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The Boiler Maker

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Last Call for Boiler Shop Kinks

A FEW days still remain in which readers may submit their contributions to the "Boiler Shop Kinks Prize Contest." Descriptions of two or more kinks covering some tool or method developed in the shop to make the job a little easier or to save time are all that is required to enter the competition. If the descriptions are mailed on or before January 20 they will be eligible for the prize awards.

The contest has been running for two months and notices of it have appeared in both the November and December, 1927, issues of The Boiler Maker. In addition posters and letters have gone out to shops and individuals throughout the country notifying them of the contest, including railroad, stationary and marine boiler shops, tank shops, plate working plants and allied industries. Kinks have already come in from all over the country covering a wide range of subjects—layout problems solved in a simple way, methods of ordering material, shop tools of many kinds, methods of doing special jobs, welding kinks, and the like. Boiler makers, foremen, apprentices, welders, layerouts, every branch of the trade has been represented, and yet the proportion who have submitted the kinks is small compared to the number of men in the field.

On page 343 of the December, 1927, issue will be found the complete rules of the contest. There is still time for you to polish up a pair of kinks and send them to the Contest Editor of The Boiler Maker, 30 Church street, New York.

Machine Tool Orders

ORDERS placed by the railroads for machine tools during the year 1927 dropped below those of the preceding 2 years. The orders placed by 99 railroads, representing 88 percent of the route mileage of the continent, totaled 2,172 units. Those placed in 1926 by 97 railroads in the United States and Canada, representing 84 percent of the total route mileage, amounted to 3,457 units while for 1925, 88 railroads, representing 77 percent of the route mileage, ordered 2,594 units.

Several reasons may be advanced to account for this falling off in machine tool orders, probably the most important of which was the completion during 1925 and 1926 of a definite shop equipment replacement program which occurred on many roads. In addition a number of new repair shops were built and equipped in this period. No new shops of large size were equipped during 1927.

From the data available it is not possible to segregate all of the boiler shop machinery ordered during the year since such tools as lathes, drill presses, punches and shears, and the like, might be used in any one of the mechanical departments. However, a good proportion of such tools purchased were undoubtedly installed in boiler shops. For example, there were 48 radial drills, 92 vertical and other type presses ordered of which a large percentage went to modernize boiler shop equipment. In the case of grinding wheels, of which 236 double end and tool wheels were purchased, it is certain that many were used in the tool rooms of the boiler shops. Under the heading of presses other than those used in wheel work there are 42 listed as having been purchased during the year. There were 4 punches, 23 shears and 20 combination punches and shears delivered during the year. In the flue shop 12 flue welders and 24 miscellaneous machines were installed while under the heading of boiler shop machinery there were 4 flanging machines, 9 sets of forming rolls and 5 riveting machines on order. Among other miscellaneous equipment for the boiler and other departments, the orders included 53 oil furnaces, 27 electric and other type furnaces, 32 overhead cranes, 194 air, electric and chain hoists, 64 air compressors and 46 electric welders.

Practically all along the line of equipment, with the exception of material handling machinery, the decrease was felt during the year 1927. However, it is certain that there is a vast amount of machinery in the field that needs replacement, but whether more than an average amount of such replacement will occur this year depends on the demands placed on the shops in the maintenance of motive power. If any material increase in the requirements of the repair departments is felt during the coming months then it is certain that the modernization of certain shops in the country will have to be speeded up.

Locomotive Accidents

THE annual report of the chief inspector of the Bureau of Locomotive Inspection for the fiscal year 1927 shows a decrease of 14.9 percent in the number of accidents as compared with the disasters of the previous year. This decrease, however, was accompanied by an increase of 27.3 percent in the number of persons killed and a decrease of 21.6 percent in the number injured. This is the second year that an otherwise laudable tendency toward the improvement of the safety of locomotives on our railroads has been marred by an increase in fatalities. The chief inspector again reiterates that a still greater reduction in accidents would have resulted and the fatalities would have been decreased if the requirements of the law had been fully complied with in all cases especially with respect to the repair of defects that are often considered relatively unimportant.

The fatalities which occurred, to the extent of 60.7 percent were directly traceable to boiler explosions caused by crown sheet failures. Twenty people killed and 205 injured in 185 boiler accidents constitutes the year's record in this class. It is true that with the increasing size of locomotives and the use of higher boiler pressures accidents will be more serious than formerly, but to offset this greater care must be exercised in their maintenance. Once again the chief inspector points out that properly applied water level indicating devices maintained in good working order at all times, that will accurately register the water in the boiler under all conditions, will greatly reduce the accidents and resulting casualties from boiler explosions.

Annual Meeting of Boiler Inspectors

ANNOUNCEMENTS have been sent out by the secretary of the National Board of Boiler and Pressure Vessel Inspectors that the annual meeting for 1928 will be held at Erie, Pa., June 18, 19 and 20.

The activities of this Board over a period of years have had a widespread influence on the construction and installation of power boilers. This body has developed a uniformity of practice in the application of the A. S. M. E. Boiler Code throughout all Code states and it goes without saying that this year's meeting will further the good work.

LETTERS TO THE EDITOR

Repair Parts

TO THE EDITOR:

It is not uncommon for manufacturers to receive letters from users of their products, in which the manufacturer is severely condemned for not having repair parts in stock, regardless of the part that needs replacing or repairing.

This is an unfortunate circumstance that can hardly be avoided by most manufacturers where the machine is of special character or where it is a machine that was developed through a sort of process of evolution into a standard perfected type.

In fields where rapid progress is being made, the design today is often just a little different from that of yesterday. In the course of a year, the change may be so marked, that the latest type loses all resemblance to the first.

The only thing that can be done in making renewals in cases of this kind, then, is to refer back to the drawings and build up the piece or pieces as a special order. If patterns are still in stock and if the piece is a rough casting, it is not very difficult to make the repair, but where considerable machining must be done the repair is usually expensive.

To be sure, where the machine is standard, there is little excuse for the manufacturer not having repair parts in stock. Our best manufacturers do keep such parts in stock.

Users should bear in mind that if they buy a "new" machine—one that has just been put on the market—they are liable to have troubles of this kind. But if you buy a standard well known machine you are safer. However, I am not knocking the new machine or the special machine. They are often the best obtainable for one's specific purpose. Manufacturers cannot always profitably do everything they would like to do for customers.

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

The Apprentice in the Modern Boiler Shop

TO THE EDITOR:

The above problem has been brought forcibly to the attention of the writer, in that he has been asked for advice in the matter of establishing an apprentice system in a modern boiler shop. By modern we mean that the shop is equipped with modern tools, air and electric and production is controlled by standard time on every job.

In looking through back copies of THE BOILER MAKER we find very little on this subject, except the more or less elaborate systems used or recommended by large railroad systems. This problem we believe would be an interesting one for discussion in THE BOILER MAKER, as we have come a long way in recent years from the old boiler shop with its hand tools and all time to do the job, according to the ability and strength of the human element.

In recent years since the advent of air operated tools, there has been a tendency to pass the young boy by and to turn to the intelligent helper and handy man for the apprentice boiler maker. This is due to the fact that the young apprentice boy does not develop physical strength fast enough to master the air hammer and other air operated tools, so we have been making specialists in the boiler shop instead of all around boiler makers. We have our rivet gang, calkers, fitters, flange turners and tube men, stayboltmen and the like.

There is a growing demand, however, at present, as many of the older foremen are being retired, for the training of the future executives. We may be able to make husky boiler makers out of helpers and handy men and keep up the production, but we should still have the young educated apprentice boy coming along with his shop schooling and instruction in order to fill the higher positions such as layout men and foremen.

Sometimes we find special gifts in our helpers and handymen, and some have risen to the higher positions, and many more might, if they would pay the price in study and preparation, but it is natural for the young to study and to them we must look for the most part for our coming executives. Perhaps both classes might be considered in establishing an apprentice system in our modern boiler shops.

No doubt many of the readers of THE BOILER MAKER have experiences along this line, it would be interesting to hear from them.

Bay City, Mich. J. A. ANDERSON.

A Tribute

TO THE EDITOR:

Early in the year 1903 the writer was employed by the boiler shop of a large steel works, and as my experience from 1893 up to that time had been confined to the repair shops of a railroad, it can be surmised that much that was new in the way of sheet iron and plate work came under observation. As I had a slumbering ambition to know how to lay out and acquire some definite knowledge of the why and wherefore of steam boilers, it was with a feeling akin to the relief one feels when traveling a dark path and it becomes suddenly illumined that a copy of *Motive Power*, lying on the foreman's desk drew my attention. A hurried turning of its pages and then, the realization that here lay the means of acquiring the much needed knowledge. That night the order for my subscription was in the mails and it has continued since, much to my pleasure and profit.

I could go on and tell you how eagerly each month's issue was awaited, the various problems studied and worked out, the subsequent cutting of paper patterns and the pasting together, the disappointments at times when they didn't come right, due to a lack of proper knowledge of the principles involved, then along came Kittredges' *Metal Worker*, and here I found the much needed explanation of principles.

The September issue of 1903 contained a problem in the development of patterns for an irregular conical shaped chute, prepared by Charles P. Patrick. How I sweated over that! It was an education in itself to develop it. That issue also contained a photograph and sketch of Claude E. Lester, with whom later I became personally acquainted and acquired a still greater respect for his splendid craftsmanship. Also that issue contained an article by our friend John Cook, who in the December, 1927, issue of THE BOILER MAKER tells us in no uncertain terms that he is still on the job and still learning. A more truthful statement was never made and will apply to all of us.

Looking back over 34 years in the trade, I have, I hope, profited by the experience and knowledge gained by others, who have been so unselfish in their desire to help as to present it broadcast to their fellow craftsmen. To those who have helped so much to make our path smooth and the way clear, I am, for one, humbly grateful.

Mr. Cook, with his 73 years in the trade and with his desire for knowledge still unsatisfied—what a lesson for us, who are fast becoming the "old hands" in the business. Mr. Cook, as a veteran of the trade, we respect you; as a teacher and a craftsman, we salute you

Lorain, Ohio. JOSEPH SMITH.

The Boiler Maker at the Blast Furnace

By E. N. Treat

AS with many another boiler maker I have had some rather unusual jobs presented to me in my career in the trade. Some of these have been in allied lines of work which do not form a part of the experience of most boiler makers, but which might be presented to any one engaged in the industry. One such job is that of inspecting boiler material at the mill. Whether any reader is ever required to handle such a job or not, nevertheless a general knowledge of the methods of making boiler material is of value to every man interested in advancement in the trade. For this purpose my own experience in this line of work is presented in this and succeeding articles for such help as it may prove to be to readers of THE BOILER MAKER. To go on with the story:

My employer had faith in me it was evident. He would not have selected me to visit the plant of a steel manufacuring company in order to complete the business of our company had he thought otherwise. I was very much surprised when I received my instructions and left our boiler shop to report at the steel mill. My knowledge of methods employed in the manufacture of the steel plates we were using in our plant was very limited. By admitting this lack of information I learned many things.

Iron ore has not of course changed in its raw state for centuries. Methods of removal, conveying and reduction of the ore have, however, progressed by leaps and bounds. Removal of ores from the earth and its reduction is a fact recorded by the Hittites who occupied Asia Minor 3,000 to 4,000 years ago. It is thought possible that an earlier race than the Hittites were versed in the art of refining iron ores. Recently an account states that one of the finds in the tomb of Tut-Ankh-Amen was an iron dagger. Removal of the ore was undoubtly from surface crops or veins and not at great depths as it is mined today.

Ore as we obtain it may be in lump or powdered form. Its appearance is generally a dark red or rusty color, irregular in form and containing a great amount of impurities and other ores in greater or less amounts. It is heavy and solid of texture and fuses at a temperature of 2,750 degrees Fahrenheit.

The detection and bringing to the earth's surface is the work of the mining engineer. Separating and reducing the iron from its raw state as ore is primarily the work of the metallurgist.

The fabricator it seems must have at least a general idea of the methods of recovering the ore and the metallurgy of it. He must also know the strength of his metal, its density, malleability and fusibility and in many cases he must know the required finished luster and conductivity of his structure. He must know the amount of impurities allowable for that structure and he should feel it a decided asset to have a general idea of the method of manufacturing the material, or accept his material without question as to its being all he should receive.

PROCESS OF REFINING THE ORE

The plate begins at the blast furnace. Here within a vertical brick bottle shaped structure the ore is charged through an opening at the top, flux is added and by means of the heat below the charge the work of extracting the iron from the ore begins. Several days is required for warming the blast furnace sufficiently for the charge. When the full charge of ore and flux is deposited the hot blast of air is admitted to the fire which is called "blowing in," and the operation of reduction begins.

Alternating charges of ore and flux are charged. These gradually descend during the course of reduction. The

(*Continued on page* 23)

Fig. 1.—A typical locomotive accident

Locomotive Accidents of 1927

Report of Bureau of Locomotive Inspection shows accident decrease of 14.9 percent over previous year

By A. G. Pack*

SUMMARIES are given, by railroads, in the sixteenth annual report of the Bureau of Locomotive Inspection of all accidents, showing the number of persons killed and injured due to the failure of parts and appurtenances of locomotives, 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.

Investigation of Accidents

All accidents reported to this bureau, as required by the law and rules, were carefully investigated and action taken to prevent recurrences as far as possible. Copies of accident investigation reports were furnished to parties interested when requested, and otherwise used in an endeavor to bring about a decrease in the number of accidents.

A summary of all accidents and casualties to persons occurring in connection with steam locomotives compared with the previous year shows a decrease of 14.9 percent in the number of accidents, an increase of 27.3 percent in the number of persons killed, and a decrease of 21.6 percent in the number injured during the year. There was a substantial decrease in the percentage of locomotives inspected by our inspectors found defective. During the year 31 percent of the locomotives inspected were found with defects or errors in inspection that should have been corrected before being put in use as compared with 40 percent for the previous year and 46 percent for the fiscal year ended June 30, 1925.

While there was a substantial decrease in the total number of accidents during the year, our investigations indicate that a still greater decrease should have resulted had the requirements of the law and rules been complied with, especially so with respect to defects the repairs of which are frequently considered unimportant.

Boiler explosions caused by crown sheet failures continue to be the most prolific source of serious and fatal accidents with which we have to deal, 60.7 percent of the fatalities during the year being attributable to this cause. There was a decrease of 48.7 percent in the number of crown sheet failures, but the average number of fatalities per accident increased, resulting in the same number of fatalities from this cause as occurred in the previous year. The fatalities per accident may be expected to increase with the increasing size of locomotives and the higher pressure carried in the boilers of modern locomotives. Our investigations indicate that material reduction in this class of accident and resulting casualties can be accomplished only

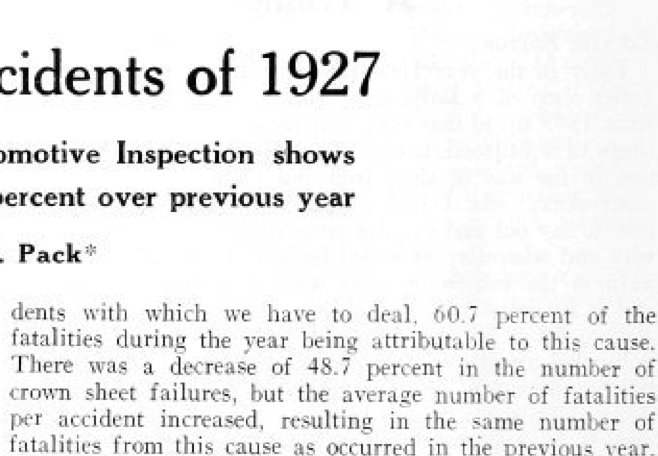


Fig. 2.—Chart showing relation between casualties, accidents and defective locomotives

by proper location and maintenance of water level indicating appliances that will accurately register the water level in the boiler under all conditions of service; the use of the safest practicable firebox construction, especially within the area which may be exposed to overheating due to low water; and the application of a device that will give an audible alarm when the water level approaches the danger point.

*Chief Inspector, Bureau of Locomotive Inspection of the Interstate Commerce Commission.

The graphic chart herewith shows the relation between the percentage of defective steam locomotives and the number of accidents and casualties to persons resulting from failure thereof, and illustrates the effect of operating locomotives in a defective condition from the viewpoint of safety.

Data in connection with locomotives other than steam are shown under appropriate captions.

Reduced Body Staybolts

In my fifteenth annual report attention was called to the danger resulting from the use of reduced body staybolts having telltale holes which do not extend into the reduced section at least 5/8 inch. Failure of this type of bolt usually occurs at or close to the fillet joining the body of the bolt and the enlarged ends. Telltale holes which do not extend into the bolts to or beyond the usual point of breakage can not perform the function for which they are intended and mislead inspectors who depend upon the telltale holes as a check of the results of the hammer test.

When applying reduced body staybolts, great care should be exercised to see that the bolts are of proper length so that the threads on the bolts engage the threads in the sheets for the full thickness of the sheets. If the bolts are too long, a full bearing for the threads is not obtained in each sheet and part of the bolt will blow out when breakage occurs, usually with fatal results.

