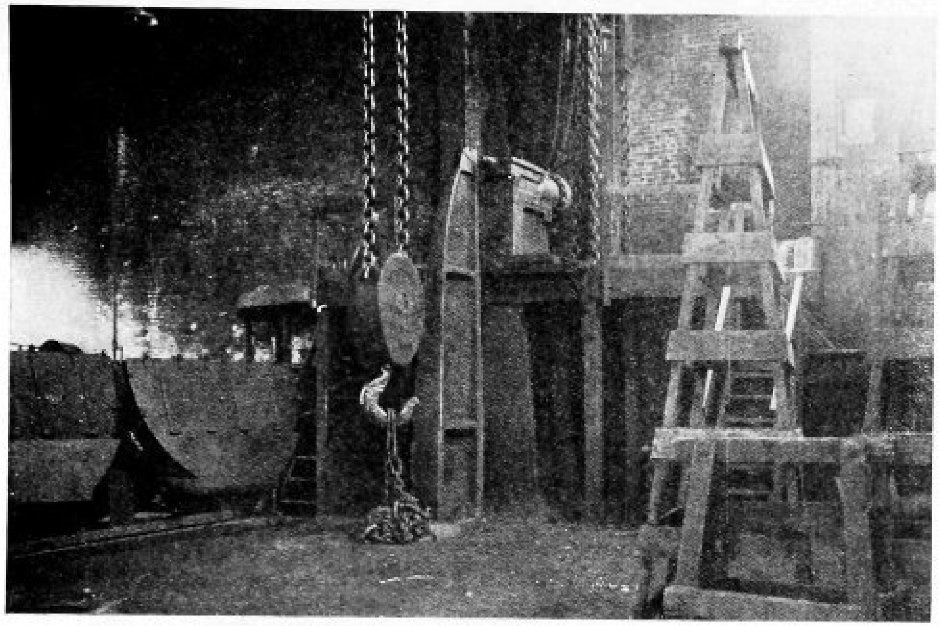
FOR over half a century the Kingsford Foundry and Machine Works, Oswego, N. Y., has been building Scotch and other types of internally fired marine boilers, the majority of which have been shipped to distant ports on the seaboard of the United States for salt water service. That work of this character should be carried on at a point distant from the seaboard indicates at once that the plant which turns it out must be of the highest class and the workmanship of the best. That this is the case at the Kingsford shop is apparent from an inspection of the shop and its products.

The Kingsford boiler shop was originally established in 1869 for repair work but soon entered upon the construction of boilers for the starch factories which at that time comprised the leading industry in Oswego and which were controlled by the Kingsford organization. With the subsequent removal of the starch factories to other parts of the country nearer the sources of supply of raw products the activities of the boiler shop were centered on high class marine work and also more recently upon the manufacture of stationary watertube boilers. The Kingsford firm manufactures two types of watertube boilers—one known to the trade as the Kingsford-Webster sectional watertube boiler which is made in sizes ranging from 100 to 3,000 horsepower and the other the Advance internally fired watertube boiler which is made in standard units of 50 to 250 horsepower.

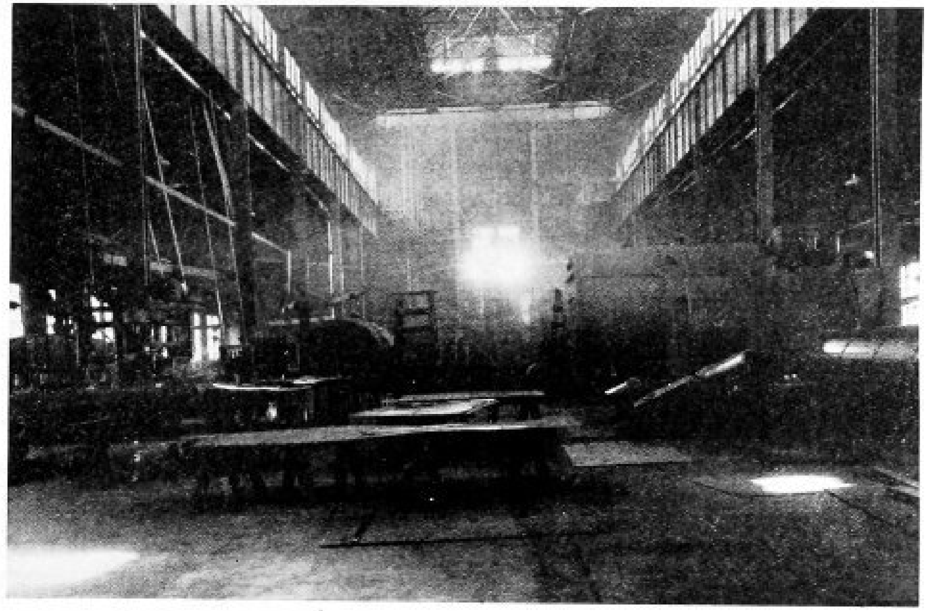


Firebox marine boiler recently completed at the Kingsford shop

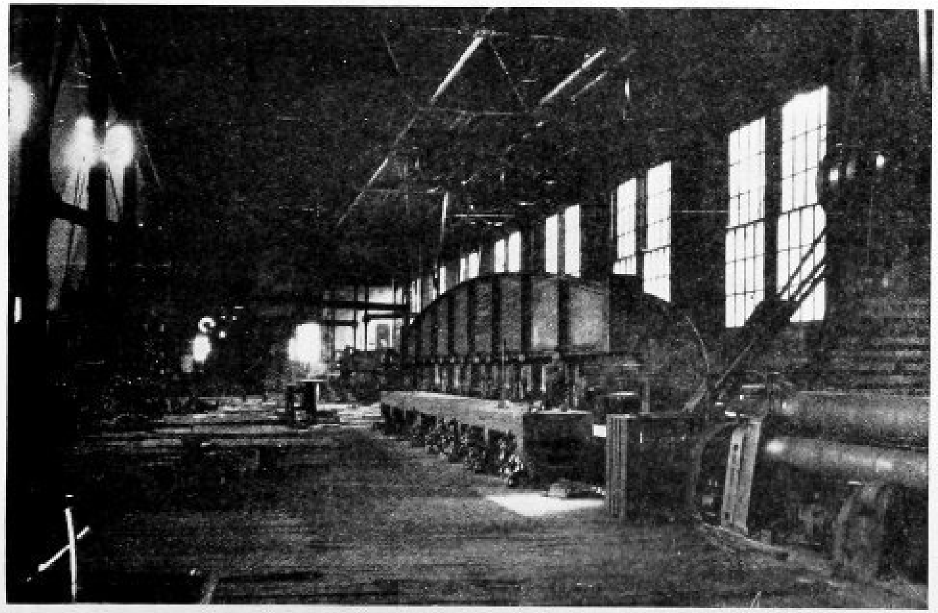
The boiler shop is a steel, brick and glass building, 330 feet long and 120 feet wide divided into three bays; the center bay being 60 feet wide and the side bays 30 feet wide. The center bay is spanned by an overhead electric traveling crane capable of lifting 30 tons. In each of the side bays the material is handled at the fabricating tools by five 21-foot wall cranes equipped with 2-ton chain or pneumatic hoists. Material is received and stored in an extension at one side of the main shop. Steam



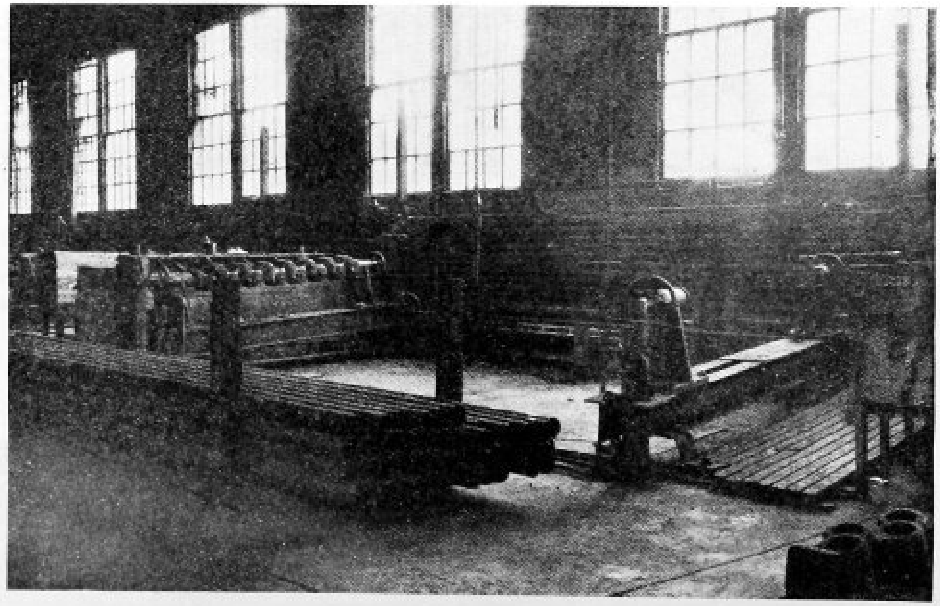
One of the hydraulic riveters



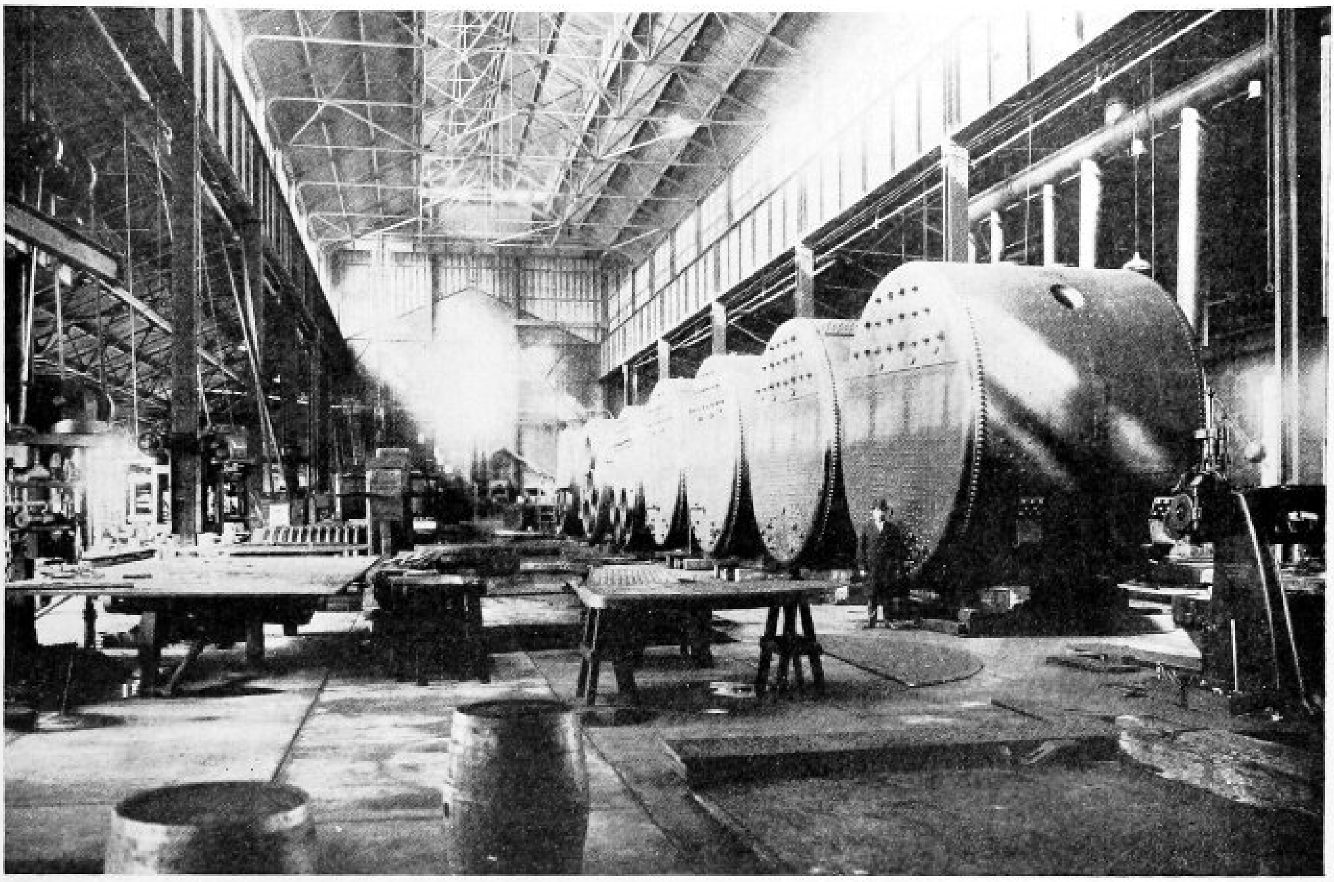
General view of the shop from laying out floor



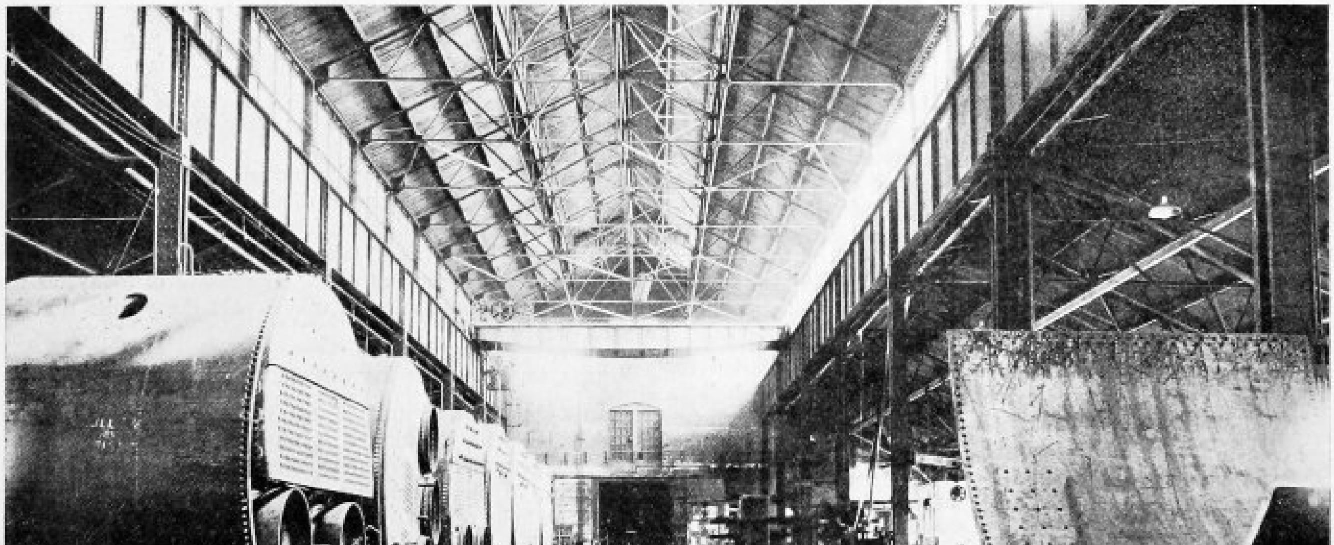
32-foot plate planer



Arrangements for setting up and testing watertube boiler sections



Looking north in the center bay, showing laying out space in the foreground



Looking down the center bay from the riveting tower for operating the plant is generated at 140 pounds per square inch working pressure by two 300 horsepower Scotch boilers built in the Kingsford shop.

Flange Shop

At the south end of the shop and separated from the main shop by a brick wall and fireproof doors is the flanging department. Here the work is handled by two jib cranes each equipped with an Ingersoll-Rand 5-ton pneumatic hoist. The flanging is done on a W. H. Wood 4-column press and a 125-ton sectional flanging machine. A Tate-Jones furnace is installed for annealing the flanged work.

Raw material enters the shop at the south end where it is laid out in the center bay. The material is then transferred to the west bay where it progresses from the south to the north end through the various fabricating operations of punching, shearing, drilling, planing and bending until it arrives at the north end where it is bolted up and riveted.

Fabricating Department

Adjacent to the laying out space and fixed to the columns between the center and west bays are 4 wall drills for general drilling and reaming. At the south end of the west bay are 3 Hilles and Jones punches and shears and a Wangler rotary bevel shear. In the center of the west bay there is a 32-foot Niles-Bement-Pond plate planer and beyond that a set of 10-foot bending rolls capable of bending 5/8-inch plate and a W. H. Wood hydraulic press for bending butt straps and similar work. The shell plates for the Scotch boilers are bent in a heavier set of bending rolls 12 feet 3 inches long located near the north end of the center bay. These rolls are capable of bending plate 1½ inches thick and are driven by a steam engine.

In the riveting department which extends across the north end of the center bay there are 3 W. H. Wood hydraulic riveting machines. The largest is a 125-ton machine with a 12-foot stake; the other two have 10-foot stakes and exert pressures of 80 and 60 tons respectively. Hydraulic cranes are installed for each riveting machine.

The sheet iron work is fabricated at the north end of the west bay which is equipped with a small set of bending rolls, two horizontal punches, a radial drill and an emery wheel for facing cast iron parts such as furnace doors and the like. On the opposite side of the shop at the north end of the east bay are 3 double staybolt cutters.

Watertube Boiler Construction

The greater portion of the floor space in the center bay is kept free for the assembling, erection and final testing of the boilers. In the east bay machinery is installed for performing special operations on the watertube boilers. This includes an Acme threading tool for long stays, two Foote-Burt 6-spindle gang drills capable of drilling 4-inch tube holes in ¾-inch plate. There are also two milling machines for cutting handholes and facing the inside of the holes on the headers of the watertube boilers.

The Kingsford-Webster sectional watertube boilers are built in either the longitudinal or cross drum types. The sections consist of front and rear cast steel headers connected by 4-inch tubes which are staggered. Opposite the end of each tube is an elliptical handhole fitted with a drop forged steel plate to which a clamping bolt is hydraulically riveted. The handhole plate is held in position by a drop forged yoke and nut. The longitudinal drums, of which there may be one or more depending upon the number of sections used in the unit, are connected with the tube headers through cross boxes riveted to the lower sides of the drums at each end. A full sized opening is made in the shell of the drum over the cross boxes so that the entire inside of the shell and the joint between the shell and the cross boxes can be calked. In order to insure a sufficient supply of water to the bottom rows of tubes, this boiler is equipped with special equalizing tubes which, in the longitudinal drum type, are placed in the extreme end of the cross boxes at the rear of the boiler and connected direct with the mud box at the bottom of the headers.

The watertube boilers are assembled in sections. Space is provided in the east bay of the shop where the individual sections are made up and tested separately before being assembled in the boiler.

Personnel

The Kingsford Foundry and Machine Works is a partnership, composed of Thomas P. Kingsford and his son, Thomson Kingsford. In 1891 the late Robert Joy became connected with the firm as superintendent. Mr. Joy made a specialty of firetube marine boilers of all types and remained in the position of superintendent until his death in 1925 or for a period of thirty-four years. His son, Harry E. Joy, is now filling this position and also has charge of the marine department.

Thomas W. Smith is in charge of the sectional watertube boiler department and Fred A. Tebeau is foreman and in charge of construction in the boiler shop.

Progress in Railroad Operation*

By E. V. Williams†

THE boiler and its appurtenances, the main subject of your deliberations, is as we all know the item of first importance in both locomotive design and maintenance, and, since it is of such predominant importance, the subject you discuss and your findings are of supreme value to all who are fortunate enough to attend your meetings as well as to those at home who profit immensely by the reading of your proceedings.

It has been said that if you have a good boiler, flues, etc., you have the major part of the maintenance of an economical locomotive behind you, and I am sure this stands today as an outstanding fact verified by every operating man in the country.

Standing out of particular notice and importance is the locomotive, the moving spirit of these improved and wonderfully efficient railroad transportation results, and we of the Mechanical Department take unusual pride in the achievement of the development of the locomotive of today, as upon its performance depends in major part the results that have been obtained.

Boiler of Greatest Importance in Locomotive Designs

In no particular unit of the construction of the present highly efficient locomotive is any part as important as its boiler. Commencing with the results to be desired in the designing of the locomotive, the boiler is the first importance as the whole of the design is dependent on the type and construction of it, and it is from this that you men assume the more important part in design and maintenance since all the desired results are so dependent on past practical experience. In a general sense most all of the other units of construction can be so designed and operated as to make them practically automatic or fool proof. It is not so with the locomotive boiler where so many contradictory conditions are encountered, many of which are still short of solution despite the study and research that has been made and is still in the making.

Combustion chamber troubles, although partially solved in

* Abstract of address presented at Seventeenth Annual Convention of Master Boiler Makers Association held in Buffalo, May 25-28.

† Superintendent of Motive Power, Buffalo, Rochester and Pittsburg Railroad.

various forms of correction and maintenance, are still unsolved as to cause that will admit of correction in the design. The breaking of staybolts is one that has been and is still with us although corrected to a great extent, and with the drilling of these bolts the entire length we have great promise of vastly corrective measures in the near future, and I am of the opinion that the time is not far distant when the entire installation of staybolts in a locomotive boiler both rigid and flexible will be drilled, throughout the entire length and so eliminate the questionable testing by the hammer and allow of the removal of broken or fractured bolts independent of any other test or at any set time other than the telltale leakage.

Part Played by the Inspector

The boiler inspector is without a doubt the most valuable man in any boiler department organization and one upon whose shoulders rests a heavy responsibility and who must be chosen solely by his ability, experience and reliability and too much importance cannot be given an efficient and capable man in this position in the matter of compensation, to get out of him the fullness of his duties and hold him to the responsibilities of his position.

We have in effect since the year 1911 and amended at various times since and further augmented by interpretations, decisions and orders, the laws, rules and instructions governing the inspection, testing and maintenance of steam locomotives by the Bureau of Locomotive Inspection and I am sure that every one here can attest the assistance and value the creation of this Bureau and its subsequent functioning has been to the officers and employees of railroad properties, as well as to the properties themselves, and the safety to the employees and traveling public.

Many of the exactions of this inspection law appeared irksome and unsurmountable when first put into effect but gradually through the cooperative effort of the bureau and the officers and employees of the railroads the carrying into effect of the provisions of the law has become a matter of routine and practically all who have to do with locomotive maintenance have a better knowledge of its exactions even in detail than the general run of instructions promulgated by the railroad company itself. Too much credit cannot be given Mr. A. G. Pack and his corps of able assistants for the educational and beneficial help they and the bureau have been to all railroads and their helpful attitude toward the many complex conditions that confront the employees and officers in the Mechanical Department and their cooperative efforts in helping to improve and solve such conditions through their investigations and independent research.

I am satisfied, however, that there is not a railroad in the country which does not agree with this and I doubt if either railroad or railroad employee would advocate any change backward in the inspection law or its organization.

Training of Apprentices

The list of subjects presented and discussed at your meeting this week are typical of this association wherein I believe you have taken up those which are the most vital and important of any that confront the locomotive boiler situation today, yet I would recommend for your consideration at your next meeting a subject that seems to me to be of unusual importance, more so when viewed in the light of circumstances from 1917 to the present date and that is "Training of Boiler Maker Apprentices." The matter of the correct, in fact, an intensive training of apprentices in this particular line has at various times received consideration but not in my opinion along definite and well defined lines that should bring about results that must be accomplished.

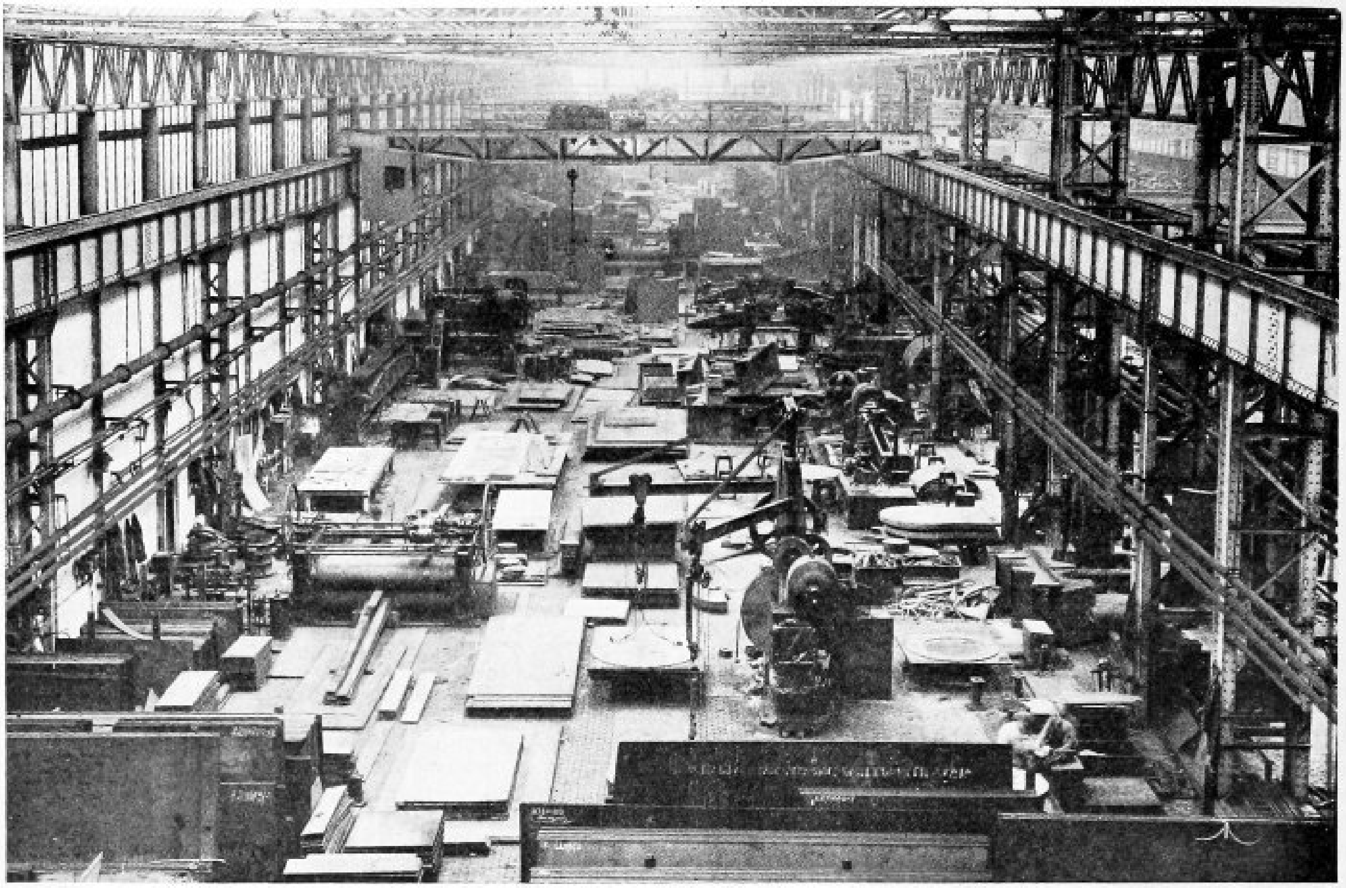
To begin with but very few boys seek apprenticeship in boiler work. It is hard, mostly physical either with or without the pneumatic tool, the work has not the attraction that the machine tool has and a fact that must be considered in this connection is that the chances of a capable machine tool operator are approximately ten to one of obtaining a position in a community to the chances of one skilled in boiler work. Therefore to attract boys to this work, not only the work but the rate of pay and the sure and advanced training in the work in all its branches must be assured to the entrant and such intensive and thorough training be made one of systematic program by instruction and explanation and actual experience.

The old-fashioned theory of making mysterious the art of flanging, laying out and fitting up is a worn-out policy and a detriment to any organization, and to depend on any one man for any of these three occupations simply and solely because he is accurate, able and entirely dependable is dissipated when one resigns, dies or possibly bids off the job and it is found that there is no runner up. I believe this condition will be found in more cases than one and if the entering apprentice can be assured of an all-around training in this work and the compensation made also attractive, I doubt if there will be a dearth of applicants nor any difficulty of keeping the quota full and providing the organization with ever increasing number of fully qualified boiler makers able to pick up any job in his line or at least 80 percent of them.

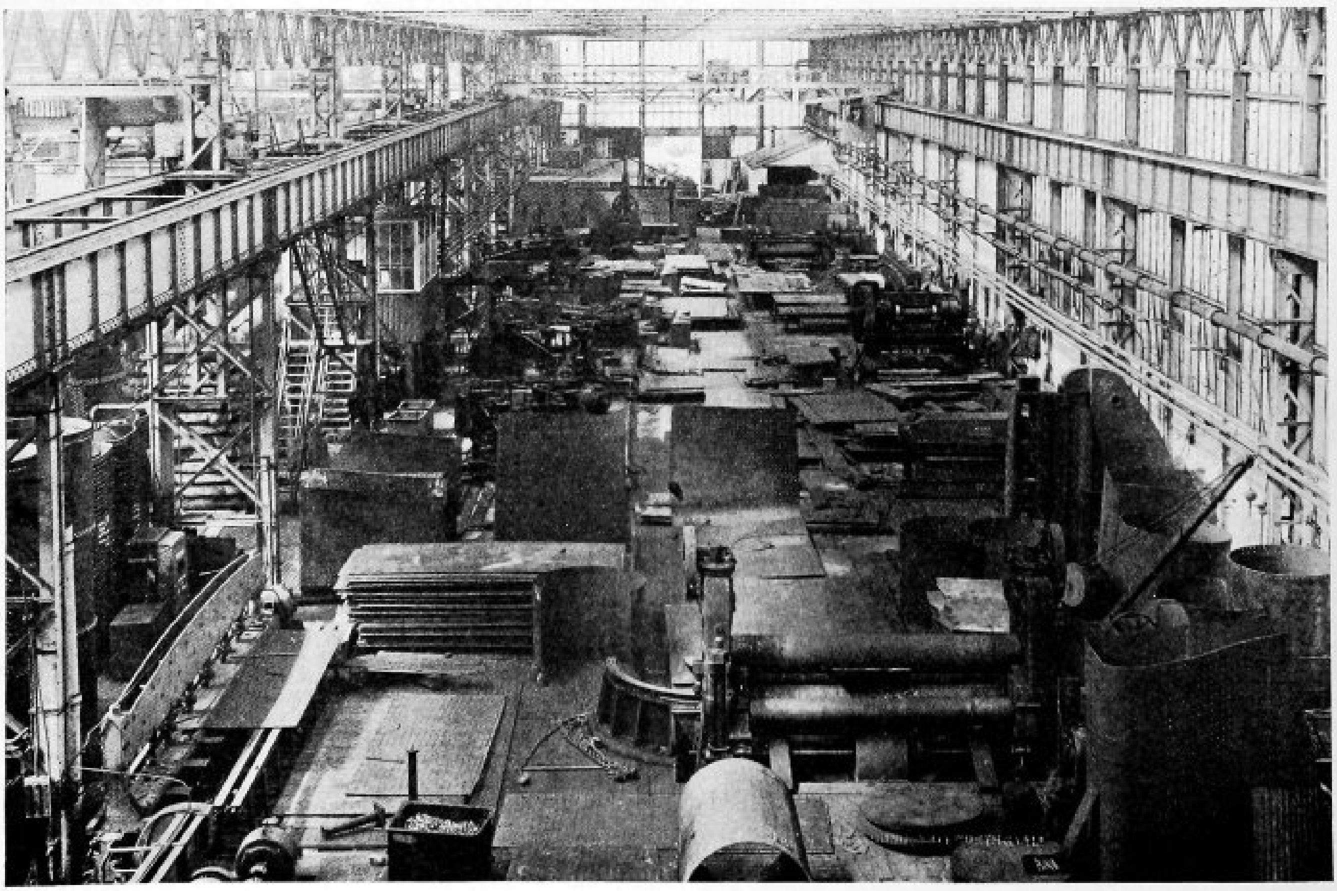
Supervisory Staff

One more thought in closing and that is the supervision. The average supervising officer today from the highest to the lowest in rank is confronted with problems that twenty years ago would have staggered him, changes in methods, in the labor situation and conditions in all directions have changed so radically that the duties of supervision have had to undergo proportionally the same changes, and adapt themselves to these conditions in handling the work and the men they supervise. The transition of the average supervisor in the last few years from one of almost if not entirely an executive function to an interpreter of regulations, rules and working conditions, a regulator of men mentally as well as productively, and instructor and a combination of all kinds of duties and responsibilities have added immensely to their exactions, still they are giving their best efforts and their inventive ability in reducing costs and increasing production and in general ever alert to devising ways and means that make for economy and efficiency. They are confronted not only with men who still have war wages and conditions on their minds but the propaganda of others and so conflicting are these conditions that at times an employee is unable to see where he is at and it therefore is necessary that every supervising officer acquaint himself fully with the mental attitude of his men as well as their physical ability and by studying conditions himself study his men, learn their peculiarities, desires and trials, be solicitous for their welfare and always courteous and civil in his attitude toward them.

Quoting an excerpt from the remarks of one of the foremost industrial executives in this country: "Employers are now learning to select for promotion employees who have a tonic effect, an inspiring and cheering effect upon others." Leadership of this type is essential and has a marked effect on the rank and file and can but have the resultant effect of not only making a valuable official but the making of a high type of manhood whose efforts and association with cannot but help to inspire others who come in contact with him. It is a known fact that any man appreciates more things that are done for his benefit when done voluntarily than as an aftermath of acute, irritating or discouraging conditions and as the ways of the world today call for deeds and results rather than promises and ideals in printed form you will find actual performances are more productive in the long run.



General view of Scotswood boiler shop, north bay, looking east

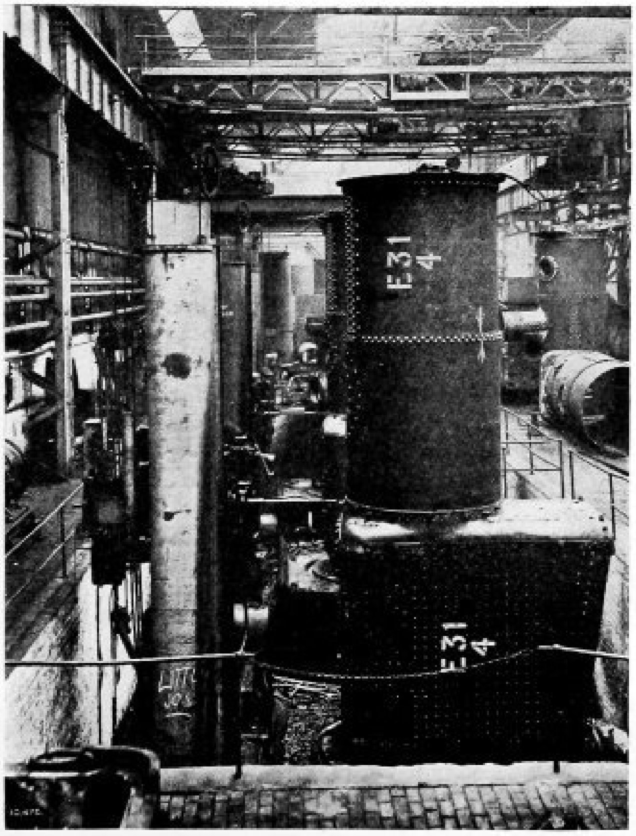


Looking to the west in the north bay

Locomotive Boiler Work in a Modern British Shop

Methods employed at the Scotswood Works of Messrs. Sir W. G. Armstrong, Whitworth & Company Limited

By F. G. Bailey



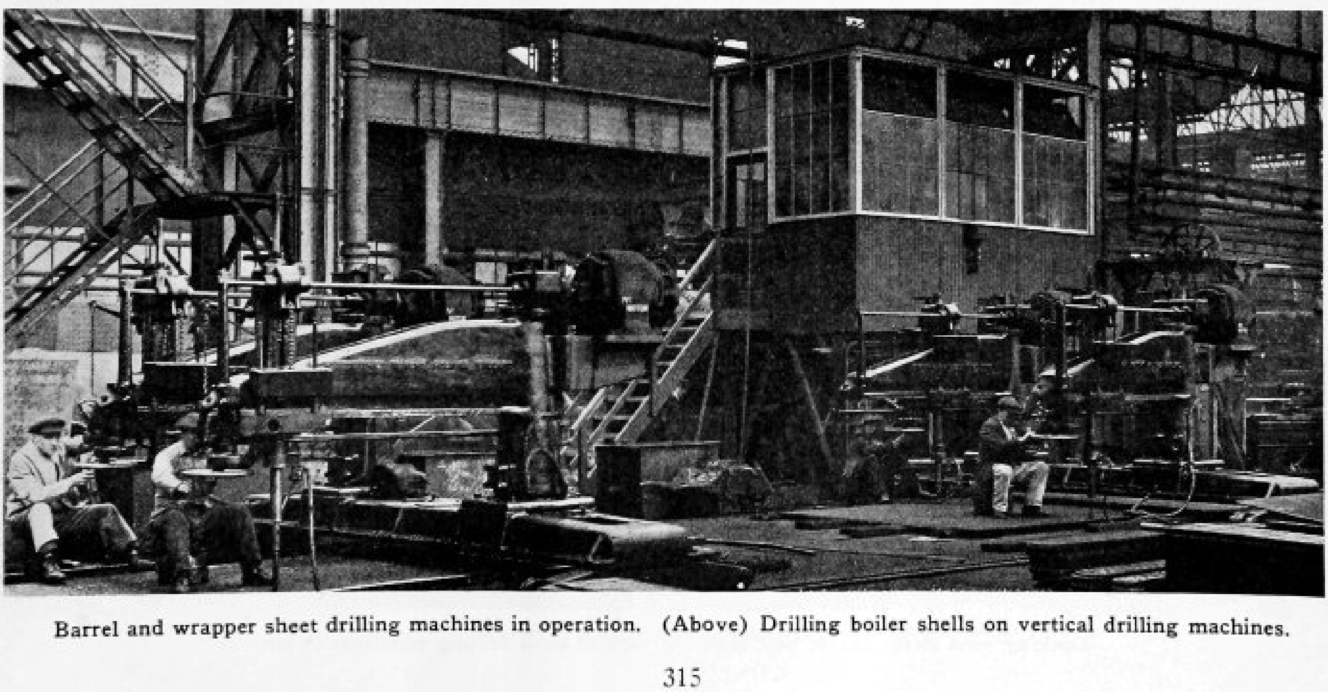
ONE of the best equipped locomotive plants in Great Britain is undoubtedly the Scotswood Works of Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, at Newcastle on Tyne, England. Used during the late war for the manufacture of enormous quantities of shells, cartridge cases and fuses, this plant was completely reorganized and equipped at the end of 1918 for the building of locomotives. So expeditiously was the work carried out, that the first locomotive, a heavy main line 0-8-0 engine with a six wheeled tender for the North Eastern Railway of England was completed and steamed on the anniversary of the Armistice, November 11, 1919. Since that date a large output of locomotives (the greater part of which has been for service abroad) has issued from this plant.

The boiler department of the Scotswood Works, to which these notes specially refer, is of interest as being one of the most modern and efficient establishments for high grade boiler work to be found in any part of the world. The shops of this department are situated at the east end of the Elswick Works, close to the old shipyard and parallel with the River Tyne. As the accompanying illustrations show, the works' buildings are of steel and glass construction and possess all the advantages that modern methods of building can provide.