Extension of Time for Removal of Flues

One hundred and forty-six applications were filed for extension of time for removal of flues, as provided in rule 10. Our investigations disclosed that in 8 of these cases the condition of the locomotives was such that no extension could properly be granted. Eleven were in such condition that the full extensions requested could not be authorized, but extensions for shorter periods of time were allowed. Twenty extensions were granted after defects disclosed by our investigations had been repaired. Eleven applications were canceled for various reasons. Ninety-six applications were granted for the full period requested.

Specification Cards and Alteration Reports

Under rule 54 of the Rules and Instructions for Inspection and Testing of Steam Locomotives, 1,806 specification cards and 9,076 alteration reports were filed, checked, and analyzed. These reports are necessary in order to determine whether or not the boilers represented were so constucted or repaired as to render safe and proper service and whether the stresses were within the allowed limits. Corrective measures were taken with respect to numerous discrepancies found.

Fig. 3.—Crown sheet failure due to low water caused this accident

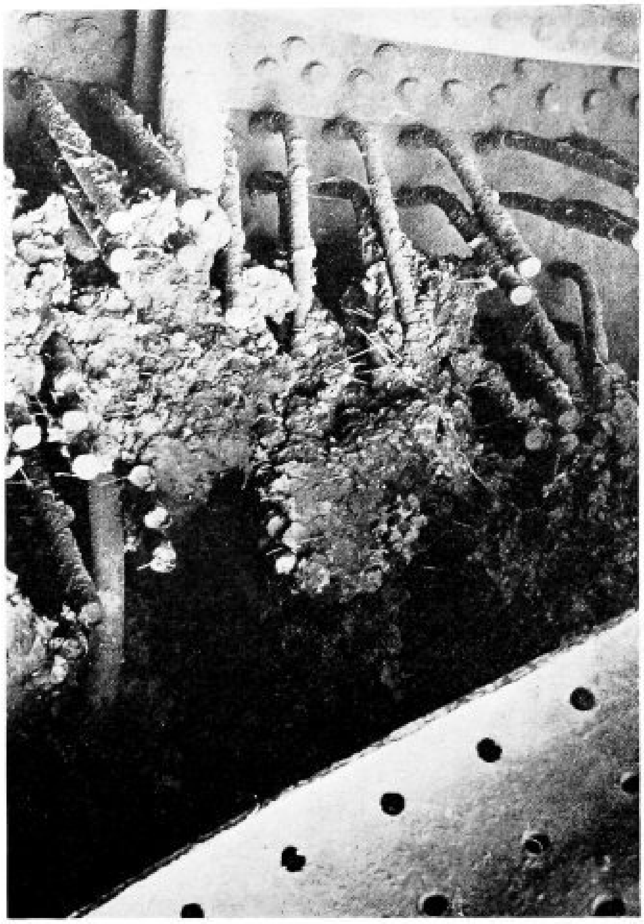


Fig. 4.—Where a side sheet seam failed for its entire length

Under rules 328 and 329 of the Rules and Instructions for Inspection and Testing of Locomotives Other Than Steam, 414 specifications were filed for locomotive units and 90 specifications were filed for boilers mounted on locomotives other than steam. These were checked and analyzed and corrective measures taken with respect to discrepancies found.

Prosecutions

Following is a brief summary of cases instituted and those disposed of during the year. Under the style of each case is shown the nature of the violations involved, number of counts, and status of the case.

U. S. v. *Bangor & Aroostook Railroad Company*, district of Maine, involved two counts for the use of a locomotive with a broken engine truck spring. Plea of guilty was entered in one count and a fine of $100 imposed. One count was dismissed.

U. S. v. *Buffalo Creek Railroad Company*, western district of New York, involved one count for the use of a locomotive with a defective superheater flue. Plea of guilty was entered and a fine of $100 imposed.

U. S. v. *Chicago & Illinois Midland Railroad Company*, southern district of Illinois, involved 146 counts for the use of locomotives while in defective condition. By agreement, and with the approval of the Attorney General, 46 counts were dismissed, plea of guilty was entered in 100 counts, and a fine of $10,000 imposed.

U. S. v. *Cincinnati, Indianapolis & Western Railroad Company*, southern district of Illinois, involves 44 counts for the use of locomotives while in defective condition. Case pending.

U. S. v. *Jefferson & North Western Railway Company*, eastern district of Texas, involves 9 counts for the use of locomotives in defective condition. Case pending.

U. S. v. *Kansas City, Mexico & Orient Railway Company*, northern district of Texas, involves 20 counts for

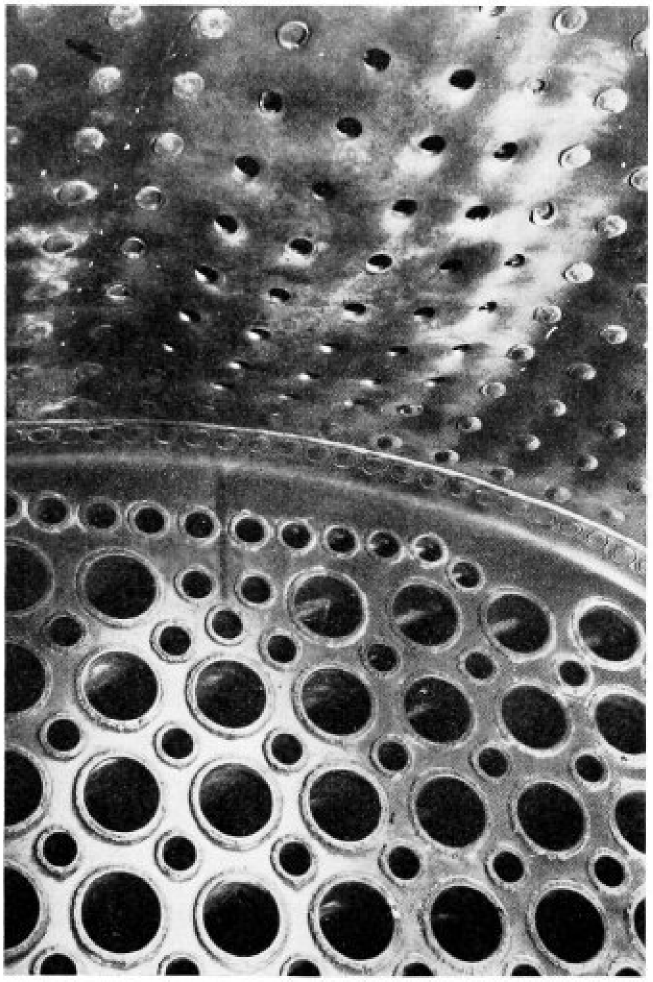


Fig. 5.—Damage to crown sheet caused by low water

the use of a locomotive with arch tubes in defective condition. Case pending.

U. S. v. *Louisiana Railway and Navigation Company*, eastern district of Texas, involves 3 counts for permitting the use of defective locomotives on the line of the defendant. Case pending.

U. S. v. *Texas and Pacific Railway Company*, eastern district of Texas, involves 3 counts for permitting the use of defective locomotives on the line of the defendant. Case pending.

Appeals

One formal appeal was taken from the decisions of our inspectors during the year. After careful investigation of the existing conditions the appeal was dismissed.

Fig. 6.—Broken, reduced body staybolt

Recommendations for Betterment of the Service

In my former reports recommendations were made, in accordance with section 7 of the act, as amended, for the application of automatic fire doors, power reverse gears, power grate shakers, horizontal handholds, stirrups on cabs, and water columns with water glass and gage cocks attached with an additional water glass located on the left side or boiler back head, and reasons given therefor.

While many of the carriers have recognized the value of these appliances and considerable progress has been made in the application thereof, the installations are not progressing as fast as could be desired to obtain the maximum degree of safety; therefore the recommendations are respectfully renewed and should be made a requirement of the rules.

Low Water Alarms

Reference was made in my last annual report to the application of audible low water alarms by many of the carriers in an effort to reduce the number of explosions caused by low water. A number of such devices have been developed, some of which appear to have proved themselves reliable from the viewpoint of the users. A large percentage of the fatalities and many serious injuries would be prevented by the use of dependable low water alarms, and the carriers who have applied these devices and those who assist in their further use and development are to be highly commended for the contribution to safety.

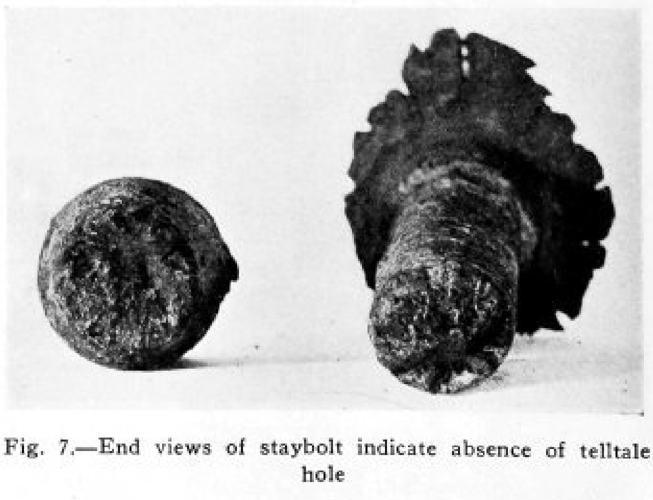


Fig. 7.—End views of staybolt indicate absence of telltale hole

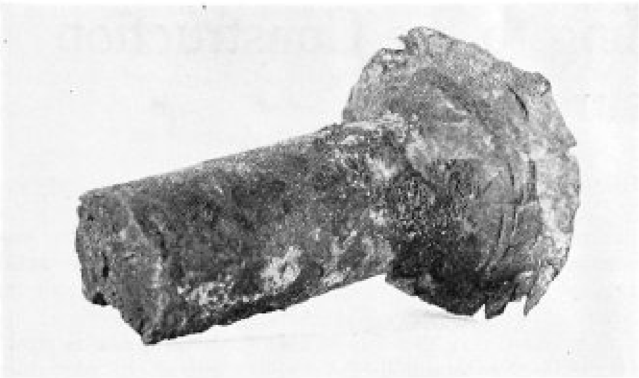


Fig. 8.—Part of broken staybolt which blew out of side sheet

TYPICAL BOILER ACCIDENTS

Fig. 3 shows the result of a boiler explosion due to the crown sheet being overheated caused by low water. The explosion, which resulted in the death of three persons, occured while the locomotive was hauling a freight train at an estimated speed of 30 miles per hour.

The boiler was equipped with one water glass located on the left side of the back head, and three gage cocks tapped horizontally into the right side of the back head close to the knuckle or flange of the wrapper sheet seam. The boiler was originally equipped with two water glasses, one on the left side of the back head and one on the right side, but the latter had been removed some time prior to the date of accident.

WATER LEVEL INDICATORS

The impossibility of ascertaining the actual water level in the boiler when the locomotive is in operation from gage cocks entered directly into the boiler back head, especially when in close proximity to the flange or knuckle, is well known. Recognizing that correct indication of water level indicating appliances is essential to safety, many carriers have equipped their locomotives with water columns, with water glass and gage cocks attached on the right side of the boiler back head, with an additional water glass located on the left side.

Fig. 4 shows a filed fusion welded side sheet seam in the the firebox of the locomotive illustrated in Fig. 3. Both fusion welded side sheet seams failed for their entire length. Accumulation on radial stays is material picked up from ground when boiler alighted and rolled over.

Fig. 5 shows the damage to a crown sheet in a firebox of riveted construction caused by overheating due to low water. The accident resulted in minor injuries to one person. The strong construction of the firebox and the fact that the fire door remained closed minimized what might otherwise have been a serious accident.

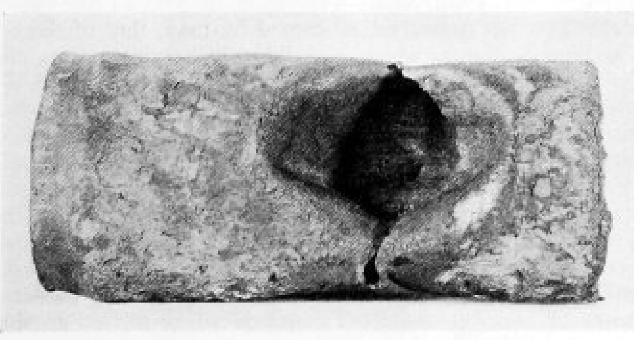


Fig. 9.—Superheater flue which collapsed

In Fig. 6 is shown a broken reduced body staybolt which blew out of the inside firebox sheet, seriously scalding a boiler maker who was removing the brick arch preparatory to making repairs. Bolt was too long when applied, resulting in insufficient engagement of the threads on the inner end of the bolt with the threads in the sheet. Inner end of the bolt had been excessively calked and flattened in the endeavor to stop leakage which had practically destroyed the threads. Telltale hole did not extend into the reduced section and was therefore not of sufficient depth to serve the purpose for which it was intended.

Fig. 7 shows the ends of the broken reduced body staybolt illustrated in Fig. 6. This plate illustrates the absence of telltale hole in the reduced section where breakage usually occurs and the excessive flattening of the inner end in the endeavor to stop leakage due to insufficient engagement of the threads on the bolt with the threads in the sheet.

Fig. 8 shows part of a broken reduced body staybolt which blew out of firebox side sheet with 200 pounds pressure in the boiler while the locomotive was hauling a passenger train at an estimated speed of 35 miles per hour, resulting in the death of the fireman who was compelled to jump from the locomotive to avoid the escaping steam and hot water. The threads on the staybolt had engaged the threads in the sheet from one to three threads when applied, due to the bolt being too long. The end had been excessively calked and flattened in attempts to stop leakage which had destroyed the threads in the sheet and on the end of the bolt. The break occurred 1¼ inches from the outer sheet near the root of the fillet joining the reduced body to the enlarged end and beyond the depth of the telltale hole which did not extend into the reduced section.

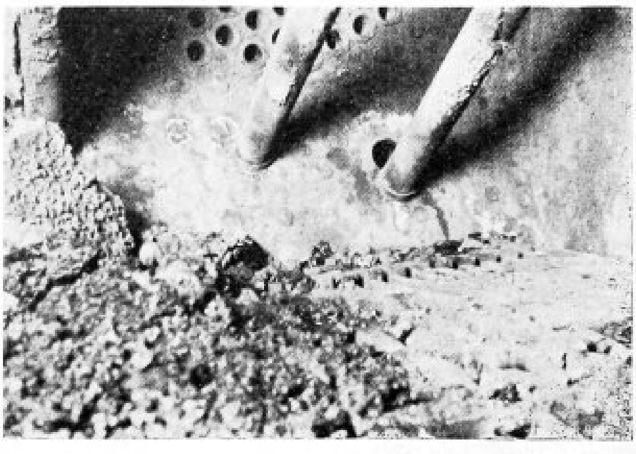


Fig. 10.—Short arch tubes caused this accident

Reduced body staybolts with less cross-sectional area in the reduced portion than at the root of the threads will not be accepted as meeting the requirements of the rules unless the telltale holes are extended into the smaller section far enough to serve the purpose for which telltale holes are applied.

Fig. 9 shows a superheater flue which collapsed after 8 months of service. The failed section of the flue was reduced to approximately 1/32 inch thickness at the safe-end weld.

Fig. 10 shows an arch tube which blew out of inside throat sheet while the boiler was under 200 pounds pressure, resulting in injury to two persons. The tube had been cut too short when applied to be either belled or beaded to secure it in place. The other two tubes shown in the illustration were applied in approximately the same manner as the failed tube. All the tubes had a heavy accumulation of scale and were mud burned and blistered.

The Application of Welding to the Construction of Large Pressure Vessels*

By T. McLean Jasper†

WELDING as a means of joining metal has developed to a point which has not only attracted the attention of engineers and fabricators of metal, but has become one of the chief methods whereby metals can be safely and economically joined.

In a manner similar to that which marked the development of the steam engine, processes for welding have gone through various stages of grief and uncertainty until today the principles underlying good welding results are very generally understood.

The fundamentals of good welding may be briefly stated as follows:

1. A complete fusion of the deposited metal with the metal joined.
2. The elimination of the oxygen and nitrogen of the atmosphere from contact with the hot deposited metal so as to avoid their embrittling effects on such metal.
3. The elimination of the overheating effect on metal adjacent to the weld so as to keep the weld and adjacent metal in metallurgical equilibrium.
4. The elimination of the personal element in welding main seams thereby tending toward a uniformity of product which insures consistency in results.

The requirements of a material to be used in welding to join two plates together are that it shall have very similar physical and chemical properties as the metal which it joins. These requirements are especially necessary in cases where corrosion plays an important factor in the product obtained. It has been generally thought that welding was necessarily associated with brittleness in the weld material and overheating of the metal adjacent. However it is now known that these things are not necessary, but are only a phase of welding which with proper care can be entirely eliminated. It is true that in many cases welding produces a brittle joint but in each method of welding it is believed that ductility, strength and homogeneity are obtainable through the exercise of proper care.

The successful joining of plates by welding has been made consistently possible by the development of automatic metal depositing devices and by protecting against the embrittling elements which readily enter into hot metal when unprotected.

With great care the above results can be obtained by hand methods, but since the human being yields to fatigue and cannot be adjusted to run indefinitely like an automatic machine, hand welding requires that greater precautions shall be exercised in order to produce the best results.

As a body of men charged with the protection of industry and the lives of people using high pressure and high temperature equipment for power and other uses it is highly necessary that you acquaint yourselves with the latest methods of joining metals and that you get some idea of the possibilities when welding is properly performed.

As higher temperatures and higher pressures are continuously being demanded in order to increase the economies in mechanical engineering and chemical engineering technology so must the methods of joining metals be modified and improved so as to produce the designs most suited to such development.

For higher temperatures and higher pressure work and for the production of chemicals of various kinds, leak proof containers of great thickness and size and of various metals are required. Welding offers a means for producing vessels of size and shape hitherto unattainable by any other method and in metals of different compositions to suit the needs of various special industries.

The old saying that "large oaks from little acorns grow" is abundantly proven in the development of one particular process of welding which the author is familiar with.

Toward the end of the War large aerial bombs were built requiring a strength of weld equal to that of the parent metal and a ductility such that the bomb would explode into small pieces rather than along the seams. This required at least one hundred percent weld strength and a weld that would not crack at the seams when the bomb exploded due to the weld being brittle.

Later rear axle housings for automobiles were made by arc welding and the demands against fatigue and load required at least one hundred percent strength factor with sufficient ductility and a proper balance in the weld to protect the structure against the insidious effects of repeated loading. Today over 2,500 miles of housing arc welding have been built representing over 2½ million housings and a service failure has yet to be heard of.

The next step in arc welding was that of the casing couplings which are used in oil wells, which not only require the weld to conform to strength and ductility factors comparable to the parent metal, but, in order to compete in production, equal machinability and density were necessary. One other element crept into this product which is most essential when corrosion becomes a factor and that is the necessity of producing a weld of the same electrical potential value as that of the parent metal so as to balance the corrosion effects between the weld and the parent metal. Today over 1¼ million of such couplings varying in size from 4¾ inches to 21¾ inches and in thickness from 7/16 inch to 15/16 inch are in the ground doing service and a service failure has yet to be heard of.

Such results, however, are not produced by chance but are obtained after much research and considerable testing. It was early recognized that the ordinary low carbon steel did not give the best results in strength and ability to resist corrosion, and research leading to the selection of the best balanced metals for work of a particular nature was carefully gone into.

Building Large Pressure Vessels

The next step in the growth of the figurative acorn into the sapling and the full grown oak was in the realm of large vessels for use at high pressures and high temperatures. The application was made in one of the most hazardous businesses yet attempted by man, that of the oil cracking business, where a failure in service means the lives of many men and the loss of much property. To most people unfamiliar with the electric arc welded pressure vessel for oil cracking and who do not see back of it the nine or ten years of strenuous development in the laboratory and in service, a test system which tries metal severely and searches out the weak spots of the process, the application of arc welding to this most severe service seemed foolhardy. One manufacturer has today in the field over 500 arc welded vessels of large size working at temperatures up to 900 degrees F. and at pressures up to 600 pounds per square inch at those temperatures. These vessels vary in weight from 100 to 230 tons each. A service

* Abstract of paper presented at annual meeting of National Board of Boiler and Pressure Vessel Inspectors.

† Director of Research A. O. Smith Corporation, Milwaukee, Wis.

failure in these arc welded vessels has yet to be heard of.

Today the largest high pressure vessel ever built is working at near 900 degrees F. and weighs over 260,000 pounds. This is an arc welded vessel.

A vessel is under construction by arc welding which will weigh, when completed, 380,000 pounds and will operate at a temperature of 900 degrees F. The size and weight of such equipment are curtailed only by the facilities for shipping and erection. Special cars have to be obtained and special routes selected for the transportation of such equipment.

The latter part of this address was devoted to an explanation of results obtained from a long series of tests on arc welded specimens of carbon steels having a yield point of from 30,000 to 35,000 pounds per square inch and an ultimate strength of from 55,000 to 60,000 pounds per square inch.

The Straight Vertical Tube Type Boiler

By Major F. Johnstone-Taylor

IT is hardly necessary to say that the watertube boiler has long been firmly established in British engineering practice, but the present tendency to higher pressures and larger units has brought with it many improved designs. The Babcock type, of course, in its modern form complies with these requirements, but there is an undoubted tendency to favor the vertical tube type in which considerable business is being done by the builders. At the present time there is no marked tendency on this side towards the use of exceptionally high pressures, the policy of those concerned with the large generating stations, with one or two exceptions, and of the owners of up-to-date industrial plants being to employ pressures of about 300 pounds for which standard types of boiler of this class are well suited. The term vertical tube boiler in this connection is applied mainly to those boilers comprising four or more drums connected by straight tubes disposed in a vertical or nearly vertical position. Boilers of the Yarrow type which are in favor for power station work and particularly for high pressure duty, while comprising drums connected by straight tubes of small bore, are of a special class in which three drums and two banks of tubes form roughly a triangle, while other designs possessing a vertical arrangement of the tubes do not employ straight ones.

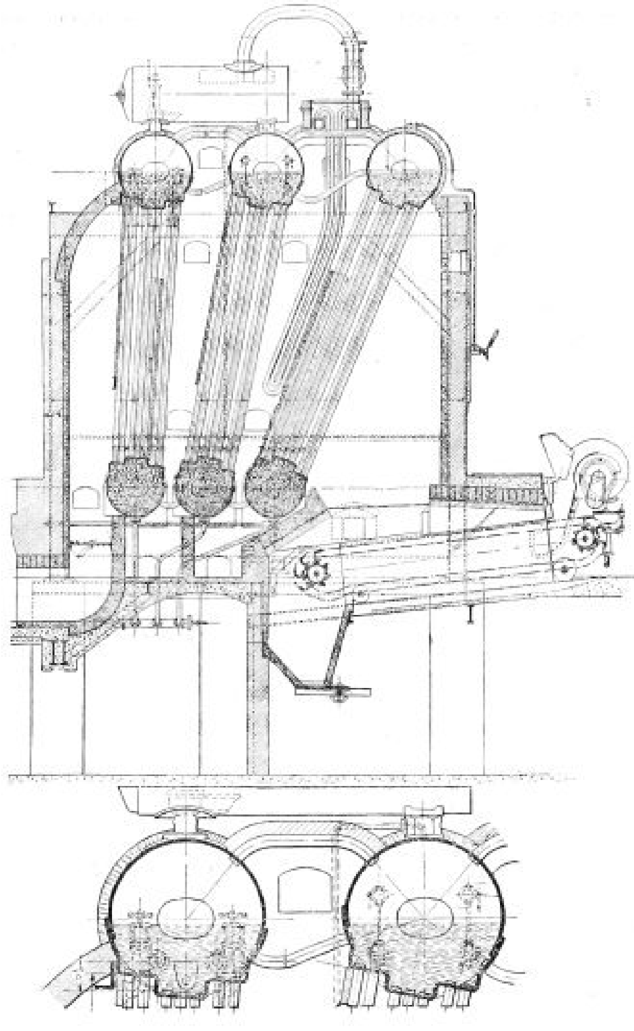


Fig. 1.—Sectional view of the John Thompson boiler

ADVANTAGES CLAIMED FOR VERTICAL TUBE BOILERS

With this type of boiler there are no rigid connections, the steam and water spaces are large and there are no tube caps to keep tight. The tubes are inserted directly into the upper and lower drums and modern designs provide for easy access to and removal of the tubes in the simplest possible manner. An upright bank of tubes is in contact with the hot gases throughout its length so that the effective heating surface is relatively large. The banks of tubes too, being in suspension, are always free to expand so that risk of leakage can be reduced to the minimum. An upright arrangement of the tubes enables the steam bubbles formed in them to rise freely to the upper drums by the shortest possible path. While this is held to cause in

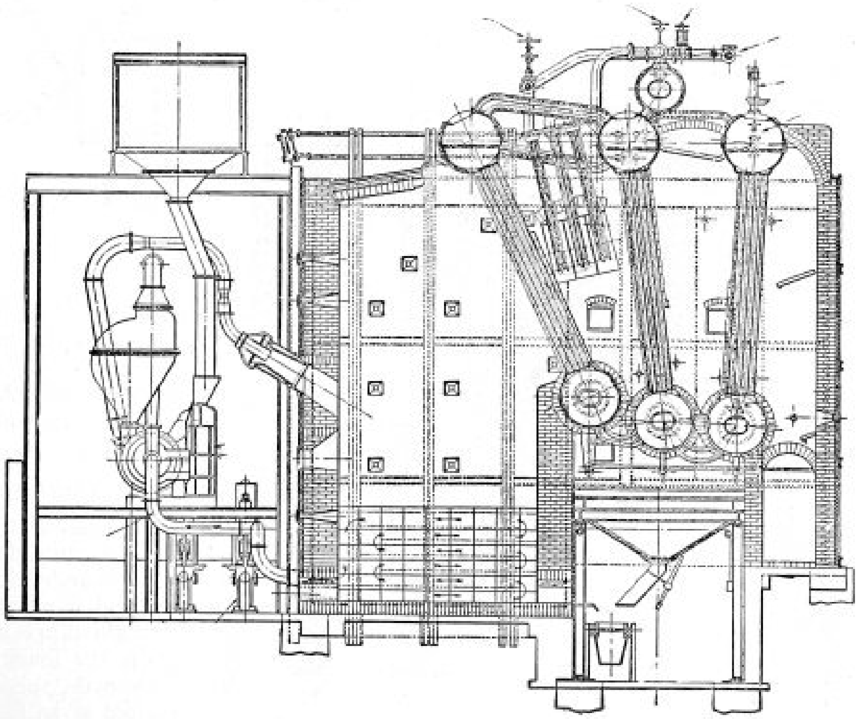


Fig. 2.—Woodeson type boiler equipped to burn pulverized coal

some instances a geyser-like action, the brisk circulation so induced is an undoubted advantage in its prevention of steam pockets and risk of overheating and incrustation and the facility with which sludge is deposited in the lower drums. Moreover vertical tubes as compared with inclined ones are favorably placed for the removal of soot. By reason of the disposition of the tubes with respect to the hot gases a rapid circulation is induced at the front of the boiler while the back tubes being in the cooler part of the furnace deal with the feedwater from the rear headers in such a way that scale forming matter is largely deposited in the form of mud in the bottom drums. Of simple design and affording rapid and easy water circulation, vertical tube boilers are entirely suited to high pressure work.

Typical Designs

In Fig. 1 is shown a sectional general arrangement of the John Thompson boiler, all the essential features being clearly shown. The enlarged detail of the steam drum and tube connections makes clear how this is effected to enable absolutely straight tubes to be used, the only curved ones being the short lengths connecting the drums. Some engineers are inclined to favor marine type boilers of a class adapted to land service as seen in the Babcock and Yarrow designs, the latter being a direct evolution of a marine boiler. The principal claims made in respect of the advantage, if any, of using marine type boilers is that floor space is economized, but this is, as a rule, only in respect of the width of the boiler house, and that, too, at the expense of height.

A compact design is made by the builders of the unit shown in Fig. 1 which comprises the two front banks of tubes arranged as shown, the third bank being horizontally disposed above them so as to function as an economizer or feedwater heater, there being an air preheater located back of the rear bank of vertical tubes. The uptake in this instance is vertical. Following on much the same lines as the design shown in Fig. 1 is the Woodeson boiler (Fig. 2) as shown in this instance equipped for burning pulverized fuel. In the Sulzer boiler (Fig. 3) which is extensively used in continental Europe a similar arrangement of drums and tubes is followed with certain modifications, as shown in Fig. 3, but it will be observed that the nest of tubes is divided by a brick baffle into two unequal parts. The front portion thereof coming into direct contact with the fire carries a somewhat larger number of tubes. The hot gases it will be noted can be diverted by means of the damper through the superheater located between the two banks after which the hot gases pass down the rear portion of the front bank and thence up and down the rear bank as directed by the baffle shown. At the extreme rear is seen the economizer. The two banks of tubes it will be noted are interconnected by large pipes between the lower drums and a steam receiver between the upper ones.

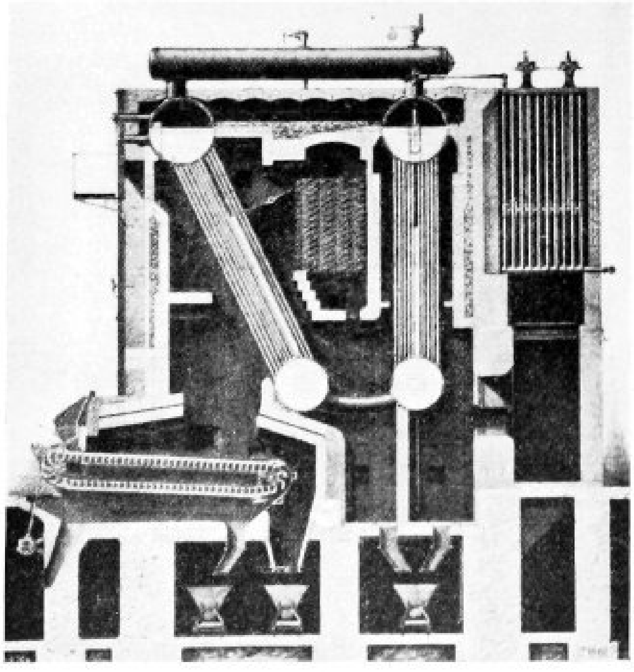


Fig. 3.—Sulzer boiler used extensively in Europe

The plates accommodating the tubes are of the Garbe type. These specially shaped Garbe plates are riveted to plain plates of nearly equal thickness by a good double butt strap joint and the buckles are large enough to permit of tubes of up to 2¼-inch diameter being inserted. The Garbe plate is provided with stepped pressed buckles or corrugations each buckle being dimensioned for the insertion of two tubes, the cylindrical shape being retained between each pair of tubes length and crosswise. This permits of a tube being withdrawn at any time without disturbing the others.

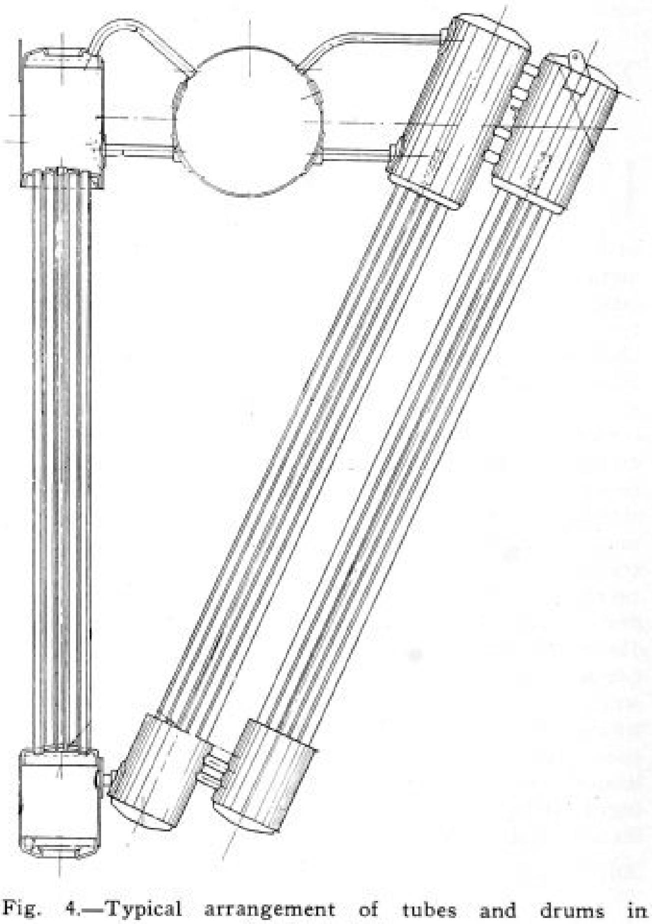


Fig. 4.—Typical arrangement of tubes and drums in Nesdrum boiler

Vertical Drums. The Nesdrum System

The essential features of this boiler are shown in Fig. 4 with the upright tubes arranged in small groups or nests and expanded into small drums. The drums are cylindrical and fitted with spherical ends and there are no stays. Straight nipple tubes are used for connecting the sections, while the lower headers are sufficiently deep to allow of both main tubes and nipple tubes being inspected with the aid of an electric torch and any tube can be withdrawn or replaced through the manholes.

Progress of the Steam Locomotive

Methods of increasing locomotive boiler economy by maximum evaporation with minimum fuel consumption

THE following paper was one of three on this subject presented at the last annual meeting of the Mechanical Division of the American Railway Association. All three papers were excellent contributions to the general subject of steam locomotive design and operation and all of them discussed some phase of the two-fold development of the locomotive, namely, the boiler and the engine. Of these two, the boiler is undoubtedly the most important at the present time, largely because the principles underlying the application of steam have for a long time been better understood than those applying to its economical generation. In the paper published herewith Mr. Fry points out that we are today without the basic facts upon which to design with certainty a locomotive boiler to produce most economically the maximum evaporation under varying service demands with a minimum fuel consumption.