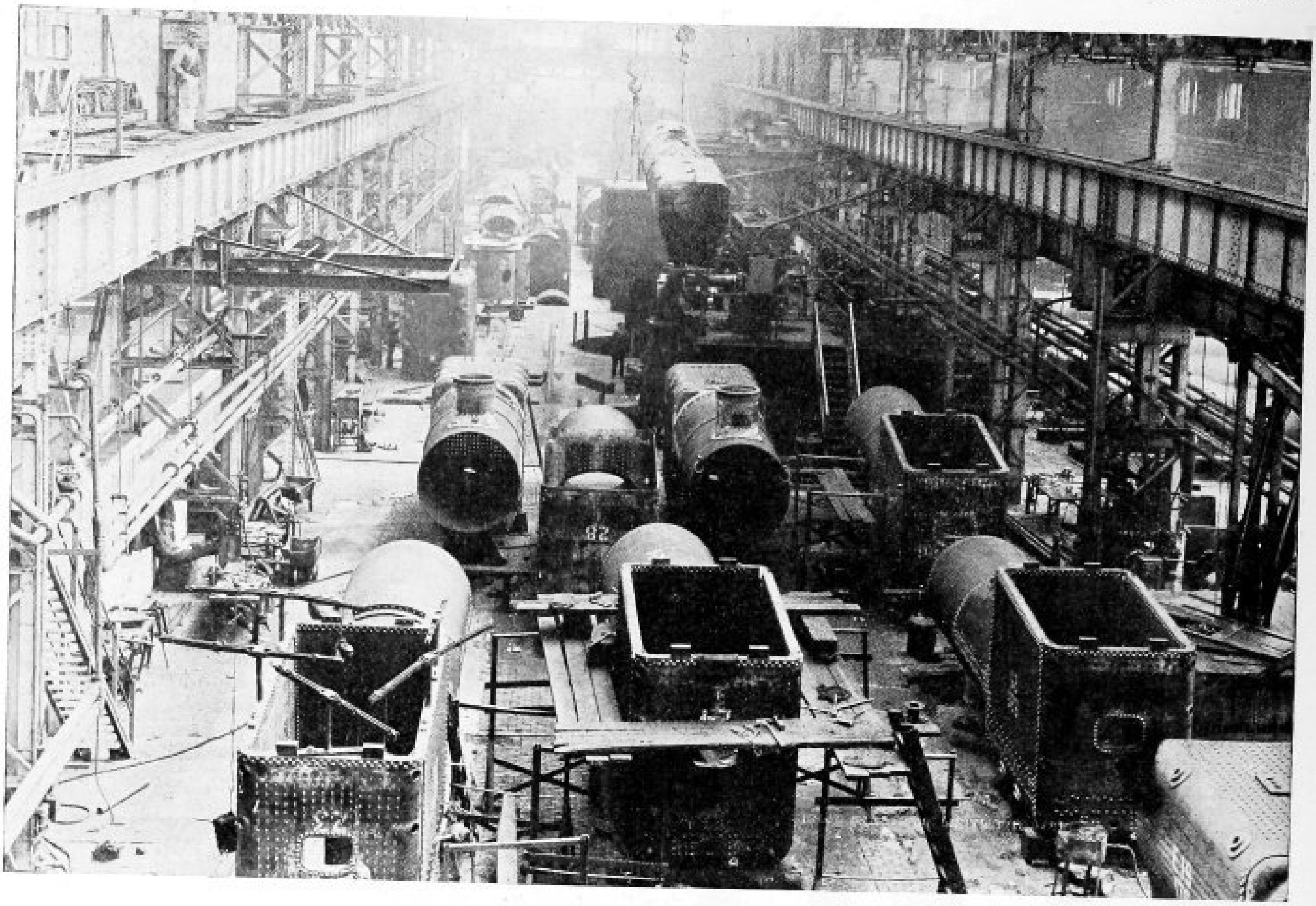
In addition to excellent natural lighting, an efficient system of general artificial illumination is provided, so that at all times ample lighting is available. It may be noted that particularly complete and adequate heating, ventilating and sanitary arrangements have been installed through the works, in order that a maximum of comfort and convenience may be provided for the men employed.

Arrangement of Boiler Shop

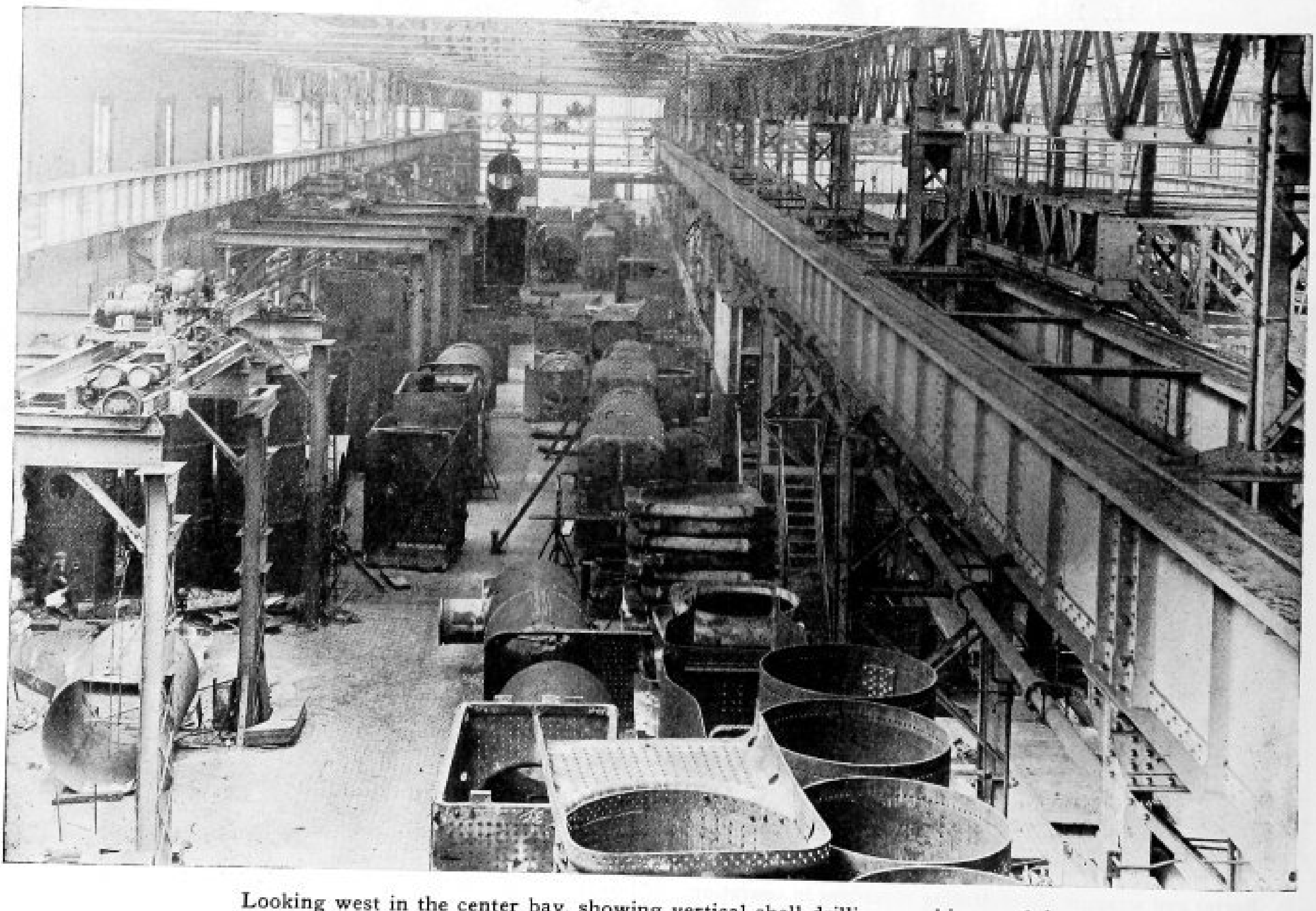
In general, the main boiler shop is located under one roof, but it is divided into three bays, each devoted to special processes in the scheme of production. Besides the main shop, there are, of course,



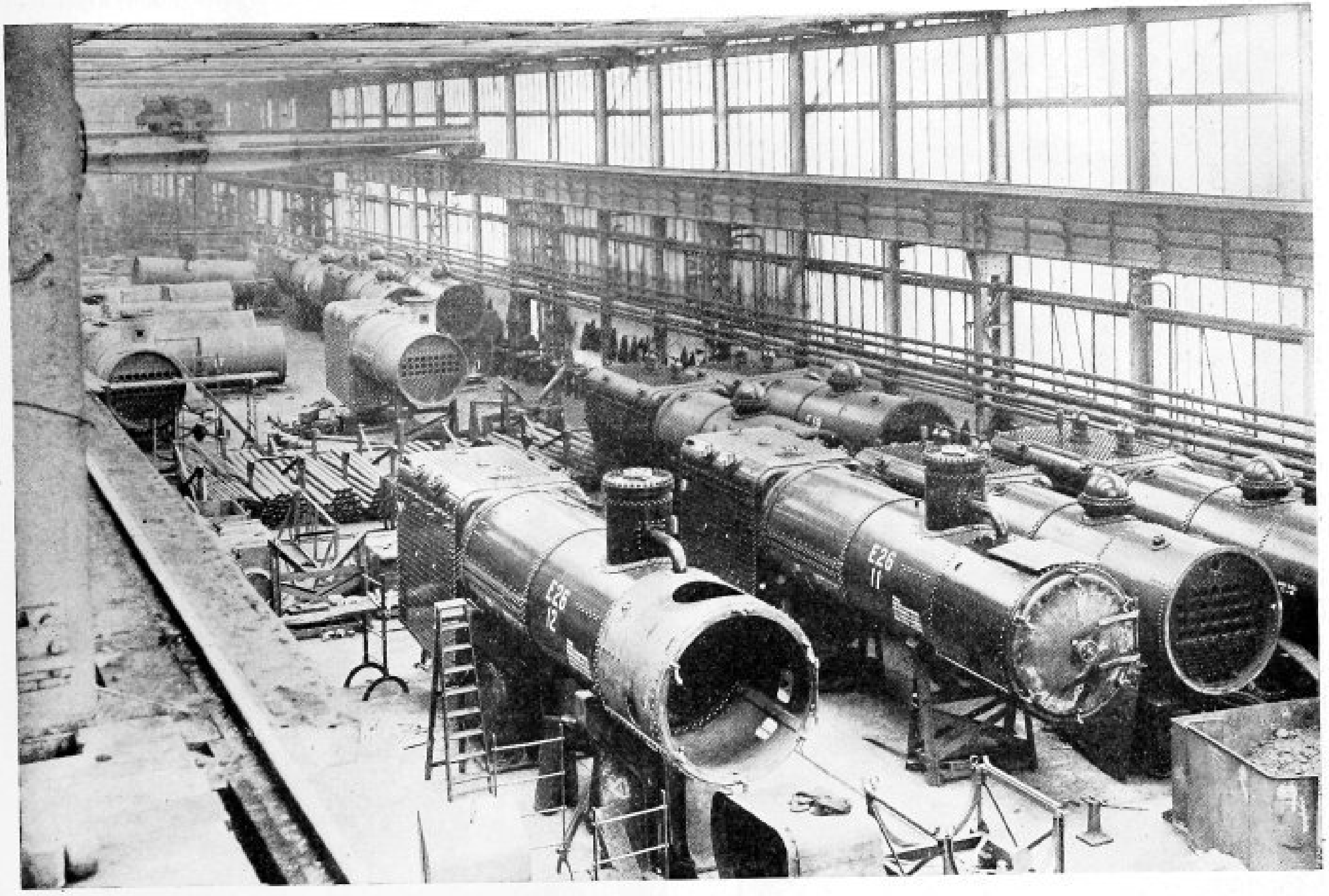
Barrel and wrapper sheet drilling machines in operation. (Above) Drilling boiler shells on vertical drilling machines.



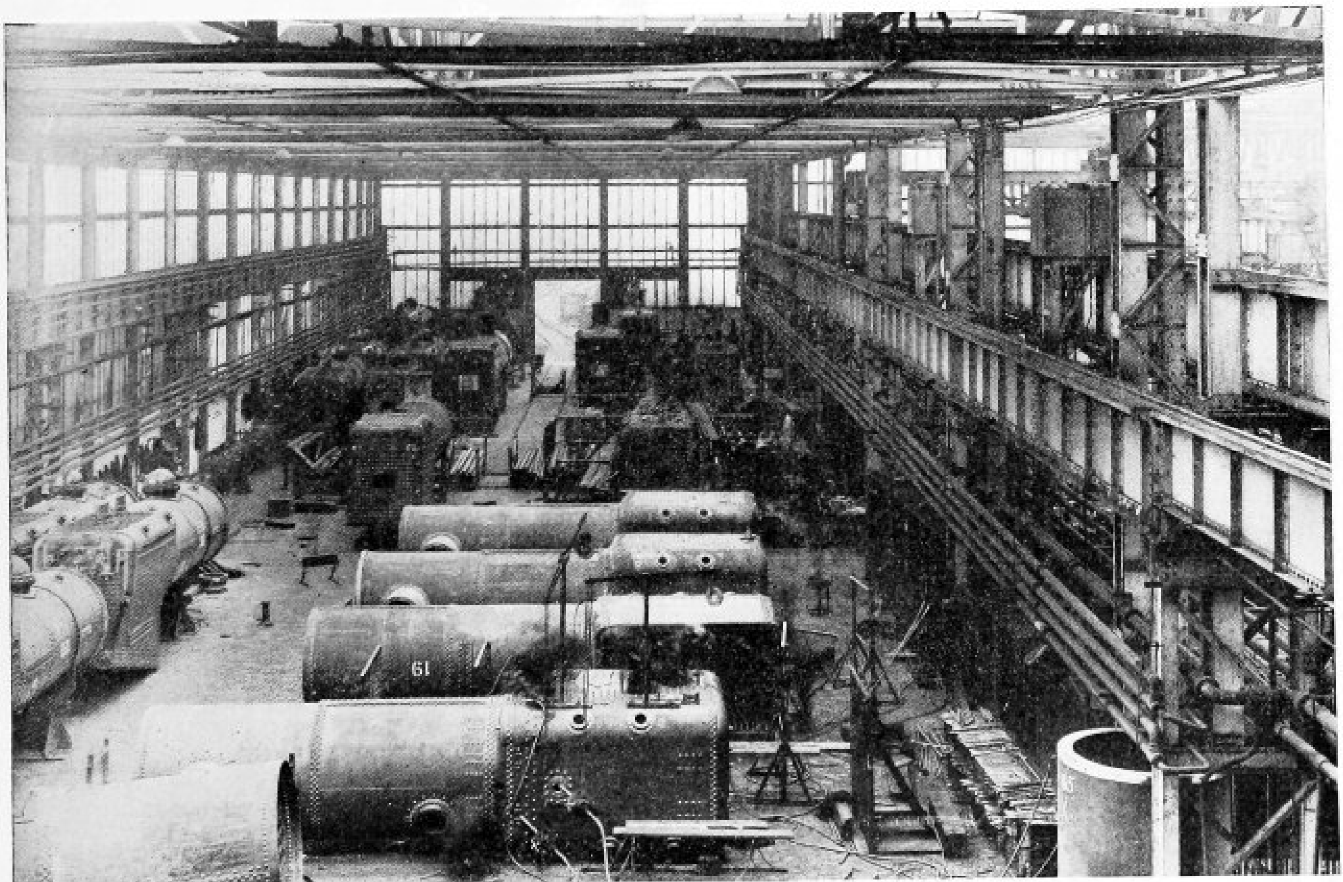
Center bay of boiler shop, looking east



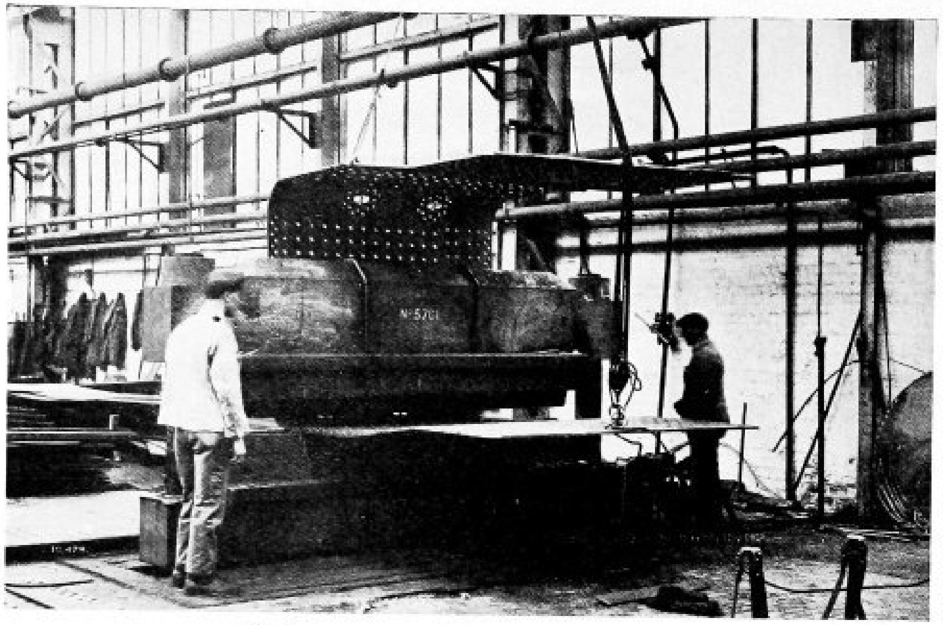
Looking west in the center bay, showing vertical shell drilling machines at left



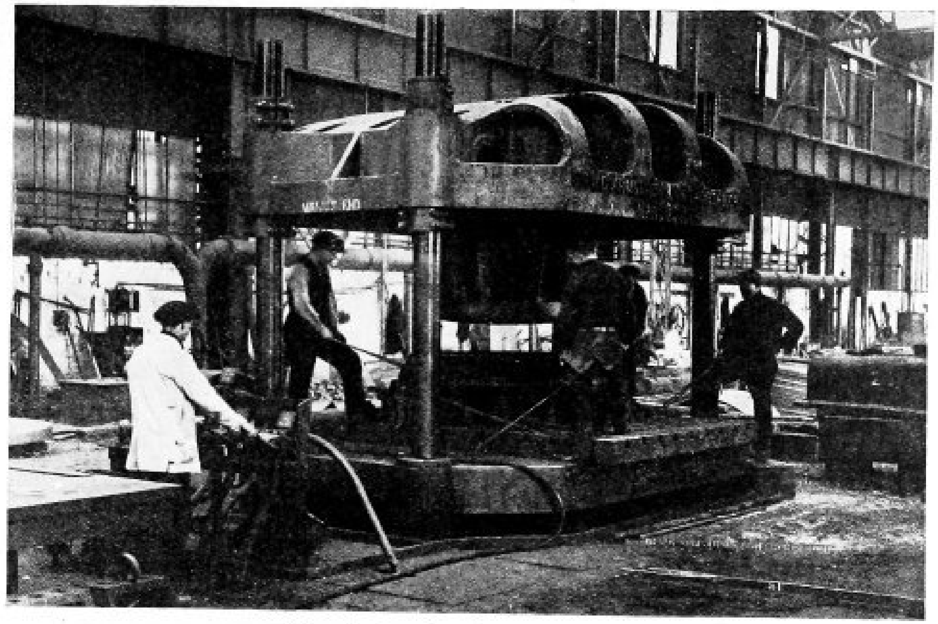
Boilers nearing completion in south bay



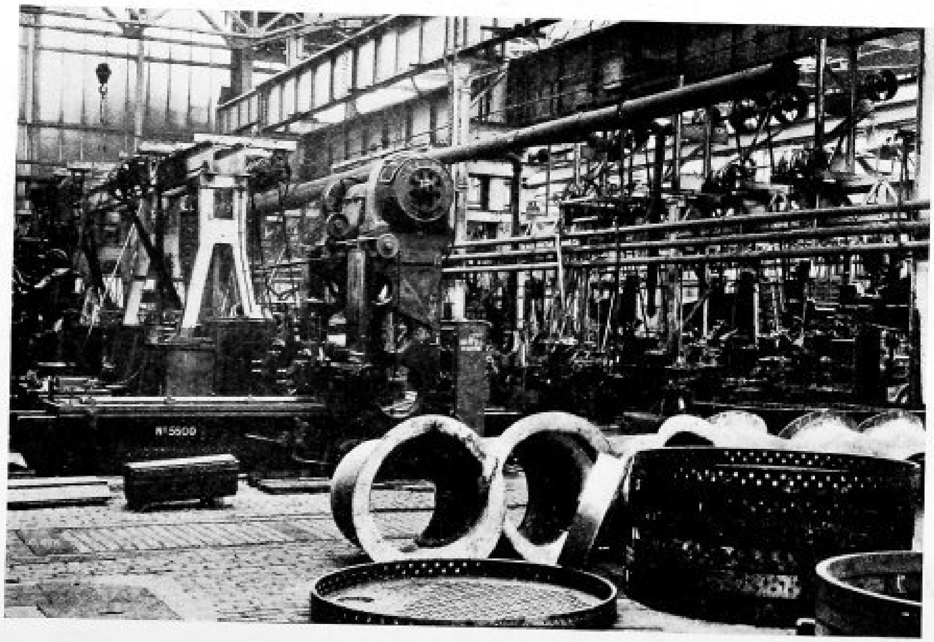
South bay, view looking west



Firebox wrapper sheet bending operation



View in the flanging department



A corner of the machine tool section

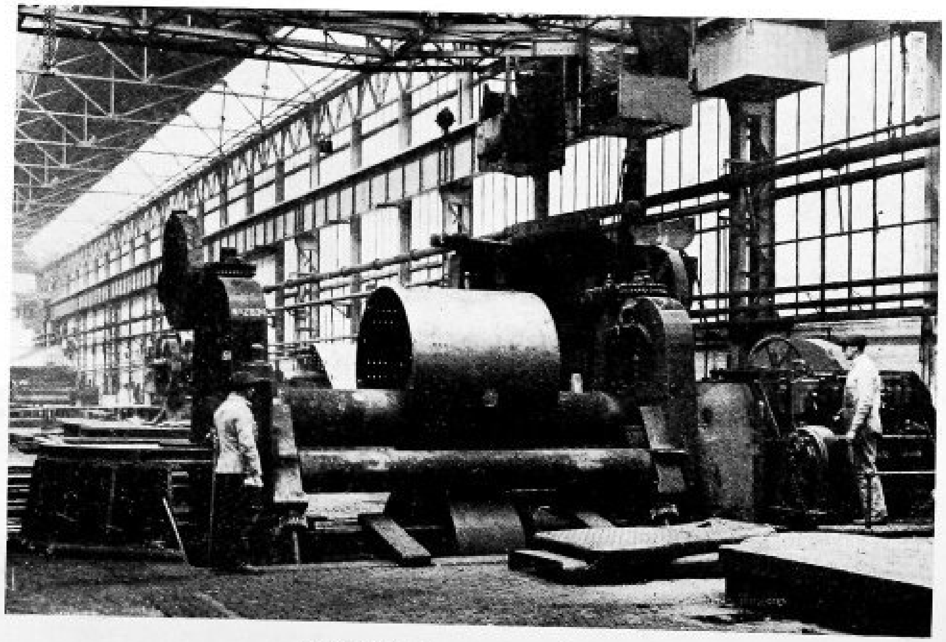
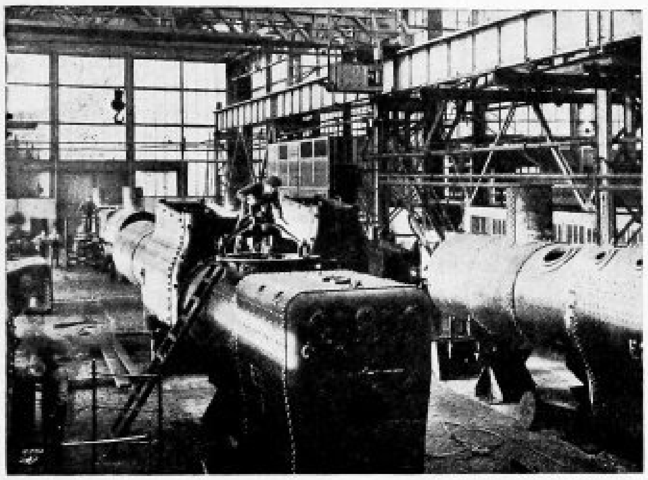


Plate rolls for wrapper sheets

numerous subsidiary sections engaged upon various items of equipment such as casting, special tools, etc. The main shop and the subsidiary departments cover altogether a floor area of approximately 150,000 square feet.

Some idea of the layout of the machinery and equipment of the various departments generally may be gained from the accompanying illustrations, which show the three bays constituting the main shop. The organization and equipment of these is singularly complete, as will be realized when it is mentioned that the average output comprises fifty main line locomotive boilers per month. While the normal number of employees is about a thousand.

The layout of the shops is such that new material enters at the west end of the north bay and then follows a horseshoe course through the different departments in regular order of manufacture. Throughout the various manufacturing operations the material follows a regular course



Portable dome ring facing machine in operation

through the departments, and, generally speaking, does not deviate from it.

Twenty overhead electric cranes, of varying capacities, make for quick and efficient handling and transportation of the plates and partly finished boilers. Over 200 machine tools have been installed, incorporating the most modern types suitable for locomotive boiler manufacture. In this connection it may be noted that the boiler shell drilling machine and hydraulic flanging presses employed were constructed by the machine tool department of Messrs. Sir W. G. Armstrong, Whitworth & Company's Openshaw Works. The flanging presses installed work in conjunction with the modern furnace equipment and electric charging machines, the installations being sufficiently powerful to enable the largest Belpaire throat plates to be flanged in a single heat.

Excellent Machine Tool Equipment

For shell work, four large hydraulic riveting machines are employed, the largest of which has a gap of 27 feet. In the smithy or forging department, a further press has been installed for the welding of firebox foundation rings and similar work.

Compressed air pipes are laid through the entire plant, and are largely utilized for riveting, calking, drilling, tapping and chipping operations. All of the pneumatic tools employed are of the firm's own design and manufacture and numerous special devices are used for conveniently supporting the tools while at work. Gages, jigs and templates are employed to the fullest possible extent in the construction of the boilers, in order to ensure accuracy and interchangeability. By these means unnecessary adjustments of pipes and fittings are eliminated when the boiler is being assembled in the engine frame.

A general view is shown herewith of the eastern section of the north bay, where the operations in connection with laying out the sheets take place. In this department also the plates are drilled and punched, and pass through the various operations of shearing, planing and bending. From the north bay the plates are transferred to the center section, where they are assembled and riveted up.

In the general view of the main bay, the boilers may be seen in the course of being tapped and stayed. In the center of this illustration are two shells in position on the hydraulic riveting machine. A subsidiary section of the main shop is fully equipped with modern machinery for the production of copper firebox stays and similar components.

At the western end of the southern bay, boilers are finally erected and completed ready for testing; and in the assembly of the numerous components parts in this section, various jigs, tools, and gages to ensure accurate alinement in the correct positioning of the pipes and fixtures are employed to considerable advantage.

Testing pits, located at the west end of the southern bay, provide for the testing of four boilers simultaneously. Underground flues are used to carry away the smoke and products of combustion to a stack outside the shop. It may be noted that the testing pits are within 200 yards of a deep water pier, where large cargo vessels can readily be berthed. The dock is equipped with a hydraulic crane capable of carrying loads up to 150 tons so that the boiler department is excellently situated for making overseas shipment. Its transport facilities in other respects are also particularly good, as rail connections and roadways are also provided to give convenient access to all parts of the works.

In any establishment of this character manufacturing difficulties are by no means simplified by the varying designs that have to be produced, often under extremely competitive conditions. Messrs. Armstrong, Whitworth have successfully overcome any troubles in this direction by arranging the layout of the shops and equipment in such a manner that each major operation or manufacturing process is carried out in a separate section. By this means the many advantages of specialization are secured, not the least important being the fact that special work may be handled without causing any dislocation of the ordinary routine.

This firm recently completed an order for 200 spare boilers that were urgently required for locomotives out of service on account of boiler defects. Especially quick delivery was essential and for a considerable period a weekly output of thirteen boilers was maintained.

Evan J. Parker, formerly of the Morgan Engineering Works, Alliance, Ohio, has joined the forces of the Northern Engineering Works, Detroit, Mich., makers of the Northern line of material handling equipment such as electric and hand cranes, electric and air hoists, foundry equipment, etc. Mr. Parker will have charge of the sales promotion division.

The Air Reduction Company, Inc., New York, has acquired all the assets of the Dayton Oxygen and Hydrogen Products Company, Dayton, Ohio, thus adding another plant to the chain of 52 plants and 169 warehouses that guarantees prompt service to Airco customers throughout the United States. The Dayton plant will furnish a new production and distributing point for the Air Reduction Sales Company to service customers in the southwestern section of Ohio with Airco high-purity oxygen and other gases used in welding and cutting. The plant went into operation under Air Reduction management October 15.

A Chart for Dished Head Computations

THE diagram herewith was prepared by Inspectors Wm. H. Cannon and W. F. Reisch of the Pittsburgh Department of the Hartford Steam Boiler Inspection and Insurance Company, primarily for use in computing allowable pressures for boilers as determined by the construction of the heads. The diagram is based upon the A. S. M. E. Boiler Construction Code formula for determining the thickness of plate required:—

$$t = \frac{5.5 \times P \times L}{2 \times TS} + 1/8$$

t = thickness of plate, inches.
P = maximum allowable working pressure, pounds per square inch.
L = radius to which the head is dished, inches.
TS = tensile strength, pounds per square inch.

This formula is for unstayed heads in which the head is a segment of a sphere with the pressure on the concave side, in other words a plus head. For minus heads—heads dished inward—the formula is modified so that the allowable pressure is but 60 percent of that allowed on a plus head of the same dimensions. This has been provided for in the accompanying diagram by separate pressure scales for plus and minus heads. The scale for minus heads is a great convenience but it should be noted, when reading intermediate pressures, that each division represents 1.2 pounds, a rather unusual value. It results, however, from taking 60 percent of 2 pounds, the value of each division on the scale for plus heads. The chart was designed for boiler steel using a value of 55,000 pounds per square inch for the tensile strength.

The method of using the chart is simple. To obtain the maximum pressure allowed by the head construction of a boiler, start at the bottom of the chart on the left. Select a point on this scale representing the diameter of the head and follow up this vertical line until it intersects the curve corresponding to the height of the bump. (If the curve representing the height of bump is to the right of, and does not intersect, the vertical line, then stop at the intersection with the sloping line marked 80 percent.) The horizontal line intersecting at this point gives the value which should be considered as the radius of the bump. Following this horizontal line to the right until it intersects the curve corresponding to the head thickness, and then following down the vertical line passing through this intersection point, the allowable pressure is given by the proper scale at the bottom on the right. There are two scales for allowable pressure, one for plus heads and one for minus heads, the latter giving values 60 percent of the former, as explained above.

For heads with a manhole, use the curve for thickness 1/8-inch less than the actual thickness.

The solution of a sample problem may make the use of the diagram more clear. Let us assume that a safe working pressure is to be determined for a boiler drum having a plus head 54 inches in diameter with an 8-inch bump and made of 5/8-inch plate. Fig. 2 shows the course to be followed in solving this problem. Starting with point *A* at the bottom on the left, we follow up the 54-inch diameter line to point *B*, the intersection with the curve marked h = 8 inches. Following across the horizontal line through this point (which on the large diagram shows the radius of curvature of the head to be 50 inches) to point *c*, where it intersects the curve marked t = 5/8 inch, then down the vertical line to point *D* we find the maximum allowable pressure based on the assumed head construction to be 200 pounds.

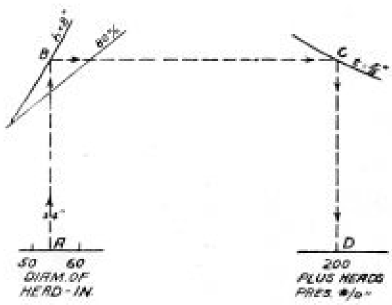


Fig. 2

Had this been a minus head, we would have read the answer on the lower pressure line of the chart, which would give 120 pounds.

Had there been a manhole in this head, we would have stopped at the curve marked t = 1/2-inch and followed down to find our answer to be 151 pounds for a plus head.

The Locomotive.

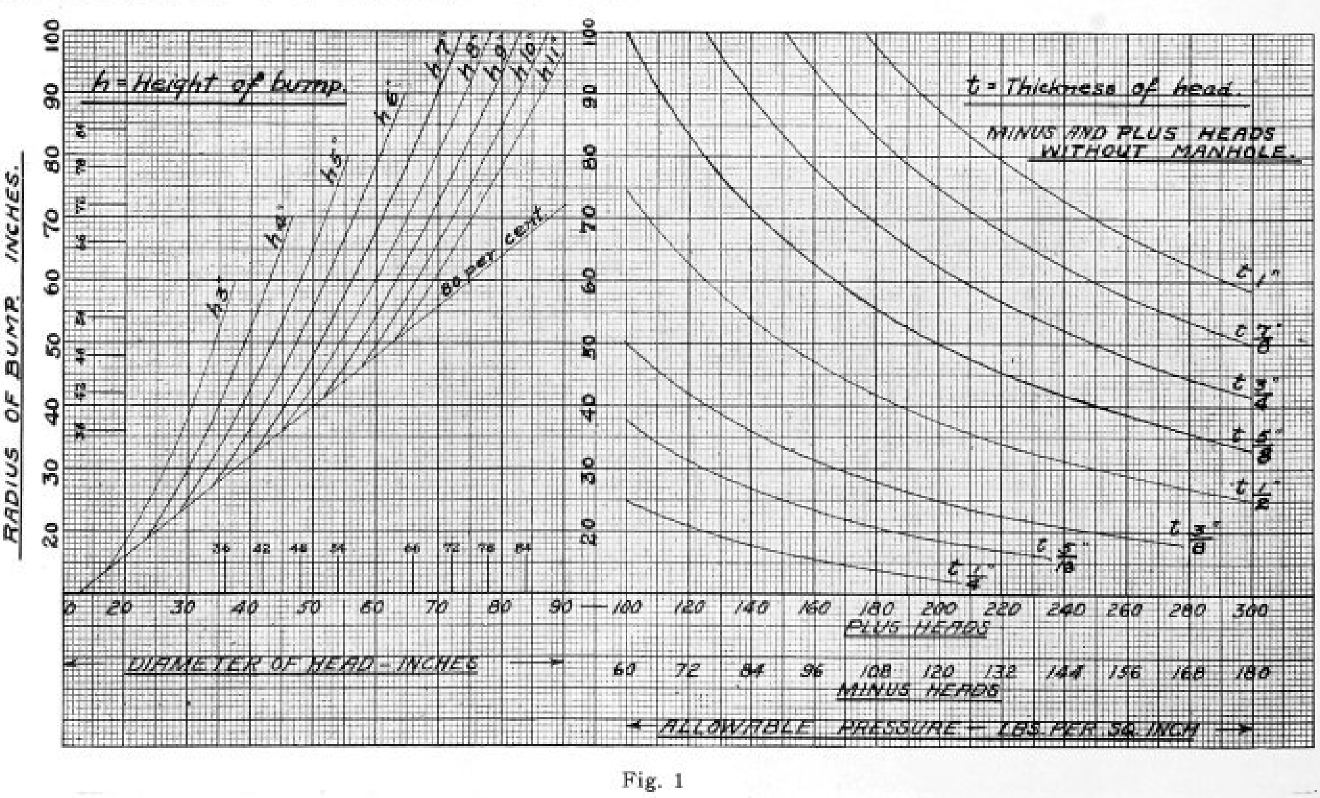


Fig. 1

Recommended Standing Practices and Standards

Action taken at annual meeting of Master Boiler Makers' Association on fusion welding practice

At the 1925 meeting of the Master Boiler Makers' Association, held in the city of Chicago, a standing committee was appointed for the purpose of investigating thoroughly the question of autogenous welding as applied to steam pressure boilers.

It will be remembered that the following action was taken upon the report of the previous committee on autogenous welding.*

Approved Without Amendment

Sections 1, 3, 4, 5, 9, 11, 19, 20 and 21.

Amended and Approved

Sections 2, 16 and 22.

Stricken Out

Sections 8 and "E" of Section 11.

Referred to Standing Committee

Sections 6, 7, 10, 12, 13, 14 (after amendment), 15, 17 and 18.

In connection with the sections referred to your standing committee the following recommendations are submitted:

Section 6. Welding of Fireboxes: Fireboxes of internally fired boilers, which have the plates properly stayed, may be welded subject to the restrictions provided in the clauses following:

Recommendation: Since this section does not provide any specific rules of practice, and since the subject of welding in fireboxes is thoroughly covered in subsequent sections, this section seems unnecessary, and, therefore, should be omitted.

Section 7. Welds in Firebox Crown Sheets.

Recommendation: It has been our experience that the use of autogenous welding in any part of the firebox is within good practice; therefore no limit should be prescribed restricting the location of such welds within the firebox.

Section 10. Welds Made on One Side Only.

Recommendation: When firebox sheets are welded from one side, the seams may be formed by either "V" welding or lap welding as determined by the requirements of local conditions.

Section 10. Clause "A."

Recommendation: The subject covered by this clause is covered by Section 7, and since it is, therefore, unnecessary, it should be omitted.

Section 12. Clause "A" Fire Cracks. Cracks in firebox seams of stayed boiler surfaces which extend from the edge of the plate to a rivet hole, may be autogenously welded provided the rivet is removed and the crack is properly "V'd" and welded through the depth of the plate. The rivet holes should then be reamed out before the rivets or screw plugs are reapplied.

Section 12. Clause "B."

Recommendation: Where cracks develop in firebox sheets between staybolts and extend in length between three or more staybolts, or where there are other cracks adjacent, a patch should be applied.

Section 12. Clauses "C," "D" and "F."

These clauses are better covered by appended recommendations and should be omitted.

Section 13. Sand Holes.

Recommendation: Approved in its present form.

*Original report of committee appeared on page 257 of the September, 1924, issue of THE BOILER MAKER.

Section 14. Staybolt Heads. This section is better covered by appended recommendations and should be omitted.

Section 15. Calking Edges.

Recommendation: Calking edges may be reinforced against leakage by autogenous electric welding where desired in fireboxes and on shell sheets and stayed surfaces only.

Section 17. Clause "A."

Recommendation: This should be omitted, as it would be governed by the requirements of local conditions and should remain optional.

Section 17. Clause "B."

Recommendation: In the application of part back flue sheets, the edge of the sheet, beveled for welding, should be located, where possible, not less than one inch from tube holes. However, where the firebox is of the combustion chamber type it is not considered advisable from an economical standpoint to apply a part sheet or patch except where the area involved is located at the top of the sheet.

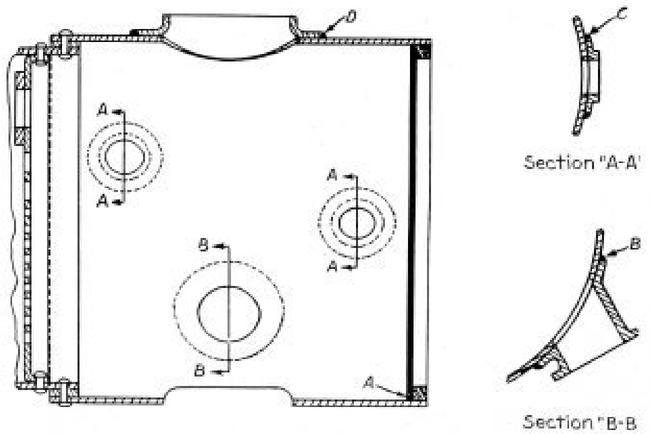


Fig. 13

Section 17. Clause "C."

Recommendation: Where the bridges between tubes are broken, the tubes in that section may be removed and the cracks "V'd" out and welded, provided no more than three bridges are cracked within the area of a 12-inch circle in which case this area should be replaced at the first opportunity.

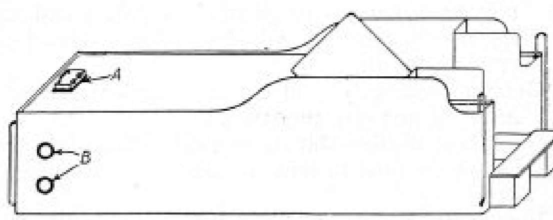


Fig. 14

Section 18. Holes.

Recommendation: In stayed surfaces only, holes of 1¼-inch diameter may be closed by welding solid. Larger holes of not more than 3½-inch diameter may be closed by applying a reinforcing plate on water side, with a lap of no more than ½ inch nor less than ⅜ inch, and filling in the hole to the original thickness of the plate.

In addition to the above, your committee has prepared for your consideration, the following list of "Don'ts" to be observed in connection with the practice of autogenous welding:

1. Don't autogenously weld or fill in pitted and grooved parts of boiler back head, outside sheets and throat sheets which have penetrated more than one-third of the original thickness of sheets or plate.
2. Don't autogenously weld upon heads of rivets, staybolts, radial stays or crown bolts.
3. Don't autogenously weld arch tubes or water bar tubes.
4. Don't autogenously weld new ends on tubes while tubes are in boiler.
5. Don't autogenously weld longitudinal cracks in boiler tubes if crack extends beyond water side of sheet.
6. Don't autogenously weld any boiler braces or stays.
7. Don't autogenously weld any portion of steam dome.

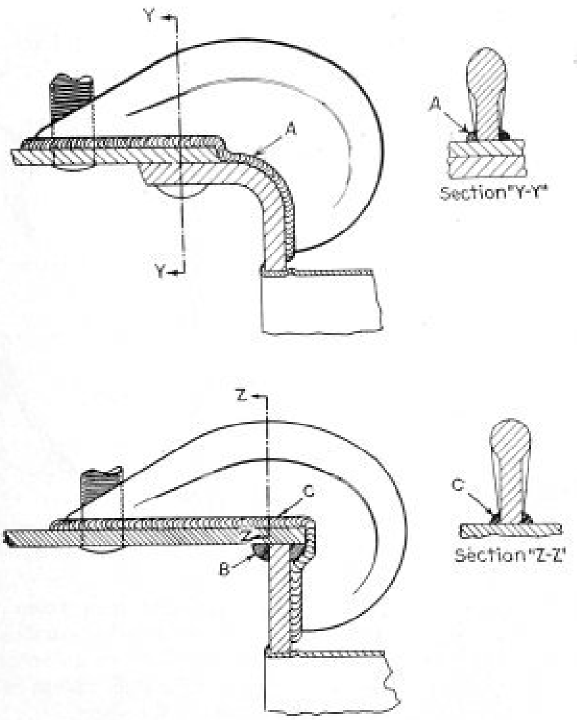


Fig. 15

8. Don't autogenously weld any part of boiler barrel sheets (except at end of seam under butt strap to prevent leakage or for similar purposes) and welding should never be substituted for a riveted joint or part thereof.
9. Don't autogenously weld any crack or seam unless the metal is properly prepared.
10. Don't heat flexible bolt sleeve caps with an oxy-acetylene blow pipe to remove same, it is very dangerous.
11. Don't autogenously weld defective steel air reservoirs.
12. Don't autogenously weld cracks in knuckles of boiler back heads or throat sheets without protecting the weld with other construction.

In conclusion your committee recommends that the following Sections, Nos. E-23, 24, 25, 26 and 27, be appended to the previous recommendations upon autogenous welding:

Section 23. Smokebox.

(a) Front end rings may be electrically welded into smokebox as shown by 'A," Sketch 13.

(b) Front end steam pipe casing may be electrically welded to smokebox as shown by "B," Sketch 13.

(c) Front end inspection hole ring may be electrically welded to smokebox as shown by "C," Sketch 13.

(d) Stack bases may be electrically welded to smokebox as shown by "D," Fig. 13.

Section 24. Tender Tanks.

(a) Manholes may be applied to cisterns by electrically welding to top tank plate as shown by "A," Sketch 14.

(b) Cracks at ends of tee bars on cisterns may be re-

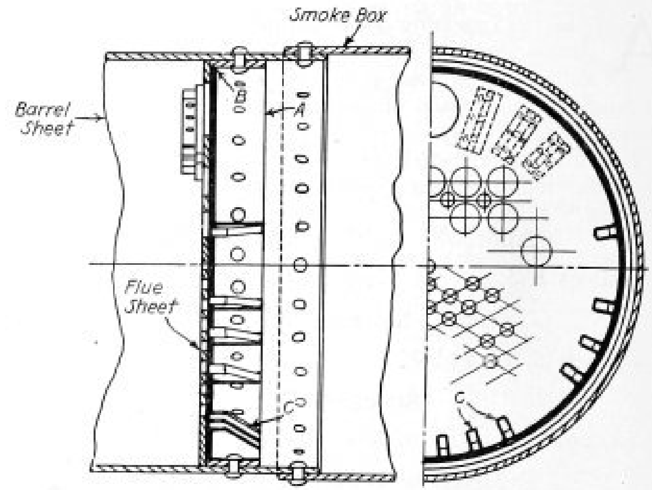


Fig. 16

paired by applying reinforcing plates with electric welding as shown by "B," Fig. 14.

Section 25. Prevention of Cracks in Back Flue Sheet Knuckles:

(a) In order to reinforce the knuckles of flanged back flue sheets and prevent cracking, reinforcing ribs may be welded in place as shown by "A," Fig. 15.

(b) In order to overcome the troubles experienced with back flue sheet flange knuckles cracking, these knuckles may be entirely eliminated by the application of a straight set in back flue sheet electrically welded to the crown and combustion chamber sheets as shown by "B," Fig. 15, provided the connection is supported by the application of reinforcing

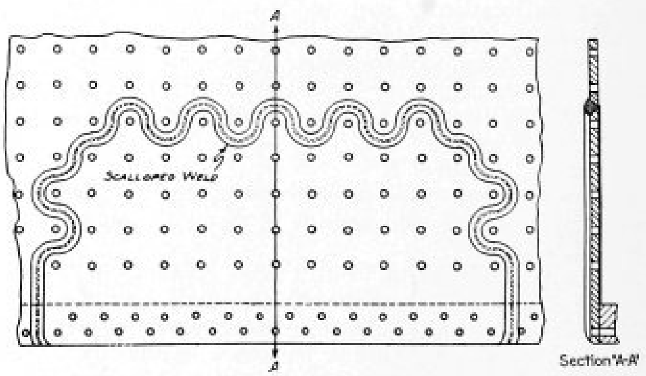


Fig. 17

ribs electrically welded in place as shown by "C," Fig. 15.

Section 26. Prevention of Cracks in Front Flue Sheet Knuckles.

(a) In order to overcome the troubles experienced with front flue sheet flange knuckles cracking, these knuckles may be entirely eliminated in the following manner: A strip or ring to be riveted to the inside of the boiler barrel around its entire circumference as shown by "A," Fig. 16, and a straight front flue sheet to be set in behind this ring and welded to it on the smokebox side (not to the barrel of the boiler, however) as shown by "B," Fig. 16.

(b) If desired, when the above construction is employed the unsupported area of the straight front flue sheet, between the tube holes and the boiler barrel sheet may be stiffened and reinforced by a series of ribs electrically welded to the ring and flue sheet as shown by "C," Fig. 16.

In our rather extensive experience with autogenous welding of firebox sheets we have found that there is no tendency for a rupture to follow the course of a weld, but will just as frequently extend into the solid sheet. In order to further safeguard against any such contingency the use of an irregularly shaped or scalloped electrically welded seam, such as shown by Fig. 17, may be used. A careful examination of the sketch will make the explanation of the further safeguard provided by the scalloped patch quite obvious.

It is generally recognized that the major stresses are tangent to the seam, and by the use of the scalloped weld lines of force are in such varied directions that any rupture will of necessity leave the seam and traverse into the solid sheet. As mentioned above this conclusion has been reached as a result of an extensive experience, and it will doubtless be remembered that at the last meeting of this association the members heard from the chairman of this committee a detailed description of a number of tests that had been made by him.

This report was prepared by a committee composed of J. A. Doarnberger, chairman, H. L. Marsalis, H. H. Service, Albert Novak and L. M. Stewart.

Discussion

John Matheson: I was once called upon to investigate an accident due to low water, the locomotive being of the 2-10-2 type, with wide firebox, the crown being connected to the crown of the firebox proper by an electric arc weld.

The entire crown sheet had been overheated and bulged downward between the crown stays, which were of the button head type except the six or eight rows in front. It had been forced down off the riveted crown stays at the front of the combustion chamber, pocketing a large area. The great pressure on this area forced the button heads off the stays until the transverse weld was reached, which broke completely, allowing the back end of the crown of the combustion chamber to be blown down against the back flue sheet, making a large opening through which the contents of the boiler were liberated to the atmosphere. The effect was an explosive force that tore the boiler from its frame and hurled it through the air. It fell a crumpled mass. Three lives had been destroyed and much property.

I have investigated many crown sheet failures where the crown sheets were forced down off the crown stays and hung like a swelled sail secured at its edges that did not rupture and minor damage was done. In this case the weld did not hold. Not one button head on the row back of the weld was torn off, and the edge of the sheet back of the weld was not lipped down by the pulling strain. The failure was complete. When crown sheets are forced down off the crown stays supporting them and hang in blanket form without the corners rupturing, no disastrous explosion takes place, as the outlet of the contents of the boiler to the atmosphere is restricted to the openings through the crown stay holes. When the sheet tears at the corners of the rectangle formed, a disastrous explosion takes place. The sheets invariably tear diagonally down from the corners to the mud ring. This suddenly liberates the water and steam in the boiler to the atmosphere. When the tear from the corners occurs, it is unavoidable, but when there is a weak seam in the crown sheet that will give way completely when under stress due to lack of support, the condition is very dangerous and could be avoided. Some one is responsible for it. In a case of this kind there is no chance for the lives of the enginemen or of the brakeman whose duty it is to ride the engine, in freight service.

While crown stays or crown bolts support a firebox sheet the failure of a fusion weld may not cause injury, but when the holding power of the stays is destroyed in many instances the cast welds have failed to hold the plates together. In welding we always take it for granted that the stays supporting the sheet will always be there. When the sheet is overheated and pulls away from the stays, the sheet is in tension and the weld, if it is not of equal strength with the plate, will break and leave a large opening for the contents of the boiler to go to the atmosphere. When that occurs, the worst has happened. As you know, crown sheets will fold over and come down. But the four corners, can't fold down and come with the rest of the sheet. Hence, they rupture. That is why it is thought that the longitudinal welds or any welds should be from twelve to fifteen inches below the highest point of the crown sheet. For when that point is reached, with the coming down of the sheet, the corners will then have ruptured, then it does not matter what takes place.

But let us bear in mind that it is not a question of the stayed surface but the unstayed in the crown sheet that causes disaster, the sheet being in full tension after the pressure forces it from the supporting stays.

Mr. Elkins (Missouri Pacific): I do not believe we have progressed far enough, or for that matter ever will do so, to put welds in the crown sheet of a high pressure modern locomotive boiler. We have all either seen or heard of the dreadful results that have come from some of these welds. After they have broken loose and men have been killed, what good does it do to say, "It was a poor weld," or "It would have held if the water had been kept on the crown sheets." The men running these engines are like ourselves, only human and liable to make mistakes. It has been demonstrated that the engineer is not to blame at all times for low water conditions, and if it were possible (which it is not) to make 99 percent perfect welds while we were making one poor weld, what assurance have we that this poor weld would not be the one put to the final test? This bad weld might be the one subject to low water. I want to protest strongly against this association recommending any welding in the crown sheet of a locomotive boiler other than that of a calking edge of riveted seam.

A. G. Pack, Chief Inspector, Bureau of Locomotive Inspection: If you have no regard for a fellow man's life and limb, go ahead. If you have, you should move cautiously. I beg you to do that. Our accurately kept records show that fatalities where sheets tear are approximately eight times as great as where they do not tear. Approximately 80 percent of autogenously welded seams involved in crown sheet failures fail, while approximately 15 percent of single riveted seams fail under exactly the same condition. It behooves this organization in the interest of humanity to stand for the most substantial construction of fireboxes that it is practicable to obtain.

Records show that from July 1, 1915, to the present time, fusion welded seams have been involved in 28 percent of crown sheet failures and in 57 percent of the total number of persons killed.

Vice-President Murphy (Pennsylvania): I agree with what Mr. Pack has said, that 75 to 95 percent of the welds in the fireboxes are good and will give no trouble. It requires only one serious failure on the crown sheet to cause us to forget all the good welds. It is true that a great deal of good welding is being done in fireboxes. Also that a lot of bad welding is being done. The welding or fusing of firebox sheets has not yet reached a point where this association can legitimately go on record as recommending the welding of patches and all sorts of welding, especially on firebox crown sheets, closer than 12 inches below the high point of the crown sheet where there is no way of reinforcing the weld on the water side.

John F. Raps (Illinois Central): If the intention is to exclude this particular section from our recommended practice, it will be necessary to make some provision for the care of welds we are making in crown sheets at the present time, and which Mr. Pack has accepted, viz.: the transverse welds in combustion chambers and welding syphons to the crown sheet. We are welding syphons in crown sheets by both electric and oxy-acetylene process and having very good success. We have 165 combustion chamber engines with transverse welds that are not giving any trouble. We have probably 100 locomotives in service with patches welded in the crown sheet that have never given any trouble. The greatest difficulty with welds in the past and a great many that are being made at the present time is not due to the process but the method of making welds, the material used and to the inefficiency of the operators.

If a systematic check is made of welders and the method of making various types of welds you will be certain that the welders are performing as they should and are making good welds. The majority of weld failures can be traced to poor material or a careless operator, which proves that we are not checking our operators close enough.

If we intend to eliminate the section referred to and go on record that we cannot make any weld in the firebox higher than 12 inches below the highest point of the crown sheet, we should make some provision for care of the transverse welds in combustion chambers and the welding of syphons in the crown sheet.

A. G. Pack: I would like to correct Mr. Raps' statement. He says I have accepted the transverse seam between the combustion chamber and crown sheet proper. I have never done so. It has proven a most dangerous weld. Mr. Raps says he has never had any trouble with transverse seams. Let us hope he never will. As I have said before, approximately 80 percent of welded seams fail in low water cases, while approximately 15 percent of the riveted seams have failed under exactly the same circumstances.

When it comes to the syphons I have not objected to their application because the circulation through them protects the crown sheet to a very decided extent. By their application you have created a safety zone not existing in the ordinary firebox. The syphon will deliver sufficient water on the crown sheet to prevent it being overheated after the water has gone below that level for a certain length of time. Further, after the water is low enough to cause damage, a safety zone is created between the syphons which will give way before the entire crown sheet has become overheated, thus gradually releasing the pressure and preventing the sheet from coming down as a whole, as is the case in the ordinary firebox without syphon.

T. P. Madden: I don't understand why we are so insistent on welds around crown sheets. There is no great gain in labor saving. When we have accidents from welds in crown sheets, enginemen seem to lay great stress on the accident being due to the welds. With the modern tools we have today, such as air tools, it doesn't take much longer to rivet a crown sheet than to weld it in. Until we are more familiar with welding, and with the heavy trains engines are pulling today, the heavy stress they are under, we should keep away from the crown sheet. Stresses are taking place that we cannot determine, and I believe in plain safety first.

P. Browning (Pennsylvania Railroad): We have about 200 engines of the N-2 type. In the last two years we have had five electric weld failures. When building a locomotive, the crown sheet can be welded on both sides. After the crown sheet has failed and is to be repaired, all the crown stays to be taken out and both sides welded, then the crown sheet might as well be taken out. To weld from the inside and not on both sides, will not give a perfect job. We do not weld higher than 12 inches below the crown sheet.

H. L. Marsalis (Illinois Central): I have heard much said with reference to a 12-inch limit. It has been my experience, and I believe I can safely say without fear of successful contradiction, that with competent supervision and a study of the human element responsible for the preparation and making of welds, a weld can be made in the crown just as safely as in any other part of the firebox.

Our committee worked hard upon the recommended practices and have presented them as conscientious and unbiased conclusions based upon practical experience. We recognize that welding is in its infancy, and probably has not progressed to that degree of efficiency we some time expect, but it has progressed nevertheless, in spite of all the restrictions placed upon it.

A. G. Pack: I thoroughly agree with Mr. Marsalis in nearly everything he has said. We must progress—we cannot stand still. We must either move forward or turn backward.

I am not going to say nor have I ever said that good welds cannot be made. No one knows what the future holds in store for welding. I am a strong advocate of welding wherever it can be done with safety, but we must take it as we find it. At the present time and in its present state of perfection it cannot be safely used in the so-called low water zone and on many other parts of the locomotive and tender where through the failure of such parts fatalities may result. Practice with your welding, make it perfect, but don't trifle with human life and limb. When you have brought it to a state where it can be depended upon you may rest assured that A. G. Pack will be with you 100 percent.

J. A. Doarnberger (Norfolk & Western): I felt certain that the recommendation as to Section 7, would provoke a great deal of discussion upon the question of limits for crown sheet welds.

As for the Norfolk & Western Railway, with which I am fortunate enough to be connected and which has I believe about the heaviest motive power equipment in the United States, it has carried the study and application of such welding at least as far if not further than any road in the country and has accumulated a mass of valuable data and experience upon this subject. Therefore, with such a mine of priceless information at our disposal I feel I can give you results and data based upon pretty wide experience. Its value of course you must decide for yourself.

Since 1912 we have had on the Norfolk & Western something like 162 low water cases of which only 11, or between 6 and 7 percent, were reported to the Interstate Commerce Commission, owing to the fact that though the majority of the other 151 cases were of a serious nature they did not result in injury to employes. Thus it is plain, at least in so far as the Norfolk & Western is concerned, and it seems reasonable to me to assume that in this respect conditions on other roads are similar, that while the I. C. C. records no doubt contain some very interesting information they are by no means conclusive in view of the small percentage of cases covered by them.

However, of the 11 reportable cases mentioned above, two that occurred just recently, namely: Engine 787, at Bond Hill, Berry Yard, Cincinnati, O., and Engine 820, at Portsmouth, O., furnished very striking evidence of the efficiency of welded seams. In each of these two cases the crown sheet was blown down, and in the former the boiler was torn loose and hurled forward a distance of 115 feet and sideways 55 feet clear of the track. The firebox of Engine 787 was completely welded throughout and contained 178 feet of welded seams of which only 22 inches (approximately 1 percent) failed. On the other hand, in the firebox of Engine 820 the crown and side sheets were riveted to the flue and door sheets while the side sheets were welded to the crown sheet with longitudinal running seams, and when the failure occurred the riveted seams gave way by tearing out of the rivet holes and shearing of the rivets; the solid metal of the crown sheet was ruptured its entire length from the flue sheet to door sheet, and as for the welded seams on each side they remained serenely undisturbed by the violence of the explosion.

It is just such cases as the two cited which account for the fact that of some 997 steam locomotives owned and operated by the Norfolk & Western Railway, 628 have fireboxes with welded seams throughout, 206 have fireboxes with seams of both types, while only 163 have fireboxes with riveted seams only. Of these 997 locomotives, 191 have what is known as the transverse weld through the crown (*i.e.*, from wing to wing of the throat sheet) though now that the rolling mills are equipped to furnish us with larger sheets we no longer find it necessary to employ this construction except in our very large locomotives.

In this connection, it will probably be of interest to you to know that our first completely electrically welded firebox was put in service in 1912, and though it has now been in continuous service about one year longer than the average time for firebox renewals the original firebox is still intact with its electrically welded seams in as perfect condition as upon the day they were first made.

In conclusion, therefore, from my experience, it is a perfectly safe statement to say that the fusing operation is safe and convenient in any part of the firebox, and any limitations are unwarranted and inconsistent with already accepted practices. Therefore, should this association see fit to prescribe limits to the location of welded seams in fireboxes, it will be taking action contrary to the satisfactory experience of many members of the association and to the result of negative vote by letter ballot cast by the railroads of the country at the instance of the A. R. A. which was very decisive in disapproving the establishment of any limitations.

John Harthill (New York Central): I have been using the welding process for repairs to fireboxes since 1910. We have been welding all sheets in the firebox where the surface is stayed. I will make the broad statement that we have practically no failures in our welds on the crown sheet. We have not had what you could call a failure on a welded crown sheet patch. I know of only one instance where any rewelding was done to a crown sheet patch and it was only about a three-inch weld. We now have many patches welded in the crown sheet at the front end of the firebox. Our method of applying these patches is to cut between two rows of radials and take in flue sheet rivets. We always rivet the patch to the flue sheet. This is safe and practical. If the weld will not hold in the crown sheet, it will not hold anywhere else in the firebox.

Welding on any part of the firebox must be done by experienced welders and good work demanded. The work being done must be watched and it must not be slighted. Take more care in fitting up the work and see that welding is done properly, and then a better job is done than riveting. A riveted seam in the firebox is only about 56 percent efficient and a good welder will get a percentage on his weld from 80 to 90 percent, if the weld is built up $\frac{1}{16}$ of an inch. We know this by taking test pieces to the laboratory and finding out in the testing machines provided the strength of the weld.

Then why should we not weld on the crown sheet? I cannot see why restrictions should be put on the crown sheet, if a patch is properly applied and the weld is always stayed by staybolts or radials on each side and riveted to the flange of the flue or door sheet. If we cannot weld in the crown sheet, are you going to ask all the railroads to take out the crown sheets that are welded? What will be the result? More leaky fireboxes than we have now. When we applied patches to the crown sheet with rivets or plugs they were always leaking and were constantly being repaired by engine house forces. In a short time the rivets were all calked and when brought to the shop had to be renewed and enlarged, a tight job on the crown sheet by this method seldom being accomplished. When the patches were welded it returns to the back shop with the weld in as good condition as left at the last shopping. Therefore, I advocate that no restrictions be made as to where welding should be done in fireboxes, as the firebox is a stayed surface.

George Austin (Santa Fe): I have investigated a great many explosions. It is my firm conviction that the welded seams wherever they have been involved in an explosion have minimized as much or as often as they have added to the intensity of the explosion. The intensity of an explosion depends upon the way the crown sheet has been heated. If an even heat over the whole crown sheet is maintained and it holds up until it gets an even heat, it comes down all at once and there isn't any kind of a seam that will stand that kind of an explosion. Solid sheets don't stand it.

We have had accidents where the riveted seams in flue sheets have broken away, sheared the rivets or broken the holes out, and the welded transverse patch across the front has gone down with very little injury. For that reason I want this association to go on record in a common sense practical view. I don't think it adds to the danger or the intensity of the explosion. I don't believe that a welded seam adds to it. In the last explosion we had 23 feet of welded seam give way, but 17 feet of solid sheet had to go before it reached the seam, and the welded seams gave way because it was one of the old welds where we put a little roll in it. When the sheet was blowing down that roll could not reverse itself, and the weld broke along the side of the roll. I would like to see this resolution approved and all restriction in welding be removed from the fireboxes.

Mr. Ryan (Kansas City Southern): The supervisor who has charge of the repair work done on a locomotive boiler should consider himself responsible. We discontinued welding crown sheet patches two years ago, and since then have been riveting. We have experienced no trouble with riveted seams.

John F. Raps: Prior to the introduction of fusion welding of firebox sheets I was called upon several times to examine fireboxes of locomotives which had been severely ruptured owing to low water, the longitudinal seams and in fact all seams being riveted. In some instances the sheets tore through the rivet holes and in some through the solid plate, the firebox sheets being practically turned inside out. Mr. Harthill stated that a riveted seam had an efficiency of about 75 percent. I defy any one to find a longitudinal seam in a firebox that is tight and has an efficiency of over 59 percent. With a properly welded seam we can raise the efficiency to 75 or 85 percent.

Please bear in mind that section No. 7 is only recommended practice and that you are not compelled to adopt it. No member is in duty bound to return to his shop and put this section into practice. They are under no obligation to do so, and should not, by any means, if they haven't operators who can be depended upon to make good welds in the firebox. I feel that we have competent welders on the Illinois Central and whenever they make a weld in the firebox, it makes no difference whether in the crown or any other sheet, we are satisfied that the work performed is better than a riveted seam. Therefore, I move the adoption of Section No. 7 as recommended practice.

(Following this point in the discussion a number of sections of the report were acted upon without changes being incorporated.)

J. A. DOARNBERGER: On behalf of the committee, I want to acknowledge our indebtedness to Mr. Pack of the Interstate Commerce Commission for the data, consisting of specimens of welding gathered from all over the country and placed on exhibition at his office in Washington, upon which the majority of these "Don'ts" are based.

A great many of us have already had the privilege of viewing these specimens. For the benefit of those who have not, Mr. Pack has been kind enough to consent to exhibit and explain lantern slides showing some of them tomorrow. However, let me say here that if any of you are ever in Washington be sure to seize the opportunity to visit Mr. Pack and examine these specimens at first hand, for my experience on similar visits makes me feel confident that you will find Mr. Pack most cordial and more than willing, not only to show them to you, but also to answer any questions you may feel inclined to ask with reference to any phase of your work.

Just a word now regarding the specimens of which I have been speaking. Some of them are unimaginable and horrible, and represent practices you would hardly believe a reasonable man would attempt; and it is just such practices that, unless they are speedily discontinued, will sooner or later be the cause of an overwhelming setback to all of our advances in the art of fusion welding. If such specimens continue to reach Mr. Pack's attention I do not believe we could much blame him for requesting some specific rulings that aim towards their prevention. We can all well fear, however, the result of an attempt to make rules to prevent practices which, while they should take care of themselves, would have the effect in one way or another of restricting safe and legitimate practices and would also tend to greatly hamper progress and advancement, which is something Mr. Pack, in his breadth of vision, has always encouraged.

Therefore, let us all make a conscientious effort to constantly keep in mind these broad principles of welding that we have today endorsed and hold ourselves and our subordinates strictly to their observance; let us go on record as suggesting to Mr. Pack that, in order that the innocent will not be made to suffer for the lapses of the guilty, should any of his inspectors discover violations of these principles, they be handled as individual cases rather than be used as a basis for general rulings.

DIGEST OF ACTION ON REPORT

Section No. 17, Clause C, left optional.

Fig. 15, and Section 25, ordered stricken from report.

The words "fusion welding" to be substituted, wherever autogenous or electric welding is mentioned. The entire report was adopted with the foregoing exceptions and changes.

A. G. PACK: May I trespass just a moment? I have given this scalloped seam of Mr. Doarnberger very considerable attention and thought. My experience, extending over a number of years, in investigation of weld failures bears out just what Mr. Doarnberger says, that we find welding fails through the seam and it is very porous and full of blow holes. Then it goes off into the original plate and follows that. Examine that portion and you have a fine weld. That demonstrates to me clearly that welds cannot be made of uniform value, even by the same welder; but, because of the different lines of stress in this scalloped weld, a saw-tooth weld or a scalloped weld, you have a weld, even though it does fail, that is not likely to fail for as great a distance, and you must have a greater strength in your weld because of the greater tension.

The Cincinnati Bickford New Radial Drill

THE Cincinnati Bickford Tool Company, Cincinnati, Ohio, has just placed on the market an entirely new design of radial drill known as the Super Service drill. In the development of this machine, which is built in 5-foot and 6-foot sizes, the aim of the builders has been to speed up drilling time by reducing handling time. To accomplish this the design incorporates a 36-speed, 18-feed head in which all speeds are in the head; power rapid traverse; an easy swinging arm readily moved by the slight pressure of one hand; single lever arm control; power column clamping, either electric or pneumatic; and finally, all controls centralized so as to be accessible to the operator without moving away from his work.

In an effort to reduce maintenance to a minimum and insure long service the machine is built with Timken tapered roller bearings, automatic lubrication with Purolator oil filter system, multiple splined shafts with integral keys, all speeds and feeds through selective sliding gears, driving and feed change gears of heat treated alloy steel and square guideway mounting of the head on the arm. Safety features have been provided by the use of a patented safety nut to sustain the arm should the main elevating nut fail, a positive interlock to prevent elevation of the arm when clamped, a safety catch which prevents the spindle from dropping should the counterbalance chain break and the placing of the counterbalance inside the head.

The base is of box section throughout. Its entire area bears on the surface of the foundation. The top and bottom of the base are tied together by a system of heavy longitudinal and transverse ribs. These ribs, which are closely spaced, uniformly support the top of the base so that jack screws or other auxiliary supporting devices are not required. The weight of the column, arm and head, together with the work, is transmitted directly through these ribs to the foundation.

The column diameter is 17 inches. The flange is double thickness and the clamping surface has a large contact area. The construction of the lower part of the column, which permits of easy swinging of the arm, is distinctive. It consists of four large diameter, hardened steel rollers mounted on roller bearings. These rollers are built into the sleeve above the clamping surface and roll on a hardened and ground steel ring on the upright trunk.

Power column clamping, either air or electrically operated, is standard equipment. It enables the operator to clamp and unclamp the column without leaving his operating position at the head. This feature eliminates two round trips from the head to the column for every hole drilled. Air clamping is obtained through a double-acting air cylinder housed in the driving motor support. Electric clamping is obtained through a torque motor mounted on top of the column. Both the air cylinder and the motor are so located that they are not exposed to dirt and chips, nor are they in the operator's way. The hand clamping lever does not move when power clamping is employed.

The arm is massive, yet swings under the slight pressure of one hand. It is of patented, triple box section. The front and rear walls are tied together with heavy longitudinal ribs. All openings in the rear wall have been completely eliminated. The depth of the arm and the length of bearing on the column have been increased. A system of square lock gibs has replaced the dovetail mounting of the head on the arm. This provides a bearing which assures alinement in service. It prevents the rocking tendency of the head due to lack of adjustment of the main gib or the cutting action of the tool.

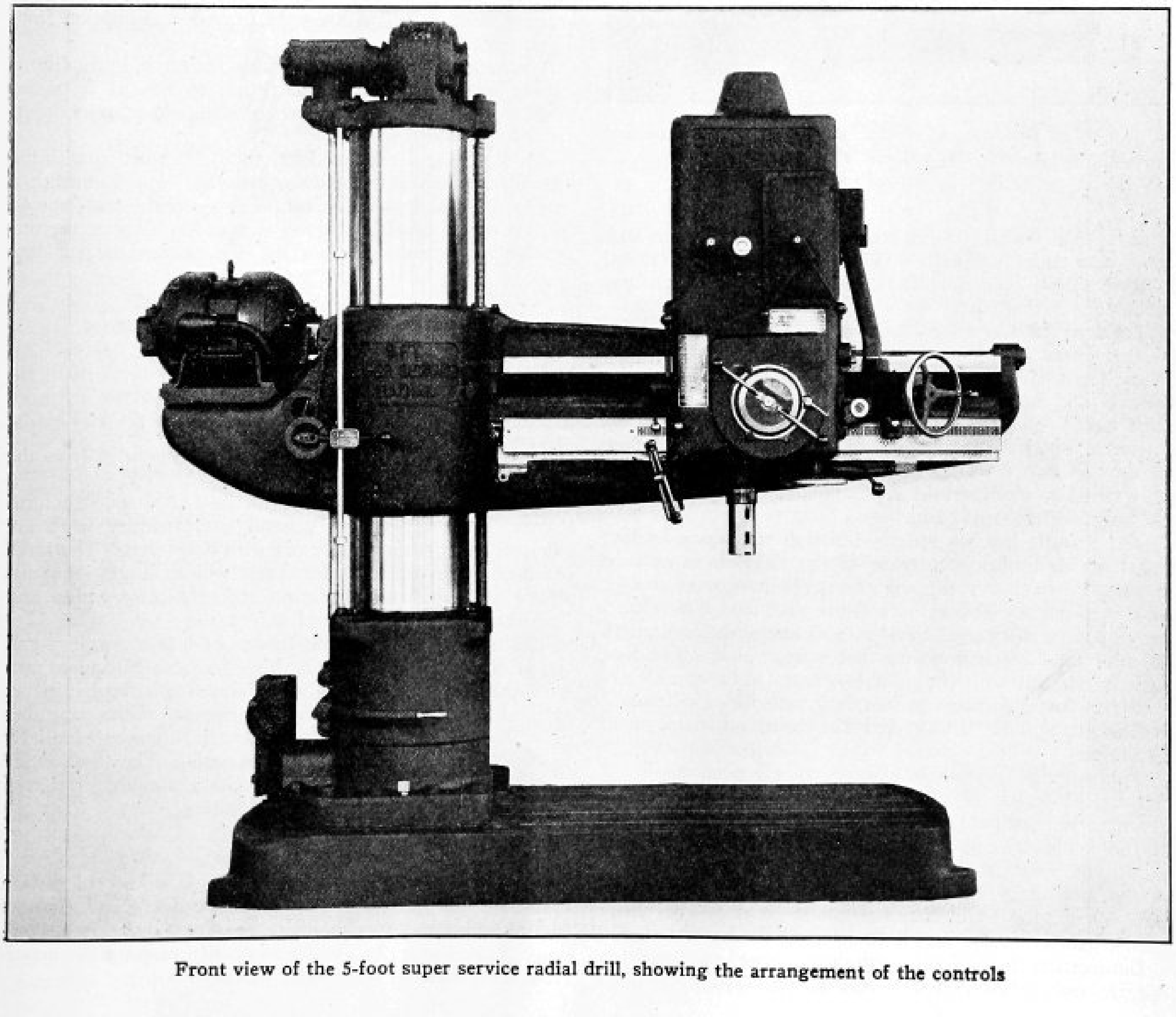
The entire raising and lowering mechanism is built into the arm as a complete unit, fully enclosed and automatically oiled by a system of flood lubrication. The old style raising and lowering mechanism on top of the column with its clash gears has been discarded. The screw is held stationary—the nut revolves. Friction clutches incorporated in the unit drive the nut in either direction. A patented safety nut sustains the arm and prevents it from dropping should any failure occur in the threads of the main nut. The safety nut gives immediate warning of the failure and the worn nut must be replaced before any further raising or lowering of the arm is possible.

A single lever clamps, unclamps, raises and lowers the arm. An equalized screw and lever action, applied at both ends of the arm cylinder, binds the arm tightly to the column. Greater leverage is provided for closing the upper end on account of the increased resistance at that point. A positive mechanical interlock prevents any engagement of the raising and lowering mechanism while the arm is clamped to the column. Safety stops prevent any movement beyond the upper and lower limits of travel.

Only one motor is required to drive the spindle, elevate the arm and operate the power rapid traverse. This motor is of the constant speed type for either direct or alternating current. Variable speed or multi-speed motors with their complicated control systems are not necessary. The motor support is of deep section and cast integral with the arm. The machine is completely wired. The wiring is run from the motor to the top of the column, down through the inside, and brought out through the rear of the base for connecting with an outlet in the floor. Piping for the air type column clamp is handled in a similar manner. Both have revolving connections in the lower part of the column which allow the arm to swing in a complete circle.

Thirty-six speeds and 18 feeds are incorporated in the head. The head is completely enclosed, includes power rapid traverse and contains the entire speed change mechanism. The entire driving mechanism—from motor to spindle nose—revolves in tapered roller bearings. They are completely sealed against the entrance of dirt and are automatically oiled. All shafts are multiple splined with integral keys. All driving gears and feed change gears are of carefully selected heat treated steels. All feed and speed change gears are of the selective sliding type. Tumbler gears and dive keys have been discontinued.

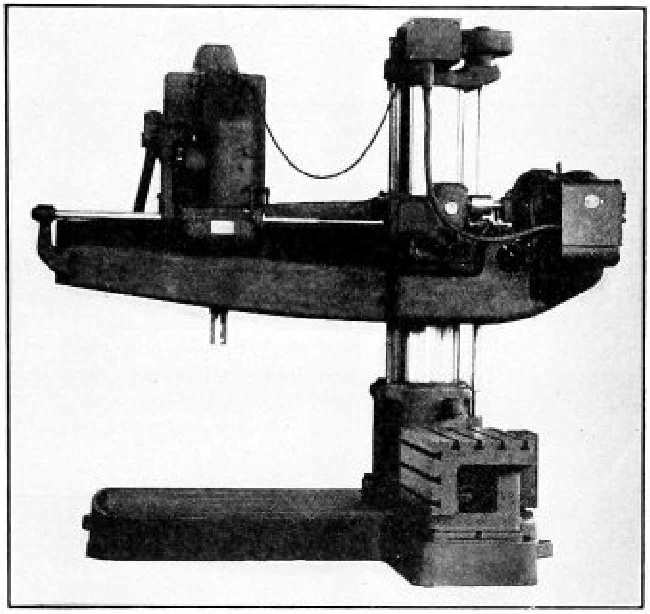
Power rapid traverse to the head is standard equipment. The constant speed arm shaft has been utilized as a source of power which reduces the rapid traverse to a relatively



Front view of the 5-foot super service radial drill, showing the arrangement of the controls

simple mechanical device. The head moving handwheel does not revolve when the power rapid traverse is engaged.

All of the 36 speed changes are in the head. They are obtainable through selective, sliding gears by the use of only three levers. They have a 60 to 1 range with a maximum of 1,415 revolutions per minute. They are closely enough graded that a speed can be selected which will drive a drill up to the limit of its working capacity. The machine can be furnished with any one of five in-



Rear view of the new radial drill, showing the oil pump and Purolator—the air and electrical connections are carried up through the column

take speeds which provide the following minimum and maximum spindle speeds—15 and 912, 16 and 1,004, 18 and 1,124, 21 and 1,278, 23 and 1,415 revolutions per minute.

Eighteen feed changes are obtained through selective, sliding gears by the use of only two levers. The feeds range from 0.006 inch to 0.125 inch per revolution of the spindle and include tap leads for 8, 11½ and 14-thread pipe taps. The tap leads relieve the operator of the exertion required to start pipe taps and eliminate the possibility of thin threads. A compensating depth gage not only drills to a prescribed depth but also compensates for the length of the drill point.

The spindle has six splines insuring minimum feeding resistance under heavy torsional loads. This is of extreme importance on heavy tapping for it eliminates the danger of thin threads. The spindle sleeve and feed rack pinion are of special alloy steel having an ultimate tensile strength of more than 200,000 pounds per square inch. The feed rack is integral with the spindle sleeve. The spindle revolves in roller bearings packed in grease which eliminates indifferent spindle oiling and the resultant damage to bearings.

The spindle is counterbalanced at all positions by a flat, coiled spring of unusual capacity. A patented cam arrangement compensates for the varying tension of the spring. The tension can be quickly adjusted to provide additional counterbalancing for heavy cutter bars, etc. A patented safety grip prevents the spindle from dropping should the counterbalance chain break. The entire counterbalance mechanism is enclosed in the head.