Improving the Locomotive Boiler by Research

By Lawford H. Fry

Metallurgical engineer, Standard Steel Works Company

The Mechanical Division has as one of its main purposes cooperative study and research directed to the betterment of railroad motive power. The paper is, therefore, planned to show how research can be directed to extending existing knowledge of the locomotive boiler. With this in view the fundamental processes of combustion and heat transfer are surveyed. The boundaries of existing knowledge are mapped out and indications given as to how these boundaries may be enlarged and the benefits that might be expected.

When the total heat energy of the steam produced is compared with the heat in the fuel fired, the overall boiler efficiency is measured. Study of locomotive boiler efficiency dates back to the earliest days of the locomotive. Pambour in 1834 reported tests showing that each pound of coke fired evaporated from five to seven pounds of water. Soon after this it was recognized that the amount of steam produced per pound of fuel—that is boiler efficiency—depended on the rate of firing, the efficiency falling off as the rate of firing was increased. A number of tests on this subject are recorded in the earlier literature, but our more accurate knowledge of the effect of rate of firing begins with the publication of Dr. Goss' experiments made on the first locomotive testing plant at Purdue University. The general relation between overall boiler efficiency and rate of operation was shown, but the information was still not sufficiently detailed to permit the separation of heat production and heat absorption, which are the components of the over-all efficiency. This more detailed study first became possible in 1904 when results from the Pennsylvania locomotive testing plant at the St. Louis Exposition were published. Since then tests made by Dr. Goss on the rebuilt Purdue locomotive, a few tests made at the University of Illinois, and the extensive series of tests made by the Pennsylvania Railroad at Altoona provide information which throws much light on locomotive boiler performance. From these tests it is possible to draw up complete heat balances for each locomotive boiler tested. Typical balances at various rates of operation are given in Table I as a matter of illustration. These balances separate the heat in the coal fired into five items:

1—Heat utilized in producing and superheating steam. This measures the over-all boiler efficiency.

2—Heat lost from the boiler by external radiation. This and the first item make up the total amount of heat taken up by the boiler heating surfaces.

3—Heat lost in the sensible heat in the smokebox gases. This with the first two items makes up the total heat produced by combustion.

4—Heat lost by the production of carbon monoxide, CO.

5—Heat lost by the escape of unburnt fuel. The last two items together make up the amount of heat lost by reason of imperfect combustion.

In addition to the five items of the heat balance as above, Table I contains two further columns giving respectively the efficiency of combustion and the efficiency of heat absorption. These are discussed below, combustion being considered first.

Combustion

The efficiency of combustion will be determined by the amount of combustible, including CO, which escapes from the firebox without having combined with oxygen, and this will depend on the mechanical conditions under which the fuel and the air enter and pass through the firebox. In the case of coal fuel, for which exact numerical information is most abundant, and which is therefore used as a basis of discussion in what follows, it is found that at low rates of combustion from five to ten percent of the fuel and about 25 percent of the oxygen will escape from the firebox uncombined. At high rates of combustion the percentages will be reversed and approximately 20 to 25 percent of the coal and about 10 percent of the oxygen fail to combine. The loss by production of CO usually appears only at high rates of operation and even then is generally not more than one or two percent.

When efficiency of combustion is measured by the heat produced expressed as a percentage of the heat in the coal fired, it is found that in all cases the efficiency falls off as the rate of combustion is increased.

This drop in efficiency of combustion as the boiler is forced to higher rates of operation is largely due to mechanical conditions which prevent the carbon and the oxygen from coming into contact and remaining in contact under circumstances favorable to their combination. A certain length of time is required for carbon in the solid state, to combine with oxygen, and therefore a certain duration of contact is essential for complete combustion.

This necessity for prolonged contact between carbon and oxygen is one of the factors which makes firebox volume of importance. Combustion in a locomotive firebox at a high rate of operation is by no means confined to the grate. Part of the primary processes of combustion take place on the grate, the larger lumps of coal are heated there and volatile matter is driven off, but above the grate the whole firebox volume is filled with flame in which combustion is taking place. The volatile gases and much of the finer coal are burned in suspension between the grate and the flues, so that the larger the firebox volume and the longer the flame-way, the better is the opportunity for combination between the oxygen and the carbon.

The firebrick arch is of value in promoting efficiency of combustion because it maintains temperature and increases the length of the flame-way. In stationary boiler practice recent installations provide greatly increased firebox volumes, and rates of operation are commonly measured in terms of coal fired per cubic foot of firebox volume. In locomotive boiler practice the use of combustion chambers is a practical recognition of the value

Table I—Heat Balances and Efficiencies of Combustion and Heat Absorption

		Heat balance						
			Heat lost				Efficiencies	
Test No.	Dry coal fired per sq. ft. of grate per hour, lb.	Heat utilized in producing steam, per cent	By external radiation, per cent	By heat in the smoke box gases, per cent	By producing CO, per cent	By escape of unburnt fuel, per cent	Of combustion, per cent	Of heat absorption, per cent
6703	18.9	78	3.9	13.5	0	4.6	95.4	85.0
6701	21.5	67	3.4	...	...	...	...	...
6702	22.3	67	3.4	12.6	0	17.0	83.0	85.0
6704	27.0	70	3.5	12.5	2.23	11.7	86.1	85.4
6705	32.3	69	3.5	13.7	1.61	12.2	86.2	83.0
6706	38.2	69	3.5	13.8	1.16	12.5	86.3	83.0
6709	39.3	68	3.4	13.1	.73	14.8	84.5	84.5
6707	49.7	64	3.2	13.8	1.50	17.5	81.0	83.0
6710	50.4	65	3.3	...	...	...	...	...
6715	58.7	65	3.3	12.8	2.04	16.9	81.0	84.3
6708	61.5	63	3.2	13.4	1.68	18.7	79.6	83.2
6711	66.4	60	3.0	11.6	1.59	23.8	74.6	84.5
6716	83.8	61	3.1	13.4	1.67	20.8	77.5	82.6
6712	85.0	59	3.0	11.8	2.00	24.2	73.8	84.0
6717	109.0	59	3.0	13.9	1.64	22.5	75.9	81.8
6713	110.2	56	2.8	12.1	1.45	27.6	70.9	83.2
6714	139.2	53	2.7	11.8	1.04	30.7	67.5	82.5
6721	141.1	53	2.7	12.3	1.94	30.1	68.0	82.0
6723	142.5	53	2.7	....	....	....	....	....
6722	163.3	49	2.5	11.8	1.58	35.1	63.3	81.5
6718	177.0	47	2.4	11.1	1.90	37.6	60.5	81.7
6719	201.3	43	2.2	10.2	1.75	42.8	55.4	81.5
6720	210.6	42	2.1	9.8	2.51	43.6	53.9	82.0

of firebox volume, but in comparing rates of firing it is almost universal practice to do so in terms of coal per square foot of grate area per hour. The evidence on the subject is not entirely conclusive, but leads to the belief that with high volatile bituminous coal, firebox volume is of more importance than grate area in determining the efficiency of combustion; but that with semi-bituminous or hard coal the grate area must be taken into account and must be made sufficiently large to avoid an unduly high intensity of draft through the grate. Further investigation of the value of firebox volume in locomotive boiler design is highly desirable. The test results plotted in Fig. 1 show that with high volatile coal as fuel the grate area in a given boiler can be changed materially without affecting the capacity or efficiency of the boiler. Three series of tests were run with the same boiler, the grate area being different in each series. In Fig. 1-A the efficiency of combustion is plotted against the coal fired per square foot of grate per hour and three lines result, one for each series. It is evident that the amount of coal fired per square foot of grate does not by itself determine the efficiency of combustion. In Fig. 1-B the same results are plotted, but here the efficiency of combustion is plotted against the amount of coal per cubic foot of firebóx volume. On this basis the results from all three series fall on a single line, showing that with this boiler and this fuel a given amount of coal per cubic foot of firebox volume produces the same efficiency of combustion no matter whether the grate area be 29.6 square feet or 55.5 square feet. Additional, though not quite such striking, evidence of the importance of firebox volume is given by the test results exhibited in Table II and Fig. 2. Table II gives the equations connecting the efficiency of combustion and the coal fired per square feet of grate. These are derived from tests with a number of different locomotive boilers of various designs burning Pennsylvania bituminous coal. These equations give a straight line relation between efficiency and rate of firing and the corresponding lines are drawn in Fig. 2-A with the firing measured in coal per square foot of grate. In Fig. 2-B the lines for the same tests are shown transformed to measure the firing rate in coal per cubic foot of firebox volume. This latter method of plotting is seen to give less divergence among the lines. Evidence is thus obtained tending to confirm the view that for a locomotive boiler burning bituminous coal the firebox volume is preferable to the grate area as a measure of the capacity for combustion. Further experimental study of the question may be expected to give information of value in enabling locomotive boiler design to be still further improved.

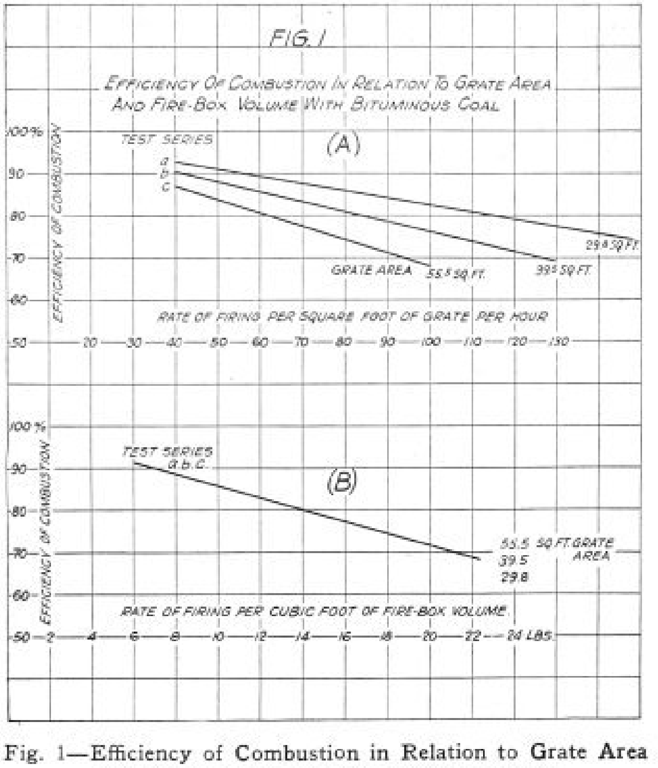


Fig. 1—Efficiency of Combustion in Relation to Grate Area and Firebox Volume with Bituminous Coal

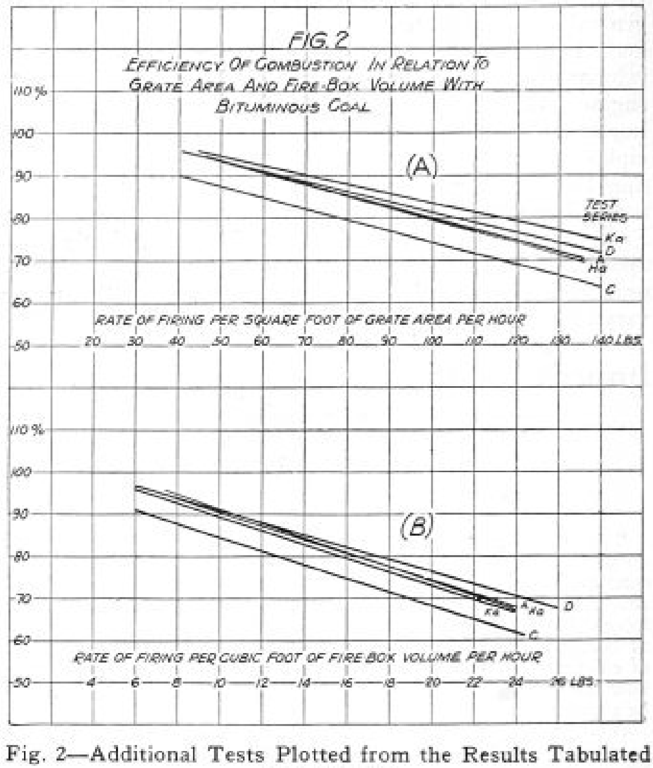


Fig. 2—Additional Tests Plotted from the Results Tabulated in Table II

Table II—Efficiency of Combustion in Relation to Rate of Firing

Code for test series	Locomotive	Grate area, R, sq. ft.	Firebox volume, V, cu. ft.	V/R	Efficiency of combustion in relation to firing per sq. ft. of grate, Fc = c — dG*		Efficiency of combustion in relation to firing per cu. ft. of firebox volume, Fc = c — d1Gv*	
					c	d	c	d1
Ab	Schenectady No. 2	17.0	106	6.3	106	0.258	106	1.62
D	P. R. R. K4s No. 1737	69.3	427	6.1	105	0.237	105	1.45
a	P. R. R. E2a No. 5266	29.8	243	8.2	100	0.170	100	1.39
b	P. R. R. E2a No. 5266	39.5	243	6.2	100	0.235	100	1.39
c	P. R. R. E2a No. 5266	55.5	243	4.4	100	0.316	100	1.39
C	P. R. R. L1s No. 1752	70.0	427	6.1	100	0.263	100	1.60
Ha	P. R. R. I1s No. 4358	70.0	455	6.5	108	0.276	108	1.49
Ka	P. R. R. M1s No. 4700	70.0	494	7.2	105	0.224	105	1.62

*Fe = Efficiency of combustion in percent.
G = Rate of firing in lb. of dry coal per sq. ft. of grate per hr.
Gv = Rate of firing in lb. of dry coal per cu. ft. of firebox volume per hr.
c, d and d1 are constants for each series of test.
R = Grate area in sq. ft.
V = Firebox volume in cu. ft.
d1 = V/R d.

Absorption of Heat by Radiation

Of the heat produced by combustion a part is taken up by the boiler heating surfaces and the remainder escapes as sensible heat in the smokebox gases. The heat absorbed is transferred to the heating surfaces in two ways, by direct radiation and by convection from the hot gases of combustion. Transfer by radiation takes place mainly in the firebox, and probably transfer in the firebox is mainly that by radiation. The amount of heat transferred in any given case by direct radiation can be estimated if the amount of heat produced, the weight of gases of combustion and the firebox temperature are known. From the weight and temperature of the gases the amount of heat carried out of the firebox can be determined, and this will be found to be considerably less than the heat produced. The difference must be the heat radiated direct to the firebox surface and therefore not available for raising the temperature of the gases. According to the Stephen-Boltzman law for radiation, if the firebox were completely filled with an incandescent body of gas radiating under ideal conditions, the heat absorbed per square foot of receiving surface per hour would be proportional to the difference between the fourth power of the gas temperature and the fourth power of the temperature of the receiving surface (see Table III). Examination of a number of locomotive boiler tests in the light of this statement leads to the belief that the heat transfer in the firebox is governed by a law of this kind. It seems necessary, however, to introduce a corrective factor to bring into account the fact that at low rates of combustion the incandescent body of gas does not fill the firebox so completely as it does at the higher rates.

It is believed that further study will give a reliable rule for the rate of transfer of heat in the firebox. This is important as providing a correct method for determining the evaporative value of firebox heating surface. Consideration of the data on which the foregoing conclusions are based indicates that the evaporative value of firebox heating surface depends on the firebox temperature, which in turn depends on the relation between rate of heat production, weight of gases of combustion and area of firebox heating surface.

With a given rate of heat production and a given weight of gases the firebox temperature must be such that the heat radiated at that temperature together with the heat carried by the gases at that temperature is just equal to the heat produced. An increase in firebox heating surface would throw matters out of balance unless the firebox temperature were reduced. The original temperature would maintain the rate of radiation unchanged so that the increase in firebox surface would increase the total heat radiated. Since the amount of gas carried heat, which is dependent on the temperature, would not change, the total heat taken out of the firebox would be increased without an increase in the heat produced which is, of course, impossible. To maintain a balance an increase in firebox surface must be accompanied by a drop in temperature, thus lowering the amount of gas carried heat. The lower temperature will give a lower rate of radiation per square foot, so that though the total heat radiated will be greater with the greater surface, the increase in heat radiated will not be in proportion to the increase in firebox surface.

Information available at present allows the foregoing statements to be made with confidence, but knowledge of this important subject is by no means complete and research would undoubtedly produce valuable results.