Lubrication has been so designed that the machine operates over a long period without oiling. The entire head is automatically oiled. A submerged pump forces oil through a Purolater filter to the top of the head where it cascades down through all gears and bearings. The friction clutches run in oil. A high pressure grease system lubricates the roller bearing spindle. A large reservoir with wicks and copper tubing oils the gibs and all surfaces of the head which bear on the arm. The arm raising and lowering unit and the motor driving gears run in oil. The arm shaft outer bearing is packed in grease.

Oxy-Illuminating Gas Cutting Torch

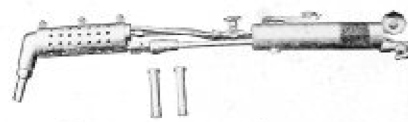
THE Alexander Milburn Company, Baltimore, Md., manufacturers of welding and cutting equipment for the past twenty years, has just placed on the market a gas cutting torch for use with illuminating and by-product gases.

This torch is the result of extensive experiment and research in the utilization of a cheaper fuel, thereby reducing cutting costs materially. With city gas costing but a small part of other gases, it can readily be seen that there is a great saving in fuel gas alone.

An outstanding feature of the Milburn torch is the superheater which heats and expands the cutting oxygen, also the preheating gases, raising the temperature of the cutting oxygen to approximately 100 degrees centigrade prior to combustion. This increases the temperature of the gases at the torch tip, increases the rate of flame propagation in the burning mixture and reduces the oxygen consumption from 25 percent upwards.

A bunsen burner, contained within the torch, burns illuminating gas which heats the cutting oxygen as it passes through a series of copper coils. This superheater is an exclusive Milburn feature.

The heated and expanded oxygen in conjunction with the illuminating gas gives better penetration into the metal, a narrow kerf and sharp, clean edges, speedy and smooth cutting with a notable absence of metallic slag on the underside of the cut. It does not case-harden the surfaces



New type gas cutting torch

cut—in fact leaves them in practically the same state as the original steel.

Heavy plate and slabs, risers of steel castings, structural shapes, gates, billets and general steel foundry work are efficiently and economically cut with this torch. The torch operates on city gas or natural gas, which, due to its availability and low cost, minimizes the cost of operation and also affords a high degree of safety.

The torch is ruggedly constructed of bronze forgings and specially drawn tubing. The high pressure cutting oxygen is controlled by a thumb valve which remains fixed in either open or closed position. The arrangement of the gas tubes gives the torch great transverse strength. It is substantially built, well balanced and easy to handle. The torch is 21 inches in length and is supplied with a complete range of tips for light, medium and heavy cutting.

Parkesburg Iron Company.—In pursuance of certain plans for the diversification of its products and changes in and additions to its facilities, the Parkesburg Iron Company, Parkesburg, Pa., will temporarily suspend the manufacture of charcoal iron boiler tubes.

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

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

Revisions and Addenda to Boiler Code

The Boiler Code Committee has recently received and acted upon a suggested new specification for hollow-forged seamless steel drum forgings which has been approved for publication as addenda to Section II of the Code. This specification is published below and is submitted for criticisms and comment thereon from any one interested therein. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th Street, New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

After thirty days have elapsed following this publication, which will afford full opportunity for such criticism and comment upon the revisions as approved by the committee, it is the intention of the committee to present the modified rules as finally agreed upon to the Council of the Society for approval as an addition to the Boiler Construction Code. Upon approval by the Council, the revisions will be published in the form of addenda data sheets, distinctly colored pink, and offered for general distribution to those interested, and included in the mailings to subscribers to the Boiler Code interpretation data sheets.

Proposed Specifications for Hollow-Forged Seamless Steel Drum Forgings

1. Process. The steel shall be made by either or both the following processes: open hearth or electric furnace.

2. Discard. Sufficient discard shall be made from the top and bottom of each ingot to secure soundness in the portion used for the drum forging.

3. Forging. The forging shall be made from a solid cast ingot, punched, bored, or hot trephined.

The resultant wall of ingot shall be reduced in thickness at least one-half by forging on mandrels.

4. Chemical Composition. The steel shall conform to the following requirements as to chemical composition:

		Class 1	Class 2
Carbon, maximum, percent		0.35	0.45
Manganese, percent		0.30–0.65	
Phosphorus, maximum, percent	Acid	0.04	
	Basic	0.035	
Sulphur, maximum, percent		0.04	

5. Ladle Analyses. An analysis of each melt of steel shall be made by the manufacturer to determine the percentage of the elements present. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative and shall conform to the requirements specified in Paragraph 4.

6. Check Analyses. As a substitute for check analyses in the general rules, the purchaser may make an analysis from a broken tension-test specimen representing each drum forging. The chemical composition thus determined shall conform to the requirements specified in Paragraph 4.

7. Heat Treatment. Prior to taking test specimen, the whole of the forging shall be simultaneously annealed above its critical temperature. If additional forging is required after taking test specimens the whole of the forging shall again be simultaneously reannealed above its critical temperature, but not above the temperature of the first anneal.

8. Tension Tests. The forging shall conform to the following requirements as to tensile properties:

	Class 1	Class 2
Tensile strength, min., lb. per sq. in.	60,000	75,000
Yield point, min., lb. per sq. in.	0.5 Tens. Str.	0.5 Tens. Str.
Elongation in 2 in., min., percent	26	24
Reduction of area, min., percent	42	38

9. Bend Tests. The test specimen shall withstand being bent cold through 180 degrees around a pin 1 inch in diameter, without cracking on the outside of the bent portion.

10. Test Specimens. a. Tension and bend-test specimens shall be taken from full size prolongation of each forging after annealing, as provided for in Paragraph 7.

b. One tension-test specimen shall be taken from each end of the forging. The axis of the specimens shall be located midway between the inner and outer surfaces of the wall parallel to the axis of the forging, the two specimens being taken from diagonal corners of an axial plane. Tension-test specimens shall conform to the dimensions shown in Fig. 1. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial.

c One bend-test specimen shall be taken from the end of the forging corresponding to the top of the ingot. The axis of the specimen shall be in a diametral plane perpendicular to the axis of the forging. The bend-test specimen shall be 1 inch by ½ inch in section, with edges rounded to $\frac{1}{16}$ inch radius.

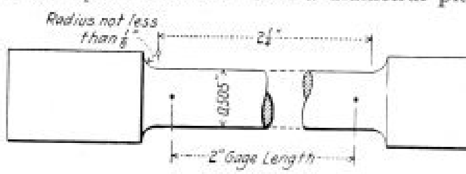


Fig. 1—Standard form of test specimen required for all tension tests of steel seamless hollow-forged material

11. Number of Tests. a. Two tension tests and one bend test shall be made for each forging.

b. If any test shows defective machining or develops flaws it may be discarded and another specimen substituted.

c. If the percentage of elongation of any test specimen is less than that specified and any part of the fracture is more than ¾ inch from the center of the gage length, as indicated by scribe scratches marked on the specimen before testing, the specimen shall be discarded and another taken.

12. Retests. If the results of the physical tests of any forging do not conform to the requirements specified, the manufacturer may reanneal the forging and retest shall be made as specified.

13. Permissible Variation. The thickness of the parallel wall of each forging shall not be less than that specified. If the thickness of a portion of the wall of the forging is less than that specified, due to accidental or unavoidable irregularity of bore, the forgings may be accepted by the purchaser, provided such irregularity will not require lowering of the allowable working pressure below that for which the drum is designed.

The overweight limits are considered a matter of contract between the manufacturer and the purchaser.

14. Finish. The forging shall be free from injurious defects and shall have a workmanlike finish.

15. Marking. Each forging shall be legibly stamped by the manufacturer at each end with the name of the manufacturer, manufacturer's test identification number, and minimum tensile strength specified for the class of forging. The manufacturer's test identification number shall be legibly stamped on each test specimen.

Railway Shops of the British Isles—II*

Specifications and standards of British locomotive boiler materials, compiled during a visit to British shops

By Thomas Lewis†

COPPER and Brass Tubes. Copper tubes for locomotive boilers to suit British standard requirements must contain not less than 99 percent pure copper with from 0.35 to 0.55 percent of arsenic. Brass tubes may be what is commercially described as 70-30 alloy or they may be 2-1 alloy.

70-30 alloy equals not less than 70 percent metallic copper;

2-1 alloy equals not less than 66.7 percent metallic copper;

and the remainder of zinc except 0.75 percent of materials other than copper and zinc is allowed.

For copper and brass tubes no tensile tests of material are necessary but the tubes must stand expanding at the ends after having been annealed until the diameter is 25 percent greater than the original diameter and must show neither signs of flaw nor cracks. They must also stand flanging without cracking until the diameter of flange is not less than 40 percent greater for copper and 25 percent greater for brass tubes than the original diameter of the tubes.

A piece of the tubes when cold, and in the case of copper tubes when at red heat, must withstand being flattened until both sides meet and then be doubled over on itself through an angle of 180 degrees at right angles to the axis of the original tube without cracking. Internal hydraulic pressure 750 pounds per square inch.

Copper Rods for Locomotive Staybolts

1. Chemical Analysis. The rods must contain not less than 99.25 percent of copper, and 0.15 percent to 0.35 percent must consist of arsenic.

The manufacturer shall supply an analysis when required to do so.

2. Freedom from Defects. The rods must be clean, smooth, uniform in diameter and free from surface defects.

3. Branding. Each rod shall be stamped with the manufacturer's name near one end.

4. Mechanical Tests. The representative of the engineer (or of the purchaser) shall select and test, up to two percent of each diameter of rod ordered under the contract, such of the rods as he may think proper. All test pieces shall be in the same condition as when severed from the rods, and must comply with the following tests:

5. Tensile Test. The tensile strength must be not less than 14 tons per square inch, with an elongation of not less than 40 percent on standard Test Piece B, having a gage length of not less than eight times the diameter when a very small test piece is required. Standard Test Piece D, having a gage length of 3 inches shall be used in which case the elongation must be not less than 45 percent.

6. Hammering or Crushing Down Test. A piece of rod 1 inch long shall be placed on end and hammered or crushed down to a thickness of ⅜ inch, without showing either crack or flaw on the circumference of the resulting down disk.

7. Inspection. The representative of the engineer (or of the purchaser) shall be at liberty to reject any material that does not conform to the terms of this specification. He will attend to stamp pieces for tests before delivery and no rod will be accepted which will not stand the specified tests, or which, upon analysis is found to exceed the limits stated for the chemical composition.

8. Testing Facilities. The manufacturers shall supply the material required for testing free of charge and shall at his own cost, furnish and prepare the necessary test pieces and supply labor and appliances for such testing as may be carried out on his premises in accordance with this specification. Failing facilities at his own works for making the prescribed tests, the manufacturer shall bear the cost of carrying out the tests elsewhere.

For Iron and Steel Tubes. Lap welded boiler tubes to meet British standard requirements should be of Swedish charcoal iron annealed at both ends. Test pieces cut from the tubes should have an ultimate tensile strength of 19 to 24 tons per square inch with contraction of area not less than 45 percent. The ends should stand bulging or expanding to 15 percent greater diameter heated, and 10 percent greater diameter when cold. A piece of tube 2 inches long should withstand crushing down when cold to 1⅜ inches long, also flattening on the diameter until both ends meet without cracking. Internal hydraulic test pressure 750 pounds per square inch.

Weldless boiler tubes to suit British standard requirements should be cold drawn from open hearth steel showing on analysis not more than 0.03 percent of sulphur or of phosphorus and should be annealed throughout their length. Test pieces cut from tubes, without further annealing except in cases of tubes over 2¼ inches in diameter, should have an ultimate tensile strength of not more than 24 tons per square inch, i.e., 53,760 pounds with elongation not less than 20 percent in 8 inches. The ends should stand expanding or bulging when cold not less than 15 percent greater diameter if under 11 S. W. G. thick or 12½ percent if 11 to 8 S. W. G. thick. A piece of tube 2 inches long should withstand crushing down, when cold to 1⅛ inches long, also flattening on the diameter until both sides meet without cracking except for tubes over 11 S. W. G. thick which should close to a width equal to their own thickness. Internal hydraulic test pressure 1,000 pounds per square inch.

For Copper Plates for Locomotive Fireboxes

1. The plates shall be of one of two classes, to meet the largely varying chemical constituents of coal and differing conditions of use, and must comply with the requirements specified below:

Class A. The plates must contain not less than 99 percent of copper and 0.35 percent to 0.55 percent must consist of arsenic.

Class B. The plates must contain not less than 99.25 percent of copper, and 0.25 percent to 0.45 percent must consist of arsenic. The manufacturer shall supply an analysis when required to do so.

2. The plates must be clean, smooth and free from surface defects.

3. Each plate shall be stamped with the manufacturer's name and plate number, at about 12 inches from the end in the center line of the plate, and shall also be distinctly

*The first installment of this article appeared on page 295 of the October issue of The Boiler Maker.

†Chief Boiler Inspector of the Lehigh Valley Railroad. Paper presented at seventeenth annual convention of the Master Boiler Makers' Association.

stamped with such marks of identification as the engineer (or the purchaser) may require.

4. The scrap margin before shearing shall be not less than 3 inches at each end, and 1½ inches at each side of the plate; from this margin a piece 2 inches wide shall be left attached to the plate at each end, from which the representative of the engineer (or of the purchaser) will mark lengths for tensile and bend tests. All test pieces shall be in the same condition as when severed from the plate and must withstand the following tests:

5. A Standard Test Piece A, having a gage length of 8 inches must show a tensile breaking strength of not less than 14 tons per square inch, with an elongation of not less than 35 percent.

6. Pieces of the plate shall be tested both cold and at a red heat by being doubled over on themselves, that is, bent through an angle of 180 degrees, without showing either crack or flaw on the outside of the bend.

7. The representative of the engineer (or of the purchaser) shall be at liberty to reject any material that does not conform to the terms of this specification. He will attend to stamp pieces for tests before delivery, and no plate will be accepted which will not stand the specified tests, or which, upon analysis, is found to exceed the limits stated for the chemical composition.

8. The manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labor and appliances for such testing as may be carried out on his premises in accordance with this specification. Failing facilities at his own works for making the prescribed tests, the manufacturer shall bear the cost of carrying out the tests elsewhere.

For Iron and Steel Tubes. Lap welded boiler tubes to meet British standard requirements should be of Swedish charcoal iron annealed at both ends. Test pieces cut from the tubes should have an ultimate tensile strength of 19 to 24 tons per square inch with contraction of area not less than 45 percent. The ends should stand bulging or expanding to 15 percent greater diameter heated, and 10 percent greater diameter when cold. A piece of tube 2 inches long should withstand crushing down when cold to 1⅜ inches long, also flattening on the diameter until both ends meet without cracking. Internal hydraulic test pressure 750 pounds per square inch.

Weldless boiler tubes to suit British standard requirements should be cold drawn from open hearth steel showing on analysis not more than 0.03 percent of sulphur or of phosphorus and should be annealed throughout their length. Test pieces cut from tubes, without further annealing except in cases of tubes over 2¼ inches in diameter, should have an ultimate tensile strength of not more than 24 tons per square inch, i.e., 33,760 pounds with elongation not less than 28 percent in 8 inches. The ends should stand expanding or bulging when cold not less than 15 percent greater diameter if under 11 S. W. G. thick or 12½ if 11 to 8 S. W. G. thick. A piece of tube 2 inches long should withstand crushing down, when cold, to 1⅛ inches long, also flattening on the diameter until both sides meet without cracking except for tubes over 11 S. W. G. thick which should close to a width equal to their own thickness. Internal hydraulic test pressure 1,000 pounds per square inch.

For Steel Plates, Angles, Etc., and Rivets for Locomotive Boilers

1. The plates, sections and bars shall be manufactured from steel made from selected material by the acid open hearth process and must not show on analysis more than 0.05 percent of sulphur or of phosphorus.

The manufacturer shall supply an analysis when required to do so.

2. The plates, sections and bars must be free from cracks, surface flaws, lamination and all other defects, and finished in a workmanlike manner.

3. No plate must be under the specified thickness at any part, nor more than 5 percent over the calculated weight.

4. Each plate, section or bar shall be distinctly stamped with such brands as the engineer (or purchaser) may require, but not near the edge.

5. The tensile strength and ductility shall be determined from standard test pieces cut crosswise from the rolled material in the case of plates, and lengthwise in the case of sectional material. When material is annealed or otherwise treated before despatch the test pieces shall be similarly and simultaneously treated with the material before testing.

Any straightening of test pieces which may be required shall be done cold.

6. Plates and Sectional Material: For Plates, Angels, etc., standard test, Piece A, having a gage length of 8 inches and for Round Bars (other than Rivet Bars) a Standard Test Piece B, having a gage length of not less than 8 times the diameters must show a tensile breaking strength of 26 to 32 tons per square inch, with an elongation of not less than 22 percent. Where bars are above 1 inch in diameter and are tested full size as rolled, or have been turned down and the resulting test piece is above 1 inch in diameter, a Standard Test Piece F, having a gage length of not less than 4 times the diameter may be used in which case the elongation shall be not less than 27 percent.

Rivet Bars: A standard Test Piece B, having a gage length of not less than 8 times the diameter must show a tensile breaking strength of 24 to 28 tons per square inch, with an elongation of not less than 27 percent. If tested on a Standard Test Piece F, having a gage length of not less than 4 times the diameter the elongation shall be not less than 30 percent. The bars may be tested the full size as rolled.

7. One tensile test shall be taken from each end of each plate as rolled, and at least two tensile tests for angle and rivet bars shall be taken from each cast.

Should a tensile test piece break outside the middle half of its gage, length, the test may, at the manufacturer's option, be discarded, and another test be made of the same plate or bar.

8. Cold Bends: Test pieces shall be sheared crosswise from plates and lengthwise from angles or bars, and shall be not less than 1½ inches wide but for small angles or bars the whole section may be used.

Temper Bends: The test pieces shall be similar to those used for cold bend tests. For temper bend tests the test pieces shall be heated to a blood red and quenched in water at a temperature not exceeding 80 degrees F. The color shall be judged indoors in the shade.

In all cold or temper bend tests, the sheared edges may be removed by milling, planing, grinding, or other method. The test pieces shall not be annealed unless the material from which they are cut is similarly annealed, in which case the test pieces shall be similarly and simultaneously treated with the material before testing.

For both cold and temper bends the test piece must withstand, without fracture, being doubled over until the internal radius is not greater than the thickness of the test piece, and the sides are parallel.

Bend tests may be made either by pressure or by blows.

For rivet bars, temper bend tests only are required.

9. One cold or one temper bend test shall be taken from each plate, section or bar as rolled.

10. Rivets selected by the representative of the engineer

(or of the purchaser) from the bulk, in such proportion as may be specified and approved, must withstand the following tests:

(A) The rivet shanks shall be bent cold, and hammered until the two parts of the shank touch without fracture on the outside of the bend.

(B) The rivet heads shall be flattened, while hot, without cracking at the edges. The head shall be flattened until its diameter is 2½ times the diameter of the shank.

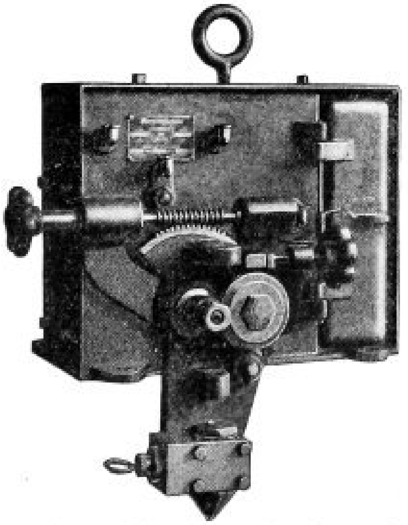
11. The maker shall adopt a system of marking the ingots, billet, slabs, plates, sectional material, etc., which will enable all finished material to be traced to the original cast; and the representative of the engineer (or of the purchaser) shall be given every facility for tracing all plates and sectional material to their respective cast, and for witnessing the required tests.

12. The representative of the engineer (or of the purchaser) shall have free access to the works of the manufacturer at all reasonable times. He shall be at liberty to inspect the manufacture at any stage, and to reject any material that does not conform to the terms of this specification.

13. The manufacturer shall supply the material required for testing free of charge and shall, at his own cost, furnish and prepare the necessary test pieces, and supply labor and appliances for such testing as may be carried out on his premises in accordance with this specification. Failing facilities at his own works for making the prescribed test, the manufacturer shall bear the cost of carrying out the tests elsewhere.

Westinghouse Automatic Arc Welder

THE new Westinghouse Auto-Arc is a machine for automatically feeding a continuous welding wire, used in metallic electrode welding, to the work at any speed up to three feet per minute, which is necessary to maintain a constant arc length and a constant arc voltage. This machine strikes the arc automatically and if necessary will exert a pull of approximately two hundred pounds in order to prevent fusion of the electrode wire to the work.



Welding machine for use in plate work

This device relieves the operator of the tiresome and exacting hand labor of maintaining the arc and feeding the welding wire, and, due to the electrical conditions of the arc remaining practically constant, it is possible to secure a better weld and to deposit metal very much faster than can be done by hand welding.

The arc length maintained can be adjusted so that the arc can be maintained at an average value of from 15 to 20 volts and will remain almost constant at any given voltage. The ¼ horsepower feed motor and the electro-magnets do not obtain power from the arc circuit, and are, therefore, selected large enough to feed any size wire up to ⅜ inch.

This automatic arc welding equipment can be used to best advantage on work requiring the welding of long continuous seams, in production manufacturing operations and also for some repair applications such as building up worn crossheads, and crosshead guides, and valve guides for locomotives. It is also applied in building up worn flanges for yard locomotives and street railway car wheels.

In such industries as the automobile, shipbuilding, steel bridge building, car building, naval yards, tank car, oil tank building, metal sash manufacturing, and structural steel fabrication, this device has many applications.

Many advantages, are claimed for it, including better fusion due to the use of a higher current, ease of operation, permitting an inexperienced operator to handle it; uniformity of deposit making better quality work, and the reduction in costs due to the ability to use wire in continuous lengths and eliminating the necessity of straightening and cutting. Other features of this equipment are dirt proof housing and ease of accessibility to parts.

Fall Meeting of the American Welding Society

TECHNICAL sessions, exhibitions and demonstrations will be held in connection with the annual fall meeting of the American Welding Society at the Broadway Auditorium, Buffalo, N. Y., November 16, 17, 18 and 19. A large variety of welded products will be a unique feature of the exposition of welding apparatus and supplies, which will open on Tuesday afternoon, November 16. The technical sessions will begin Wednesday morning at 10 A.M. During these sessions the progress made by the welding research department of the American Welding Society (American Bureau of Welding) will be discussed. The program for the meeting is as follows:

WEDNESDAY, NOVEMBER 17

Morning: "Welding of Locomotive Parts," by M. Gjersten, master welder, Northern Pacific Company; "Organization of Welding on the Railroad," by F. H. Williams, assistant test engineer, Canadian National.

Afternoon: "Comparative Tests on Arc and Riveted Structural Members," by A. M. Candy, general engineering department, Westinghouse Electric & Manufacturing Company: "Tests on Welded Roof Truss," by H. H. Moss, Linde Air Products Company.

THURSDAY, NOVEMBER 18

Morning: "Welding Science in the Engineering Curriculum of Universities," by Prof. G. J. Hoffman, Purdue University; Prof. B. L. Lucas, Mississippi Agriculture and Mechanical College; Prof. S. T. Hart, Syracuse University; Prof. deZafra, New York University; Prof. R. D. Rickley, Ohio State University; Prof. F. V. Larkin, Lehigh University.

Afternoon: Welding Wire Specifications Committee, C. A. McCune, chairman; meeting of the American Bureau of Welding; dinner dance.

FRIDAY, NOVEMBER 19

Morning: Short technical session on Welding in a Gaseous Atmosphere, including demonstrations and exhibitions, will be made by P. P. Alexander and R. A. Weinman, of the General Electric Company; meeting of Directors.

Afternoon: Inspection trip to Niagara Falls Power House.

Questions and Answers for Boiler Makers

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

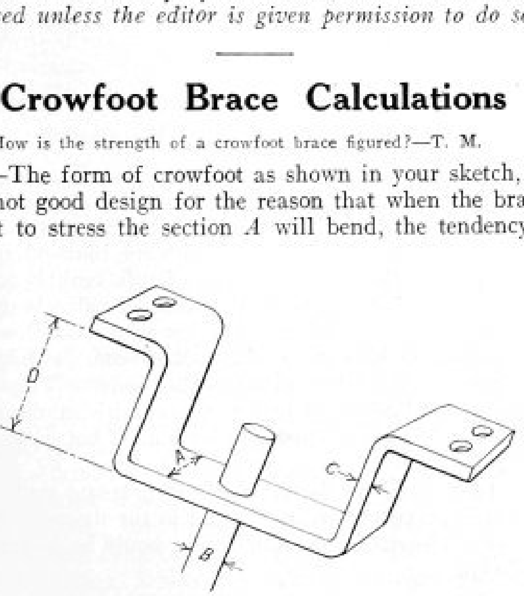
Conducted by C. B. Lindstrom

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

Crowfoot Brace Calculations

Q.—How is the strength of a crowfoot brace figured?—T. M.

A.—The form of crowfoot as shown in your sketch, Fig. 1, is not good design for the reason that when the brace is subject to stress the section *A* will bend, the tendency being to form a U section. This condition would allow the surface so supported to deflect.



Type of crowfoot brace

Since you have not stated whether this crowfoot is designed for diagonal stays or through stays we are assuming it for use with a through stay.

The A.S.M.E. Code requires for this form of stay that the front head in return tubular boilers be supported by means of nuts inside and outside and the rear head by structural shapes. Refer to Fig. 8, A.S.M.E. Code p. 201 to p. 223.

Diagonal Seams in Patches

Q.—I would like to know if you could give me the address of the Hunt Inspection of Chicago? I would also like to know whether a man has to pass an examination to work for those people, or does he have to be recommended by some one? I would appreciate any information you could give me in this matter. I would also like to ask why patches applied on shell of boilers have to be laid out and cut on 45-degree angle?—J. P. R.

A.—Write to R. W. Hunt Company, 2200 Insurance Exchange, Chicago, Ill. They will give the necessary facts on their requirements and qualification of applicants for their different departments of engineering and inspection.

Boiler patches are made in various shapes, and should be so designed as to obtain the strongest seam possible. Diagonal seams in patches need not be at an angle of 45 degrees, provided the seam gives an efficiency of joint at least equal to that of the longitudinal seam.

For a given pressure the stress per square inch of joint in a boiler shell is twice as great in the longitudinal joint as in the girth seam; therefore, the efficiency of the girth seam need be only half as great as the efficiency of the longitudinal seam. This is the reason why girth seams are usually single riveted. Since the ratio of the stress on the seams is 2 to 1, it is evident that a diagonal seam of the same proportions as a horizontal seam will have an effective efficiency between the efficiency of the longitudinal seam and its efficiency if it were a girth seam; depending on the angle the diagonal seam makes with the girth joint.

Brace Calculations

Q.—Having recently become one of your subscribers, I would like to avail myself of your department in settling the following question:

Locomotive type portable boiler 75 horsepower, 175 pounds pressure, built to the A.S.M.E Code. Back heads, 456 square inches net area to be stayed, using ten 1¼-inch weldless Scully braces, with two ⅞-inch rivets at each end. Holes reamed $\frac{15}{16}$ inch.

Front tube head 431.8 square inches net area to be stayed, using ten 1¼-inch Scully weldless braces, same number of rivets, same size reamed holes as in back head above.

What size rivets should be used on these braces according to the code?—T. C. E.

A.—Par. 223-8 A.S.M.E. Boiler Code specifies that the combined cross-sectional area of the rivets at each end of the brace to equal at least 1¼ times the *required* cross-sectional area of the brace. In this case the diameter of the braces equals 1¼ inches. Cross-sectional area of each brace equals $1\frac{1}{4}^2 \times 0.7854 = 1.22$ square inches. Diameter of rivets (driven size) equals $\frac{15}{16}$ inch; equals 0.9375 inch. Cross-sectional area of 1 rivet equals $0.9375^2 \times 0.7854 = 0.6903$ square inch. $0.6903 \times 2 = 1.3806$ square inches. $1.227 \times 1.25 = 1.5334$ square inches, required cross-sectional area of rivets; showing that the combined cross-sectional area of the two $\frac{15}{16}$-inch diameter rivets is too small.

$1.5334 \div 2 = 0.7667$ square inch required cross-sectional area of one rivet. The nearest rivet size giving this area is a $\frac{15}{16}$-inch rivet diameter, being driven to a 1-inch diameter, the cross-sectional area of which equals 0.7854 square inch.

We have not checked the required *cross-sectional area of the braces* because in order to do this the measurements for determining the stresses in diagonal stays must be given.

Fire Cracks

Q.—How do fire cracks form?—R. E.

A.—Fire cracks, or lap fractures, arise very often in externally fired boilers from exposure to the fire; too much pinning with the drift pin; and to punched holes, not properly reamed. Such fractures may extend from the rivet hole to the outer edge of the lap, into the body of the plate, and between rivets. Cracks between rivets may extend from one rivet to the other, until a seam fracture results. Such a condition is dangerous and therefore should receive attention as soon as discovered.

Camber and Cone Calculations

Q.—As a subscriber to The Boiler Maker and an interested reader of your section, I would appreciate your help in a few boiler shop problems:

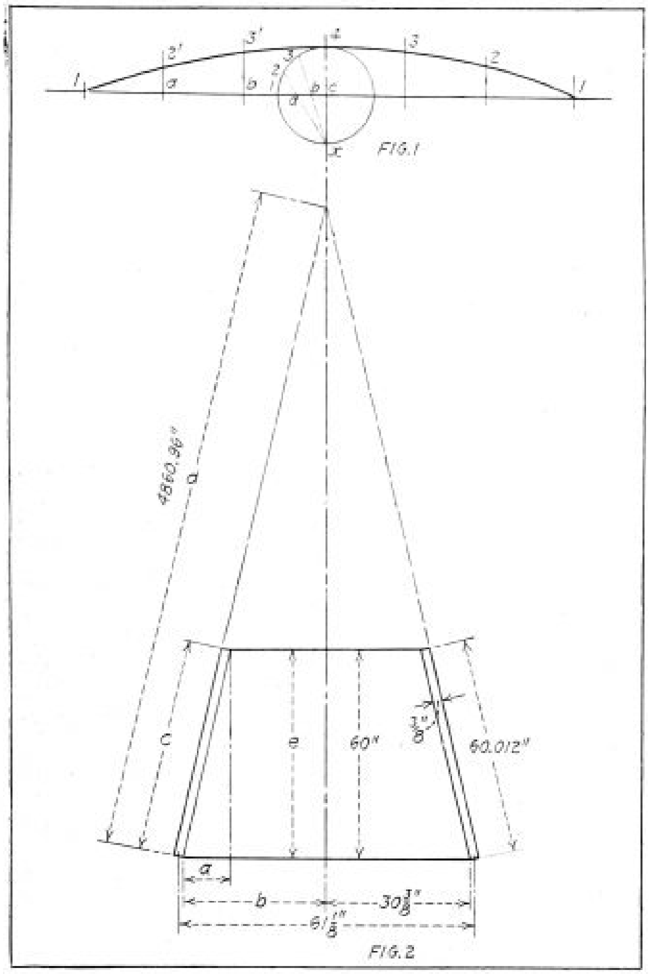
(1) A method to layout the camber on shell plates of a large tank having a long taper, say 5 feet diameter and courses 5 feet high, and tapered to fit inside at the joints (telescopic plates) ⅜-inch thick. Also a method for calculating the amount of camber in such plates.

(2) Is there a method of calculating the diagonal on a rectangle or square by the use of a table of the natural functions of trigonometry?

(3) What purpose does the double casing serve on a marine smokebox which usually has an air space between the said casing and smokebox?

Hoping for an early reply through your column.—T. J. G.

A.—(1) A short method for laying off the points on the camber line is shown in Fig. 1. The stretchout *1-1* is laid off first, then the height *C-4* or *versed sine* commonly referred to in laying out. With *C* as a center draw a circle with *C-4* as a radius. Divide one quarter of the circle into a number of equal parts. Also divide one half the stretchout into the same number of equal divisions. Make *b-3'* equal *b-3* and *a-2'* equal *a-2*. Through points *1-2'-3'-4* draw in the camber line.



To determine camber of shell plates for large tanks

The calculations for ascertaining the versed sine, involves first the finding of the length of the side of the conical section shown at *C*, Fig. 2, and the slant height of the cone of which the frustum is a part.

The length $C = \sqrt{A^2 + e^2} = \sqrt{0.375^2 + 60^2} =$ 60.012 inches.

The slant height of the cone, *d* may be found by proportion based on the following ratios: The thickness of the shell plate *a* is to the radius *b* of the cone as the width *c* of the frustum is to the slant height *d* of the cone:

$$\text{Thus } \frac{a}{b} = \frac{c}{d}$$

$$\text{and } d = \frac{b \times c}{a} = \frac{30.375 \times 60.012}{3/8} = 4{,}860.96 \text{ inches.}$$

This radius is too great for drawing the camber line for the base of the cone, therefore the simplest way is to determine the versed sine *x* as shown in Fig. 1. This may be done graphically or by calculation.

By calculation, square the length of the stretchout, measured from center to center of rivet holes and divide the product by 8 times the radius (slant height of the cone) measured in inches, the quotient is the versed sine.

For heavy plate work make the stretchout calculations to the neutral layer of the plate, using the diameter *d'* Fig. 2. Thus, $61\frac{1}{8} \times 3.1416 = 192$ inches.

$$\text{Then, } \frac{192 \times 192}{8 \times 4{,}860.96} = 0.95 \text{ inch.}$$

(2) The solution to problems of this character can be obtained trigonometrically using the functions, sine, cosine, tangent etc., when the angles are given. If the dimensions *a-b* and *b-c*, Fig. 3, are known the diagonal *a-c* may be found as follows:

$$ac = \sqrt{ab^2 + bc^2}.$$

(3) To prevent radiation of heat.

Blow-Off Tanks

Q.—We build a number of tanks called *blow-off tanks;* what are they used for?—N. O.

A.—A blow-off tank is connected below the level of the blow-off valve, connecting directly with the blow-off piping leading to the boiler. The purpose of this tank is to trap the hot water and steam, when the blow-off valve is opened for blowing down the boiler. The hot water is allowed to cool and at each blow-down the cooler water is displaced by the hot water discharged from the boiler. The water thus cooled is discharged into a sewer, without damaging the sewer, which might otherwise be done if hot water were discharged.

Such tanks need not be designed as pressure tanks, if a vent pipe is installed, at least, equal to the diameter of the inlet pipe. The discharge outlet pipe should be larger than the inlet pipe.

TRADE PUBLICATIONS

From the Ore to the Bolt.—This book, which is being issued by the Bourne-Fuller Company, Cleveland, Ohio, is intended primarily to present in pictorial form the story of the manufacture of bolts and nuts from the ore to the finished product in a complete plant. Each picture contained in the books shows a different stage of development in the manufacture of bolts and nuts in the Upson Works of this company.

Boiler Water Treatments.—This brief treatise on modern methods of water treatment and care of boilers has been prepared for distribution by the Bird-Archer Company, New York. The subject matter includes chapters on common impurities found in natural water supplies, scale formation, boiler corrosion and preventive treatments, foaming and leaking and their prevention, the important subject of boiler washing, types of blow off cocks and their use, treatment of water for stationary boilers and a final explanation of the service which this company is in a position to supply to those boiler users, both locomotive and stationary, who are experiencing trouble in connection with the feedwater supply.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

Steamboat Inspection Service of the Department of Commerce

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

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—C. D. Thomas, Salem, Oregon.
Statistician—E. W. Farmer, Rhode Island.

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

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

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

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

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

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

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

Master Boiler Makers' Association

President—J. F. Raps, general boiler inspector, Illinois Central.

First Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.

Second Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.

Third Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.

Fourth Vice President—George B. Usherwood, supervisor of boilers. New York Central.

Fifth Vice President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington and Quincy.

Secretary—Harry D. Vought, 26 Cortlandt Street, New York.

Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.

Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—J. W. Kelly, National Tube Company, Pittsburgh, Pa.

Vice President—A. W. Clokey, American Arch Company, Chicago, Ill.

Treasurer—George R. Boyce, A. M. Castle and Company, Chicago, Ill.

Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie, Pa.

Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.

Secretary-Treasurer—A. C. Baker, 801 Rockefeller Building, Cleveland, Ohio.

Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; Owsley Brown, Springfield Boiler Company, Springfield, Ill.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Wroks, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

Cities

Chicago, Ill.	Memphis, Tenn.	St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Los Angeles, Cal.	Philadelphia, Pa.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Missouri	Pennsylvania
California	New Jersey	Rhode Island
Delaware	New York	Utah
Indiana	Ohio	Washington
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Nebr.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Memphis, Tenn.	Philadelphia, Pa.	Tampa, Fla.

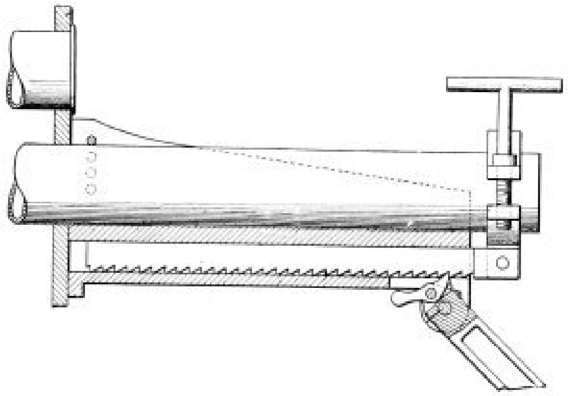
SELECTED BOILER PATENTS

Compiled by
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,596,464. DAVID SMITH, OF WELLESLEY, MASSACHUSETTS. TUBE-EXTRACTING JACK.

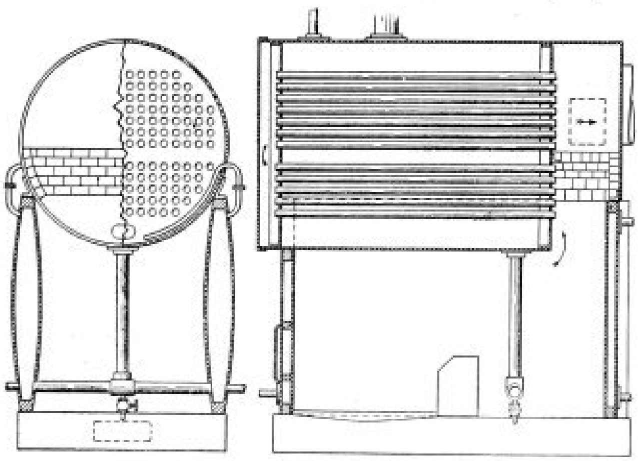
Claim 1.—A tube extractor and setter comprising a jack having a channel shaped standard to receive the tube, means for detachably securing



the standard upon the tube, a lifting member, means for reciprocating the same longitudinally of said standard and means for clamping said tube pivotally connected to said lifting member. 5 Claims.

1,597,567. FREDERIC W. BAKER, OF CLAYMONT, DELAWARE, AND JOHN R. O'NEILL, OF BALA, PENNSYLVANIA. BOILER.

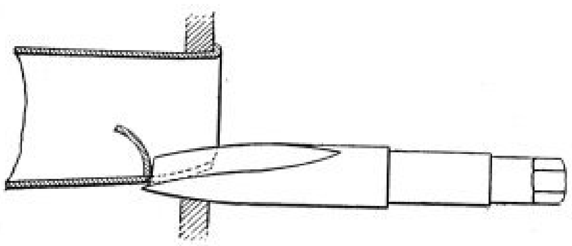
Claim 1. In a firebox structure for a boiler, a wall comprising two



outwardly curved, oppositely disposed plates co-operating to provide a water chamber.
Three claims.

1,598,458. JOHN P. SULLIVAN, OF NEW YORK, N. Y. TOOL FOR REMOVING BOILER TUBES.

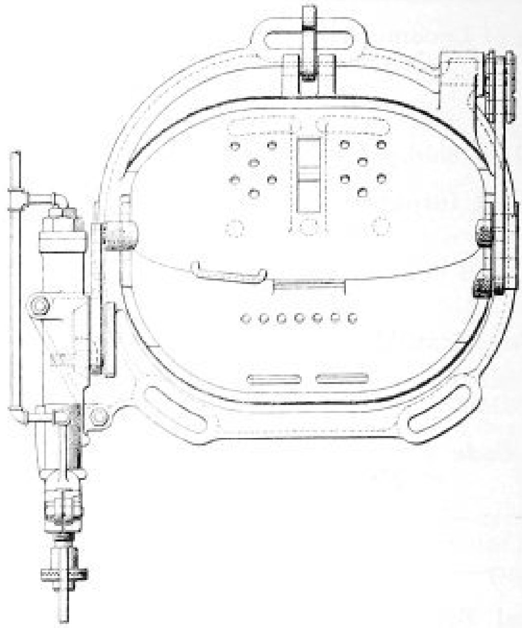
Claim 1.—A tool for facilitating the removal of boiler tubes, comprising a body having a beveled upper face, a curved lower surface, and a rib on the beveled upper face, said tool being adapted to be driven between



the end of a tube and the wall of the opening in the crown sheet of a boiler to cause a longitudinal strip to be ripped from the tube by the rib, and the edges of the tube defined by the ripped strip adapted to move up the beveled face to curl the said edges and thereby contract the end of the tube. 4 Claims.

1,582,160. FIRE-BOX DOOR. EINAR JOHAN BRING, OF FRANKLIN, PENNSYLVANIA.

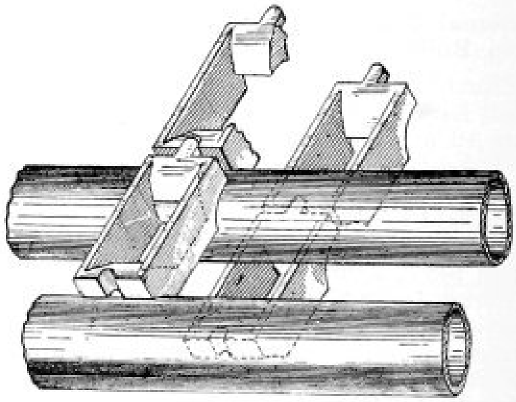
Claim 1. A clam shell door for a re box opening including segments rotatable toward the box to uncover the opening and outwardly to cover the



opening. A clam shell door for a re box opening including segments having their ends pivoted adjacent the box so that the segments rotate toward the box in door opening movement. Sixteen claims.

1,596,540. DAVID S. JACOBUS, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY. BAFFLE.

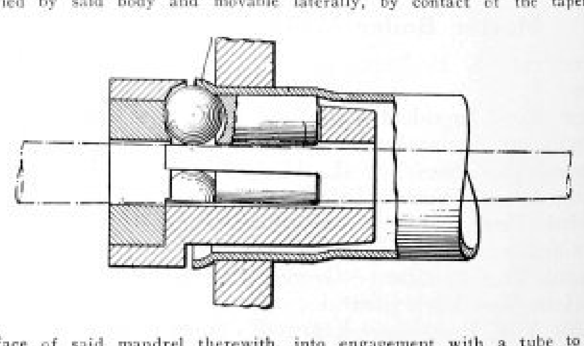
Claim 1.—A metallic member for a baffle, said member having relatively



thin flat side walls and relatively thin curved end walls adapted to engage boiler tubes, said walls being spaced apart to form an opening in the body portion of said member. 15 Claims.

1,596,262. JAMES WALKER, OF ELIZABETH, NEW JERSEY. TUBE EXPANDER AND FLARER.

Claim 1.—A tube expanding and flaring tool, including a body having an opening therethrough for the reception of a tapered mandrel, rollers carried by said body and movable laterally, by contact of the tapered



surface of said mandrel therewith, into engagement with a tube to be expended, and spherical flaring members carried in said body at one end thereof and each having a single point of contact with the tapered surface of said mandrel and movable laterally outward relative thereto, as the mandrel is fed longitudinally through the opening in said body, to engage and flare the end of said tube. 2 Claims.

The Boiler Maker

Volume XXVI December, 1926 Number 12

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 Church Street, New York, N. Y.

Edward A. Simmons, *Pres.*
L. B. Sherman, *Vice-Pres.*
C. R. Mills, *Vice-Pres.*
Roy V. Wright, *Sec'y.*
Henry Lee, *Vice-Pres. and Treas.*
Samuel O. Dunn, *Vice-Pres.*
F. H. Thompson, *Vice-Pres.*
George Slate, *Business Manager*

Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ave.
Mandeville, La.
Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.
Cable address: Urasigmec, London.

H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

The Boiler Maker is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

Entered at the Post Office at New York, N. Y., as mail matter of the second class. The Boiler Maker is registered in the United States Patent Office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. When paid through the London office, 34 Victoria Street, S. W., 1, 12s 6d., single copies, 1s 2d.

Request for change of address should reach us two weeks before the day of the issue with which it is to go into effect. It is difficult and often impossible to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address please be sure to send us your old address as well as the new one.

CONTENTS

Annual Index

THE annual index of The Boiler Maker for the year 1926 will be published separately from the magazine at the end of the year. As the complete index will be useful only to those of our subscribers who have kept a complete file of the magazine for the year, only a sufficient number of copies will be printed to meet the requirements of those who notify us at once of their desire for a copy. A copy of the annual index will be mailed without cost to each subscriber whose request for it is received at our New York office on or before January 15, 1927.

Progress in Boiler Construction

DEVELOPMENTS in the field of steam power engineering, both in land and marine practice, during the past year have been toward higher pressures, higher superheat and above all heat economy at all pressures.

Reviews of the developments during the year in stationary and locomotive boilers as prepared by committees of the American Society of Mechanical Engineers are given elsewhere in this issue. Briefly, advanced power station practice has boosted the former maximum of 350 and 400 pounds working steam pressure up to 600, 900 and 1,200 pounds per square inch. Suggestions have even been made of utilizing the critical steam pressure of 3,300 pounds. Grave problems of design, construction and inspection now face the boiler industry because of this adoption of high pressures, the use of which will rapidly increase as time goes on.

The technique of construction for such boilers has advanced in the past year to the point where the requirements for future work are fairly well known. One of the most striking features of this development is the fact that with drums of relatively small diameter, shell thicknesses are demanded which exceed the practical limits of riveting for the joints. Experience with large bore rifles, hydraulic cylinders and other forms of high pressure construction has supplied the boiler manufacturer with a type of forged seamless drum that answers all requirements. In fact the production of drums of this character has reached such proportions that the American Society of Mechanical Engineers' Boiler Code Committee, in cooperation with the American Society for Testing Materials, has proposed a new specification covering material required for such forgings. This specification has been approved for publication as an addendum to the material specifications of the Boiler Code.

The attachment of nozzles and fittings to drums of such great shell thickness have also required careful attention and a treatment that is more or less new to the industry. Various means have been adopted to make such fittings and attachments permanently tight. One method adopted with a considerable degree of success is to forge down one end of the drum and machine directly on it a pipe flange to be used as a direct connection for the header or the main stop valve. In another case where a nozzle is required at the side, the flanged plate or nozzle is fitted with studs since the great thickness of the shell provides an ample depth of thread. One proposal has been made to insert the end of the neck of a long bodied nozzle into a drilled hole in the shell and expand it at the inner end in a similar manner to a boiler tube.

Inspection during the construction of high pressure boilers and after they have been placed in service must be of the most painstaking variety. The causes of leaks and of deterioration of the metal in a high pressure boiler as well as in all fittings are practically an unknown quantity at present. The potential hazard to public safety in such boilers if not properly guarded is tremendous and can only be prevented by constant and adequate inspection by well qualified men.

In the steam locomotive a corresponding tendency towards higher pressures and temperatures is noted. More locomotives using high steam pressures have been built during the year than in any preceding one. The Pennsylvania Railroad ordered two hundred 4-8-2 type locomotives with 250 pounds per square inch pressure; the Illinois Central fifty 2-8-4 locomotives carrying 240 pounds; the New York Central twenty-five additional 2-8-4 freight locomotives carrying 240 pounds and the Northern Pacific twelve 4-8-4 locomotives also having 240 pounds per square inch working pressure. The Baldwin Locomotive Works built one 4-10-2 type engine carrying 350 pounds per square inch pressure; at the American Locomotive Works several 4-8-2 type locomotives working at 250 pounds pressure and equipped with the McClellon watertube firebox were built for the New York, New Haven and Hartford Railroad. Abroad, the outstanding development in the field of high pressure is the 4-6-0 three cylinder compound locomotive built by Henschel and Son of Germany to the designs of the Schmidt'sche Heissdampf Gesellschaft and carrying three different boiler pressures, namely, 1,200, 900 and 200 pounds per square inch.

High heat economy, which means essentially the conservation of fuel, is rapidly bringing about the re-establishment of the steam power boiler in its proper place as an economic factor in relation to oil engine, hydraulic and other forms of power which until recently showed economies not possible in the old days of steam.

There is every indication that the advance and general adoption of boiler developments to new boiler construction in all fields will be even more rapid in the coming year.

Boiler Exhibits at the Power Show

IN view of the important, and in many cases, somewhat radical developments that have been taking place in the design and construction of steam boilers during the past year it was only natural to assume that the boiler making industry would be well represented at the annual Power Show which was held in New York early this month in connection with the annual meeting of the American Society of Mechanical Engineers. Contrary to expectations, however, out of a total of nearly 500 exhibitors only 12 were boiler manufacturers. Excellent as these relatively few boiler exhibits were, they can hardly be said to be an adequate representation of the boiler making industry or to indicate the importance of the boiler in power plant equipment. The New York Power Show is national in character and affords an excellent opportunity each year to bring before the leading engineers of the country the latest developments in the generation of steam for power purposes. If the manufacturers of other types of power plant equipment find that it pays to take advantage of such opportunities as this for publicity and educational propaganda, why should the boiler manufacturers neglect it?

LETTERS TO THE EDITOR

Experimental Boiler Crown Sheet Design

TO THE EDITOR:

In the October issue of THE BOILER MAKER we have an interesting problem before us in E. J.'s description of the deflection of wrapper and crown sheet in his experimental boiler when under pressure. As you state in your reply, it is evident that there is lack of sufficient staying and, as there are no definite measurements given of these parts, we are forced to surmise a good deal.

Now I would like to suggest to E. J. that the length and shape of his crown sheet are such as to offer no great resistance to pressure when it is handicapped, as we might say, by the insufficient staying of the wrapper sheet.

Would it not be good policy to apply the crown sheet with a radius to it, even at the expense of shortening the side sheets, so that in raising the height of the crown sheet along its central line we would not lessen the area between the crown sheet and the bottom row of flues? This would give us the advantage of a surface that would not accumulate scale and mud so easily as a flat surface.

In the area between the top row of cross stays and the outer row of radials, I would suggest leaving out the top row of cross stays; also the outside flue in the top row on each side. Apply tee irons to the shell in this space at a distance apart of not less than two rows of cross stays and apply cross braces with jaws securely bolted to the tee irons. Removing the two flues would give clearance for the tee iron and also preclude the possibility of an accumulation of scale between the flue and the shell, which so often occurs at these points. Also, the added circulation would more than offset the presumed loss in the heating surface.

The fire door shown calls for improvement. Here we have another flat surface at the top of the door. This type of fire door is known as a mud catcher. Would it not be better to have it of circular or elliptical design thus affording a better opportunity of keeping it clean and free from mud blisters?

Lorain, Ohio. JOSEPH SMITH.

Staying Crown Sheets

TO THE EDITOR:

In order to obtain the maximum amount of efficiency and service that we expect but do not always obtain from crown sheets and crown bolts, it is very necessary that the sheets and bolts be properly threaded and applied.

This result can only be accomplished with proper taps and careful consideration of the pitch of the thread when threading the bolts.

If, as is very often the case, the threaded portion of the tap is not long enough, and some style of spindle tap is not used to engage both the crown and roof sheets at the same time, the tap would in all probability start in the second sheet off the pitch of the thread. A casual inspection of the threaded holes reveals a perfectly cut thread, top and bottom, but such is not the case as regards the pitch of the thread; the threaded portion of the tap should be long enough to overcome this, thus insuring a perfect pitch; or some style of spindle tap should be used.

The threading of the bolts is an operation where great care must be taken. Where this is done on a turret lathe and no consideration taken of the pitch of the thread, as regards length of the bolts, a poor fitting bolt is the result.

The result of these two operations, if not perfect, is that when the bolts are applied they are too hard to screw in, and the threads are turned or strained on either the bolt or the sheet. This can be proved by turning out a bolt and examining the thread on the bolt and sheet. Then again, the crown sheet is pushed or pulled at this particular point the amount that the pitch of the thread is off, one way or the other. This applies to bolts of the proper size, as we understand that a bolt that is too tight will also damage the thread if strained. True, where any pitch of thread is used there is not at the most more than one-half a pitch, but, nevertheless, it is there and where one bolt is off *up* and the other is off *down* we have twice one-half or one full thread, which means that either the bolt or the sheet has to take this strain which means a poor job.

If the previous two operations are perfectly performed we eliminate these strains on the crown sheet and bolts and obtain a perfectly meshed thread on both sheet and bolt, which makes a good tight job that will stand up and give the maximum amount of efficiency and service.

This is one of the sensitive spots on our boilers and should be given all the consideration and care that it is entitled to.

Olean, N. Y. ALEX MCKAY.

Deflection in Boiler Sheets

TO THE EDITOR:

The writer has read with interest the article in the October issue of THE BOILER MAKER on the "Deflection in Boiler Sheets." The question found here is one that is, no doubt, present in the majority of firebox boilers, but, on account of their very acceptable performance over a long period of years, the fact of their deflections has not come to the surface. Perhaps, private investigations have been made, but, to the best of my knowledge, nothing has been printed on the subject.

In a firebox boiler the designer tries to replace the lower half of a cylinder with plates shaped to conform with the contour of the firebox, stayed or strengthened in such a manner as to duplicate the joint at the tangent of the upper circle, and have the condition as found in a cylinder. Obviously, this is impossible.

There are a few questions that have come to my mind since reading this inquiry which are as follows:

1. After the pressure was released, did the plates assume their original position?
2. Was any deflection noted in the water leg sides and, if so, in which direction?
3. Was the maximum deflection of the crown sheet the same as the maximum deflection of the outside wrapper?

In hemispherical bottom tank construction, similar stresses are found as explained by Ernest G. Beck in his book on "Tank Construction," published by Emmot & Company, Ltd., London, England. On page 185 of this book Mr. Beck shows a semi-elliptical bottom tank, and graphically, by the trial method, determines the shape under pressure. In the conclusion, he states that no practical thickness of the sheet could give sufficient strength and stiffness to maintain the shape of the trough against loading. Mr. Beck also states that this construction could be stiffened by means of curved ribs and bracing which, to my mind, would be the correct method. Stiffening of this nature would naturally be costly, and, probably, detrimental to the best performance of the boiler by restricting the circulation.

In regard to the deflection, 1 inch seems considerable, and in all probability, means that when the pressure was relieved the sheets did not return to their original positions. If this is true, some part of the boiler passed its elastic limit, and there was permanently set. If the plates returned to their original position, it would mean that the stresses were below the elastic limit of the structure or the plate, and, therefore, static stresses would give way to fatigue stresses as being more important in designing the boiler.

This topic is a very interesting one and worthy of a great deal of consideration.

Joliet, Ill. W. B. RUSSELL.

Locomotive Boiler Practice in England

TO THE EDITOR:

I have read with great interest an article in the October issue of THE BOILER MAKER regarding Railway Shops in the British Isles. Although this article is not yet completed I venture to criticize some of the statements made. I understand that Eastleigh, Swindon, Crewe and Derby were places visited; surely the incident regarding the patch on the belly of the boiler and the manager beginning to wake up could not possibly have happened at one of these places. In a small private concern with inefficient workmen I might give the story credit, but it would have been an impossibility for such a job to have been executed at one of the above places. At each place mentioned a highly efficient staff is employed and is ably managed by expert foremen. Imagine the criticism the foremen would get if he even suggested such a patch, notwithstanding the fact that the inspector would condemn it. Also it is not general practice to hot roll copper plates to shape, they are usually rolled cold. The same applies to flanging of copper plates, these are then annealed afterwards. It is quite correct that the Belpaire type of boiler is the general design in locomotive work, and that the boiler shell is of boiler steel, with copper fireboxes and copper staybolts, but in nearly all cases steel flues are used, and with very few exceptions (personally I do not know of any) brick arches *are used*. Regarding the iron staybolt in the illustration, these are usually steel and are now very largely used in the nonbreaking zone. The general practice being to apply the nut only on the firebox side as a protective measure, the shell side is simply calked with no nut. Applied to a great number of boilers these stays have given good results.

Trusting you will receive these criticisms in the spirit in which they are sent. Personally I have been delighted with the enormous scope which THE BOILER MAKER covers and the many valuable hints given.

Brighton, Sussex, England. C. H. WHAPHAM.

Lancashire Boiler Flues

TO THE EDITOR:

In reference to the article "New Design of Lancashire Boiler Flues," by John Gordan Kirkland, in the November issue of THE BOILER MAKER, will say that after having carefully studied both his design and the comments accompanying same, I am certain that the construction would not meet the requirements of either the British Board of Trade, or any other boiler regulations code, where the requirements are such as to absolutely prohibit the use of welded joints where in tension.

In Mr. Kirkland's proposed design, the tee bars are on the outside of the flue and in order to be of any value whatsoever, they must be rigidly fastened to the flue. Why? To give the flue stiffness against collapse. It is plain, that whatever connection is made between the tee bars and the flue will be in tension, yet Mr. Kirkland states in his article that the electric welding which binds them to the flues does not depend on this structure to support the flues against collapse. Let us imagine then that welding, being unnecessary, is dispensed with; the rings will no more prevent the shell from collapsing than are my chances for swimming the English Channel. Not only are the rings of no value as supports, but they are actually a dead weight tending to sag an already over long beam. Better to place saddles under the flue if points of support is all that is meant by the B. O. T. regulations.

What Mr. Kirkland has in mind by shrinking the tee bar rings to the flue, is a "misery" to me, although I know, and anyone else can see that it would simply place an initial compressive stress in the flue plate. In other words, he is putting a load on the flue of the same kind that the flue will receive when under steam pressure from without. Bands are only shrunk on cylinders when it is necessary to prevent them from bursting, particularly when made of metals that have little or no tensile strength, like the cores of locomotive wheels, and fly-wheels, where the central body of the casting is of iron, and a steel band is shrunk on, as the tire or the rim. In conclusion, if I were requested to pass on Mr. Kirkland's proposed design, I should be obliged to condemn it, unless the tee bar rings were placed on the inside of the cylinder, but that in itself would be poor boiler design, probably prohibitive due to the excess of metal between the path of the hot gases and the water. The outstanding leg of the tee bars would be continually at near red heat, particularly at the top of the flange.

Yours very truly,

Erie, Pa. WILLIAM C. STROTT.

Railway Shops of the British Isles

TO THE EDITOR:

Readers of THE BOILER MAKER will remember a report under the above title which appeared in the October issue, being the substance of a paper presented at the Master Boiler Makers' Association convention by Thomas Lewis, chief boiler inspector of the Lehigh Valley Railroad.

Just to avoid the possibility of readers forming the opinion that we are a lot of numskulls in Britain, I am taking the privilege of refuting several of the comments contained in the paper submitted.

The opening paragraphs dealt mainly with the number of locomotives that our main services had in operation and the speeds at which they traveled. I hope Mr. Lewis found the Flying Scotsman quick enough for him. However, to proceed along the lines of fair comment, I wish to repeat this extract from the reports, viz.: Mr. Lewis says, "Some of the latter engines have been equipped with superheaters and in a few cases with brick arches. With these exceptions engines do not have any accessories."

I particularly want you to forget the authenticity of that statement. For example, the water chute suspended from the tenders is an accessory that can scoop up water as the train travels along at 60 miles per hour. Robert Stephenson's of Darlington (probably the finest locomotive builders in the world) made tenders like that 20 years ago.

Then again, we have another little accessory that escaped the eye of Mr. Lewis. I refer to the exhaust steam being carried into the side tanks or tender which heats the water before it passes into the boiler.

I wonder if our friend observed some little gadgets in the tubes (i.e., what you call flues), known as spiral retarders. As general information I may say that a spiral retarder is a piece of twisted plate which runs the full length of each tube in the path of the hot gases. The gases are forced to travel a greater distance and incidentally at a greater speed, thereby giving off a greater amount of heat, and radiation by friction. I would require about 20 pages of THE BOILER MAKER to enumerate the accessories now in operation on British locomotives.

And now to the copper boxes. Copper fireboxes are used in Britain because British engineers and boiler makers and rivet lads know that they give the best results and not because we get the same price per ton for scrap copper as we pay for new because we don't. Mr. Lewis admits that the copper plates are more ductile than steel and, consequently, more efficient in normal expansion and contraction. In addition to that, however, copper is a much better conductor of heat than steel. Therefore the evaporative duty per square foot of heating surface per unit is greater and consequently the consumption of fuel per unit is less. Steel fireboxes and steel tubes may be cheaper but the economy effected in the life of the copper box and copper flues or tubes more than compensates for the additional initial outlay.

The iron staybolts to which Mr. Lewis refers are not common iron, but what is known in this country as low Moor iron, also best Yorkshire iron. Both these special irons are equally as ductile as copper and rivets for foundation rings, fire hole rings and even for copper boxes are oftentimes made of these materials.

We will now follow Mr. Lewis in his interview with one of our works managers. From this we gather that a patch was fitted to the belly of a locomotive boiler without cutting away the defective plate. Mr. Lewis says the patch had longitudinal seams but they did not come up to 70 percent solid plate as they would be required to do in United States. From this we may assume that 70 percent is the standard in United States, irrespective of diameter thickness or pressure. If so it does not apply to our formulæ. Longitudinal seams vary from 60 percent to 90 percent according to the requirements of design, and if I am not mistaken the same prevails in America.

The amusing part about his interview with the manager was that the latter had apparently never heard of 70 percent and invited Mr. Lewis to return on the morrow to tell him all about it.

Having read Mr. Lewis' report, I can only conclude that he wished to impress upon his listeners how superior the American locomotive is to the British and how vastly more learned the men. Such ideas are erroneous to say the least.

Batley, Yorks, England. JOHN GORDON KIRKLAND.

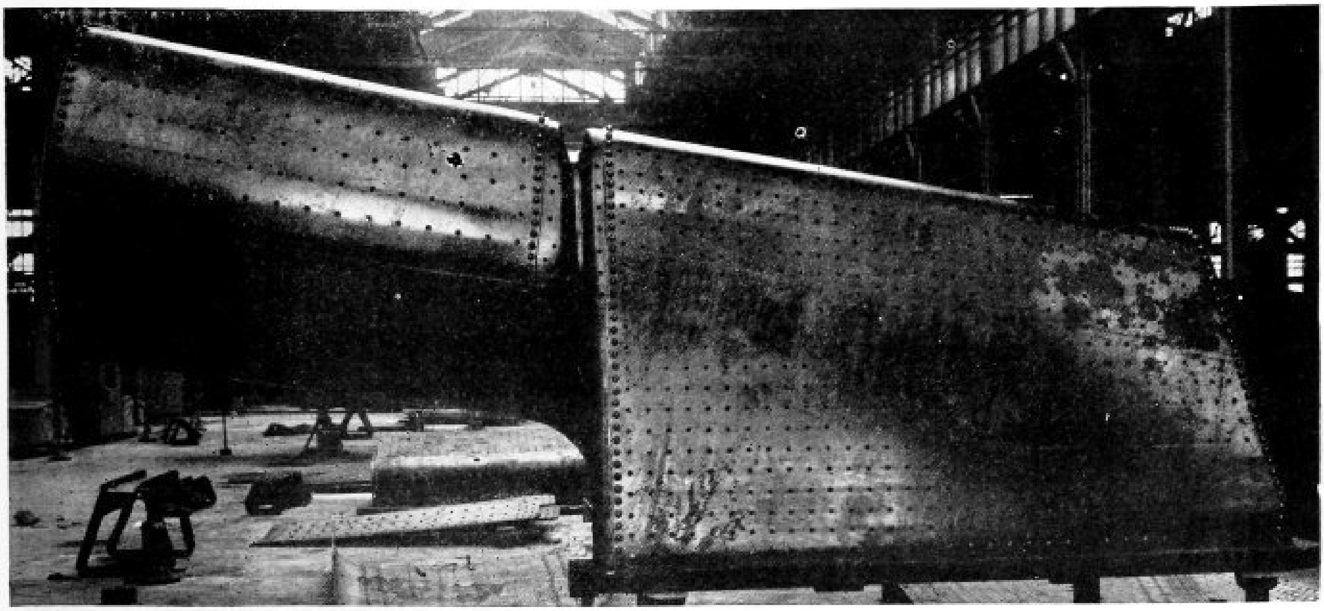
New Cruisers Ready for Guns—Boiler Makers Needed

The Navy's new light cruisers, the *Pensacola* and the *Salt Lake City*, have now reached the stage of construction where they are ready for their guns. Twenty-five boiler makers are needed at the Washington Navy Yard for the construction of the turrets, it is stated by the United States Civil Service Commission.

The indications are that the boiler makers will have at least a year of steady work. Those who are interested in this employment should address the Recorder of the Labor Board, Navy Yard, Washington, D. C.

The *Pensacola* and the *Salt Lake City* are two of the eight scout cruisers of 10,000-tons displacement authorized by Congress. These vessels represent an entirely new class of warships, a development resulting from the provision of the Treaty Limiting Naval Armaments. The Treaty limits the size of guns on such vessels to 8 inches in caliber.

W. M. Bastable, until recently general sales manager of the Wilson Welder and Metals Company, has been appointed manager of the New York office of the Electric Welder Controller Company, Pittsburgh, Pa., with offices at 26 Cortlandt street, New York city.



Inside firebox and combustion chamber complete, showing corrugated connection

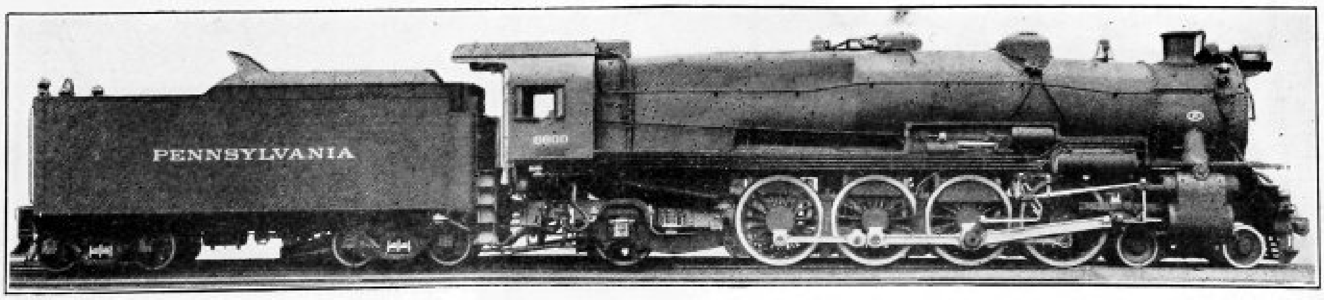
Pennsylvania 4-8-2 Locomotive Boiler Has New Features

Expansion joint formed by corrugated plate between firebox and combustion chamber and in bottom of tube sheet

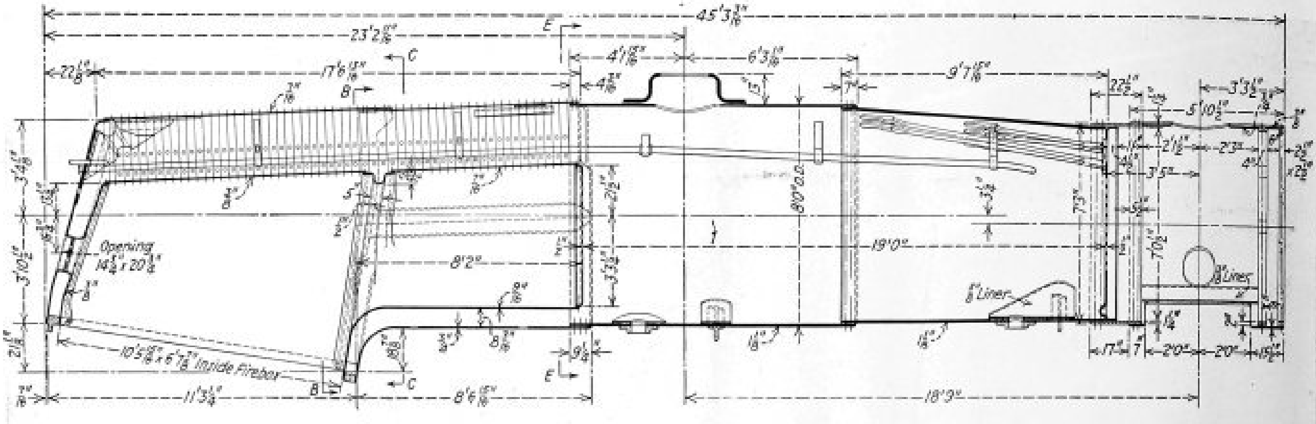
A NEW 4-8-2, type locomotive, notable because of its high capacity and unusual details of construction, was built by the Pennsylvania Railroad in 1923 at its Juniata shops, Altoona, Pa. In accordance with the Pennsylvania's policy, this locomotive was subjected to a series of exacting tests both on the road and at the Altoona test plant, before any additional units of the same class were ordered. After the locomotive had proved itself fitted for the service requirements, orders were placed with the Baldwin Locomotive Works for 175 and with the Lima Locomotive Works for 25 additional locomotives of the same type. These locomotives are designated by the railroad company as Class M 1, and are now being placed in service. They were designed by the motive power department of the Pennsylvania under the supervision of J. T. Wallis, chief of motive power. They are intended for heavy passenger service for which reason the driving wheels are 72 inches in diameter, but will also be used for fast freight service, for which the high drawbar pull makes them suitable.

The Class M 1 locomotive develops a tractive force of 64,550 pounds. The cylinders have a diameter of 27 inches and a stroke of 30 inches. The boiler has a working pressure of 250 pounds per square inch. With 266,500 pounds on the driving wheels, the factor of adhesion is 4.13. This high starting power in combination with a boiler of generous steaming capacity, enables these locomotives to develop large horsepower for sustained periods.

In accordance with the Pennsylvania's practice, the boiler of the Class M 1 is of the Belpaire type with tubes of moderate length—19 feet between the tube sheets. Exclusive of the smokebox, the cylindrical section of the boiler consists of two rings, the first of which is sloped, increasing the outside shell diameter from 84½ inches to 96 inches. The dome is placed on the second ring. It is of pressed steel and measures 31 inches in diameter



Pennsylvania Mountain Type Locomotive, Class MI



Elevation Drawing of the Boiler

and 13 inches in height. The longitudinal seam on this ring is placed on the right hand side and after the sheet has been rolled to a circular shape it is flanged on top at the rear to form the hip joint connection for the Belpaire firebox.

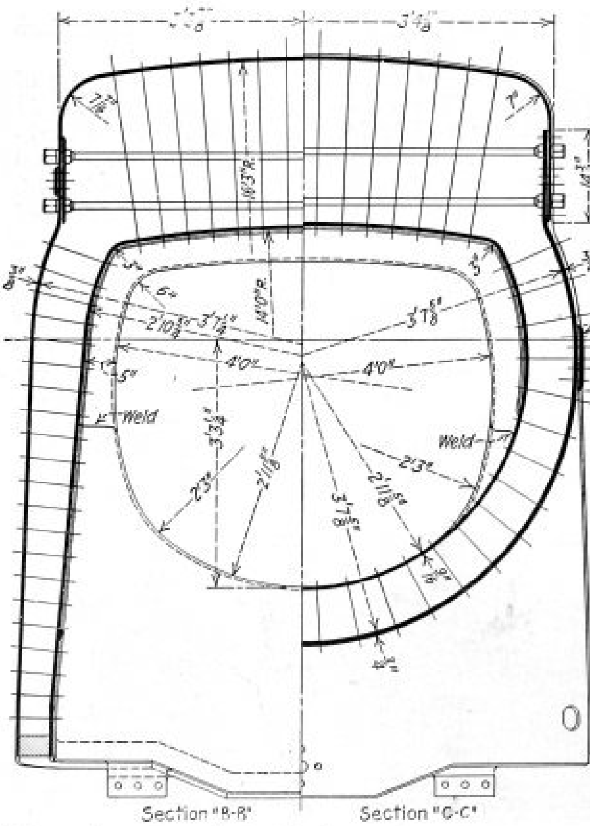
The combustion chamber in the boiler is 8 feet 2 inches long and this necessitates the use of a wrapper or outside shell section of corresponding length, having the Belpaire shape and staying. This combustion chamber section of the outside shell is made up of four pieces, namely: a bottom half, which is in one piece with the outside throat sheet; two side pieces and a top piece. The radius of the throat is unusually large, being 16 inches at the center, reducing to a smaller radius at the sides. The outside firebox shell is of three piece construction, the top and sides being separate.

The crown and sides of the inside firebox are in one piece and the inside throat sheet is in one piece with the lower half of the combustion chamber. The sides and crown of the combustion chamber constitute a separate sheet, which is butt welded to the lower sheet on each side. The firebox and combustion chamber are united above the welded longitudinal seam by a corrugated plate which constitutes an expansion joint. This plate has riveted seams, except on the short longitudinal side seams, which are welded. The corrugation is made with a 2-inch radius and forms a trough about 5 inches deep across the crown sheet. This trough can be cleaned through two washout holes, one of which is placed on each side.

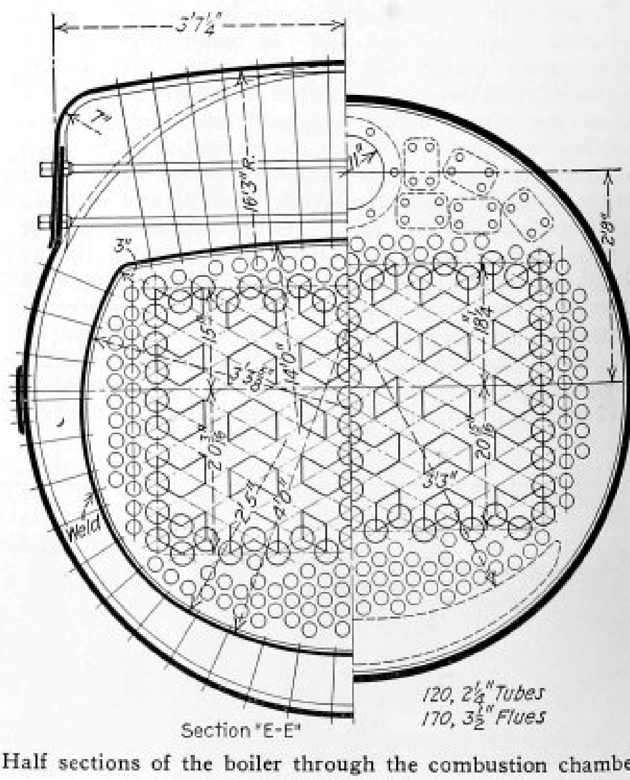
Method of Flanging Corrugated Plate

The flanging of this corrugated sheet is done on a hydraulic press and is an interesting process. As the transverse width of the sheet after flanging is greater at mid-height than at either the top or bottom, the sides of the die are hinged so that they can be collapsed after flanging and the plate thus lifted out. The flanging of the throat sheets also requires special treatment, due to the large size of the plates and the fact that the radius at the center is considerably greater than at the sides.

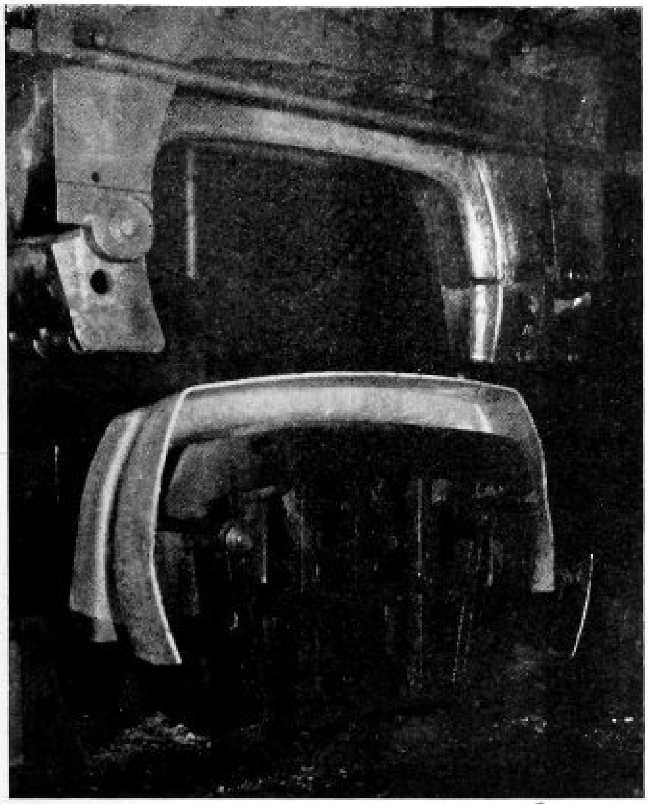
The corrugated joint described in the preceding para-



Half sections through the firebox and combustion chamber



Half sections of the boiler through the combustion chamber and first course

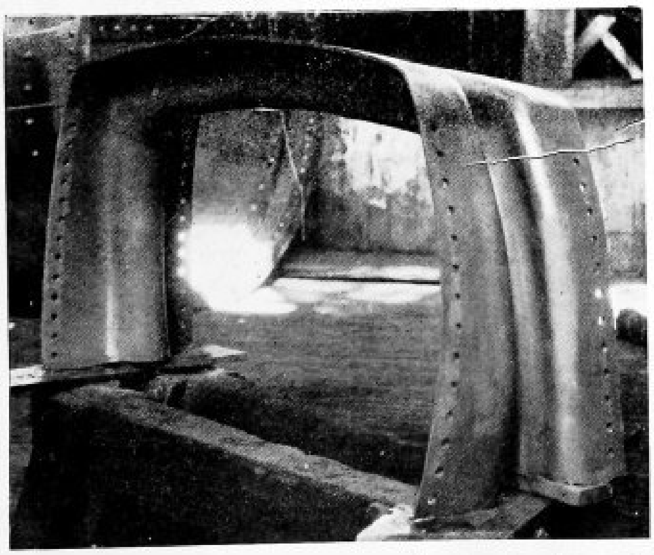


Dies for flanging corrugated connection

graphs compensates for expansion and contraction in the upper part of the firebox. To make similar provision for the lower part of the firebox, a crescent shaped corrugation is formed in the front tube sheet below the tubes. This corrugation has a maximum depth at the center of 2 inches. The combined length of the firebox and combustion chamber is so great in this design that an arrangement such as has been described is desirable in order to prevent distortion and tube leakage.