Transfer of Heat by Gas Convection

The general problem of the transfer of heat by convection from a gas flowing through a flue has been studied by many experimenters. By combining the results of a number of these studies a formula has been developed to give the drop of temperature as the gas passes along the flue. See Table IV. This is a double exponential formula and shows that the temperature drop along the flue depends on the temperatures of gas and of flue, on the flue dimensions and on the rate of gas flow in the flue. It has been used with success to estimate the general condition of heat transfer in locomotive flues and will give a high degree of accuracy if the method of determining or estimating the flue wall temperature is perfected. Fig. 3 and Table IV show the results obtained by using the formula to compute the temperature drop along the boiler flue. The rate of temperature drop is shown for two cases in which the only difference is the rate at which the gas flows through the flue. One case has a rate of gas flow corresponding to what might be expected in a locomotive boiler at the maximum rate of operation, while in the second the rate of gas flow is half that of the first. In passing 20 feet through the flue the gas temperature, which is assumed to be 2,600 degrees F. on entering the flue in both cases, drops to 625 degrees F. under high power conditions and to 545 degrees F. when the rate of gas flow is halved. This agrees with the usual experience that as the rate of operation is reduced the smokebox temperature is lowered. Translated into terms of heat taken up from the gases of combustion, these temperatures show that the amount of heat given up by each of the 300 pounds of gas flowing at the high rate is about four per cent less than the amount given up by each pound of gas at the low rate. Put the other way round the heat taken from each pound of gas at the high rate is 96 per cent of that taken up at the low rate of gas flow, but as the total weight of the gas is double, the total amount of heat taken up is increased in the proportion of 192 to 100. Doubling the rate of gas flow very nearly doubles the total amount of heat transferred from the gas to the flue. The heating surface of the flue is, of course, the same in both cases. This is an extremely important proposition. Among other things it shows that if half the tubes in a locomotive boiler were plugged and if it were possible to maintain the same total amount of gas flow as before, the doubled rate of flow in the remaining flues would increase the activity of heat transmission to such an extent that the evaporative power of the boiler would be reduced by only about four per cent. It becomes evident therefore that the major factor in determining the evaporative power of the flues is not the area of heating surface they offer, but the amount of gas that can be taken through them. In an actual locomotive boiler working at high power it would not be practicable to plug half the tubes and still maintain the same total rate of gas flow. The increase in draft required to move the same amount of gas through half the number of flues would be prohibitive. It is, however, a matter of fairly common experience that a considerable number of flues can be blocked up without reducing the capacity at all proportionately. Applied to the superheater flues, the formulas which have been used to find the curves of Fig. 3 show similar curves, but with a slightly more rapid drop of temperature. This would indicate that the gases emerging from the superheater flues would have a slightly lower temperature

Table III

Temp., deg. F.	Heat radiated per sq. ft., B.t.u. per hr.	Temp., deg. F.	Heat radiated per sq. ft., B.t.u. per hr.
1,400	18,200	2,100	67,900
1,450	20,500	2,150	73,400
1.500	22,800	2,200	79,300
1,550	25,300	2,250	85,500
1,600	28,000	2,300	92,000
1,650	30,900	2,350	98,900
1,700	34,000	2,400	106,200
1,750	37,300	2,450	113,900
1,800	40,900	2,500	122,000
1,850	44,700	2,550	130,500
1,900	48,800	2,600	139,500
1,950	53,100	2,650	148,900
2,000	57,800	2,700	158,700
2,050	62,700	2,750	169,100

Heat radiated per square foot of receiving surface at various temperature from formula.

$$\text{Heat radiated} = 1600 \left\{ \left(\frac{T}{1000} \right)^4 - \left(\frac{t}{1000} \right)^4 \right\}$$

T = Temperature of radiating gas in deg. F. absolute.
t = Temperature of receiving surface in deg. F. absolute.
Temperature of receiving surface assumed 391 deg. F. = 850 deg. absolute.

Table IV—Heat Drop Along 2-Inch Flue by Formula

	With 300 lb. of gas flowing through flue per hr.			With 150 lb. of gas flowing through flue per hr.		
Distance along flue, ft.	Gas temperature, deg. F.	Heat carried per lb. of gas, B.t.u.	Heat given up per lb. of gas from entrance of flue, B.t.u.	Gas temperature, deg. F.	Heat carried per lb. of gas, B.t.u.	Heat given up per lb. of gas from entrance of flue, B.t.u
0	2,600	706	0	2,600	706	0
1	2,305	617	89	2,250	600	106
2	2,060	543	163	1,960	514	192
3	1,850	482	224	1,730	448	258
4	1,670	431	275	1,535	394	312
5	1,520	389	317	1,380	350	356
7	1,280	323	383	1,130	282	424
9	1,100	275	431	960	238	468
11	960	238	468	825	213	493
14	810	199	507	697	170	536
17	700	171	535	608	148	558
20	625	152	554	545	132	574
23	565	137	569	500	121	585
26	525	127	579	470	113	593

The entering temperature is taken as 2,600 deg. F. and the flue wall temperature as 390 deg. F.

The temperature drop is given by the equation: lolog (T1/t) — Mx = lolog (T2/t).

Where "lolog" means logarithm of the logarithm of a number.

T1 is the absolute gas temperature at any point and T2 is the absolute gas temperature at a point x feet along the flue.

M is a coefficient depending on the flue diameter and rate of gas flow in accordance with the following equations:

$\log M = B - m \log W/P.$

$\log (B + 1.3) = 9.71 - 0.54 \log d.$

$\log m = 9.36 + 0.37 \log d.$

Where W is the weight of gas in lb. flowing per hour through the flue.
P is the inside perimeter of the flue in inches.
d is the inside diameter of the flue in inches.

than the gases which come through the plain flues. In view of the higher steam temperature in the superheater pipes this is not exactly what might have been expected, but there is some experimental evidence in its support.

The formulas as at present established are of value in showing how heat transfer by convection is affected by the various factors rate of gas flow, temperature, diameter and length of flue. To apply them though, at present, it is necessary to make certain assumption as to the relative distribution of gas between the superheater and the plain flues, and also as to the wall temperature of the flues. Further research to throw more light on these points would make the formulas of still greater value in analyzing locomotive boiler design.

Before leaving the subject of heat transfer it may be noted

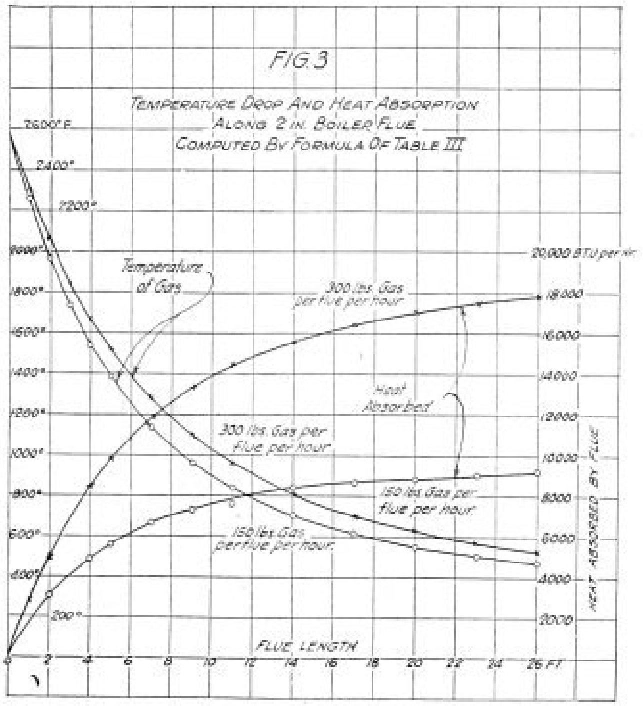


Fig. 3—Chart Showing Temperature Drop and Heat Absorption Along a 2-Inch Flue

that the transfer by convection in the flues is to a certain extent dependent on the transfer by radiation in the firebox. An increase in firebox surface while increasing the heat taken up by radiation reduces the temperature at which the gases enter the flues and therefore reduces the heat available for absorption by convection.

If the total efficiency of heat absorption, that is the total heat taken up by the boiler expressed as a percentage of the heat produced, is studied it is found that in any given boiler the efficiency of heat absorption is only slightly affected by the rate of operation, the variation between minimum and maximum power being usually less than four percent. Actual values of the efficiency of heat absorption depend on the boiler design and show a range of from 75 to 85 percent at maximum power.

To complete the survey of the boiler in action attention must be given to the conditions under which the air for combustion is supplied. Since George Stephenson's time the locomotive boiler has been distinguished by the use of the exhaust steam from the cylinders to draw the air for combustion through the fire. Though the method has often been criticized as theoretically inefficient its simplicity and practical advantages have maintained it in universal use. In spite, however, of the fact that all locomotives use exhaust steam in a blast pipe to produce draft there is very little organized theoretical knowledge as to the details of this fundamental process. The research carried out in 1896 by Dr. Goss for the Master Mechanics Association could with great profit be brought up to date and further extended to provide a solid scientific basis for front end design.

Summary

As a final word may I quote some remarks I made recently before the American Society of Mechanical Engineers in a discussion of locomotive testing plants:

A very great step forward could be made if the American Railway Association were to construct or to take over a locomotive testing plant to be devoted to the scientific and impartial study of locomotive designs and devices, and to undertake research work concerned with the basic scientific laws governing locomotive operation. Correct locomotive design is based on definite natural laws, knowledge of which can be obtained only by accurate experiment. The great influence which the locomotive testing plant has had on locomotive design is due to the opportunity it has given for thorough and accurate study of the fundamental laws governing locomotive operation. It is evident that the wider and the more accurate the knowledge a designer has regarding the laws governing the operation of his product, the more confidently and the more successfully can he proceed with improvements in design.

Discussion

C. A. Seley (Locomotive Firebox Company), in discussing Mr. Fry's statements relative to combustion and heat transfer, referred to test data compiled at the locomotive test plant at the University of Illinois. The test referred to included a series of medium firing rates or about 52 pounds per square foot of grade per hour and at higher rates averaging 112 pounds, the fuel being run-of-mine, nut, egg, lump and two grades of screenings, thus covering the general conditions by taking the averages of performances. The proportion of the firing rates was more than doubled, being 1 to 2.15, but the average firebox temperatures at the higher rates were only increased about 18 percent. The speaker said that according to Mr. Fry the additional heat developed at the grate was largely transferred by radiation. He also said that further study of the University of Illinois test data showed that at the high rates, the total evaporation was increased 80 percent and the total steam temperature 7 percent, the balance being accounted for in increased stack loss and slight increase of front end temperature. He stated that he did not wish to give the impression that heat transfer is entirely by radiation as the firebox gases, although increased only 18 percent in temperature, do contribute somewhat by convection to firebox evaporation, and doubling the rate of flow nearly doubles the amount of heat transferred through the flues. Mr. Seley called attention to Mr. Fry's assumption of a firebox temperature of 2,600 degrees F. in Fig. 3, whereas the average firebox temperature of the Urbana tests were 1,887.5 and 2,224.3 degrees F., respectively, for the medium and high firing rates, and said that a curve much flatter than that shown would result under these conditions.

H. H. Fanning (A. T. & S. F.) asked Mr. Fry if any consideration had been given to the development of ratios between the grate area and the firebox volume. Mr. Fry replied that he was not arguing for firebox volume as against grate area but was trying to point out that we do not know the relation between firebox volume and grate area and that it was very desirable to have some further accurate experiments which would give us a law for that relation.

There was some discussion relative to the relationship of tube spacing to the efficiency of heat transfer. A. I. Lipetz said that the question of spacing the tubes has been tested and no conclusive results have been obtained, for the reason that the question was not followed up to completion. He advocated more road testing, which, he said, could be conducted in many places under sufficiently constant conditions to add greatly to the limited fund of test plant data.

Hendrick Manufacturing Company, Carbondale, Pa., manufacturers of Mitco Interlocked Steel Grating, Mitco Shur-Site Stair Treads and Mitco Armorgrids, announces the opening of a Chicago District Office, 223 Railway Exchange Building, Chicago, in charge of Lon Sloan.

The Lincoln Electric Company, Cleveland, Ohio, announces the transfer of John Van Horne from Atlanta to Moline, Illinois, where he will be located at 514½ Fifteenth Street, covering the Tri-Cities, on the sale of "Linc-Weld" motors and "Stable-Arc" welders. He will operate under the direction of R. D. Malm, western manager at Chicago, Illinois.

The "Cleco" Chipping Hammer

THE Cleveland Pneumatic Tool Company, Cleveland, Ohio, has recently brought out a new chipping hammer. This tool has been developed to meet the present-day demands for high speed production and embodies a new method of air circulation and control which permits of exceedingly high speed without short stroking or sacrificing power or easy holding qualities of the hammer. This "Cleco" hammer is air balanced and each of its moving parts is synchronized to eliminate vibration and recoil in operation.

The throttle valve is the two stage type, which graduates the air supply and regulates the force of blow. The valve is the ball type and has a graduating apron at the front so tapered as to allow the air to pass into the hammer gradually and as the thumb latch is further depressed the movement of the piston is gradually accelerated until the maximum speed and power of blow is reached, thus eliminating all recoil, or vibration in action. No air vent port is required in the Cleco throttle valve and therefore no loss of air is experienced at this point which would be wasteful and annoying to the operator.

The cylinder at its forward end is reinforced by a tapered retaining wall and the piston is tapered correspondingly which eliminates any breakage of cylinders at this point. The piston has liberal bearing surface which makes for steadiness in action eliminating any lateral motion which causes undue wear of cylinder bore. The main valve is the spool type and is reinforced at the lower end and has liberal bearing surface. The valve, valve block and cylinder have liberal bearing surfaces which are hardened, ground and honed to a glass-like finish.

The handle is drop forged, of alloy steel, of proven quality for pneumatic service and is made in two types with clamp bolt lock or ratchet lock, as preferred. Two styles of handles are furnished—open or enclosed with outside latch.

Six-Foot Extension Added to Plate Rolls

AN unusual job was recently successfully accomplished when a set of 34-foot plate rolls at the General American Tank Car Corporation was lengthened to 40 feet. This gives the concern the only 40-foot roll in the middle west.

The original machine, a Ryerson-Kling bending roll, had a capacity of 34 feet 2 inches by ¾ inch with an upper roll 29 inches in diameter and two 20-inch lower rolls. It had been in service since its installation in 1919.

In making the addition it was necessary to dismount the rollers, extend the base and move out the rear housing. The 6-foot extensions, made of Mayari iron, were slipped over the journals and welded along the circumference of the joints. Additional center support was furnished and placed at the joints of the lower rollers.

A subsequent order calling for the rolling of 200 ½ inch by 8 feet by 38 feet plates to a 34-inch radius paid for the entire extension and netted a substantial profit as well. If the company had been unable to enlarge the rolls, it would have been necessary to buy the plates, fabricate them, ship them to Pittsburgh for rolling and re-ship to East Chicago, Indiana, at fabricated steel rates.

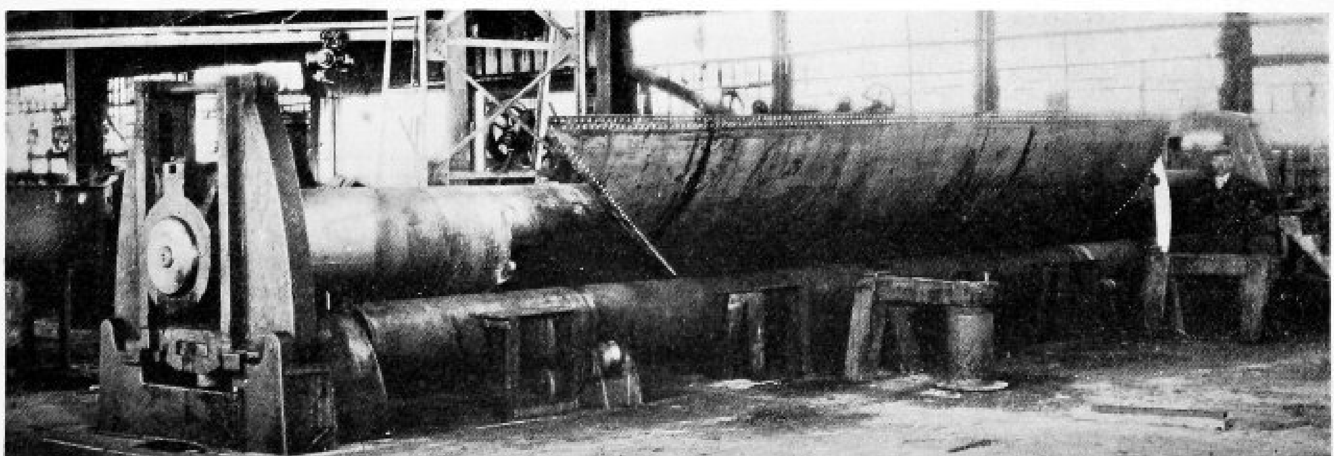
Soldering with an Acetylene Flame

MANY industrial operations require an easily manipulated source of heat that can be applied to a small area. For some operations, such as welding, extremely high temperatures are essential, and here the oxy-acetylene flame has been found ideal. There are many other applications, however, such as soldering, brazing and local heating, where a lower flame temperature will do the work quite as well. With suitably designed burners, acetylene alone will give a flame that is hot enough for many purposes.

For the practical application of this process there has been developed a very convenient, inexpensive outfit consisting of a light blowpipe handle and a set of special tips giving flames suitable for all types of soldering, brazing and heating work. The outfit is most conveniently used with a small tank of acetylene, and a 6-foot length of hose is provided for connecting the blowpipe to such a tank.

With this unit a hot, steady flame is instantly ready for use the moment the tank valve is opened and the burner lighted. Portability is an added advantage; the outfit can be taken right to the job wherever it may be, and no matter how limited the working space.

Soldering may be done in two ways. The direct flame from one of the smaller tips may be used to apply the solder. Or the blowpipe may be quickly converted into a soldering iron by slipping the soldering copper that comes with the outfit over the end of one of the tips and tightening a single set screw to hold it in place. This forms a soldering iron that is maintained constantly at just the right temperature by the internal flame. Work can be continued without interruption.—*Oxy-Acetylene Tips.*



Ryerson-Kling plate rolls after lengthening six feet

Practical Training for Welding Operators

Denver Public Opportunity School offers free courses in all branches of the welding art

By A. G. Odell*

IN the city of Denver, Colorado, has been established for some years what is known as a Public Opportunity School. Among other practical subjects in the course of study offered to people of all ages are complete courses in welding.

The classes in welding at the Opportunity School have the following aims:

KNOWLEDGE: An understanding of the welding processes and their possibilities. A thorough knowledge of the principles of physics and metallurgy involved in making a good weld. A knowledge of metallography. A knowledge of the limitations of the processes. A knowledge of every unit of the apparatus used. Complete knowledge of all the common metals and the methods of identifying and welding each of them.

SKILL: Skill in handling the apparatus with confidence and proper regard for safety considerations. Ability to make minor repairs and adjustments. Ability to recognize different metals and select the right procedure for welding each of them. Ability to plan and carry out each job with the least possible expenditure of gas, current and time. Ability to secure perfect fusion and thorough penetration on every weld. Ability to test his own work, recognize defects and overcome them. Ability to dispose work and apparatus so as to weld with maximum comfort and efficiency.

TRAINING

Welding has come upon the scene at a period in the world's economic development when the rule of thumb method has been supplanted by scientific research. We are fortunate in this respect for, instead of blind groping, our forces can be intelligently marshalled to get results.

The development and application of welding will be hastened through the training of welding efficiency engineers, as welding is becoming more and more a specialized profession and trade.

Broadly speaking, the fields for training include:

Engineers, designers and draftsmen, supervisors, inspectors, foremen, welders, practical instructors and the most important, instructors for schools, universities and colleges.

Successful extension of welding absolutely depends upon the engineer. This point cannot be stressed too strongly, for the mechanic generally speaking, is unable, through lack of training, to appreciate and overcome the problems which are daily met in this branch of knowledge. Steps should be immediately taken to encourage graduating mechanical and electrical engineers to take a post graduate course in subjects related to this branch, such as chemistry, metallography, metallurgy, etc. Students should gather together all available data and take a course at some accredited school. (The Opportunity School is recognized by the North Western Association of Schools and Colleges and the Welding Departments by The Gas Products Association and many manufacturers of welding equipment and supplies.)

The student will find in this search for knowledge that he has entered one of the few uncharted fields, and one which affords unlimited opportunities for research. A welding engineer is today a necessity in every railroad system, shipyard and many industrial plants, yet few engineers with enough welding knowledge to fill these positions are available.

The training of the designer will have to go hand in hand with that of the engineer and welder, for, as the connecting link between the two, the problems of welding are necessarily his.

Our method of teaching fusion welding describes in detail the theory and practice of every welding process. We tell and show how to weld every weldable metal by each of the following processes—forge, oxy-acetylene, electric arc, metal and carbon electrode, electric resistance, and thermit; also soldering, brazing, etc., giving detailed instructions for handling such important jobs as boiler welding, sheet metal welding, tank welding, pipe welding, refrigerating machinery, condenser coils, rail joint welding, railroad welding, structural steel welding, cutting, etc.

We show how to prepare parts for welding, how to preheat, how to anneal, how to select welding material.

We explain the meaning of all words and terms found in metallurgical, metallographic, physic, chemical and welding literature.

We tell how to install and care for welding equipment, giving federal, state and insurance laws, rules and regulations governing the installation and operation.

Our regular lectures consist of practical welding, chemistry, metallurgy, metallography, servicing, salesmanship relating to the welding industry, executive training and instructorship. We use a number of valuable charts and tables of useful information.

Our general lectures are given at the beginning of the school term and thereafter at the beginning of each month to all day and night students. This lecture lays the foundation for good work by making clear that welding is a fusion process, and they are told that the only way to success is by mastering the principles which govern perfect fusion and physical requirements.

The various methods of welding are compared so as to indicate that the fundamental purpose of each is to secure perfect fusion of two or more parts. It is also indicated, in a general way, that welding blowpipes, regulators, gages and electric machines are instruments of precision requiring careful handling, and that there are certain common sense safety principles which must be observed. At this point, too, we find it highly desirable to point out the responsibility resting upon the welder, who is often the only competent judge of his own work until that work is subjected to service. The purpose and scope of our instructions is then carefully explained so each student will understand that he is not expected to become a finished welder "in one term" through this instruction, but only to secure the knowledge and skill required so that he may start in as an apprentice welder without danger of continually making fundamental mistakes.

In the shop, each new student or group of students is taken in hand by advanced students for practical training; the purpose of this is to see if the advanced students can impart the knowledge they have obtained to others; it is also part of their training as instructors and supervisors.

The lecture room is very well equipped (with more equipment promised). Our projection and reflecting picture machines are very useful in showing slides, cuts, advertis-

* Technical Director, Welding Dept., Denver Opportunity School.

ing matter from magazines, catalogs, etc. At the end of the room, facing the class, is a slate blackboard the full width of room, and in the center and above is our screen for pictures which is on rollers to be pulled down over the blackboard. On each side of screen are two demonstrating tables for gas cutting and welding, electric arc cutting and welding, resistance and spot welding. At one side in front is an acetylene generator. The room is 27 by 33 feet. We also have in our lecture room a collection of welds and metals. Weld specimens are good, bad and indifferent from various shops, firms and industrials. Steels of every composition and in every state are here for explanation of heat-treating, case hardening, scleroscope, Brinell, etching, Rockwell, metallographic, and physical tests. We expect to have in the near future, a finer physical laboratory in connection with our lecture room, the machines to be made in our own machine shops.

Our library has many books and publications on welding, metallurgy, and metallography, is open at all times to students, and books may be taken home by taking out a card.

We have a fully equipped chemical, metallurgical and metallographic laboratory, the only one, we believe, in the United States in any school or college devoted exclusively to the science of welding. Excluding equipment for chemistry and metallurgy, our metallographic equipment consists of Hoskins carbon determination furnaces, Wysor metallographic grinding and polishing machines, balances of all kinds, including quantitative balances. Also miscroscopes, light projectors, spectroscopes, cameras for photomicrographs, etc.

Our welding laboratory or shops are also well equipped with manifolds for gases, separate tables for cutting, portable outfits, blacksmith forge, electric arc welding machines, furnaces for preheating with charcoal, kerosene preheating torches, large bench shears for sheet metal, heavy cast iron face plates, heavy cast iron cone for forming all sizes of circles, heavy vises, pipe vises, work benches other than welding tables, grinding and brushing wheels and stands, compressed air, very large supply of tips for various makes of blowpipes, cutting and welding, heavy tools of all kinds, etc.

We have an assortment of torches to the number of thirty, and we have to thank several firms for apparatus donated to the school in the interest of welding.

Our shop takes care of all the commercial welding for the Public Schools of the City and County of Denver, including all the manual training shops and the machine shop as well as the automobile shops of this school and much outside work.

Many firms of this city contribute all kinds of scrap materal to practice on and even offer to deliver it. This support has been furnished generously by Hendrie & Bolthoff, Mine & Smelter Supply Co., York Products Co., manufacturers of refrigerating apparatus, Western Steel Products Co., manufacturers of heavy boiler plate products: Eaton Tank Co., manufacturers of tanks of all kinds, Burkhardt & Son, manufacturers of structural steel products.

The average enrollment for the past five years has been around three hundred and twenty-five. We have no waiting lists in the welding departments. A student can begin his studies as soon as he enrolls, at any time during the year and devote as much time to it as he can spare, getting what he can from that time, registering again the following term. We can handle sixty (60) men in the shop each week, fifteen (15) each night.

In registering, first come, first enrolled; and as soon as the shop quota is filled, those who were unable to get in the shop can come to lectures four times a week if they choose or take up chemical work two of the four nights. No student can hope to get or stay in the shop unless he attends lectures at least one night each week, because there is a technique to welding arrived at after many years of experiment and research work and we want our students to have a foundation upon which to build future worth.

A lecture room student is advanced to the shop in the following manner:

Each student is given a number for the purpose of better checking his attendance as well as the progress he is making and to show no partiality in advancement to the shop. By putting numbers as well as the names to be advanced to the shop on the board, the student is told just how near he is to practical work and all are anxious to get in the shop. Suppose No. 3 decides he does not care for welding after a few days, No. 61 takes his place. Suppose No. 59's work interferes with his night attendance, No. 62 takes his place. No. 32 leaves the city, No. 63 takes his place in the shop, and so on.

Night classes are held from 7:30 P. M. to 9:15 P. M., the first four nights of the week.

Day classes are held from 9:00 A. M. to 3:00 P. M., one hour for lunch, these classes are held the first five days of the week.

Laboratory ("chem") work is optional, but is necessary to obtain a degree of welding efficiency engineer or welder of Class A.

The number of day students or students attending day classes average fifteen for the year or term, although at times we have had twenty-five in attendance for weeks at a time.

Lectures for day students are from 9:00 A. M. to 11:00 A. M. Shop work for day students from 11:00 A. M. to 12 noon—one hour for lunch. Shop work again from 1:00 P. M. to 3:00 P. M.; total of five hours. Should crowded conditions exist in the shop during the day, those that do not care to work under these conditions are permitted to go to the library and study.

In the evening, we have many welders who come for lectures only, and many of our day students are ones who work night shifts and come to classes in the morning before going home. Some of them work in the morning and come to classes in the afternoon and to lectures in the evening.

Very often we have at our lectures, men who do not care to weld but are connected directly or indirectly with welding and wish to know something of the fundamental and technical principles concerning the application of fusion welding.

Until last term "1926-1927" we have not been able to confer a degree on account of not having a laboratory. Now we give the degree of Welding Efficiency Engineer, "W.E.E.," but to get that degree it has to be earned with the following:

500 hours school shop work.
300 hours school lectures and Physical Laboratory.
400 hours school Elementary Chemistry, Metallurgy and Metallography.
400 hours school Advanced Chemistry, Metallurgy and Metallography.
900 hours Industrial Training (working as a welder).

2,500 hours Total.

The student may have 2,500 hours to his credit and not be able to obtain his degree because he did not have the number of hours required in any one subject—Lecture, Shop, Chemistry, Metallurgy, Metallography or Industrial Training. Should the student have the required number of hours in all subjects he can then take his final examination and if he can pass, making a grade of 80 percent, he is given a diploma. A student may accomplish this in the usual time of four years, over a number of years, or he may reduce the actual number of school terms or years by much studying and handing in of essays and papers and by discussions in the lecture room. He is given credits according to the merits of his papers or discussions, but he must have his full nine hundred hours of industrial training. When the student is in industrial training he must make reports as to his progress from time to time, and it is our desire that he work at as many different kinds of welding in different shops as possible in the nine hundred hours or one year.

Should a student be working as a welder before or at the time he enrolls in this school, and can show nine hundred hours actual industrial training, he is considered as having earned those credits and that cuts his time down in obtaining his degree.

We also give certificates as follows:

CLASS "A"

500 hours school shop work.
300 hours school lectures.
400 hours school Elementary Chemistry, Metallurgy and Metallography.
900 hours Industrial Training.

CLASS "B"

500 hours school shop work.
300 hours school lectures.
900 hours Industrial Training.

CLASS "C"

500 hours school shop work.
300 hours school lectures.

We have had a great many students who have gone out in the industrial world and are making good as welders. Many have returned year after year and we expect to give quite a number of "W.E.E." diplomas and Class "A" certificates during the school term of 1927-1928. One student obtained his degree this year as Welding Efficiency Engineer.

Success or failure of any undertaking depends largely on organization, this being especially true in the science and art of welding. What is done in the early stages of welding development will shape its course and either retard or hasten application to industry in general. Therefore it is to the interest of all employes, employers of welders, or those in charge of welding, to cooperate heartily and this applies especially to welders.

Due to lack of trained engineers, supervisors and welders it will rarely be possible to build up the ideal organization desired overnight, but by degrees one handicap after another will be removed. The successful application of welding is based on engineering principles, and therefore, it rests with the trained mind of the engineer (not engineers who have conferred the degree of welding engineer upon themselves), for successful development. An engineer should be placed at the head of every welding organization.

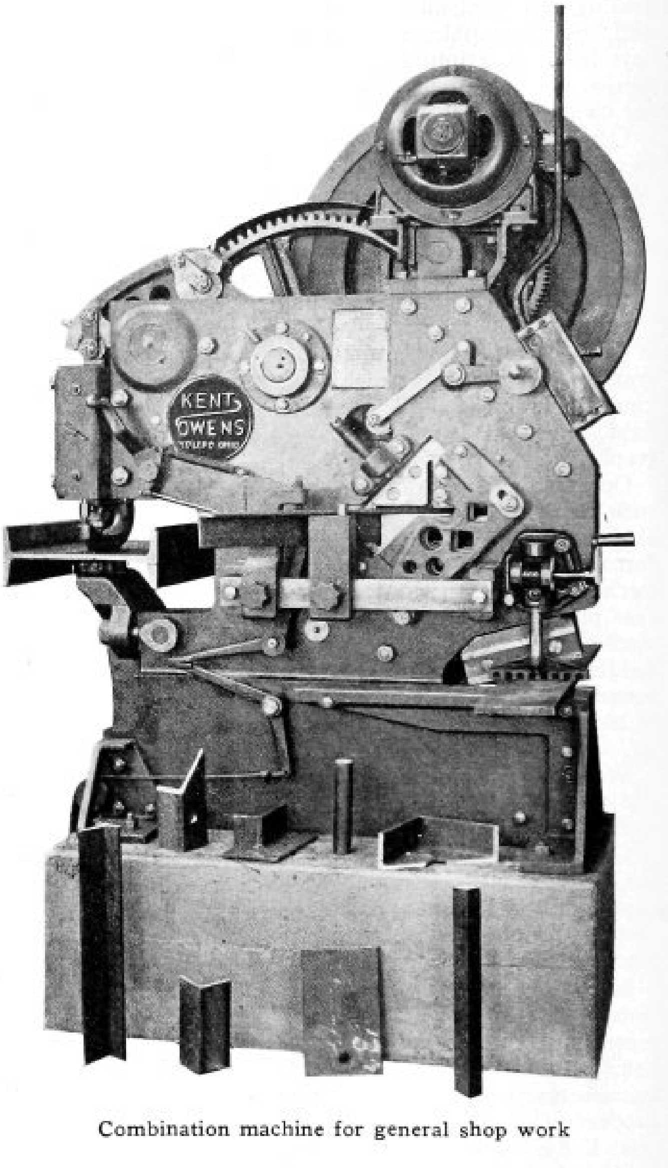
All Purpose Iron and Steel Worker

THE Kent-Owens all purpose iron and steel worker, a product of the Kent-Owens Machine Company, Toledo, Ohio, is designed particularly to meet the needs of shops having a variety of work. The various tools provide for punching, cutting and mitering of sections, shearing of round and square bar stock and shearing flats and plates. A simple attachment also provides for coping and notching.

The mechanism is so arranged that the punch may be operated independently of any of the other tools. That is, one operator may be punching holes while a second is either cutting sections, bar stock or shearing plates. This compact combination of several tools in a single unit makes for a lower initial investment and greatly reduced handling costs as compared with single purpose machines.

A significant feature is the welded frame construction. The side members of the frame are rolled from special analysis open hearth steel. These are electrically welded to intermediate forgings placed and shaped so as to provide the maximum rigidity. This welded steel frame not only gives superior strength of steel, but also is rigid and is entirely free from slipping or weaving of side members as sometimes occurs when a bolted construction is used.

The punch is full floating with an adjustable stroke. It may be brought down to the surface of the work by means of a hand lever or else the stroke may be set so that it will always come to rest immediately above the work. This



Combination machine for general shop work

feature makes for convenience either when punching material of varying thickness or when punching a large number of holes in material of uniform thickness. The punch and dies blocks are so constructed that large clearances are provided for punching holes in the web and flanges of I beams, H sections, channels and other sections without having to change tools.

An adjustable gage is conveniently located for cutting off sections either square or at any desired angle. The bar cutter has an adjustable hold down plate, all of the openings in which are clearly visible.

Interchangeable upper and lower steel knives, having four cutting edges each, are used in the shear. The welded construction permits large clearance in the shear ways. These ways are free from any obstructions.

Bearings are all phosphor bronze lined. Lasting alinement is insured by the rigidity of the welded frame construction. Lubrication is by high pressure alemite grease system. All slides are counterbalanced to insure smooth and easy operation.

The punch handles work up to 1-inch hole in ½-inch plate. Angles up to 4 inches by 4 inches by ⅜ inch may be cut off square and up to 3 inches by 3 inches by ¼ inch mitered at 45-degree angle. Rounds up to 1⅝ inches and squares up to 1½ inches may be cut off in the bar cutter. The shear takes flats and plates up to ½ inch thickness.

The machine may be arranged for motor drive, as illustrated, or for belt drive. Steel cut gears are used in the driving mechanism. Operations of the various tools is effected by a simple, positive action type of clutch. A 3 horsepower motor is recommended. The weight is about 3,300 pounds. The machine may be mounted either upon a concrete foundation as shown or upon a structural steel box section.