The firebox tube sheet and back sheet are riveted in place, but the joint around the door sheet is electrically welded. The flues are welded into the back tube sheet.

These locomotives are fired by mechanical stokers, the Duplex and the Du Pont Simplex, each being used in 100



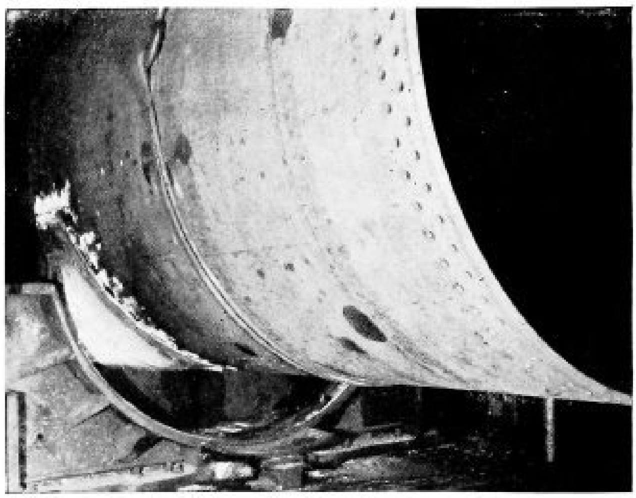
Connection between firebox and combustion chamber ready for installation

of these locomotives. The grates are arranged to shake by hand and have transverse drop plates near the front end of the firebox. The ash pan has two deep hoppers which are fitted with drop bottoms. These are controlled by levers placed on the left side, under the front end of the firebox.

The two injectors are non-lifting and they feed through checks placed on the back boiler head. The feedwater is conveyed to the front end of the barrel through internal pipes, this arrangement being in accordance with the regular practice of the Pennsylvania. The steam turret is placed outside the cab and receives its steam supply from the highest point in the boiler through an external pipe which connects to the shell near the front end of the combustion chamber roof sheet. The two safety valves are tapped directly into the shell just forward of the steam turret connection.

In addition to the usual gage cocks which are tapped into a water column on the back head of the boiler, there is a second set having pipe connections which terminate over the highest part of the crown sheet. These pipe connections are run through an external pipe which is filled with steam so that condensation is avoided. These gage cocks are placed over the boiler head in the cab. They have extension handles, conveniently located and drain into the drop funnel, so that the discharge can be easily seen by the engineman.

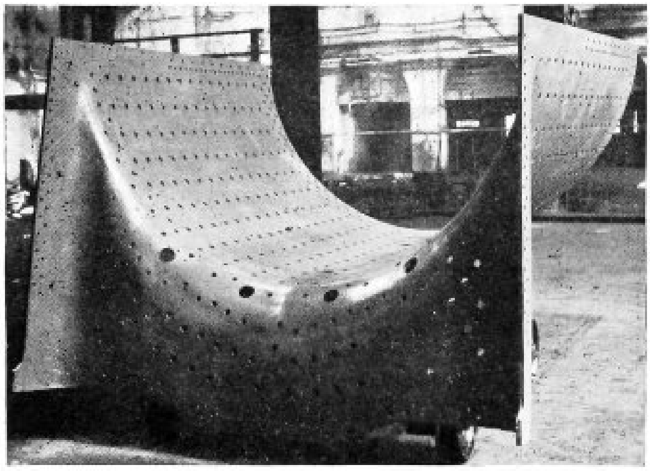
The dome contains a throttle valve with a balancing



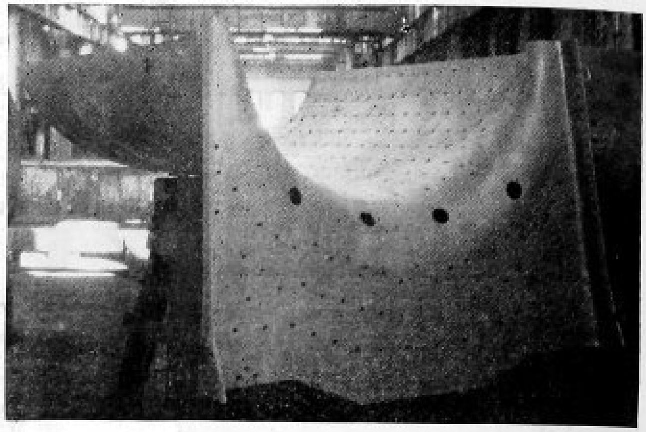
Flanging hip joint connection in second boiler ring

piston from which steam passes to the superheater header through an internal dry pipe 8½ inches in diameter. The superheater is a type E composed of 170 single loop elements placed in as many 3½ inch flues. The steam distribution is controlled by 12-inch piston valves which are operated by a Walschaert gear and are set with a travel of 7 inches and a lead to 9/32 inch. The steam lap is $\frac{7}{16}$ inch and the exhaust clearance $\frac{7}{16}$ inch. A power reverse mechanism is applied.

Among the interesting details used on these locomotives may be mentioned the air operated bell ringer. When the device is in use the bell itself remains stationary, while the clapper moves. The bell can also be rung by hand in the usual way if necessary. The cylinder cocks are steam operated and are controlled from the cab. When the operating valve is open the cocks are closed by steam pressure acting on their plungers. When the steam pressure is released, the plungers are moved upward by spring pressure and the cocks open. This provides a ready means



Outside throat sheet flanged in one piece



Inside one piece throat sheet and lower part of combustion chamber

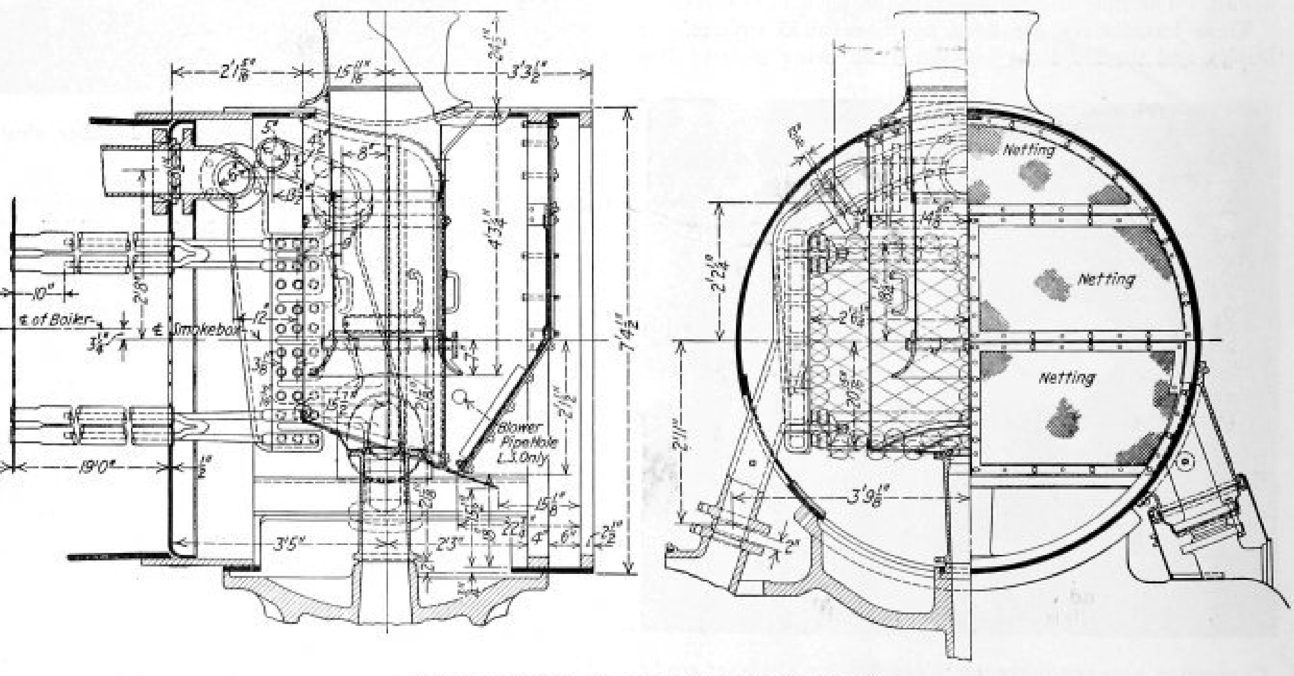
of keeping the cylinders drained while the locomotive is standing. The cylinder cocks will also open in case the pressure in the cylinders exceeds the boiler pressure due to water being tapped in the cylinders.

Details of Tender

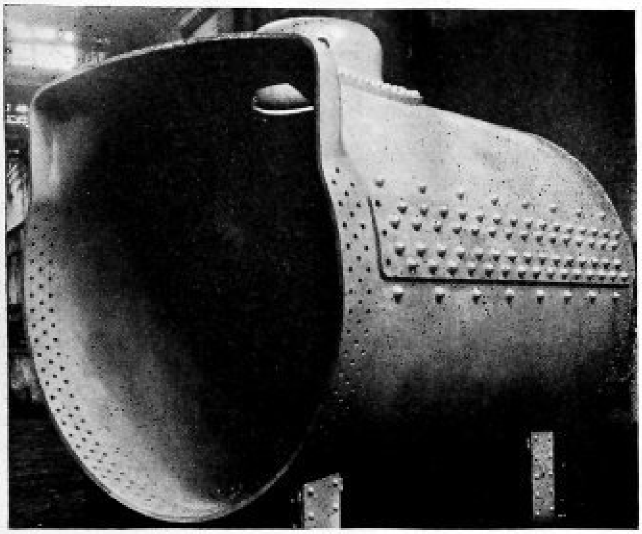
The tender has a one-piece frame of cast steel and is carried on two four-wheel trucks having cast steel side frames. The fuel and water capacities are respectively 35,000 pounds and 11,000 gallons and an air operated water scoop is applied.

Table of Dimensions, Weights and Proportions for the Pennsylvania Class M 1 Locomotives

Railroad	Pennsylvania
Builders	Baldwin 175, Lima 25
Type of locomotive	4-8-2
Service	Heavy passenger and fast freight
Cylinders, diameter and stroke	27 in. by 30 in.
Valve gear, type	Walschaert
Valves, piston type, size	12 in.
Maximum travel	7 in.
Outside lap	$1\frac{7}{16}$ in.
Exhaust clearance	$\frac{7}{16}$ in.
Weights in working order:	
On drivers	266,500 lb.
On front truck	59,300 lb.
On trailing truck	56,600 lb.
Total engine	382,400 lb.
Total tender	217,900 lb.
Total engine and tender	600,300 lb.
Wheel bases:	
Driving	18 ft. 10 in.
Rigid	18 ft. 10 in.
Total engine	41 ft. ½ in.
Total engine and tender	79 ft. 3⅞ in.
Wheels, diameter outside tires:	
Driving	72 in.
Front truck	33 in.
Trailing truck	50 in.
Journals, diameter and length:	
Main	12 in. by 16 in.
Others	11 in. by 16 in.
Front truck	6½ in. by 12 in.
Trailing truck	6½ in. by 12 in.
Boiler:	
Type	Belpaire
Steam pressure	250 lb.
Fuel	Bituminous

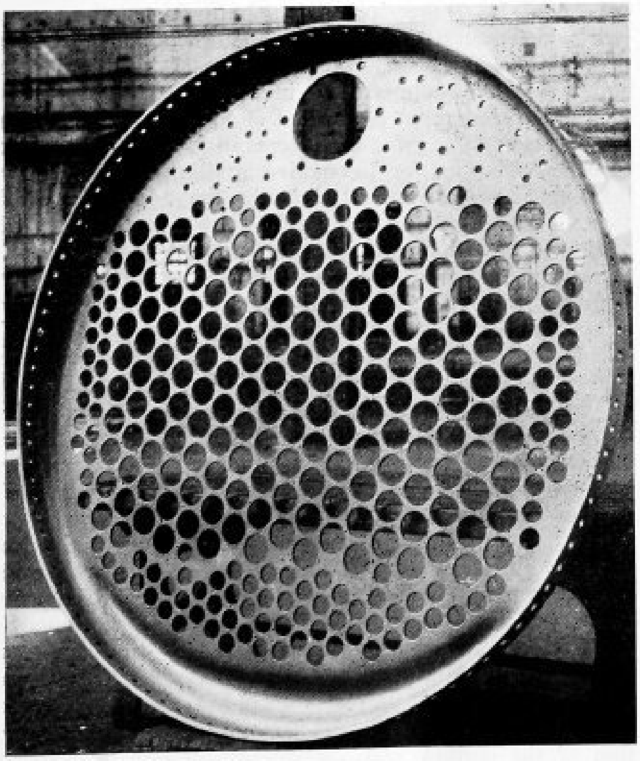


Details showing the smokebox arrangement



Second course flanged for Belpaire connection

Diameter, minimum inside	82¼ in.
Combustion chamber, length	98 in.
Tubes, number and diameter	120—2¼ in.
Flues, number and diameter	170—3½ in.
Length over tube sheets	19 ft. 1 in.
Grate area	69.9 sq. ft.
Heating surfaces:	
Firebox and comb. chamber	370 sq. ft.
Arch tubes	29 sq. ft.
Tubes and flues	4,303 sq. ft.
Total evaporative	4,702 sq. ft.
Superheating	1,630 sq. ft.
Comb. evap. and superheating	6,332 sq. ft.
Tender:	
Water capacity	11,000 gal.
Fuel capacity	35,000 lb.
Wheels, diameter	36 in.
Journals, diameter and length	6½ in. by 12 in.
General data, estimated:	
Rated tractive force	64,550 lb.
Cylinder horsepower (Cole)	3,280



Front tube sheet showing corrugation

Weight proportions:	
Weight on drivers÷total weight engine, percent	69.7
Weight on drivers÷tractive force	4.13
Total weight engine÷cylinder horsepower	116.7
Total weight engine÷total heating surface	60.5
Boiler proportions:	
Comb. heat. surface÷cylinder horsepower	1.93
Tractive force comb. heat. surface	10.25
Tractive force: diam. drivers, comb. heat. surface	73.5
Cylinder horsepower÷grate area	46.9
Firebox heating surface, percent of evap. heat. surface	8.14
Comb. heat. surface÷grate area	90.6

The Use of Portable Electric Lights in Boilers

ALTHOUGH entirely aware of the dangers of electricity at high voltages, nearly everyone has become so familiar with the usual 110-volt lighting circuits that little thought is ever given to the possibility of serious accidents from such circuits. Yet there are several cases on record in which shock from a 110-volt circuit has proved fatal. In the Syracuse Bulletin of May 14, 1926, there appeared an account of the death from electric shock of Ralph Merrill, a millwright at the Skaneateles Mill of the Oswego Falls Corporation. The man was working inside of a boiler preparing it for internal inspection and was using a lamp and extension cord from a 110-volt circuit. In some way, probably through a faulty connection and contact with the brass socket, he received a shock that resulted in his death.

In the September, 1925, issue of THE BOILER MAKER appeared a brief account of the death from electric shock of Michael O'Brien, while he was cleaning a boiler in the Administration Building, Montclair, N. J. Faulty insulation on the wire of a lamp which he held in his hand while in contact with the boiler is said to have allowed the current to pass through his body with fatal results.

About two years ago an inspector called at the plant of the Detroit Brass and Malleable Company, Detroit, to make an inspection. Upon inquiring for the engineer, a helper set out to find him. The inspector soon received a call to the top of one of the boilers, and there on top of the tubes inside of the boiler lay the engineer. He had been dead about a half hour. The charge from a 220-volt lamp on an extension cord which he had taken into the boiler with him had burned a hole about the size of a five cent piece near his heart.

Each of the above accidents happened with voltages such as one is likely to encounter in lighting circuits about an industrial plant. Whether a test was made to ascertain what voltage actually existed in each of the above cases is not stated, but in other somewhat similar cases tests were made but failed to show more than the normal voltage. It would appear then that even a circuit of "only 110" volts may under certain circumstances be dangerous, and conditions under which boilers are inspected and cleaned are by no means the safest. In the first place the boiler has an excellent electrical connection with a feedwater pipe and hence is well grounded. Furthermore the man working in a boiler is usually perspiring rather freely so that his moist hand or any part of his body that touches the metal makes a fairly good connection. It remains only for a short circuit through the brass lamp socket or a frayed cord to send a charge through the man.

Whether a shock from a 110 or 220-volt source will prove fatal depends likewise upon considerations other than merely good connections. For instance, the body resistance of different persons varies over quite a range, just as do all other physical characteristics. Hence, a man having a

(*Continued on page* 354)

Progress in Railroad Mechanical Engineering*

Sections of an A. S. M. E. Railroad Division Report that deal mainly with locomotive boiler developments

DURING the current year progress in railroad mechanical engineering, as related to motive power and rolling stock, has continued steadily along the lines which have been indicated in previous reports submitted to the society by this Division.

This progress may be summed up by saying that there has been a movement toward the greater effectiveness and earning capacity of equipment. In the case of motive power, the aim has been to obtain more ton-miles per hour at a reduced operating and maintenance cost.

This report will briefly discuss the following:

A—Motive Power:

1. Higher steam pressures.
2. Higher steam temperatures.
3. Greater sustained capacity.
4. Internal combustion engines.
5. Three cylinder locomotives.
6. Back pressure gages.
7. Unit cars for rail operation.
8. Unit cars for non-rail operation.
9. Motor buses.
10. Transmissions.
11. Longer locomotive runs.

Motive Power

Higher Steam Pressures: High steam pressures has been used to a greater degree in newer locomotives than in any preceding year. Orders have been placed for more than 400 large and economical locomotives, many of which have been completed during the present year. The Pennsylvania Railroad ordered 200, 4-8-2 type locomotives with 250 pounds pressure, the Illinois Central 50, 2-8-4 locomotives carrying 240 pounds pressure, the New York Central 25 additional 2-8-4 type freight locomotives carrying 240 pounds pressure, and the Northern Pacific 12, 4-8-4 type locomotives with 240 pounds pressure. The Baldwin Locomotive Works built one 4-10-2 type engine carrying 350 pounds pressure. Abroad the use of higher steam pressures has made headway, the most striking example being the 4-6-0 three-cylinder compound locomotive built by Henschel & Son, of Germany, to the designs of the Schmidt'sche Heissdampf Gesellschaft and carrying three different boiler pressures, namely, 1,200, 900, and 200 pounds per square inch. More detailed description of this very novel and interesting locomotive design will be submitted to the Society at the annual meeting in a paper by Professors Schmidt and Snodgrass, offered by the Railroad Division.

The report of the American Railway Association's Committee on Locomotive Design and Construction, presented at the 1926 meeting of that Association, made interesting reference to the 4-8-2 type locomotive, carrying 250 pounds boiler pressure, placed in service and tested by the New York, New Haven & Hartford Railroad. This locomotive showed an increase of 15½ percent in thermal efficiency over a similar locomotive carrying 200 pounds pressure, having a radial stay firebox instead of a McClellon watertube firebox, and having 85 percent maximum cut-off as compared with the 70 percent maximum cut-off of the high-pressure engine.

Consideration of increase in steam pressure necessitates consideration of boiler and firebox construction better adapted to the higher pressures. That these higher pressures may require a modification in the firebox structure is evidenced by the consideration that has been given the use of watertubes and the partial, or complete, elimination of flat stayed surfaces. The Baldwin experimental locomotive, the McClellon firebox on the New York, New Haven & Hartford, and the very interesting watertube firebox on the Schmidt-Henschel locomotive are developments which are along the lines of progress, both as to suitability for the higher boiler pressures and, as is indicated, at least in the case of the McClellon firebox, in a reduction in maintenance and repair cost.

Higher Steam Temperatures: The increase in steam temperature has been of steady growth for a decade or more, and while the maximum temperature, with materials available at present, has been quite closely approximated in a good many cases, there is abundant evidence that motive power officials are cognizant of the fact that additional advantage will accrue from a further increase in steam temperature. With the increasing demands for greater capacity in locomotives, attention has been turned to the Type "E" superheater, which has been growing in favor during the past four or five years. A large majority of all the high-capacity locomotives built during the past year have been fitted with this type of superheater. Reference to Table 1 will prove interesting in this connection.

Greater Sustained Capacity: Greater sustained capacity of the modern locomotive is one of the goals toward which progress is continually being made. Greater power output per unit of weight of locomotive is demanded. Locomotive builders, and all others associated in the development of new motive power having steam or internal combustion prime movers, have bent their efforts in this direction. It is interesting to note that the Canadian Pacific in some 4-6-2 and 2-8-2 type locomotives built during the present year adopted an alloy steel for boiler shell plates in order that, for the 250 pounds boiler pressure being carried, the boiler weights would not be increased. This means an increase in the output per pound of locomotive weight and should result in a reduction in operating cost. The use of superheated steam for locomotive auxiliary apparatus has been made possible at all times by the use of a throttle located between the superheater and the steam chest. In addition to a reduction in the fuel costs there has been an increase in the sustained capacity of the boilers, because the thermal savings resulting from the use of superheated steam by the auxiliaries have left a larger amount of power available for the main engine. Adoption of this feature has been characteristic of new locomotive building during 1926.

The use of larger grates and increased combustion volumes in fireboxes has contributed to better firebox efficiency and may properly be considered as a mark of progress in locomotive design. The use of boosters on trailing and tender trucks has increased the effectiveness of locomotives by giving them increased power at starting and in many instances has avoided the use of pusher engines, thus decreasing operating costs. The additional first costs and maintenance expenses are probably well warranted in many cases, but it is questionable if, in some classes of service, such additional costs will always be justified. A marked increase in the utilization of exhaust steam for feedwater heating has characterized locomotive construction of the current year. Feedwater heaters of both the pump driven and injector type have been applied in a large

* The Executive Committee of the Railroad Division of the American Society of Mechanical Engineers is as follows: H. B. Oatley, *Chairman*, Marion B. Richardson, *Secretary*, and A. F. Stuebing, R. S. McConnell, Wm. Elmer, and Elliot Sumner.

number of the outstanding modern locomotives built during the year.

Mention may be made of the 4-12-2 type three cylinder locomotives built for the Union Pacific, which are the largest and most powerful non-articulated engines ever constructed. A high sustained boiler capacity was desired and has been fully realized in this design, produced jointly by the American Locomotive Company and the Union Pacific. Type "E" superheaters and feedwater heaters contributed largely to this result. There was also a very effective use of the adhesive weight, made possible by the use of three cylinders, producing a more even torque on the drivers. There is also noted a growing preference for the use of cast steel cylinders because of the resulting decrease in weight and also for the reason that this material affords the greater strength required by the higher boiler pressures now being used. Progress in design is reflected by the use of such material.

Internal Combustion Engines: Use of the internal combustion engine has also continued and is an indication of the desire to provide a lower operating cost of motor units where conditions are not as well met by the steam locomotive.

Three Cylinder Locomotives: The three cylinder locomotive, to which reference has already been made, has been built in larger numbers during the past year. While the four cylinder engine has not made its appearance in this country, or Canada, in recent year, an interesting locomotive has been built abroad and data concerning its performance have appeared during the year. This engine is a 4-8-2 type, built for the Paris, Lyons & Mediterranean, having four cylinders compounded. A marked improvement in operating conditions is reported from this locomotive. From the standpoint of lowering the permissible factor of adhesion, a four cylinder locomotive offers equal, or greater, opportunities than even the three cylinder locomotive, although the cranked driving axle is a feature which American railroad motive power officials will accept only after demonstration.

Back Pressure Gages: The number of locomotives during the year which have been fitted with gages enabling the engineer to observe pressures existing in the exhaust passages show clearly that operating advantage is appreciated and that efforts are being made to still further improve the operating effectiveness.

Longer Locomotive Runs: Longer locomotive runs are evidences of a realization of fundamental economic locomotive operation, and have been responsible in no small degree for the improvement in operation of our railroads during the past year. Tests indicate that coal-burning locomotives can be operated past intermediate terminals and over as great distances as oil burners, as far as fire conditions are concerned. This is due in a large measure to the fact that locomotives are being equipped with more efficient mechanical devices designed to improve the overall efficiency of the locomotive as a power unit. For a considerable period the New York Central operated one of its trains a distance of about 1,000 miles between New York and Chicago without changing engines. In one test the Chicago, Burlington & Quincy operated a locomotive in mixed-train service a distance of 2,645 miles with a single fire, the life of the fire being more than 183 hours. It was the consensus of opinion that the fire could have been continued indefinitely, burning the average run of coal on the divisions in question. A coal-burning locomotive was operated about 2,000 miles by the Northern Pacific without receiving any terminal attention en route or being uncoupled from the train. Four grades of coal, largely lignite in character, were burned. The Terminal Railroad Association of St. Louis has operated four switch engines in continuous service for a period of thirty days without having the fires cleaned. This shows what can be accomplished, and is an indication of what can be expected of modern steam locomotives.

Trend in Development

Steam Motive Power: The trend in the development of motive power is unmistakably toward larger units of power, whether steam or internal combustion-engine driven. With steam driven motive power there is also a very clear trend toward the use of higher steam pressures and higher steam temperatures, and such features of design as have been referred to in the foregoing portions of this report, with an aim to still further reduce the cost of operation and to increase the earning power of the locomotives.

Union Management Cooperation

No report of the progress made in the railroad industry during the past year would be complete without mention of the joint meeting on February 5, 1926, of the Taylor Society, the Metropolitan Section and the Management Division of the A. S. M. E., and a number of other organizations. This was the first formal presentation of the subject, Union Management Cooperation in the Railway Industry, under the auspices of a scientific body. The principles and workings, as well as the advantages, of what is commonly known as the Baltimore & Ohio plan were discussed by Otto S. Beyer, Jr., the consulting engineer who developed the plan as an advisor to the shop crafts unions. This was followed by an address giving organized labor's appraisal of the plan by Bert M. Jewell, president of Railway Employees Department of the American Federation of Labor. The meeting closed with an appraisal from the standpoint of the management by Sir Henry Thornton, president of the Canadian National Railways.

Bonus Payments to Groups of Employees Mean Better Wages and Lower Costs

Experiences of a number of manufacturers with the plan of paying bonuses based on group efficiency to groups of employees are summarized with the details of the plan in a booklet entitled "The Better Wage, an Analysis of Group Bonus Labor Payment" just issued by Ernst & Ernst, New York accountants.

An increasing number of employers representative of various industries are said to be adopting this plan using as models the methods already tested by other employers.

When a manufacturer, the booklet emphasizes, pays workmen for the results of their individual efforts instead of for the results of cooperation or group effort, he must provide at extra expense a substitute for cooperation in the form of close supervision and complicated accounting. The substitute, it is said, is at best only a poor one because of the high cost of it and the large amount of wasted time, wasted materials and other wastes which cannot be controlled.

"Under the group bonus labor payment plan," the text reads, "pay for individual work is made subject to the results of teamwork. The workers are assembled into groups and each worker is guaranteed the payment of an hourly base rate for his time, regardless of his production. If the efficiency of a group as a whole for a pay period is 75 percent of a standard, each of its members receives 1 percent of his base rate earnings as an additional wage or bonus. The bonus percent increases," in accordance with a fixed scale, "for each increase of 1 percent in group efficiency:

"Group bonus labor payment is a dominant feature," the booklet says, "in the development of means through which the natural and unchanging laws of good management are made to control present day conditions," the implication being that the plan is one of the means of reducing costs that may be adopted by many American manufacturers during the next few years under the pressure of the keener competition now developing.

Ernst & Ernst offer "The Better Wage" free on request at any of their offices in various cities.

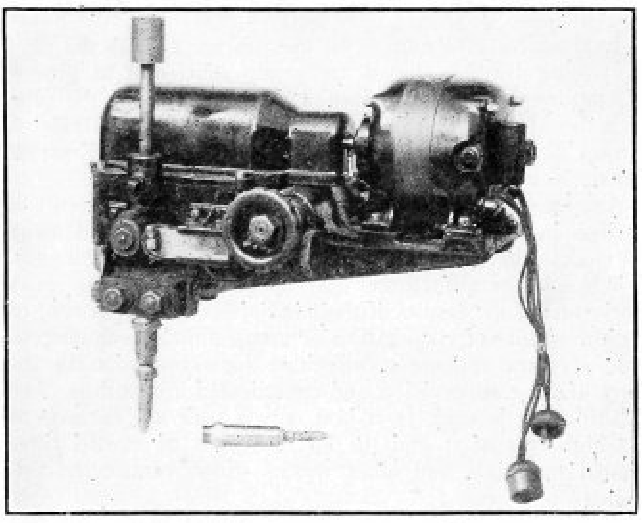
Automatic Arc Welding Head

AN automatic arc welder, designed to weld with smoothness, speed and accuracy, has been introduced by the General Electric Company, Schenectady, N. Y. With this equipment, the operator pushes a button to start the sequence of operations which produce the weld without any further effort or skill on his part. The welder starts the arc by first touching the electrode to the work and then withrdawing it, thereafter maintaining a constant arc length by feeding the electrode wire to the weld at the exact rate of speed necessary to replace the electrode fused into the weld.

The automatic welding head incorporates the necessary mechanism for feeding the electrode to the arc, and consists essentially of a pair of feed rollers geared to a constant speed motor through a magnetic clutch. The gearing and feed mechanism are contained in one housing, to which the motor is bolted.

The rollers feed the welding wire through the nozzle to the arc. The distance and pressure between these rollers is readily adjustable. Each welding head is equipped with a set of nozzles for 1/32-inch, 1/8-inch, 5/32-inch, 3/16-inch and 1/4-inch wire.

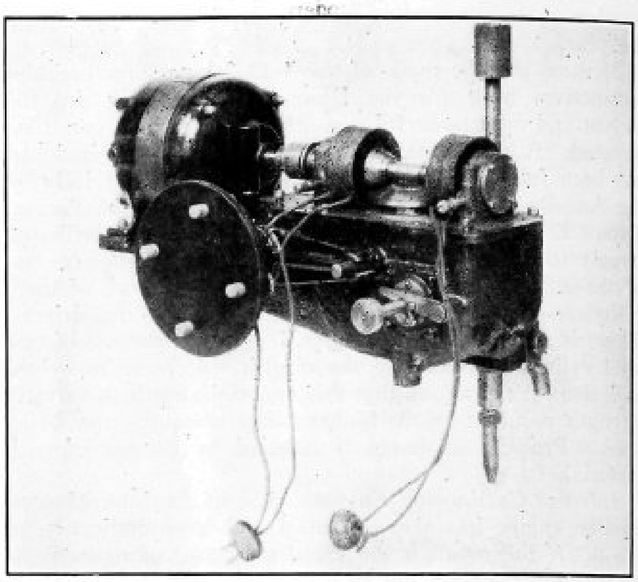
The speed of wire feed may be adjusted by means of a selective gear changer, which permits the gear ratio to be altered at will to adapt the speed of the feed rollers to the size of wire and the welding current used. Three



General Electric Type MC automatic welding head

gear speed changes can be made by moving the gear shift pin which extends from the rear of the gear housing. An additional finer adjustment can be made by means of rheostat in the field of the motor. Provision is made for pointing the electrode backward or forward in the line of weld, and also for moving it sideways. The pointing of the electrode is obtained by rotating the head on its horizontal shaft, and the lateral movement by means of the handwheel on the front of the head.

The control equipment consists of a control panel, a meter panel and a push button station. The control panel mounts the main line contactor for the welding circuit



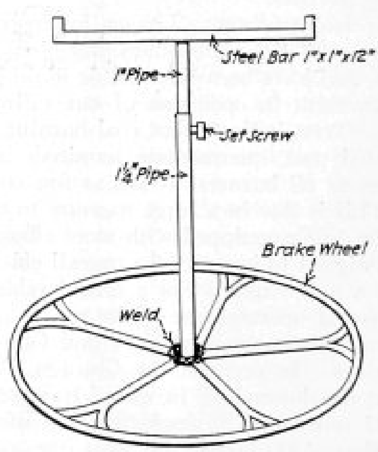
Rear view of the General Electric automatic welding head

and two smaller contactors for interlocking the travel motor with the arc. By means of auxiliary contacts the line contactor controls the starting and stopping of the feed motor. The magnetic clutch is operated forward or backward by a voltage relay, the coil of which is connected across the arc. Thus the electrode is fed to or from the work automatically, adjusting itself to any irregularities in the surface of the work. One rheostat controls the speed of the feed motor and the other controls the voltage setting of the arc.

Pipe Support for the Shop

By Joseph C. Coyle

A HANDY accessory used in the blacksmith shop of the Denver & Rio Grande Western, Denver, Col., is a movable, adjustable support for holding the free end of bar iron or pipe, the other end of which is being worked on. It is made by welding an 18-inch section of iron pipe to



Portable support for holding bar iron or pipe

an old brake wheel. A similar section of one-inch round steel slips inside the pipe. This section can be adjusted to any height desired and is held in place with a set screw. A cross piece, 12 inches long of 1-inch by 1¼-inch steel turned up at each end, is welded to the top as shown in the sketch. The ends are turned up to prevent the bar from sliding off.

Progress in Steam Power Engineering*

Abstract of A. S. M. E. report outlining the tendencies in the design, construction and operation of power boilers

THE year 1926 has not witnessed any let up in central station development. As far as size is concerned, the most interesting development is the announcement that a power station with an ultimate capacity of 1,000,000 kilowatts is to be built on the shores of Lake Michigan. This is two or three times as large as the largest power station operating at the present time, and is equal to the combined generating capacity in the Chicago, Illinois-Indiana industrial district. The first unit to be installed in this station will have a capacity of 208,000 kilowatts. The year 1926 has witnessed the initial operation of a large number of modern stations.

There has been no radical reduction in the fuel consumption per kilowatt during the past year. A number of stations are operating on an equivalent of 1 pound of high-grade coal per kilowatt-hour, while one station expects to operate on a consumption of about 0.9 pound of high grade coal after all of its equipment is in service.

Now that the coal consumption has been reduced so that the coal cost is only about one-third of the cost of power up to the bus bar, concentrated efforts are being made in some quarters to reduce the first cost of the power station, which is now responsible for about two-thirds of the power cost.

Boiler Room

Coming to the details of the boiler room equipment, the outstanding development during the year is the introduction of the Wood type of boiler known as the "steam generator" into this country. This boiler consists of a furnace with the evaporating surface of the boiler distributed over all six sides. On the four sides and top the heating surface consists of a single row of tubes with the space between them filled by means of fins welded to the tubes and forming an extended heating surface. At the bottom of the furnace is a bank of bare tubes about four rows deep. This type of furnace is not adaptable to stoker firing, but is designed for pulverized coal burning. The burners for feeding the pulverized coal are located in the upper part of the furnace and in the corners. The axes of the burners are at a slight angle with the horizontal and point a little to one side of the center of the furnace so that the flame and gases are given a whirling motion, similar to that which exists in the well type furnace. After a large portion of the heat has been absorbed by radiation, the hot gases pass down through the bank of tubes at the bottom of the furnace and then up, first through a superheater and then through an air heater. The advantages claimed for this type of boiler and furnace are that furnace brickwork is almost entirely eliminated and that the space required is less than that required by the standard form of boiler.

The use of water cooled furnace walls, of which there are now several types, has extended very rapidly during the past year. One type consists of bare tubes allowing the brickwork to be exposed between the tubes. Another type is the fin type of tube which entirely covers the brickwork and presents an all metal water cooled surface to the furnace. Still another type employs cast iron blocks which are bolted to water cooled tubes. The faces of the blocks are covered with a thin layer of refractory. Two other types of water cooled furnaces employ water cooled tubes which are protected by cast iron blocks. In one type the blocks are fitted on the tubes with a close fit, while in the other type they are cast on the tubes.

The use of water cooled walls has permitted boiler ratings to be increased to a marked degree, and at the same time has very much reduced the cost of brickwork maintenance. In pulverized coal installations the use of water cooled walls has permitted a reduction in furnace volume in some cases.

The year 1926 has witnessed a number of installations of radiant-heat superheaters. There have been a number of superheaters of this type installed in connection with water cooled walls where the superheater is placed between and to the rear of the water wall tubes. This type of installation retains the advantages of the radiant heat type and at the same time the superheater is somewhat protected by the water tubes and so is not subjected to such severe punishment.

The principal cause of the failures of the tubes in the interdeck and radiant heat type of superheaters has been the accumulation of solids in the tubes. These solids are carried over from the boiler by the moisture in the steam. This has led to the development of a number of steam purifiers, which take the place of the usual dry pipe in the boilers.

A great many installations of air heaters have been made during the past year. The use of water cooled furnace walls has no doubt not only simplified the use of air heaters, but has also made their use desirable in cases where water wall cooling has been applied to a great extent.

Two stage combustion has been suggested again, whereby the furnace of a boiler is divided into two parts. Part of the fuel would be burned in the first part with a high excess of air. The products of combustion would then pass over a part of the boiler heating surface and would thus have their temperatures reduced, and then into the second combustion chamber, into which the remainder of the fuel would be fed. The final products of combustion would then be very low in excess air, and at the same time the furnace temperatures would not be found to be excessive at any time.

Before leaving the boiler room side of the power station, mention should be made of an investigation of the causes of the embrittlement of boiler plate, the results of which have been published during the past year. This subject is of very great importance to boiler users. However, there has been a great divergence of opinion as to the cause of this trouble. Briefly, the conclusions arrived at as a result of this investigation are that embrittlement of boiler plate is caused by a combination of stress in the metal and chemical attack. This emphasizes the importance of careful fitting of boiler parts so as to reduce abnormal stresses to a minimum.

In certain sections there has been a decided increase in the number of pulverized coal installations. In a number of cases, due principally to the unit system, the cost of a pulverized coal system has been cheaper than that of a stoker installation. Stoker installations have shown a trend toward better furnace design and larger grate areas. There has also been an increased use of automatic stokers on smaller sizes of boilers, in some instances on boilers of but 100 horsepower.

One encouraging feature of progress has been the increase in reliable records of continuous operation. Not only the larger plants but several small plants have shown very high

* Executive committee of the Power Division of the American Society of Mechanical Engineers is as follows: H. B. Reynolds, *Chairman*, John A. Hunter, *Secretary*, Frank S. Clark, Vern E. Alden, and F. M. Gibson.

efficiencies. The lack of records in the great majority of industrial power plants has been the chief cause of the lack of interest on the part of owners and of the excessive cost of industrial power. The present trend toward reliable power records is therefore most encouraging.

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

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

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

Below are given interpretations of the committee in Cases Nos. 530 to 533, inclusive, as formulated at the meeting of September 24, 1926, all having been approved by the council. In accordance with established practice, names of inquirers have been omitted.

CASE NO. 530

(In the hands of the committee)

CASE NO. 531. *Inquiry:* Is it the intent of Par. U-23*b* of the Code that where circumferentially welded joints are permitted for vessels of diameters up to 72 inches when at least 75 percent of the load on a flat head is supported by tubes or stays, through stays must be used in order to afford support for the heads such as is provided by tubes, or would diagonal stays between the heads and the shell be permissible?

Reply: It is the intent of the Code that where welded circumferential joints are used on pressure vessels of diameters exceeding 48 inches and not exceeding 72 inches as provided for in Par. U-23*b*, the support of 75 percent of the load on a flat head must be provided either by tubes or through stays extending from head to head.

CASE NO. 532. *Inquiry:* Is it permissible, under the Miniature Boiler Section of the Code, to construct watertube type boilers for operation at 60 pounds per square inch with removable heads of pressed steel construction in which the heads are drawn from $\frac{3}{16}$-inch steel plate? Par. M-3 of the Code permits $\frac{3}{16}$-inch thickness for seamless shells, but in this construction the heads are bolted to gasket surfaces on the tube sheets which are in excess of the $\frac{3}{16}$-inch head thickness required by Par. M-3.

Reply: There is nothing in the Code to limit the thickness of such removable heads of miniature boilers. The limit of thickness in Par. M-3 applies to shell plates only.

CASE NO. 533. *Inquiry:* Is it permissible, under the Code, to utilize a studded connection for connecting pipe outlets larger than 3 inch pipe size direct to flat surfaces of shells or heads of boilers, without a nozzle or saddle flange? Par. P-268 is specific in its requirement for a nozzle or saddle flange riveted to the boiler, but it has long been customary to attach flanged pipe outlet connections direct to the boiler heads where the surface is flat enough to apply a gasket and the thickness of the shell is sufficient to permit insertion of studs.

Reply: Par. P-268 requires that nozzles and saddle flanges shall be riveted to the boiler shell or head, but it was not the intent to prohibit the attachment of flange pipe outlets direct to shells or heads where a surface flat enough for the application of a gasket is available and the thickness of the plate is sufficient for insertion of studs. It is the opinion of the committee, however, that for the insertion of studs the thickness of the plate should be at least equal to the diameter of the bolt that would be required for the flange connection. A revision of Par. P-268 is contemplated which will provide for such studded pipe outlet connections, and until this revision is completed it is the opinion of the committee that studded pipe outlet connections as above outlined may be used with safe results.

Removing Boiler Scale

By J. A. Snyder*

IF boilers could be run with perfectly pure water—for example, with water that had previously been distilled—many of the difficulties encountered in actual practice would never arise, and the fireman's duties and responsibilities would be correspondingly lessened and simplified. Unfortunately, this ideal condition of things cannot often be realized. We cannot afford to use distilled water and in most cases feedwater has to be taken in accordance with that mode of selection which is known to the world at large as "Hobson's choice," that is, we have to take what we can get. In cities and towns, good water may usually be had

Result of allowing scale to accumulate in a boiler

from the city mains, but in sparsely populated districts the manufacturer has to depend upon wells or upon running streams.

To remove the scale forming matter from boiler feedwater, there are today many systems, and to prevent scale forming on boilers and to remove that already formed, there are compounds, metal treatments, surface cleaners and appliances galore. Many are good, and some are better than others. Where the treatment is especially suited to the water conditions good results are obtained, especially so, as the old chief engineer said "if the engineer will use the proper amount of 'hoss' sense."

Some years ago a rolling mill plant was induced to try a boiler compound. The instructions were to use a certain amount daily and not blow down the boilers nor clean them for at least thirty days. There was considerable scale forming matter in the feedwater and after four weeks' trial as directed the boilers were cooled and emptied for examination. The installation consisted of a battery of four boilers

(*Continued on page 359*)

*Chief inspector, Pittsburgh department, Hartford Steam Boiler Inspection and Insurance Company.

Boiler Shop Machine Tool Development in Germany

Electrically driven vertical bending press for boiler plates and an electrically driven boiler drill

AMONG recent heavy tool developments in Germany *Engineering Progress,* a monthly review of the *Verein Deutscher Ingenieure,* has given descriptions by prominent engineers of two tools which are particularly designed for the boiler shop. These descriptions by Weil of a vertical bending press and by O. Pollok of a boiler drill are abstracted and illustrated below.

Vertical Bending Press

Consideration of the advantages and disadvantages of electric versus hydraulic drive for bending presses to accommodate heavy plate, some months ago persuaded the firm of Schiess-Defries A. G. of Düsseldorf, to design boiler plate bending presses for electric drive. As shown in Figs. 1 and 2, the working principle of the hydraulic press has been maintained throughout, however. For constructive reasons the transmission of the pressure to the bending arm is not effected by means of oblique wedges and pressure rollers, but by means of an eccentric shaft, as with shears and punching machines.

As may be inferred from the illustrations, the machine consists of three standards, of which the stationary one contains the complete electric drive, the center one represents the bending arm, and the end standard the overhung arm. The electric driving motor transmits the working pressure by means of a gear to two superposed eccentric shafts, which impart the required pressure movement to the center standard, whereby a safety shearing coupling provided in the main drive protects the driving gear from becoming damaged when overloaded. Apart from this, the center beam contains a safety plate, which acts similarly as with punching machines and shears. The end standard (crosshead), horizontally adjustable, is connected with the main standard by means of two heavy forged steel tension bars, driven by a worm shaft common to both, and these effect the adjustment of the crosshead relatively to the boiler plate.

The working principle of the machine based on the so-called three point system, functions in such a manner that the plate to be bent is introduced between the crosshead and bending arm and by operating a hand lever, the horizontal adjustment of the crosshead is initiated, whereby a pointer moving over a scale and actuated by the drive, indicates the clearance between the bending arm and the crosshead exactly to a fraction of an inch. The actual work of bending is initiated by a clutch coupling, whose lever, when fixed, sets the bending arm to continuous work. The plate rests on two rollers adjustable according to the bending radius, and after each stroke automatically glides a certain distance through the machine, adjustable within wide limits, until it is bent completely circularly.

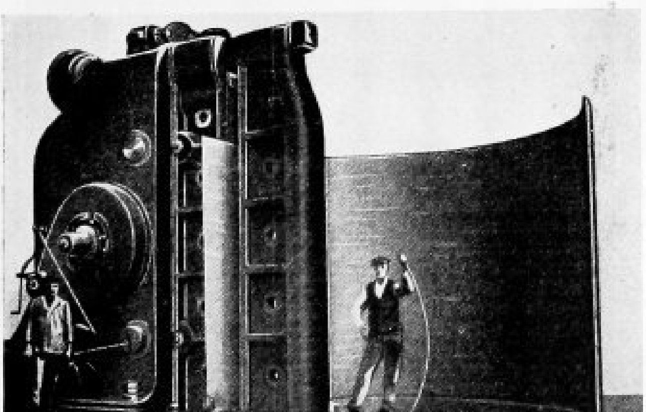


Fig. 1—Electrically driven boiler plate bending press

The boiler section thus produced, is lifted out of the machine by means of a crane, whereby the upper rotary articulated tension bar is previously swung back. The swing-back motion is effected by a special motor of about 5 brake horsepower output, mounted on the top of the main standard. By reversing the motor, the said tension bar can be swung back into its original position. An automatic safety connection prevents rough and jolting return to the initial position by braking the motor.

The design described above, numerous as its advantages

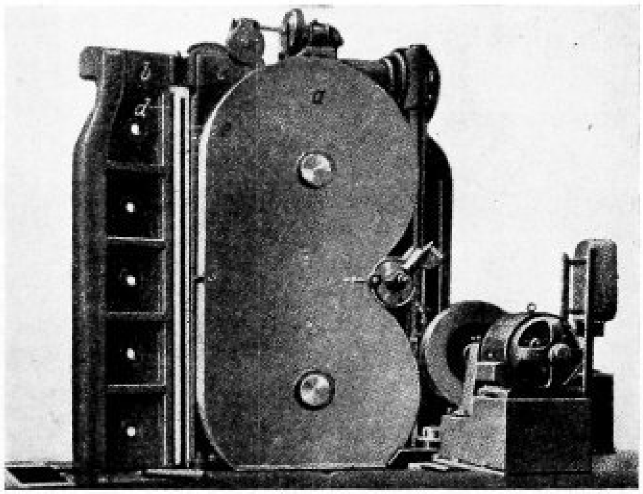


Fig. 2—Rear side of machine showing electric drive

are, yet has one drawback, viz., it requires comparatively high workshops (like the hydraulically-driven bending machine), the height of which must be more than twice the length of the boilers because the finished boiler section has to be lifted vertically out of the machine. However, to render the machine serviceable also in low shops, its design was modified in such a manner that the finished boiler sections may be withdrawn laterally. This is achieved by arranging the end standard so that it can be lowered whereby it glides downwards along a vertical guide. This movement is performed mechanically, the drive being derived from the main motor. Fig. 3 illustrates this arrangement. The firm of Schiess-Defries Aktiengesellschaft of Düsseldorf builds three types of these very strong bending machines for plates of 30, 40 and 50 millimeters (about 1.18, 1.58 and 1.97 inches) thickness and for any breadth. A motor with an output of from 75 to 80 brake horsepower is required for plates of 50 millimeters (about 1.97 inches) thickness and 4 meters (about 13 feet) breadth.

The chief advantage of these bending presses compared with bending rolls is that the plates can be completely bent in *one* operation, while with bending rolls the end piece of the plate cannot be bent circularly and, therefore, requires preliminary bending on another machine. Apart from this, the sagging of the plates in horizontal bending rolls, due to their weight, is tiresome and hampers measuring, a disadvantage not encountered in the above-described vertical bending presses.

ELECTRICALLY OPERATED BOILER DRILL

Electric drive with several motors as applied to boiler drilling machines offers the simplest possibility of remote control, i.e., of operating the entire plant from one operator's stand. A further advantage of this method of drive consists in its high degree of economy due to all complicated

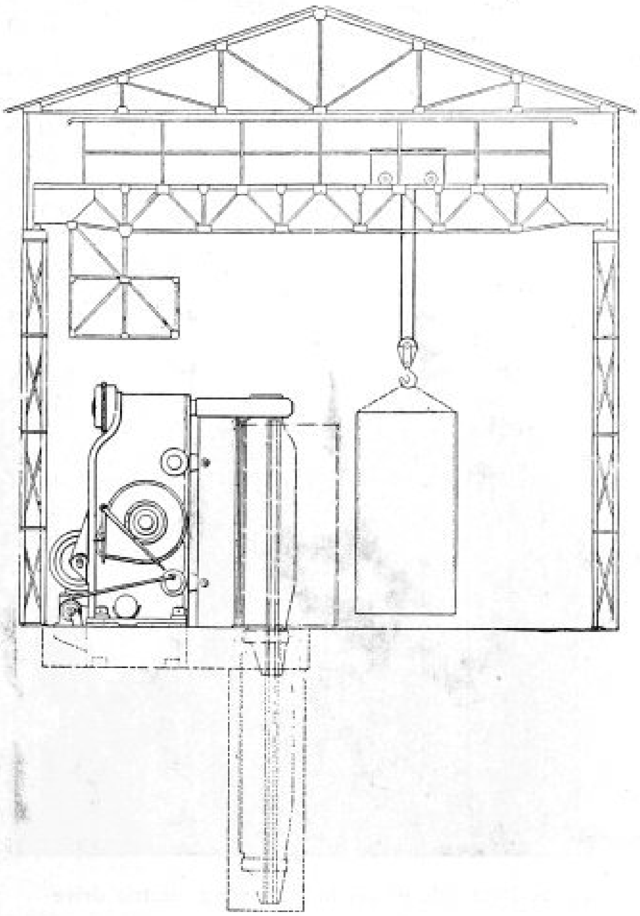


Fig. 3—View of press showing arrangement for lowering standard

gears, which are moreover mostly running light, being omitted.

True, boiler drilling machines do not exactly belong to the heavier types of machine tools, nevertheless they belong to those working with a large radius corresponding to the boiler diameters. The auxiliary motions are therefore of particular importance in their case. For the main motion, viz., the rotation of the drills, the use of direct current control motors obviates the need of further gears and their wasted power consumption together with all losses incurred by running light. This arrangement has the further advantage of the drive permitting of almost perfect adaptation both to the tool and the material worked owing to the control being to all practical intents and purposes adjustable without steps, a good deal of working time thus being saved.

A twin boiler drilling machine for horizontal boilers is depicted in Fig. 4. This machine was supplied to Messrs. Gebr. Sulzer (Sulzer Bros.) in Winterthur (Switzerland) by Messrs. Maschinenfabrik Collet & Engelhardt A. G. (Ltd.), of Offenbach-on-the-Main. Its electric equipment comes from Messrs. A.E.G. (General Electric Company). The two drilling standards move on a bed measuring 16

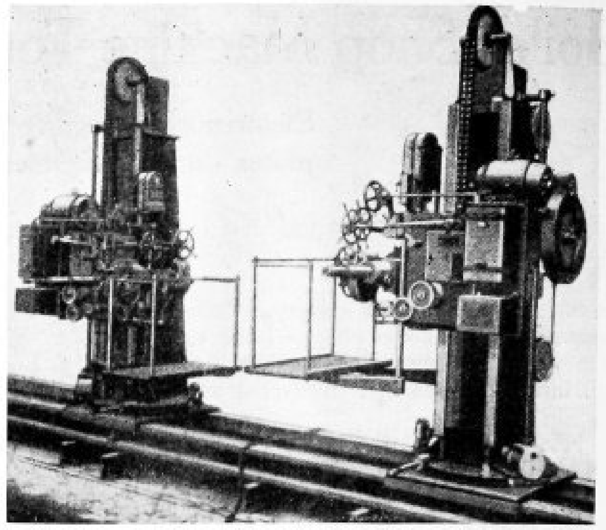


Fig. 4—Twin drilling machine for horizontal boilers

meters (about 53 feet) in length. In front of this are the roller bearings for the boiler (Figs. 6 and 7); each set of three roller bearings derives its motion from the motors situated at either end of the bed. Each set can be started in one or the other direction, and braked dynamically by push button control arranged on the adjacent drilling standard. The boilers can thus be adjusted accurately for hole centers in a most convenient manner, without the least trouble, and with the greatest rapidity. In the case of long boilers the turning systems can be coupled together, in that case receiving joint drive from either the one or the other of the two turning motors alone. The motors having an output of 8.8 kilowatts each is amply able to cope with this full load when required. Each of the drilling standards carries a second plate of push buttons controlling the turning-motor at the other end. This second set of button controls is used when the two turning sets are coupled together or if both drilling standards are being applied on the same half of the machine. Brush contacts wiping on contact bars, arranged carefully protected in the longitudinal bed, bring

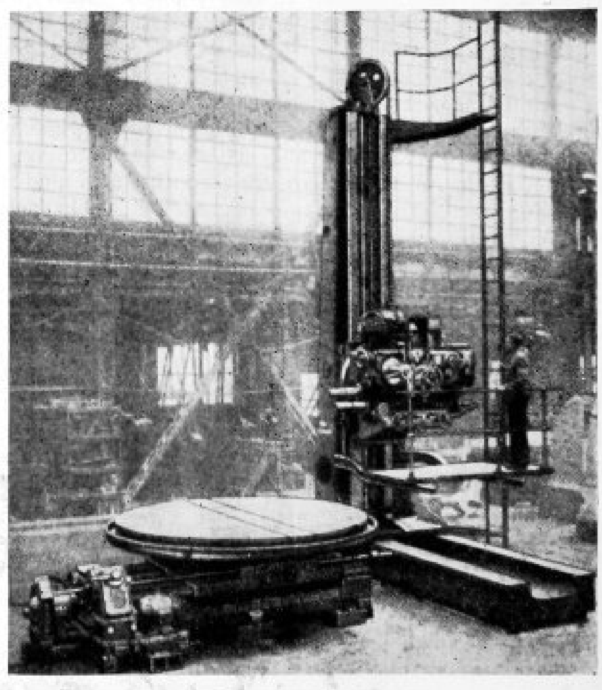
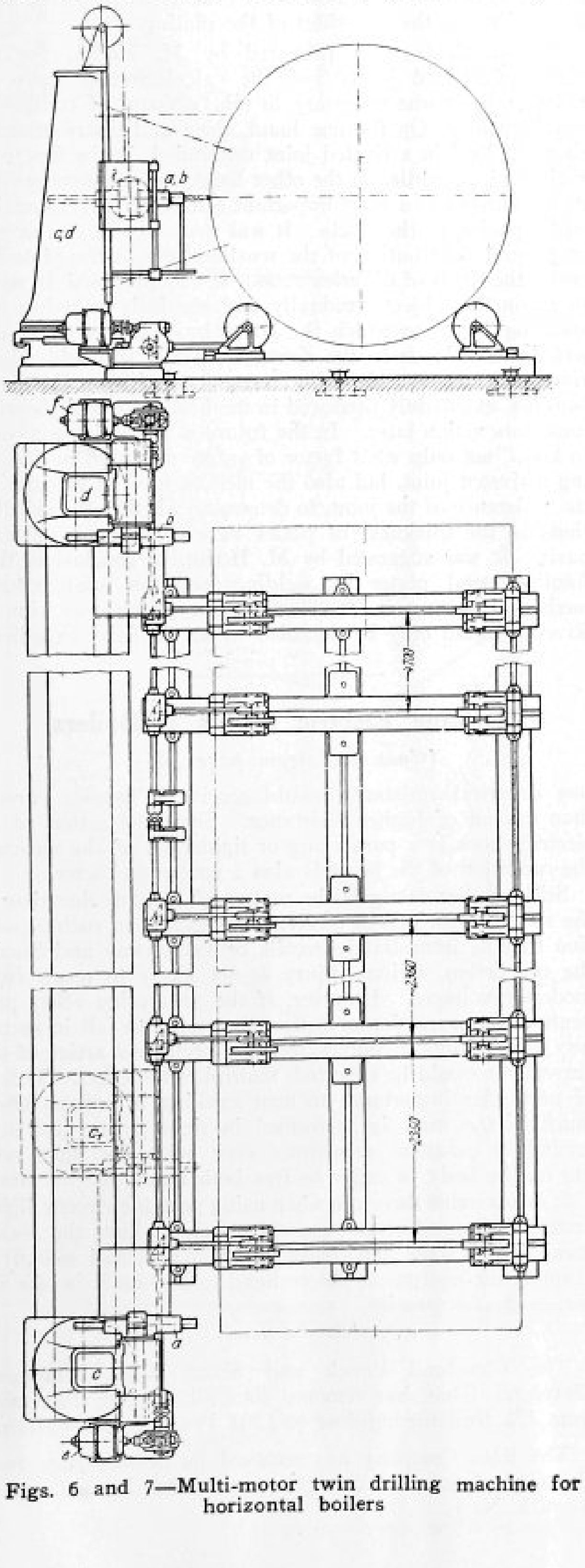


Fig. 5—Firebox drilling machine with three-motor drive

the current supply up to the two standards whence they further reach the magnetic reversing and braking starters of the turning motors.

The drilling motors each have 6 kilowatts output. They are cut in and out and otherwise adjusted from the operator's stand by means of drum controllers with crank gears (Fig. 4).

Fig. 5 shows a firebox drilling machine fitted with 3 motors. This machine emanated from the works of Messrs. Schiess-Defries A.G. (Ltd.), of Düsseldorf, and was delivered to the Orange Iron Works (Gewerkschaft) in Gelsenkirchen, their electric equipment again being supplied by Messrs. A.E.G. (General Electric Company). The drilling motor consists in a reversing control motor of 6.2 kilowatts at 760 to 1,650 revolutions per minute. It drives two drilling arbors working simultaneously. The drilling motor is operated by means of a control lever reversing gear starting up the motor in one or the other direction by a single manipulation which may be performed in the roughest manner conceivable. Besides that, it allows of adjusting the number of revolutions per minute, braking, and reversing. The latter can be done when cutting threads, fitting staybolts, etc.



Figs. 6 and 7—Multi-motor twin drilling machine for horizontal boilers

Using high-speed steel drills, the machine is capable of drilling about 90 to 100 rivet holes in boiler plates of say 18 millimeters (about 0.7 inch) thickness per hour. The spindle box can be given an inclination of up to 25 degrees upwards as well as downwards.

Two auxiliary motors are provided for horizontally moving the firebox to be set up on the circular table, and for turning the table itself. In the same way as in the case of the preceding machine, these auxiliary motors are operated by push buttons on the operator's stand, and by magnetic reversing starters with self-acting, dynamic braking. The hole centers can thus be adjusted very quickly and with the highest possible degree of accuracy.

Riveted and Welded Joints in Boiler Construction*

WHENEVER new methods of construction of any type of engineering plant become available, it is necessary to exercise caution before their general application is advocated. This applies particularly to cases where the stresses to which the parts are subjected are of considerable magnitude, or are of an alternating character. For many years, riveting was the sole means of connecting the curved steel plates used to form the drums of boilers. Welding, both by the use of an oxy-acetylene blowpipe and by means of the electric arc, is now commonly used in repair work, and also in some types of constructional work. It has been thought by many engineers that these processes might be applied with success and economy by the boiler maker. Before any general adoption is possible, however, it is necessary that the results of tests conducted by strictly impartial investigators should be available. Much work of this nature has been done by many different authorities, but unfortunately the results have not always been made available for study by the general engineering public. We therefore welcome a report of the work done by M. E. Hœhn, the chief engineer of the Swiss Association of Owners of Steam Boilers. This report bears the title "Rivure et Soudure des Chaudières à Vapeur," and in it comparisons are made of the characteristics of boiler drums forged in a single piece, with those having riveted and welded joints of various types, either separately or in combination. In his introductory remarks, the author states that he would not have undertaken further work on riveting, so much of which has already been done, if he had not been able to use a new method of determining the state of tension in the riveted construction. This consisted in measuring, by means of extensometers, the expansion of the plate and of butt straps on the test bars and on the various riveted joints used in boiler construction.

The conclusion arrived at by M. Hœhn, after his investigations were completed, was that, without doubt, the boiler drums affording the greatest security against rupture were those forged in a single piece, without any seam, and with hemispherical ends formed in a die press.

*From *Engineering*, October 15, 1926.

It was known, however, that the electrically welded joints possessed great strength and it ought to be recognized that riveting of hemispherical ends to seamless cylinders should be allowed, within certain limits, if the edges of the drums and ends were electrically welded. The ends could be riveted to the drum with a single riveted lap joint, even when the thickness of the material was great, for, in a circumferential seam, the bending moments were much less important than in a longitudinal riveted joint. It was also possible, when the thickness of the metal was not very great, to use butt welded joints between the ends and the drum, either made by the use of the blowpipe or with the electric arc, if the joints were reinforced by butt straps, welded at intervals to the drum and ends. In one system of construction, drums were welded to the ends with water-gas. In this process, the drums were subjected to a hydraulic test pressure which was sufficient to ensure that the tangential tension attained 1,500 kilograms per square centimeter (or 21,330 pounds per square inch); after testing, the drums were annealed. By this means very great solidity was obtained.

Boilers and other vessels, when the walls were not very thick and when high test pressures had not to be used, might be welded either with gas or electricity. For the purpose M. Hœhn proposed the use of a reinforcement consisting of butt straps electrically welded at intervals to the two parts, which had been butt-welded. In tests, it had been found that these butt straps invariably broke before they were pulled away at the welds. As their use augmented the section of the welded joint, and consequently the moment of resistance, the bending moments were reduced in effect. Joints, reinforced in this way had been shown in tests invariably to give way in the plain plate. Both gas and electric welding were certain to have extended use in the future and to prove cheaper than riveting. Their principal fault was that they were more dependent than riveting on the experience and conscientiousness of the workman. A preference was indicated in the report for the use of flux-coated electrodes, and it was also suggested that the work could best be done with a continuous current electricity supply.

It had to be admitted that, when plates were riveted together, slip took place if heavy stresses were applied. In the experimental work done by M. Hœhn, it was found that there were two kinds of displacement of this character: the internal and the external. The first was due to the unequal extension of the plates and the butt straps, and resulted from the fact that the rivets in different rows were subjected to different loads. The external relative displacement of a riveted joint was due to the deformation of the rivets, either elastic or permanent, at the edges of the holes. The elastic state of a riveted joint could be completely modified when butt straps were introduced, the edges of which were welded to the plates. In that case, the welded joints were the important ones. Riveted butt straps at welded joints had not, however, the same efficiency, unless their breadth was great and their thickness was sensibly greater than that of the plate. In dealing with this case, double butt straps were the only ones considered, as butt straps on one side of a joint were regarded as bad practice. It was suggested that, in future, butt straps should always be welded.

The tests showed that, in the riveted longitudinal joints of boiler drums, the bending moments were greatest at the edge of the butt straps. In a single riveted lap joint, they were shown to be a maximum at the edge of the plate. It was particularly in the case of riveted joints with double or treble riveted butt straps, and with one row of single-shear riveting, that the bending moment actions were pronounced. In single riveted lap joints, the bending moments had greater effects than tensile stress. In the future, the conditions under which single riveted lap joints would be approved would become more severe, and the factor of safety used in their design would need to be increased. One fault of double butt straps with double, or treble riveting, one row of which was in single shear, was the existence of bending moment actions, as already indicated, but this system of construction possessed a certain flexibility, because the thickness of the total section changed gradually from that of the plate to that over the butt straps, as well as on account of the chamfering, due to calking, or the welding introduced to secure freedom from leakage, which were not in line on the two sides of the plating.

New methods were proposed by M. Hœhn, for the study of riveted joints and the calculation of their resistance, as it was necessary to take account of conflicting requirements. On the one hand, the equal distribution of shearing load in a riveted joint demanded, in the first row, a close pitch, while, on the other hand, the resistance of the plate, which was a most important consideration, demanded wide spacing of the rivets. It was necessary to aim at getting equal distribution of the tensile stress in the plate between the rivets of different rows. It was proposed, in order to attain this object, gradually and regularly to reduce the shearing forces to which the rivets in each row were subjected. The loads on the rivets, especially in double shear riveting, comprised bending moments and shear actions; bending was mainly produced in the first place and shearing came into action later. In the future it would be necessary to know, not only what factor of safety was used in designing a riveted joint, but also the method used in calculating the resistance of the joint, to determine whether the calculations of the thickness of plates were made on a uniform basis. It was suggested by M. Hœhn, in conclusion, that joining metal plates by welding was the most natural method, resulting in an elastic state which was simple. Riveting could only be regarded as an artificial expedient.

Portable Electric Lights in Boilers

(*Continued from page 345*)

low electrical resistance would receive a heavier current than a man of higher resistance. Since the action of an electric shock is a paralyzing or tightening of the muscles, the condition of the heart is also a governing factor.

Still another factor is the matter of time or duration of the shock. If a person receiving a shock is in such a position that he immediately recoils or falls away and breaks the connection, serious injury is not likely to result from moderate voltages. However, if the paralyzing effect prevents voluntary action or causes the victim to fall in such a way as to maintain contact, then the prolonged action of the current, as would be expected, multiplies the effect. This is of particular importance to men working in boilers where much of the work is performed in tight places and in a recumbent position, sometimes even with the light resting on the body in order to free both hands for the work.

It is advisable therefore when using portable electric lights around boilers, first, to use only such as have the socket encased with some non-conducting material, and second, to examine the equipment before hand to be sure it is safe for use.—*The Locomotive*.

The Cleveland Punch and Shear Works Company, Cleveland, Ohio, has removed its Philadelphia, Pa., office from 321 Bulletin building to 1201 Pennsylvania building.

The Roto Company has removed its headquarters from Hartford, Conn., to Sussex avenue and Newark street, Newark, N. J.

Layout of a Ventura Stack Connection

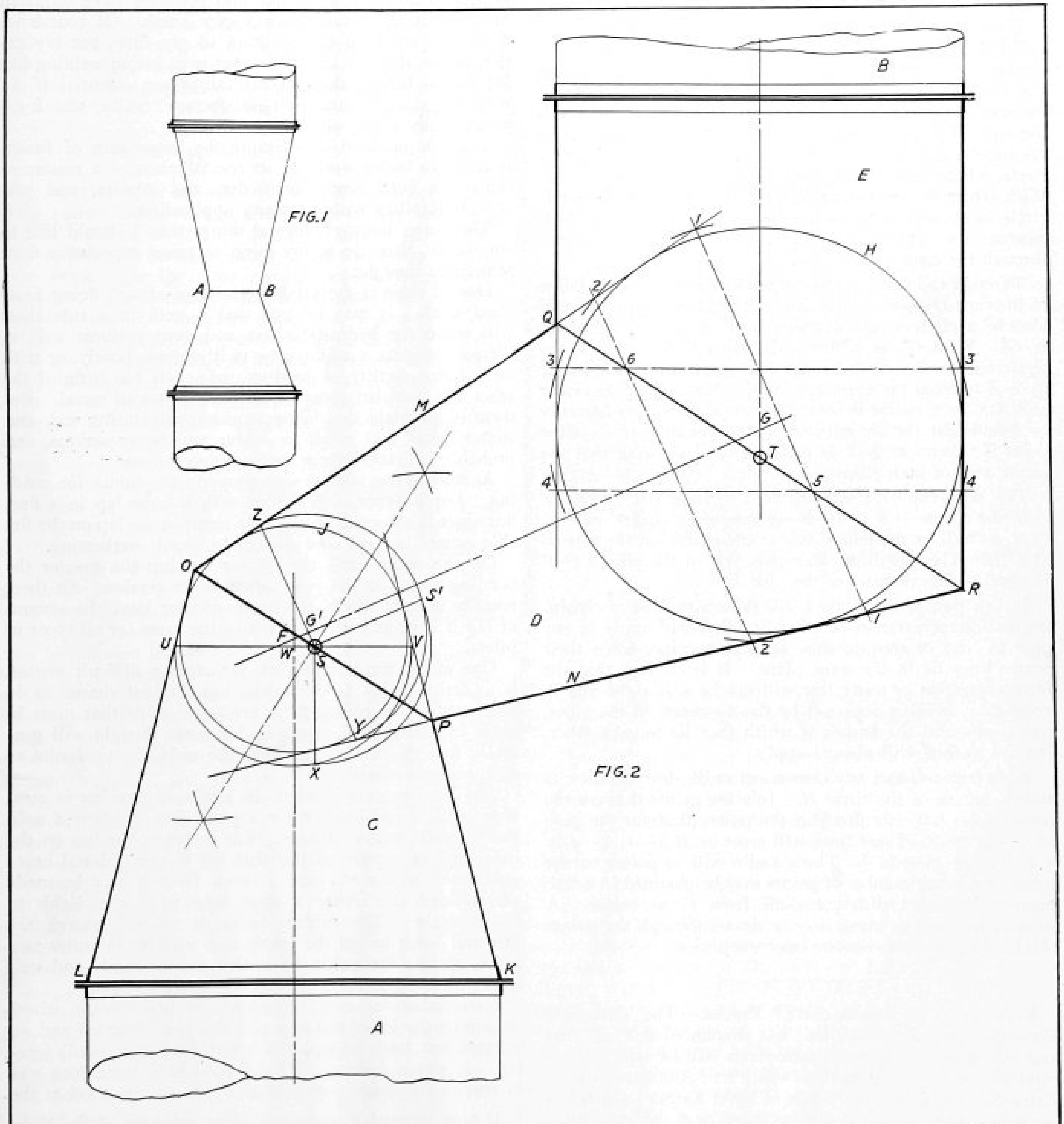
This construction consists of two frustums of cones having their sides at different angles

By I. J. Haddon

IN Fig. 1 is shown the usual type of Ventura stack; it is made of two frustums of cones and generally one of them is longer than the other, as shown.

It will readily be seen that, although the cones are of different angles, they may both be cut by a plane *A B* so that the diameter of each at *A B* is the same. It is obvious that *any circle* may be cut from *any cone* as I have emphasized in previous articles.

Fig. 2 is a very unusual connection and is drawn to show the connecting miter line between two cones at any angle,



Layout involving two frustums of cones having their sides at different angles also the connecting miter line of a cone and pipe at any angle, as well as to show that both of these connecting miter lines *are ellipses.*

Construction Details

Draw the center lines of the cones *C* and *D* and the center line of the pipe *E* crossing each other at *F* and *G*.

With center *G* and radius equal to half the diameter of the pipe *E* describe the circle *H*.

With center *F* and any radius desired, describe the circle *J*, then from *K* and *L* draw tangents to the circle *J* as shown, also draw lines *M* and *N* tangent to the circles *H* and *J* crossing the lines already drawn from *K* and *L* in *O* and *P*, also crossing the sides of the pipe *E* in *Q* and *R*. Join *Q R*, also join *O P*, then *O P* will be miter line of the cones *C* and *D*, and *Q R* will be the miter line of the cone *D* and pipe *E*, both of these miter lines *are ellipses.*

Bisect the line *O P* in *S*, the center line of the pipe *E* will bisect the miter line *Q R* in *T;* therefore *S* and *T* are the centers of two ellipses. Now I will show that although the cones *C* and *D* are of different angles, the distance through the cone *C* at *S* is the same as the distance through the cone *D* at *S*. Through S draw a line *U V* parallel to the base *L K*. It is obvious that the plan of this line is a circle, whose center is on the center line of the cone at *W*. With center *W* and radius *W U* or *W V* describe the semicircle as shown; then from *S* drop a perpendicular to *U V* meeting the semicircle in *X;* then *S X* is the distance through the cone *C* at *S*.

Through the point *S* and perpendicular to the center line of the cone *D* draw the line *Y Z*. The plan of this line will also be a circle whose diameter is *Y Z* and whose center is *G'*. With *G'* as center and radius *G' Z* describe the semicircle as shown; then from *S* drop a line perpendicular to *Y Z* meeting the semicircle in *S'*. Now with *S* as center and *S S'* as a radius describe the arc *S' X*. It will readily be found that the arc will cross the semicircle *U V* at the point *X;* therefore *S X* is equal to *S S'* showing that the minor axis of both ellipses are alike.

The same could be demonstrated to show that the point *T* of the ellipse *Q R* is the minor axis of an ellipse on *D* at *Q R*, as well as the minor axis of the ellipse on the pipe *E* at *Q R*. The length of the minor axis of the ellipse *Q R* is equal to the diameter of the pipe *E*.

In this part of the figure *l* will show a method of obtaining an interpenetration or miter line that will apply to any pipe to cone or cone to cone or pipe to pipe, when their center lines lie in the same plane. It is obvious that the interpenetration or miter line will not be a straight line in every case, it being governed by the diameters of the pipes, cones, etc., and the angles at which they lie to each other, but the method will always apply.

With center *G* and any convenient radii, describe arcs as shown outside of the circle *H*. Join the points that cut the cone as *1—1*, *2—2*, also join the points that cut the pipe as *3—3*, *4—4*. These lines will cross as at *1—1*, *4—4* in *5* and *2—2*, *3—3* in *6*. The *5* and *6* will be points on the miter line. Any number of points may be obtained in a like manner by using different radii from *G* as center. A straight line or fair curve may be drawn through the points obtained to give the line of interpenetration.

Reduction in Boiler Rivet Prices.—The Townsend Company, New Brighton, Pa., has announced that all cone and button head boiler and tank rivets will be sold without extra charge for boiler quality, which will eliminate entirely Extra No. 15 of "Standard List of Rivet Extras" which has heretofore required a 20 cent advance over the base price for such rivets.

Essentials in Fusion Welding*

By S. W. Miller†

I REMEMBER when I was serving my time as a machinist apprentice, while I was working in the erecting gang I think I spent more time in the boiler shop, when I could dodge the gang foreman, than in any other department. I became pretty well acquainted with the fellows there, and they gradually persuaded me to try my hand at riveting. In those days it was all done by hand in our shop, and I don't think I ever had a prouder moment in my life than when I was able to drive successfully one-half of a crown bar rivet.

What I have to say is not in regard to any particular point in connection with boiler welding, because you gentlemen are in it every day and probably have forgotten more about the details than I ever knew. Of course we never did anything of that kind in my time, but my experience in the last 15 or 16 years with fusion welding has led me to believe that several things are essential if we want to get economical and satisfactory results; and I am going to say a few words about that.

There is no need of stressing the importance of fusion welding in boiler work, as its use is taken as a matter of course in both new construction and repairs, and you are all familiar with its many applications.

There are, however, several things that I should like to emphasize, that are to my mind of more importance than sometimes thought.

One of these is the vital necessity of always doing first-class work. It may be true that a weld in a side sheet will stand the hydrostatic test and even perform well in service for quite a while, even if it is made poorly, or with an inferior quality of welding rod, or if too little of the sheet has been cut away to get back to sound metal. But there is no doubt that better workmanship, better rod, and sound metal will result in longer and better service, and probably will save one or more engine failures.

Another thing is to design properly the joints for welding. For instance, a lap joint with a large lap in a firebox sheet is not good, because the metal in the lap on the fire side cannot be kept cool enough to avoid overheating.

On the other hand the shorter the lap the greater the bending stress on the joint when under tension. So there must be a point where, for any particular joint, the amount of lap is best, and this may not be the same for all types of joints.

One of the most important, yet often a difficult matter, is to design welds so the welder has the best chance to do good work. Of course there are some welds that must be made in places hard to get at, but some thought will generally find the best design from the welder's standpoint as well as from others.

The hardest case is when an awkward position is combined with a bad location for a weld, that is, where a weld has to stand undue stresses. For instance, the lug on the lower end of a pedestal jaw that fits in the pedestal brace sometimes breaks off, and a small forging may be made and welded on. After a short time it is very liable to break again. The proper design is to cut through the jaw and lower bar of the frame and weld in an entire new piece, placing the welds where they can be easily and well made, and where they will not be heavily stressed.

I remember one case, though not in boiler work, where the lug on the lower end of a pedestal jaw broke off and an attempt was made to repair it by welding on a small forging. It was a failure. What should have been done was to remove the entire corner of the lug, cutting it off at the

* Paper presented at seventeenth annual convention of the Master Boiler Makers Association.

† Union Carbide and Carbon Research Laboratories, Long Island City.

bottom member of the frame and also in the jaw and welding in a new piece.

Another matter is the materials to be used. It is often beyond the power of the shop to secure changes in material specifications, but it is entirely within their province to point out that certain materials are better for welding than others. Fortunately boiler and firebox steels are easily welded. It is at times necessary to devise special methods to overcome this trouble, as for instance the use of bronze for welding malleable iron, and such developments often result in successful welding of materials that are not easily or safely welded by ordinary means.

Again, there is not much use in welding a patch in a badly corrugated side sheet, as the sheet has been injured, and good results cannot be expected. Here again, however, the question of design enters and a corrugated or dished patch will give better results than a flat one.

Method in welding has been referred to, but it may stand a little further comment. It refers particularly to such things as the allowance for contraction, order in which the weld is made, preparation of the parts, and in general, the procedure followed from the time the job is assigned till it is finished. It is obvious that success can be had only by seeing that the various items involved in this procedure are correct.

The supervision of the work is of great importance. In a large railroad shop the jobs are often widely scattered, and it is much more difficult to keep track of them than in the ordinary production shop. Also the varied nature of the work calls for close control, which means close supervision. There are very few boiler shop foremen who are welders, and it is therefore imperative that the welding supervisor be of the most competent kind, able to do the work himself, and also able to impart his knowledge to the welders and to see that they carry out his instructions.

Whether the supervisor can himself train the operators, or whether they should be taught in a central place, depends on conditions. On a very large system the central training school would seem best, unless each shop has a teacher who has time enough to train the men properly. In many cases the supervisor can do it, if he is of the right type. But in any case the means is of minor importance, the essential thing being to see that the men are properly and thoroughly trained. It must be remembered that a man may be a very good mechanic but a very poor teacher, and in fact the combination of both qualities in one individual is very rare.