To Develop the Frustum of a Right Cone When the Apex Is Inaccessible

By I. J. Haddon

Draw the line *A-B*, Fig. 1, set off *C* and *D* at right angles to *A-B*, and distant apart equal to the large end of the frustum.

Draw *E-F* parallel to *C-D* at a distance from *C-D* equal to the depth of the frustum; make *E-F* equal to the small end, viz., *E* and *F* to be equidistant from the line *A-B*. Join *C-E* and *D-F*. *Note:* The lines *C-E* and *D-F* should represent the center of the thickness of the material to be used for the frustum.

From *F* with radius *F-C* draw the arc shown at *G*, then with *D* as a center and the same radius, draw the arc shown at *H*.

With *D* as a center and radius *D-C* cut the arc in *G*. With *F* as a center and radius *F-E* cut the arc in *H*. Draw the line *G-H*.

We now have *C-D* and *G* which are three points on the curve at the large end, we also have *E-F* and *H* which are three points on the curve of the small end.

Now refer to Figs. 2 and 3. You will see that the curve *J* is part of this circle. Take *any* three points such as *E*, *F* and *H* on the curves, and with template laths make a frame mold *K* so that the wood touches the points as shown.

Now if scribers be held at *E* and *H*, and the mold pushed around so as to touch the scribers *E* and *H* at all times, the point *F* will be on the circle at all times, just the same as if the curve had been drawn with the trammel, with the center of the circle as a radius.

In Fig. 3 you will notice the angle at different positions; the geometrical proof of the accuracy is shown in Euclid 3 book, proposition No. 21, wherein he states "the angles in the same segment of a circle are equal to each other"; therefore, to refer back to Fig. 1, make a mold as shown to touch the points *E*, *F* and *H*, hold scribers at *E* and *H* and draw the curve with a pencil held at *F*. The angle at *C-D-G* is equal to the angle at *E-F-H;* therefore, the same wood mold will do to enable you to draw the curve through *C-D-G*.

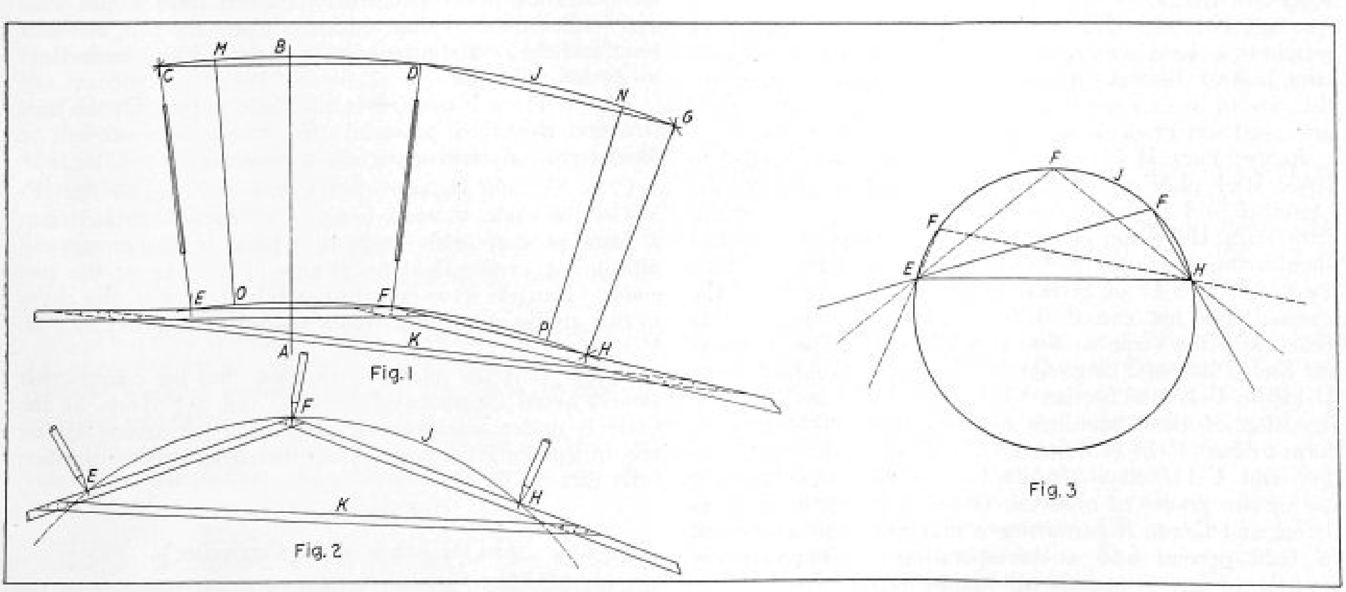
Having drawn the curves at the top and bottom, calculate the circumferences for each end according to the diameters and divide by 4, to equal one-quarter circumference.

Set off from *D* to *M* one-quarter and from *D* to *N* one-quarter, *measuring along the curve.* Do the same at the bottom in *O* and *P*. Join *M-O* and *N-P*, then *O-M-D-N-P-F-O* will be *half* of the complete frustum. *O-M* and *P-N* represent the centers of holes if lapped joints; allow on laps where required.

Australia's Most Modern Boiler Riveter

The largest cargo lift with a ship's gear ever undertaken in an Australian port was made recently when the Commonwealth cargo steamer *Fordsdale* discharged at Williamstown a hydraulic gap riveter weighing over 96 tons, consigned to the Victorian Railway Workshops at Newport.

The riveter is the most up-to-date of its kind in Australia and was designed and made by Fielding and Platt, of Gloucester, Eng. It will be used for the Pacific class of boilers at Newport, and will insure a great saving of labor. Nearly 40 feet in height, and possessing a 26 foot gap, it will be able to accommodate all sizes of boilers. The machine will be built in a well, only 4 feet 6 inches of it being above ground, and the boilers will be lowered into the gap by means of an overhead crane, the boiler being gradually lifted while the machine hydraulically rivets up the seam.



Method of developing the frustum of a right cone

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, 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 and simultaneously published.

Below are given records of the interpretations of the Committee in Cases Nos. 551 (reopened), 552 (reopened), 558, 563, 564, 565-568 inclusive, as formulated at the meeting of October 28, 1927, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

Case No. 551 (Reopened) *Inquiry:* Will it be permissible to form a nozzle on a drum of diameter not less than 30 inches, where the shell is 2 inches or more in thickness, by the use of a steel tube not exceeding 3 inches in diameter, which is rolled into a hole in the drum and into an outer flange? Attention is called to the fact that if a flanged nozzle were to be attached to a drum by riveting as required in Par. P-268 of the Code, the rivets would become so long that it would be difficult to make a tight and satisfactory joint, and also it is believed that the method of screwing a threaded pipe connection into the drum as provided for in Par. P-268 would be unsatisfactory on account of damage to the threads through corrosion or other means.

Reply: A revision of the requirement pertaining to nozzles in Par. P-268 is being considered which will modify the present mandatory requirement for the riveted attachment to shells or drums. It is the opinion of the Committee that the proposed construction is allowable under the conditions specified provided the outside diameter of the tube does not exceed 4 inches. In all cases the tube used for the nozzle shall conform with the requirements of Pars. P-21 and P-251.

Case No. 552 (Reopened) Inquiry: Is it necessary in purchasing base metal plate for welded steel low pressure heating boilers, to specify firebox quality for plates that are to be exposed to the products of combustion, or is any good soft grade of steel acceptable for this purpose?

Reply: Pars. H-74 to H-77 of the Code are intended to cover steel plate of either flange or firebox quality, the chemical and physical requirements to be in accordance with Pars. H-74 and H-76. In all other respects the steel should conform to the Specifications for Steel Boiler Plate, Pars. S-5 to S-17 of Section II of the Code, provided the carbon does not exceed 0.20 percent. Such material is practically the same as that covered by the Specifications for Steel Plate of Flange Quality for Forge Welding, Pars. U-110 to U-125 of Section VIII of the Code, and it is the intention of the Committee to revise Par. H-74 to conform to Par. U-70 of Section VIII of the Code. Pars. U-112 and U-115 have already been revised to permit the use of two grades of material, Grade A being the same as before and Grade B permitting a maximum carbon content of 0.20 percent and a corresponding minimum tensile strength of 50,000 pounds per square inch.

Case No. 558 *Inquiry: a.* Is it permissible, under the requirements of Par. U-39 of the Code, to reinforce a dished head with a manhole ring without a flange of such size and thickness as to compensate for the metal removed from the head?

b. Can this ring be placed on the pressure side of the head and then fastened thereto by welding first the outer edge of the manhole ring to the head and then the inner edge of the ring to the manhole opening edge, or must such attachment be made with rivets?

c. Is this requirement met by welding a ring into a manhole opening in a dished head if such opening and the ring are concentric with the axis of the vessel?

Reply: a and *b.* Inasmuch as Par. U-39 of the Code requires a head to be flanged for a manhole opening, the use of a separate ring is not permissible.

c. Inasmuch as Par. U-39 requires the opening in a dished head to be flanged, no other construction is permissible under the Code.

Case No. 563 *Inquiry:* Is it the intent of Par. P-289 of the Code, which requires flanged inlet connections for safety valves mounted on superheaters, that this rule shall apply when the superheaters are attached to horizontal return tubular boilers operating at pressures not to exceed 150 pounds and superheat temperatures not to exceed 450 degrees F.? It is pointed out that the safety valves used on such horizontal return tubular boiler superheaters are 2 inches in size and that the superheating service is not severe on this class of boiler.

Reply: Par. P-289 is specific in its requirement for flanged safety-valve inlet connections to superheaters.

Case No. 546 *Inquiry:* Is it to be understood that under the requirements of Par. P-268 of the Code steel-plate reinforcing pads may be welded on the inside of boiler shells and not conflict with the provision for welding in Par. P-186? It is also desired to use this method of reinforcement on down draft boilers for the pipe plug closures of the access openings to the water-grate tubes.

Reply: Par. P-268 does not specify the method of attachment of reinforcing pads, but Par. P-186 provides for the application of fusion welding only where the stress is carried by other construction. There is nothing in the Code to prohibit the construction shown provided the welding is only for tightness and not for strength.

Case No. 565 *Inquiry:* Is it permissible, under the requirements of the Code, to construct a furnace with an OG connection at a lap riveted joint having the overlapping plate at the joint cut away along the OG curve so that when the plates are brought together they will form a butt joint and result in single plate thickness along the OG, the butt joint and the overlapping edge to be joined and made tight by fusion welding?

Reply: There is nothing in the Code to prohibit the construction described provided the stresses are carried by other forms of construction which conform to the Code.

Case No. 566 *Inquiry:* Is it permissible, under Par. P-323 of the Code, to use a hanger construction formed from a plate or strap with supporting point at the center and attachment to the shell by groups of riveting at the two ends? Hangers have been extensively used with the rivets in two groups, hence not evenly spaced as required by Par. P-323.

Reply: It is the intent of the Code that the construction should avoid concentrated stresses, and a revision of the Code is under consideration to provide for accomplishing this in a more general way than the paragraph in question calls for.

Case No. 567

(In the hands of the Committee)

Case No. 568 *Inquiry:* Will it be permissible, under the requirements of the Code for Unfired Pressure Vessels, to form the heads of a steam and water drip tank, not to exceed 24 inches in diameter, intended for operation at 400 pounds pressure, by inserting dished heads with the concave side to pressure in the ends of lap-welded pipe or tubing and crimping the ends of the pipe or tubing down over the knuckle of the dished head, using fusion welding for tightness? It is noted that Par. U-74 specifies the length of flange for dished heads concave to pressure but does not specify other than in the illustration in Par. U-3*j* as to its method of attachment to the shell.

Reply: There is nothing in the Code for Unfired Pressure Vessels to provide for this form of construction. If fusion welding is to be used to attach the head to the shell of a vessel, the weld should be made in accordance with the method illustrated in Fig. U-3*j* and the head thickness reduced to that of the shell as specified in the last sentence of Par. U-74.

Revisions and Addenda to Boiler Construction Code

IT is the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of 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 the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the 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.

Par. H-1. Revised:

H-1. These rules for steel-plate boilers shall apply:

a To all steam boilers for operation at pressures not exceeding 15 pounds per square inch.

b To [steel plate] hot-water boilers TO BE OPERATED AT PRESSURES not exceeding [60 inches in diameter or] 160 pounds [working pressure] PER SQUARE INCH, or temperatures not exceeding 250 degrees F.

c. For conditions exceeding those specified above, the rules for construction and setting of power boilers shall apply.

Par. H-70. Revised:

H-70. Steel-plate boilers constructed by autogenous welding under the rules prescribed for steel-plate heating boilers may be used for steam heating at pressures not exceeding 15 pounds per square inch, or for hot-water heating at pressures not exceeding 160 pounds per square inch, OR FOR TEMPERATURES NOT EXCEEDING 250 DEGREES F. For pressures in excess of 30 pounds per square inch for hot water boilers, the factor of safety for autogenously welded steel-plate boilers shall be not less than 5, assuming the strength of the welded seam at 28,000 pounds per square inch of net section of plate.

Par. H-74. Revised:

H-74. *Material for Base Metal.* The base metal composing the plates of autogenously welded steel-plate heating boilers shall be of good weldable quality and shall be made by the open-hearth process, conforming to the requirements of the Specifications for Forge Welding, Pars. U-110 to U-125 of Section VIII of the Code, or to those for flange and firebox classes of steel given in Pars. S-5 to S-17 of Section II of the Code, provided the carbon does not exceed 0.20 per cent.

M-17. Revised:

M-17. Each steam line from a miniature boiler shall be provided with a stop valve located as close to the boiler shell or drum as is practicable, EXCEPT WHEN THE BOILER AND STEAM RECEIVER ARE OPERATED AS A CLOSED SYSTEM.

Proposed Addenda

In the preamble of the 1924 edition of the A.S.M.E. Boiler Construction Code a statement was made that the general rules appearing in the 1918 edition covering pipe flanges and fittings were repeated therein for the reason that the report of a Committee working under the American Engineering Standards Committee to revise and enlarge this standard for application to higher pressures, had not then been completed. The new Tentative American Standard for Steel Pipe Flanges and Flanged Fittings has, however, now been completed and approved by the A.E.S.C. (in June, 1927), and it is now issued in pamphlet form.

The Boiler Code Committee now has under consideration the adoption of these new standards and incorporating them in the Power Boiler Section of the Code to replace the original American Standard as published in the last edition.

Any one who has special interest in this feature of the Code requirements is invited by the Boiler Code Committee to examine the new standard and study it critically with a view to offering any desired comments thereon to the Committee.

Attention is called by the Boiler Code Committee to the fact that in the new standard the 4½- and 7-inch pipe sizes have been omitted, but as those sizes are in such extensive use in connection with boiler construction and erection, the Committee proposes to include figures to cover them, with notation to the effect that they are to be treated as special sizes.

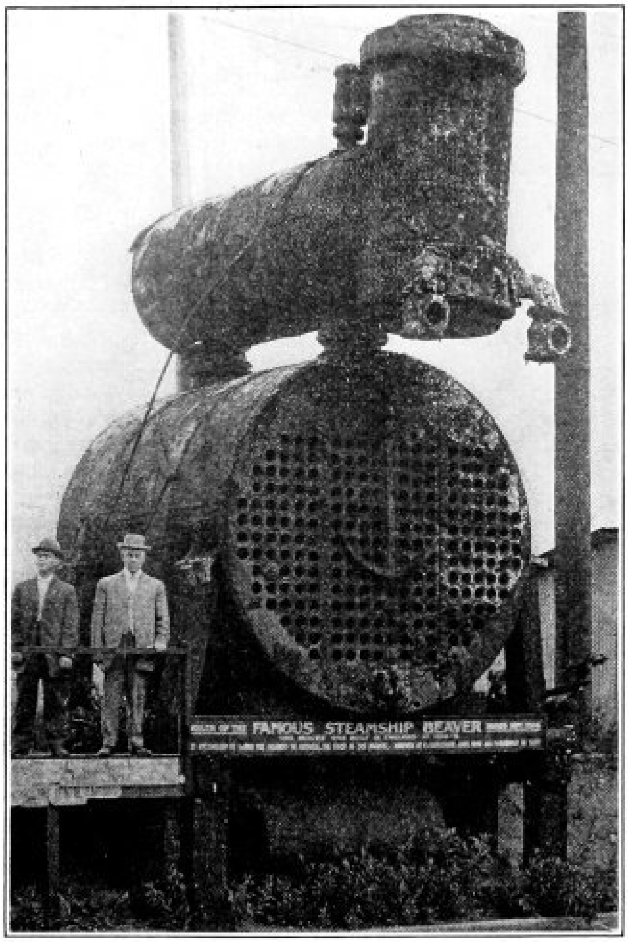
Brent A. Tozzer, New York sales manager of the Niles Tool Works Company and Pratt & Whitney Company, New York city, has resigned, effective December 31. Mr. Tozzer expects to announce his new plans about the first of the coming year.