One of the most important parts of a welder's training is the testing of specimens of his work. This can be done best by pulling welded test pieces in a tensile testing machine, because it gives actual figures, and as the tests can be made at regular intervals, both during the training period and in his actual service, improvement can easily be noticed, and defects, if any, corrected. If a testing machine is not available, fair results can be had by clamping the test pieces on an anvil, or in a heavy vise, and bending them with a sledge. Such a method is far better than none, as it shows up defects, and if properly done, gives a rough idea of the strength.

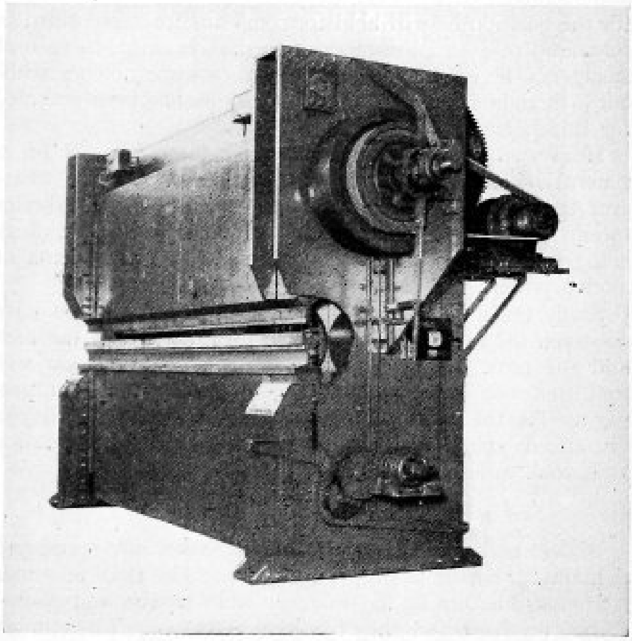
All finished products are tested in some way, the test depending on the nature of the product. Chemical analysis, hardness tests, breaking of a certain number of pieces, cutting samples from a finished piece, hydrostatic pressure, and comparative tests in service, are a few of the many means employed. The hydrostatic test is the one usually employed in boiler work, and it should always be used after any part of the boiler is welded. Hammering the welds with an ordinary hammer, but not hard enough to cause distortion, is sometimes of value, and any properly made weld will stand this test easily.

Summing up the above items, we have as the matters that must be given careful attention: design, materials, methods, supervision, training, testing. If all of these are properly carried out, there can be no question of the results being successful and satisfactory in every way.

Heavy Duty Bending Brake

THE Dreis & Krump Manufacturing Company, Chicago, Ill., manufacturers of steel up and down press brakes for sixteen years, has recently added to its line a toggle motion double housing gap press brake for heavy bending or multiple bends in one stroke.

It is claimed that the toggle motion increases the pressure at the bottom of the stroke where the final bend is made. A direct motor to flywheel drive consists of the Allis-Chalmers Texrope with cast iron sheaves, one sheave being mounted on the clutch rim on the flywheel and one sheave on the motor. The flywheel turns on Timken roller bearings. A bronze ring is mounted on an eccentric which is shouldered into the bull gears. This eccentric actuates



Double housing gap bending press

steel connection straps which drive against the toggles and operate the ram, the toggles being bronze lined throughout. The toggles are so located that they do not completely straighten when the ram is down and thus eliminate the possibility of the ram being jammed on dead center when too close adjustment is made.

The adjustment for various heights of dies and thickness of metal is controlled by a small independent reversible motor furnished with the machine. This operates reducing spur gears and worm gears, the worm gear acting as a nut to raise or lower a screw supporting the bed. The adjustment can be made independent at each end or in unison as may be required. Each housing is constructed of two steel plates spaced with heavy channels and between which the bull gear, eccentric, toggles and driving gears operate. Each housing has an independent driving unit mounted within, these units being connected with a drive shaft on which the flywheel and clutch are mounted. A Madison-Kipp oiler, forced feed, provides lubrication to bearings and slides.

These machines are made in various lengths and capacities up to 14 feet in length and to bend up to ½ inch steel plates.

Making Master Boiler Makers

Practical suggestions for training for promotion in the locomotive boiler shop

By John Mitchell

PERHAPS a discourse on this subject would be beneficial to many of us and first of all it should be emphatically stated that we cannot be overtrained or have too much ability for the job at hand. The greatest assurance of promotion comes from this extra or reserve ability and is much like the reserves of a bank in that it makes it strong and dependable. One of the greatest examples of thorough and complete training, far beyond the immediate needs, is found in the training of army and navy officers. A graduate of West Point or Annapolis is so well grounded physically, disciplinarily, academically and socially that he is certainly much more than well fitted for the position he will hold for some time; namely, third in command of a small number of men. However, in case of emergency he can be pushed up two or three notches without a thought as to his competency as he has been groomed for this place.

If every boiler maker would strive to fit himself for a general boiler inspector, master boilermakership, or whatever the title, he would surely be competent for a boiler foreman's place and there would be even more boiler makers going on up to master mechanics and superintendents of motive power.

Study the next job ahead and when you think you have mastered the intricacies of this keep on and study the next and the next. As you change your perspective you will find that you have missed some important items in preparing for the first step and did not realize it until you visualized yourself as general and in your imagination undertook to supervise the plain foremen.

Keeping Accurate Records

Boiler makers, inspectors and foremen are employed to maintain boilers in proper condition. The chief of course is responsible, but he has to know what repairs and renewals are needed before they can be undertaken. The number of locomotives is such that he gets beyond the realm of personal, intimate knowledge of each individual boiler. Therefore his first and most important duty is to have records from which he can secure this detailed information and to be sure that these records are complete and accurate. If you know exactly what you want it is much easier to have it done just so. If your plans are not well formulated and your instructions are not specific the results produced by your organization will be haphazard and well below par. The fellow who cannot get things done as he wants them is invariably at fault himself in not knowing just what he does want and in not giving complete and specific instructions. You can take only very little for granted in these days of scattered organizations and strenuous activities.

The manager of a last year's champion baseball team is out of a job this year because of lack of plans. His organization could not repeat or even approach a repetition this year. A good record one year should be improved upon or certainly approached the next year and if it does not, you, as the directing head, should know it, know why and know it in time. If you are not accomplishing what you should and can go to the superintendent of motive power and tell him what is wrong he will surely respect you and help to correct it. Furthermore did you ever know a man in a responsible position, who was slipping, to lose out before receiving warning? If when the warning comes you have or can point out the weaknesses and suggest and apply the remedy you should be stronger than ever for that shows reserve and come-back ability.

Railroads accumulate a number of records and statistics of various and sundry kinds, not enough perhaps on boilers, but do we get the full benefit of these and use them to gage our results? They are our book of achievement and should be studied from every angle. The old adage "figures don't lie, but liars do figure" has made us perhaps prone to do much figuring, but accurate records are as necessary in railroading as in banking. The more records are studied the more uses can be made of them and they are truly the only instruments to measure accurately the degree of goodness or badness.

To be specific. Most roads use diagrams showing the number and location of broken staybolts. How many master boiler makers can tell you, with figures to prove it, whether it pays to remove the adjacent staybolts to broken ones? Many of us probably feel that it does pay but a properly kept record would show definitely. For instance, class "X" locomotives were in for broken staybolts on an average of every twelve days and average number of bolts found broken was six, but perhaps by removing the adjacent bolts we have increased the periods for renewals to sixty days and average breakage is five. With removal of adjacent bolts then we have an average staybolt renewal of twenty-five bolts in one operation each sixty days as against five renewals of six bolts each and it is easy to prove the more economical system giving consideration to keeping the engine in service, non-duplication in removing jacket and appurtenances and reducing the possibility of failure due to broken bolts.

Use of Graphic Charts

The inspector does most of the work when he fills out a diagram showing broken staybolts and it is merely a clerical matter to have determined each month the number of broken bolts per boiler by classes of locomotives. A graphic chart showing this is a simple matter, enables you to notice any unusual variations, and leads to further study and enlightenment.

Some years ago a road used no diagrams, but each boiler foreman had a book showing the number of broken staybolts renewed. One class boiler was known to break a considerable number of bolts and a few hours' work on these book records showed the average per boiler was 42 per month, engines being brought in as often as conditions would warrant. Questioning of the foremen determined the approximate location of the breaking zone and the application of some 230 flexible bolts per boiler reduced this breakage to about 5 per month. These records had been available for several years but were not utilized. Here was an expensive and dangerous condition that was known of in a general way by the inspectors and foremen, but no one had the specific information as to just how bad it was. When the condition was put in understandable terms corrective action presented itself and there was no hesitancy in taking this action.

It is not necessary to perpetuate all records as one or an occasional check may be sufficient. If we want to check washout plugs, the storekeeper can tell you the number of plugs used per year and by a simple calculation you are then in position to tell the foremen they are using say 24 plugs per locomotive per year and that you want to try and reduce that to half, or 1 per locomotive per month. By checking the engines you will probably find that most of the wear is due to rechasing to remove accumulations of hard graphite, leakage and dirt. Plugs must be cleaned and good threads maintained but there is no need of putting on an excess of graphite to harden, collect dirt and require frequent cleaning. A small amount of graphite put in the hole answers the purpose better and avoids to a great extent such frequent cleaning.

Nearly every item of boiler maintenance is subject to a first class analysis from data on hand, or readily obtainable and it behooves us to be inquisitive, alert and more and more specific.

Report of the M. B. M. A. Standing Committee on Autogenous Welding*

During the past year the members of this committee have been in conference and in more or less constant correspondence with each other, as well as the officials of roads who are also interested in autogenous welding. A number of visits have been made to some of the larger and important shops throughout the country where this work is being handled and where valuable experience was to be found, also much information to be had concerning contemplated operations, with the result that the report your committee is now making is believed to represent the best and safest practice at this time.

Although autogenous welding is still young, it has undoubtedly revolutionized many shop operations; and by the use of autogenous welding, many satisfactory results hitherto unknown have been accomplished. It is quite true that there may have been limited fear on the part of some in the handling of certain operations. Some of these fears may have been well-founded; on the other hand, others have been largely the influence of the detail methods employed. It is safe to say, however, that those who have given the matter the closest study have undoubtedly concluded that we may yet be far from knowing the full value of the practice and the still further efficient use to which the autogenous welding process may be safely and economically applied. The statement might be ventured, on account of being at least partially correct, that the operation is so simple that it may in some instance invite carelessness. But this should not be allowed to prevent the economical use of such a valuable means of accomplishing the work safely and with good results when the care and attention it deserves is applied.

The appended statements which are being submitted by your committee are accompanied by the further statement on the part of your committee that it should be clearly understood that the conclusions herewith submitted represent the best practice and the recommendations of your committee at this time. The experience of your committee, as well as of others who are also studying this subject, has been that the state of the art is ever changing and what we are now recommending they may in time wish to modify. Suffice it to say, however, that for the present, the following embodies our best views which are unhesitatingly offered as good and safe practice. In some instances, it is fair to say that, based upon experience, there will undoubtedly be necessity for further extensions and the further handling of operations along lines now unknown and that may yet be discovered to permit autogenous welding to be safely and economically applied where rather unwarranted conservatism now prevails. On the other hand, it may be found, and doubtless will, that lack of opportunity, reason to try, or conservatism has kept us from the economic handling of certain operations by autogenous welding that we shall later on find perfectly safe and economical to so handle; or in other words, as time goes on and our experience increases, we might expect to learn still more about the use and range of autogenous welding and modify our views and practices accordingly.

This subject, therefore, should continue to receive the close study of your Association and for the reason that as time goes on further suggestions may be offered in the light of additional experience.

J. A. Doarnberger,
Chairman.

* The following statement has been sent out by the secretary of the Master Boiler Makers' Association, to be added as a preface to the report on "Welding" which appeared on page 321 of the November issue of The Boiler Maker

Removing Boiler Scale

(*Continued from page 350*)

connected to common steam and mud drums. It was with great difficulty that the large hand hole plate was removed from the mud drum, but when this was finally accomplished it revealed that the drum was filled almost solid with scale and stiff mud, leaving a very poor circulating connection between the boilers. It was with great difficulty that the mud drum and other parts of the boilers were cleaned. If the compound was loosening the scale the boilers should have been blown down more frequently than was the usual practice. Another week of operation of these boilers would probably have resulted in burning them, to be followed by expensive repairs.

The water of the Monongahela River in the Pittsburgh district during the autumn season contains a high percentage of acid. One plant using water from this river in its steam boilers was troubled with considerable leakage during the fall season. Someone told the chief engineer to use lime in his boilers to prevent corrosion and leakage. He accordingly sent two barrels of lime to one of the boiler plants and told the water tender to use plenty of it as the water was bad. Three days later the plant was obliged to shut down, and parts of the bottoms of four boilers were cut out and patched by half sheets. Very large depressions had appeared on the bottoms of these boilers, and when the boilers were opened very heavy coatings of lime were found on the plates that were immediately over the fire. Entirely too much lime was used in this case.

The accompanying illustration shows a depression on the first course of a horizontal return tubular boiler. This boiler was 78 inches in diameter and 20 feet long. The shell plates were 9/32-inch thick, the longitudinal joints having eight rows of rivets. The depression was down 7 inches and was about 18 inches wide at one point. A fracture 1⅛ inches long had opened at the apex of the bulge and the metal was drawn down to a knife edge at the fracture and was considerably reduced at other places.

There was scale in the boilers in this plant, and a scale solvent had been used for a short time to remove it. When the depression and leakage were noted the boiler was taken out of service and cooled; when opened, a heavy deposit of scale and sediment was found in the depression and on the lower plates. The indications were that scale was loosened from the tubes and shell plates too rapidly in comparison to the rate of removing it from the boilers by cleaning.

Nearly all boiler compounds, metal treatments and scale solvents are of some value when used in steam boilers, but care should be exercised when beginning the use of them. It should first be ascertained whether the one selected is suited to the boiler feedwater, and further, if scale is removed rapidly from tubes or plates, it should likewise be removed from the boiler or overheating of plates and expensive repairs may result.—*The Locomotive.*

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Coating Sheet Metal—Galvanizing

Q.—At your earliest convenience I will appreciate it very much if you will publish in THE BOILER MAKER whether or not, when sheet iron is galvanized if it is galvanized completely through the thickness of metal, or if just on the surface. Very recently we had a water spout leaking very badly in the soldered joints and I brazed them with tobin bronze. Before starting I was told by the pipefitter I would have to file all the galvanizing off the pipe before the bronze would hold. I told him to do that I would have to file all the metal away as the metal was galvanized completely through the thickness. G. W. S.

A.—Most metals exposed to weather, especially damp atmosphere, corrode, that is, oxidize. Sheet steel rapidly corrodes or rusts unless protected by paint or other means. Lead, copper, zinc and aluminum so exposed are protected by a film of oxide, which prevents deterioration.

To protect sheet iron or steel, galvanizing is a common method. For this operation the sheets are first cleaned in a pickling solution of muriatic acid and water in equal parts. This solution removes grease, oil and other foreign substances. The sheets are then dipped in water ready for the galvanizing bath, in molten zinc. The galvanizing does not extend through the metal, it simply coats the surface.

Arrangement of Tube Holes—Boiler Explosions

Q.—Are all flue holes in locomotive boilers laid out on 60-degree angles? I have been told that in a boiler explosion the steam gage hand goes all the way around. What causes this and does putting the injector on that cause it to burst? Would it have burst if the injector had not been put on? If you have anything further along this line I would like to hear from you. J. F. D.

A.—The term *flues* is applied to the tubes which contain the superheater pipes, and *tubes* to the other units which are smaller in diameter than the flues. Flue holes need not be laid off on 60-degree angles.

A boiler explosion may occur from any of the following causes:

1. Improper design.
2. Defective material.
3. Defects in construction.
4. Corrosion and reduction of material.
5. Mismanagement in operation of the boiler.
6. Excessive steam pressure.

The great danger in the operation of locomotive boilers arises from low water over the crown sheet. This sheet is the highest in the firebox and will be the first to be affected from low water. The overheating of the crown sheet takes place rapidly when dry. The temperature of this sheet when covered with water rarely rises above 400 degrees F. when free from scale and oil. The temperature in the firebox may be close to 2,500 degrees F.; therefore, if the crown sheet is not covered the excessive heat reduces the resistance of the plate, which drops in pulling away from the stays due to the pressure, and invariably results in an explosion.

Riveted Joint Calculations

Q.—In reference to a correct formula, and method of deriving same for finding the factor of a diagonal seam, I wish to advise that there is nothing in the July issue, 1917, of THE BOILER MAKER giving this information, and would certainly appreciate it if you would furnish me this information. —L. W. D.

A.—In calculating the strength of a riveted joint it is essential to analyze the different ways the joint may fail. For this purpose a unit length of the joint is taken, equal to the pitch of rivets measured in the outer row for butt strap joints of the type shown in Fig. 1.

In the joint, Fig. 1, there are practically three different types, shown respectively within the brackets M, N and O. For M, the unit length of the joint is equal to P, in N to P_1 and in O to P_2.

On this basis an explanation will be given for the joint section M; using the rivet diameter plate thickness as designated in the following data:

Since the butt strap thickness is not given, refer to Par. 19, page 4, A.S.M.E. Code which gives the minimum thickness of butt straps in this case to be ½ inch, when the shell plate is ⅝ inch.

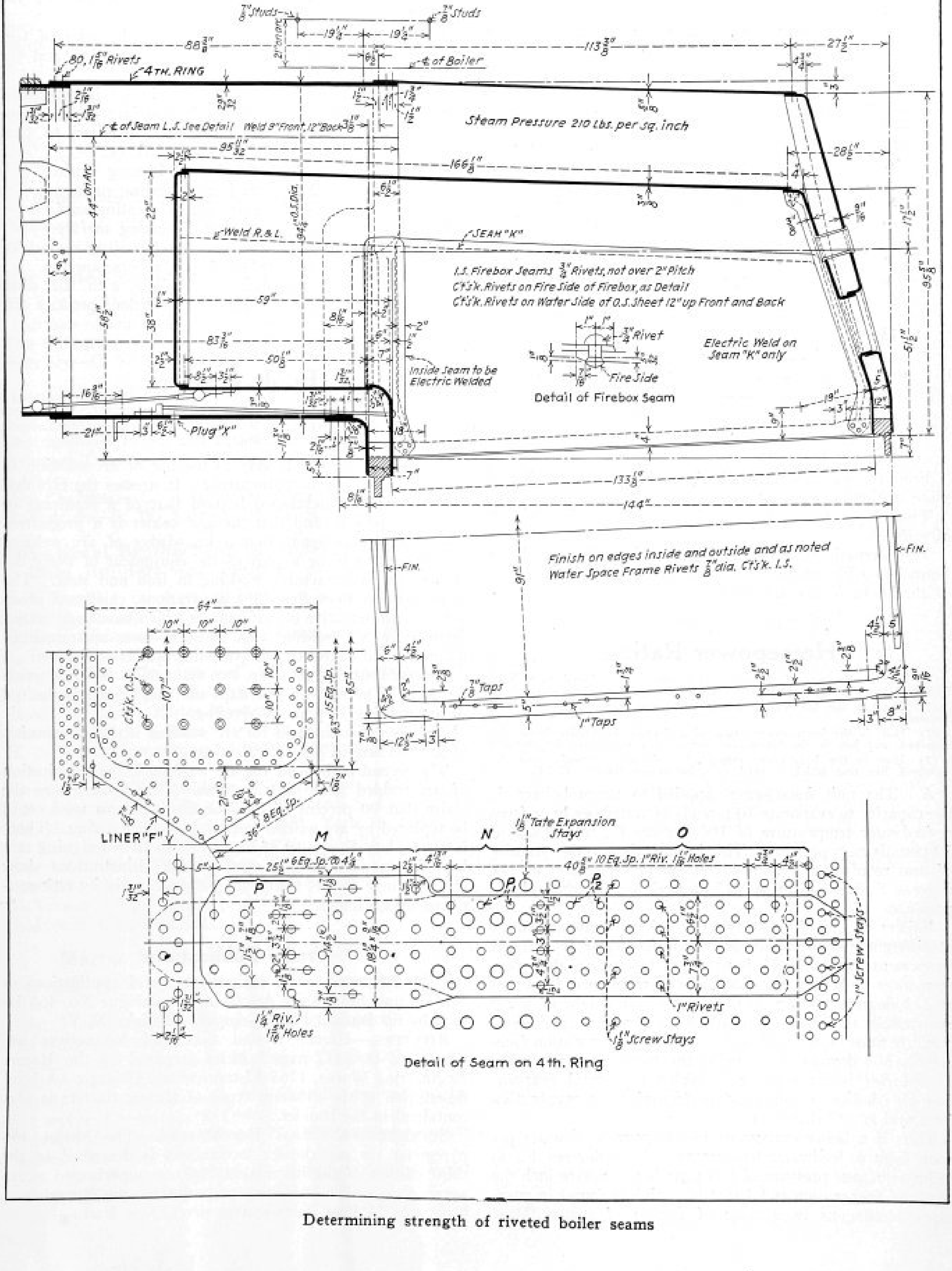
To explain the calculations, the following symbols are given:

TS = tensile strength of plate, pounds per square inch = 55,000 pounds per square inch.
t = thickness of boiler shell = ⅝ inch.
b = minimum thickness of butt straps = ½ inch.
P = pitch of rivets in outer row (unit length) = 8½ inches.
d = diameter of rivet hole in inches = $1\frac{5}{16}$ inches.
a = area of rivet driven size square inch = $1\frac{5}{16} \times 1\frac{5}{16} \times 0.7854 = 1.353$.
s = shearing strength of rivets in single shear = 44,000 pounds per square inch.
S = shearing strength of rivets in double shear = 88,000 pounds per square inch.
C = crushing strength of mild steel (boiler steel) = 95,000 pounds per square inch.
n = number of rivets in single shear in unit length = 1 in this example.
N = number of rivets in double shear in unit lengths = 4 in this example.

With these data calculate the strength of each part of the joint. Divide the least strength value so found by the strength of the solid plate section in the unit length and the quotient is the efficiency of the joint.

The strengths of the different parts are figured in the following way:

A = Strength of solid plate section equals $P \times t \times TS = 8\frac{1}{2} \times \frac{5}{8} \times 55{,}000 = 292{,}187$ pounds.



Determining strength of riveted boiler seams

B = Strength of plate between rivet holes in outer row, equals $(P - d)\ t \times TS = (8\frac{1}{2} - 1\frac{5}{16}) \times \frac{5}{8} \times 55{,}000 = 247{,}070$ pounds.

C = Shearing strength of 4 rivets in double shear, plus the shearing strength of 1 rivet in single shear, equals $N \times S \times a + n \times S \times a = 4 \times 88{,}000 \times 1.353 + 1 \times 44{,}000 \times 1.353 = 533{,}588$ pounds.

D = Strength of plate between rivet holes in the second row, plus the shearing strength of 1 rivet in the outer row, equals $(P - 2d)\ t \times TS + n \times S \times a = (8\frac{1}{2} - [2 \times 1\frac{5}{16}]) \times \frac{5}{8} \times 55{,}000 + (1 \times 44{,}000 \times 1.353) = 259{,}285$ pounds.

E = Strength of solid plate between rivet holes in the second row, plus the crushing strength of butt strap in front of 1 rivet in outer row, equals $(P - 2d)\ t \times TS + d \times b \times c =$ $(8\frac{1}{2} - [2 \times 1\frac{5}{16}]) \times \frac{5}{8} \times 55{,}000 + (1\frac{5}{16} \times \frac{1}{2} \times 95{,}000) = 264{,}296$ pounds.

F = Crushing strength of plate in front of 4 rivets in inner rows, plus the crushing strength of butt strap in front of 1 rivet in outer row, equals $N \times d \times t \times c + n \times d \times b \times c = 4 \times 1\frac{5}{16} \times \frac{5}{8} \times 95{,}000 + 1 \times 1\frac{5}{16} \times \frac{1}{2} \times 95{,}000 =$ 373,943 pounds.

G = Crushing strength of plate in front of 4 rivets in inner rows, plus the shearing strength of 1 rivet in the outer row, equals $N \times d \times t \times c + n \times a \times s =$ $4 \times 1\frac{5}{16} \times \frac{5}{8} \times 95{,}000 + 1 \times 1.353 \times 44{,}000 = 371{,}132$ pounds.

From these calculations it is shown that the net section of plate in the outer row is the weakest. Refer to B.

Then, $B \div A = 247{,}070 \div 292{,}187 = 0.845$, efficiency of joint.

The strength of the other joint sections N and O are figured in a like manner, using the diameter of stays at root of thread in N and the pitch.

Horsepower Rating

Q.—Taking advantage of the service you offer your subscribers to THE BOILER MAKER I would like to get information on the following:

(1) How is the horsepower rating of a watertube stationary boiler determined?

(2) How is the horsepower rating of a firetube locomotive boiler determined, and how is the horsepower rating of a locomotive determined?

(3) How is the horsepower rating of a firetube vertical boiler determined, like that which is used on a locomotive crane? E.E.E.

A.—The unit *horsepower*, applied to steam boilers, is the capacity to evaporate 30 pounds of water per hour from a feedwater temperature of 100 degrees F., into steam at 70 pounds gage pressure. This is equivalent to the quantity of heat required to evaporate 34.5 pounds of water at 212 degrees F. into steam at 212 degrees F., or atmospheric pressure.

Boilers of the different types mentioned generate steam at different pressures and receive the feedwater at different temperatures; therefore it is necessary to compare their performances on the evaporation basis as mentioned from and at 212 degrees F. To do this, the actual weight of water evaporated under the conditions of pressure and temperature must be reduced to the equivalent evaporation from and at 212 degrees F. by using the *factor of evaporation*. This factor is the number by which the actual evaporation of a boiler is multiplied to determine the evaporation from and at 212 degrees F.

Thus if a boiler evaporates 14,000 pounds of water per hour from a feedwater temperature of 60 degrees F., to steam at a gage pressure of 100 pounds per square inch the factor of evaporation is 1.198 (this value is found in engineer's handbooks in a table of factors of evaporation). This factor indicates that if the water is 212 degrees F. and is evaporated into steam at this temperature the boiler could have evaporated $14{,}000 \times 1.198 = 16{,}772$ pounds of water from and at 212 degrees F.

Since one boiler horsepower is the evaporation of 34.5 pounds of water per hour from and at 212 degrees F. the horsepower in this example equals $16{,}772 \div 34.5 = 486$ boiler horsepower.

The design of the boiler, grate area, character of fuel burned, methods of firing affect the evaporation and the efficiency of the boiler.

The approximate horsepower of a boiler is sometimes figured by dividing the total heating surface by the number of square feet of heating surface required to produce one boiler horsepower given as follows:

Tubular—12 to 16 square feet of heating surface.
Vertical—11 to 20 square feet of heating surface.
Watertube—10 to 12 square feet of heating surface.
Locomotive—1 to 2 square feet of heating surface.

Thus if a tubular boiler has a total heating surface of 300 square feet, then $300 \div 12 = 25$ horsepower.

This method is indefinite, as boilers with the same heating surface will under different conditions produce different quantities of steam.

Book Review

ARC WELDING, THE NEW AGE IN IRON AND STEEL. 160 *pages illustrated, 6 inches by 9 inches, published by the Lincoln Electric Company, Cleveland, Ohio.*

This book is devoted largely to the use of arc welding in general production manufacturing. It stresses the fact that arc welding has developed beyond that of a repairing or salvaging process and that the arc welder is a production tool. It also contends that a knowledge of arc welding principles should be a part of the equipment of every designer and manufacturer working in iron and steel. The book contains more than 200 illustrations, chiefly of products of representative manufacturers which have been manufactured by arc welding. In addition there are numerous diagrams and charts showing welding speeds and costs.

It points out that there are two main fields for production welding. The first and perhaps the best known is the use of arc welding in place of riveting.

The second main field for arc welding is the substitution of arc welding in place of riveting.

The second main field for arc welding is the substitution of arc welded steel for cast iron. This book makes the claim that 90 percent of the iron castings now used could be replaced by arc welded steel at a decided saving. There is a complete discussion of how to go about redesigning cast iron for manufacture in steel and the illustrations show clearly where this is being done commercially by representative manufacturers.

Trade Publications

UNIT HEATERS.—The various types and applications of Buffalo unit heaters are described in catalogue No. 466 issued by the Buffalo Forge Company, Buffalo, N. Y.

RIVETERS.—Hanna riveted cars and locomotives are illustrated in a 12-page booklet prepared by the Hanna Engineering Works, 1765 Elston avenue, Chicago. A brief description of the different types of Hanna riveters is also contained in the booklet.

SUPERHEATED STEAM PYROMETERS.—The Model 496 pyrometer for superheater locomotives is described in the third edition of the instruction book on superheated steam pyrometers which has been prepared by the Superheater Company, 17 East Forty-second street, New York.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

Steamboat Inspection Service of the Department of Commerce

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

American Uniform Boiler Law Society

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

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—Fred R. Low.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—C. D. Thomas, Salem, Oregon.
Statistician—E. W. Farmer, Rhode Island.

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

J. A. Franklin, International President, suite 522, Brotherhood Block, Kansas City, Kansas.
William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.
Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.
James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.
H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.
International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C. Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Avenue, Columbus, Ohio.

Master Boiler Makers' Association

President—J. F. Raps, general boiler inspector, Illinois Central.
First Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.
Second Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.
Third Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.
Fourth Vice President—George B. Usherwood, supervisor of boilers, New York Central.
Fifth Vice President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington and Quincy.
Secretary—Harry D. Vought, 26 Cortlandt Street, New York.
Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.
Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—J. W. Kelly, National Tube Company, Pittsburgh, Pa.
Vice President—A. W. Clokey, American Arch Company, Chicago, Ill.
Treasurer—George R. Boyce, A. M. Castle and Company, Chicago, Ill.
Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie, Pa.
Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.
Secretary-Treasurer—A. C. Baker, 801 Rockefeller Building, Cleveland, Ohio.
Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; Owsley Brown, Springfield Boiler Company, Springfield, Ill.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Wroks, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

States and Cities That Have Adopted the A. S. M. E. Boiler Code

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Territory of Hawaii

Cities

Chicago, Ill.	Memphis, Tenn.	St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Los Angeles, Cal.	Philadelphia, Pa.	Tampa, Fla.

States and Cities Accepting Stamp of the National Board of Boiler and Pressure Vessel Inspectors

States

Arkansas	Missouri	Pennsylvania
California	New Jersey	Rhode Island
Delaware	New York	Utah
Indiana	Ohio	Washington
Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Nebr.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Memphis, Tenn.	Philadelphia, Pa.	Tampa, Fla.

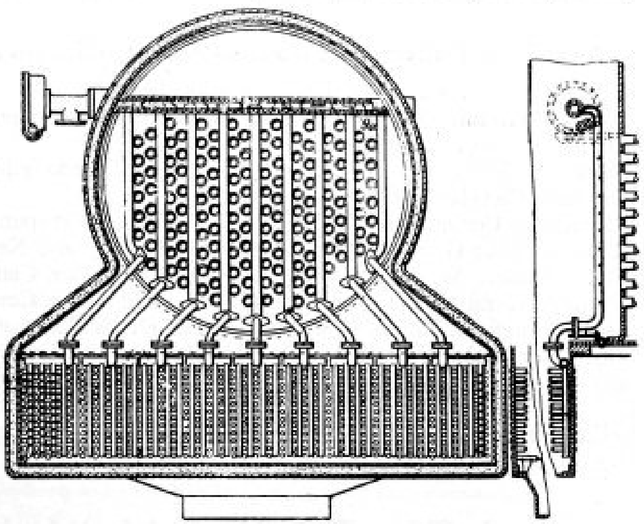
SELECTED BOILER PATENTS

Compiled by
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,549,841. FREDRIK LJUNGSTROM, OF BREVIK, SWEDEN, ASSIGNOR TO AKTIEBOLAGET LJUNGSTROMS ANGTURBIN, OF STOCKHOLM, SWEDEN, A CORPORATION. SWEEPING DEVICE FOR BOILER TUBES.

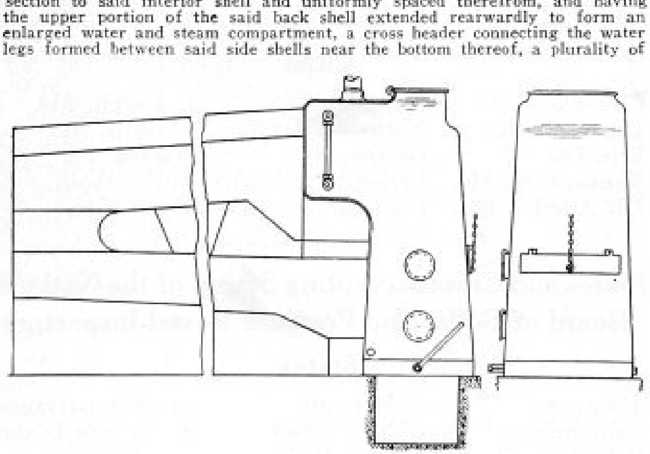
Claim 1. In a boiler structure, the combination with boiler tubes disposed in spaced vertical rows, of a steam distributing device, stationary



vertical steam distributing pipes arranged in front of the interspaces between said vertical rows of boiler tubes and provided with outlet means positioned to clean the respective tubes, and connections between said distributing device and said distributing pipes and valve means so arranged as to supply steam successively to said distributing pipes from said device. 4 claims.

1,548,638. CHARLES W. SMART, OF MEMPHIS, TENNESSEE. WATERTUBE BOILER.

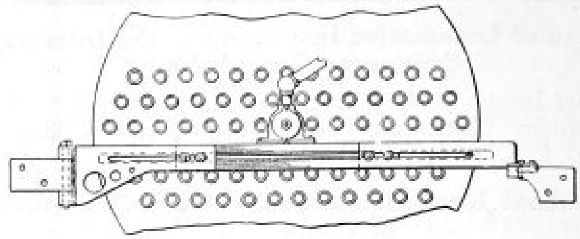
Claim 1. In a furnace, the combination with a hollow boiler having an interior shell of truncated pyramidal form and rectangular cross section forming a fuel compartment, with the back section of said shell terminating above the side sections thereof, a fuel opening in the top of said compartment and a cover for the same, an exterior shell having the front, sides, and lower portion of the back thereof conforming in cross and vertical section to said interior shell and uniformly spaced therefrom, and having the upper portion of the said back shell extended rearwardly to form an enlarged water and steam compartment, a cross header connecting the water legs formed between said side shells near the bottom thereof, a plurality of



vertical tubes connecting the bottom of the water leg, formed between said back shells, and the said cross header, and a similar number of pairs of vertically aligned substantially U shaped tubes extending rearwardly, the lower end of one tube of each of said pairs from said header, and of the other from the rear of said back water leg near the bottom thereof, and the upper ends of both tubes of each of said pairs connecting into the back of said enlarged water compartment; of grates beneath said fuel compartment, an air inlet leading through the front water leg of said boiler into said fuel compartment above said grates, and a flue chamber extending rearwardly from said exterior shell and surrounding said tubes, said flue chamber being divided into a rearwardly directed and a return section by a baffle wall extending rearwardly from the lower end of the rear water leg of said boiler into the bend in said U shaped tubes. 7 claims.

1,549,415. JAMES A. HAFER, OF CHAMBERSBURG, PENNSYLVANIA. BOILER BLOWER.

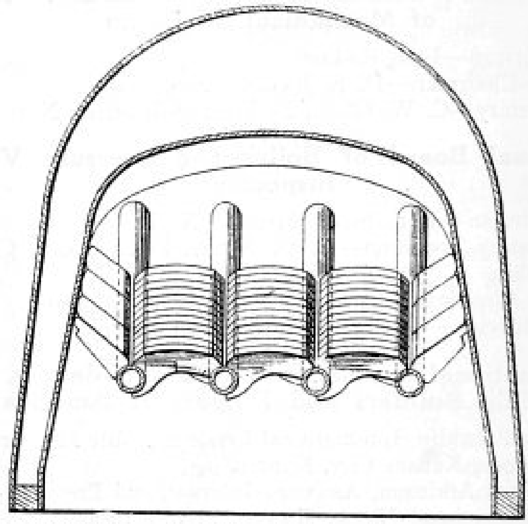
Claim 1. In a boiler blower, a casing to receive fluid under pressure, a rotatable member mounted in the casing and communicating therewith and having a distributing arm adapted to traverse the flues of the boiler, a base plate supporting the casing in front of the boiler, said casing and



said base plate having registering longitudinal slots therein, and clamping bolts arranged in the slots of the base plate and casing for securing the casing to the base plate in various adjusted positions throughout the lengths of said slots and maintaining the distributing arm in proper spaced relation to the front of the boiler. 5 claims.

1,549,306. RALEIGH J. HIMMELRIGHT, OF ENGLEWOOD, NEW JERSEY, ASSIGNOR TO AMERICAN ARCH COMPANY, A CORPORATION OF DELAWARE. LOCOMOTIVE ARCH AND BRICK THEREFOR.

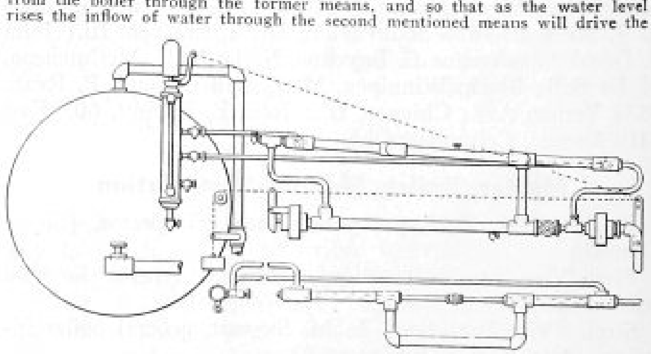
Claim 1. A sectional arch for a locomotive fire box including in combination with spaced supports a plurality of reversible brick units, each of



which is constructed to project below the plane of the supports at one end and to rest upon the supports at the other end so that when the bricks of an arch are arranged in alternation end for end, a plurality of pockets will be formed on the under face of the arch. 3 claims.

1,574,235. LEWIS C. DAVIS, OF BALTIMORE, MARYLAND. BOILER-WATER-LEVEL AUTOMATIC CONTROL APPARATUS.

Claim 1. In a boiler water level automatic control apparatus, a chamber, means forming communication between the interior of the boiler and said chamber, and means for forming communication between the boiler and said chamber at a lower level so that as the water level lowers in the boiler the water in said chamber will drain therefrom, in accordance with the water level, through the latter means, allowing steam to enter said chamber from the boiler through the former means, and so that as the water level rises the inflow of water through the second mentioned means will drive the



steam from said chamber through the first mentioned means, in combination with a container normally sealed and extending in said chamber, an operative agent in said container of such nature as to be acted upon by the heat of the steam thereon and so caused to expand to generate pressure in said container and to be condensed back to normal by immersion of the container in water of normal boiler temperature, means actuated by the expansion of said agent in said container for causing the supply of water to the boiler until the water level has been raised sufficiently to drive the steam out of said chamber and act on said container to cool the agent therein to reduce the pressure therein, and means adapted to put said chamber and said container temporarily in communication to fill said container. 4 claims.