PACKING.—A handy folder with price lists has just been published by the Flexitallic Gasket Company, Camden, N. J. The folder gives complete information for ordering Flexitallic gaskets for pipe flanges, tube caps and manholes. It includes dimensions, prices, a list of over twenty boilers to which this tube cap gasket is applicable. The gasket is, as the name indicates flexible and is partly metallic. It contains more asbestos than metal. The metallic portion is what makes it flexible and elastic. It is recommended for places where it is impossible to hold joints tight with other gaskets. In other words, it is a flexible metallic gasket built on correct mechanical principles to withstand modern high pressures and intense heat.

Boiler of the Steamship Beaver

THE accompanying picture shows an ancient marine boiler which will undoubtedly be of interest to many of our readers, particularly those of maritime inclinations, because of the history of the vessel in which it saw service. As can be observed by the sign displayed in the photograph, the vessel known as the *Beaver* is credited with a transatlantic trip and is further credited with being the first steamship to round Cape Horn and the pioneer in the Pacific ocean.

The vessel was built in Blackwall, London, England, in 1834. The engines and boilers were installed by Bowlton & Watt, weighed 63 tons, and cost $22,000. As the early log of the vessel speaks of "wooding up," it was undoubtedly a wood burner, externally fired, probably with a Dutch oven such as we encounter today. It is further interesting to note the superheater section, which formed a part of the uptake and is quite prominent in the photograph. The length of the *Beaver* was 101 feet 4 inches; the breadth was 20 feet inside of the paddle wheel boxes and 33 feet overall; the depth was 11 feet 6 inches. The vessel was registered as of 109 tons, and is said to have carried a crew of 26 men and to have been armed with 5 nine pounder guns.



Boiler of the first steamship to round Cape Horn

The *Beaver* sailed from England August 29, 1835, for the Pacific ocean by way of Cape Horn, arriving at the Island of Juan Fernandez (Robinson Crusoe's Island) on December 17, 1835, and at the mouth of the Columbia River on April 4, 1836. The vessel evidently had a long career on the Pacific for it is reported to have sunk in Burrard Inlet, Vancouver, B. C., on July 26, 1888. The boiler remained in salt water until September, 1906, when it was raised and brought to the Washington State Historical Society at Tacoma, where it is now on exhibition.

The first transatlantic steam vessel was the *Savannah*, which crossed the ocean in 1819, requiring 26 days for the trip. The Savannah, however, is generally discounted as the first steamship because the engines were merely for auxiliary power in quiet waters and in docking. Her paddle wheels could be rapidly disassembled and brought on deck when not in use. It is of interest to note in passing that the *Savannah* was entirely an American vessel, having been financed, built, and engined in the United States, and sailed on this historic voyage from the port of Savannah, Georgia.

The *S. S. Curacao* of the Royal Netherlands Navy is said to have sailed, or rather steamed, from Holland to the Dutch West Indies in April, 1827, and to have made additional trips in 1828 and 1829.

In 1833 the Canadian steamer *Royal William* left Quebec for England, and by continuing the service became the first transatlantic liner. Because of indifferent financial returns, the vessel was later sold and the service discontinued.

In 1838 the *Sirius* made a trip from London to New York in 17 days, and was followed shortly after by the *Great Western*, which made the trip from Bristol, England, to New York in 15 days.—*The Locomotive*.

Warranties in the Sale of Boilers

By Leslie Childs

WHEN an individual or firm buys a boiler, it is usually intended for a particular purpose and the question of whether or not the seller warrants the fitness of the boiler for the purpose intended may easily arise. This point has been the subject of considerable litigation and the general rules applied by the courts upon it may be summarized as follows.

If the seller of a boiler expressly warrants its fitness for the purpose intended by the buyer he is bound by his warranty. It follows, if the boiler does not fulfill the buyer's needs the seller may be held liable. Or, in the absence of an express warranty of fitness, if the buyer relies upon the judgment of the seller in furnishing a boiler for a particular purpose and the seller agrees to do so, an implied warranty of fitness may result.

On the other hand, in the absence of an express warranty, if the buyer orders a known, specified, type of boiler, without more ado, he will be deemed to have taken the risk of its fitness for the purpose purchased. By the same token, when the seller has furnished that which was ordered he will have fulfilled his contract and cannot be held liable, if after trial the buyer is disappointed in the boiler. Now, let us see.

BOILERS ORDERED FOR A PARTICULAR PURPOSE

In Grand Avenue Hotel Company v. Wharton et al., 79 Fed. 43, the plaintiffs were engaged in manufacturing and selling boilers, and entered into a written contract to furnish the defendant with two safety boilers of 150 horsepower each for $3,600. The boilers were intended for use by the defendant in a hotel it was operating in Kansas City, Mo. They were of a well known class and the contract contained full, particular, and minute specifications of the material and construction that was to be put into them by the plaintiffs.

The plaintiffs manufactured the boilers in strict compliance with the terms of the contract. The defendant made no complaint of the materials used, or of the construction or manner of installation. But, after the boilers had been in use some time, it became clear that they did not operate properly because of the character of the water used in them, i.e., the muddy water of the Missouri river and owing to the defendant's location no other water was available.

In the operation of the boilers, this water left sediment in unusual quantities that soon filled the boiler caps and caused incrustations which in turn reduced the heating capacity of the boilers in a marked degree. Further, the filled caps frequently burst which of course required replacements which resulted in serious interruptions in the heating of defendant's hotel.

In this situation the defendant refused to pay for the boilers, taking the position that the plaintiffs, as manufacturers, should have taken the character of the water to be used into consideration when they manufactured the boilers. In other words, that since the plaintiffs knew the character of the water that would be used in the boilers, they impliedly warranted the fitness of the boilers for its use in the heating of the defendant's hotel.

In reply to this, the plaintiffs denied the making of any warranty whatever in respect to fitness. They pointed out that the defendant had ordered a definite type of boiler which had been furnished in strict compliance with the terms of the contract. That the question of whether or not the boilers could be successfully operated with the muddy Missouri river water was not discussed. In view of which, the plaintiffs contended that the defendant had assumed the risk involved in the use of this water in the boilers.

The parties failed to adjust the dispute between them and the plaintiffs filed suit to collect the price of the boilers. The lower court found in favor of the plaintiffs and gave them judgment for the amount involved. The defendant appealed from this and the higher court in stating the general rules in situations of this kind said:

The Language of the Court

"Where a manufacturer contracts to supply an article which he manufactures to be applied to a particular use of which he is advised, so that the buyer necessarily trusts to the judgment and skill of the manufacturer, there is an implied warranty that the article shall be reasonably fit for the use to which it is to be applied. . . .

"But when a known, described, and definite article is ordered of a manufacturer, although it be stated by the purchaser to be required for a particular use, yet if the known, described, and definite thing be actually supplied, there is no implied warranty that it shall answer the particular purpose intended by the buyer. . . ."

Following the foregoing statement of the general rules, the court turned to the record of the instant case and in applying them thereto, among other things, said:

"Here the purchaser [defendant] contracted for a definite, well-known kind of boiler. . . . The specifications as to size, form, material and every detail were minute and embodied in the contract. The manufacturers [plaintiffs] were obligated to deliver exactly such boilers as were described and contracted for and could not, under the contract, deliver anything different.

"There is no claim that the boilers did not in every respect conform to this contract and specifications, nor any claim that they were defective, either in respect to workmanship or material. The purchaser did not exact a warranty that the boilers would operate with the muddy waters of the Missouri river, and therefore assumed that risk itself. . . ."

In conclusion, the court affirmed the judgment in favor of the plaintiffs for the price of the boilers. Holding, as outlined in the opinion, that there was no warranty of fitness for the purpose intended under this contract and that since the plaintiffs had furnished the exact type of boilers ordered they were not responsible for the failure of the boilers to operate to the satisfaction of the defendant.

The Boiler Maker at the Blast Furnace

(Continued from page 3)

heat liberates the iron from the ore. The gases generated by the union of the various materials ignite and impart an increased temperature to the mixture, which assists the reduction during the blow.

The melted iron ore falling upon the hearth is drawn from the furnace by means of an opening leading to the liquid metal. This procedure is called "tapping the heat" and is accompanied with great heat and considerable danger to those engaged about the blast furnace. A slip of the foot means an instant death in a fiery cauldron of molten iron. Gases, deadly or seriously injurious are present. Familiarity of the procedure by those employed reduces the number of accidents to a negligible degree.

When sufficient metal is drawn from the furnace the opening or tap hole is again closed and the operation is continued. This procedure during the night presents an appearance of a huge fiery serpent as the molten metal issues from the furnace and flows through sluice ways to the transporting receptacle.

It is in such a way that our material has its beginning. Here is the basis of our plate. Within this metal is to a great degree the strength we desire. That strength is later increased by the addition of other materials and the working of the iron after these additions have been made in the desired proportions.

A carefully finished weld will save time on a rush job as it requires less grinding or machining than a rough, although beautifully rippled weld. . . .

Wherever possible, a heavy job should be welded from both sides making a double-vee weld. . . .

Hose coiled properly and tied is easy to handle when carried out on the job.—*Oxy-Acetylene Tips.*

The Air Reduction Company, Inc., 342 Madison Avenue, New York, has acquired the assets and business of the Carolina Standard Gas Products Company, with an oxygen plant at Charlotte, North Carolina. The Air Reduction Sales Company now has the production and distribution facilities of 36 oxygen plants and 20 acetylene plants. These with warehouses give the company a total of 110 distributing points for oxy-acetylene gases, equipment and supplies.

The Delaware, Lackawanna & Western Railroad is asking prices on the following equipment:

1 42-in. squaring shears.
1 50-ton drop table, electric driven.
1 Wheel press recording gage.
2 A.C. motor driven floor grinders.
1 50-ton forging, bushing and bending press.
1 18-in. reach pneumatic yoke riveter.
1 Hose dismounting and assembling machine, pneumatically operated.
1 30-in. by 10-ft. geared heavy duty engine lathe.
1 54-in. by 30-in. by 16-ft. heavy horizontal spindle milling machine.
1 50-ton forcing, bushing and bending press.
1 42-in. vertical turret lathe.
2 16-in. by 6-ft. heavy duty geared head bolt lathes.
1 13-in. by 16-in. power hack saw.
1 48-in. radial multi duty ball bearing drill.
1 14-in. single spindle high speed ball bearing sentitive drill.
1 20-in. by 8-ft. heavy duty selective geared head engine lathe.
1 Metal band saw for cutting tool steel.
1 Flexible shaft grinder.
1 Nibbing machine and cutter.
1 100,000-lb. capacity testing machine.
1 8,000-lb. double leg guide ram steam hammer.
1 10-in. by 36-in. universal grinding machine.
1 Heavy double axle lathe 30½ in. by 9 ft.
1 Slitting shears.
1 Rotary pump for pumping oil.

Questions and Answers for Boiler Makers

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

Conducted by C. J. Zusy

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.*

Developing an Uptake Pipe

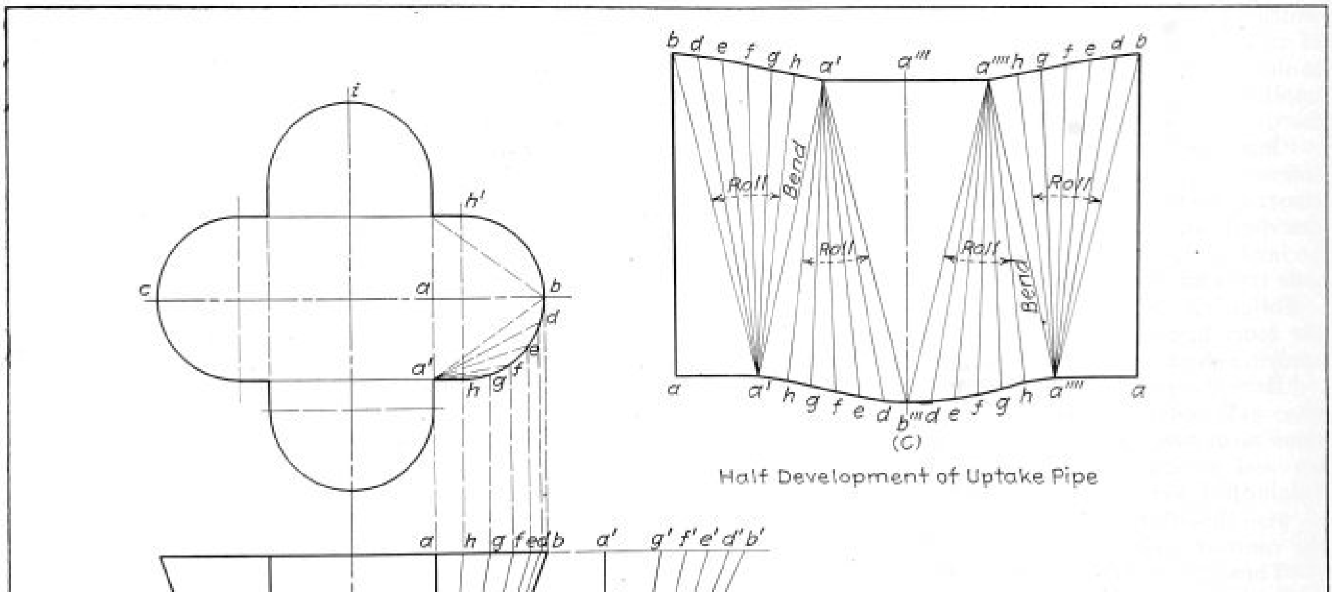
Q.—I will appreciate it if you will publish a development of an uptake pipe.—W. T.

A.—To develop the uptake pipe as shown in Fig. 1, it is necessary to draw a plan and elevation. Draw the horizontal center line *c-b* through the plan, thus dividing the object into symmetrical halves. It will now be seen that if a development is made of the lower portion as seen in the plan, a duplication of the resulting figure will be the complete development.

The object consists of four symmetrical tapered sections. The side sections as shown in the plan taper from the bottom base to the top base, while the top and bottom sections, as shown in the plan, taper from the top base to the bottom base. This being true, it will only be necessary to obtain the surface angles on half of one section, then by reversing the angles a true development will be obtained.

In order to locate the sides of the angles that are to be assumed on the surface of the object draw center line *a-b* through the plan of one section, thus dividing the section into symmetrical halves. Draw the line *a'-b* intersecting the line *a-b* at the outline of the base. The angle *a, b, a'* thus found represents the flat portion of the tapered section.

Draw the line *h-h'* parallel to the center line *i-j* and intersecting the center of the radius of the base. Divide the outline of the base between the points *b* and *h* in the plan into a convenient number of equal spaces, five in this case and letter them *d, e, f, g*. Draw lines *a'-d, a'-e*, etc. Project points *d, e, f, g, h* to the elevation and draw the lines *a'-h, a'-g*, etc. The surface of the object is thus divided into a number of triangles.



Plan, elevation and half development of uptake pipe

The chord distances *b-d*, *d-e*, *e-f*, etc., may be taken directly from the plan as they are there shown in their true length.

A construction of right angled triangles is necessary, however, in order to find the true lengths of the lines *a'-b*, *a'-d*, etc.

The heights of all the angles which it is necessary to construct, are the same, due to both upper and lower bases being parallel. Draw perpendicular *a''a'* as shown at (*a*). Project the height of the angles from the lower and upper bases of the elevation. Take the distance *a'-b*, as shown in the plan, and set it off with the dividers, as at *a'-b'*; in like manner, make *a'-d'* equal to *a'-d* as shown in the plan and proceed to copy all the distances there shown. It will be seen from an examination of the projection that the lines *a-b* and *a'-h* as shown in the plan, are shown in their full length in the elevation and a triangle is, therefore, not required for these lines.

The true lengths of all the lines now being determined, the triangles may be constructed as shown at (*c*). Draw the line *a-b* equal in length to the line *a'-a* as shown in the elevation; next, describe an arc from the point *b* as a center with a radius equal in length to the hypotenuse of the right angle triangle *a''a'b'* as shown at (*a*); intersect this arc by an arc described from *a* as a center, with a radius equal to the distance *a-a'* taken from the plan. This completes the triangle *a-b-a'*. Next scribe an arc from *a'* as a center, with a radius equal to the hypotenuse of the right angle triangle *a''a'd'* as shown at (*a*) and intersect this arc by an arc described from *b* as a center with a radius equal to the chord distance *b-d* as taken from the plan. This completes the triangle *a'b d* and the same procedure should be followed until all the angles are completed.

The development is now complete to line *a'-a'* and represents half of the tapered section from point *b* to *a'* on the plan. The next step is to reverse the ends of the angles and also reverse their order as shown at (*c*). The lengths of the sides of the angles are the same as those already developed and which bear the same designating letters. After the second set of angles is drawn, the development is completed to the center line *a'''-b'''* of the half pattern shown at (*c*). The completion of the right half of the development shown is accomplished by reversing the procedure followed for the left half of the development.

Design of Locomotive Front End

Q.—On the A. B. & A. Railroad we have had good success with a certain type front arrangement using lump coal; however, we are now using what is called washed coal and are using entirely too much coal with the front end arrangement as it is, and would like to have some information in regard to changing it.

1. Is it better to have a petticoat pipe extending up into the smoke stack?
2. How much under draft, that is between the exhaust stand and the bottom of the petticoat pipe, should we have?
3. How do you get the length of the petticoat pipe in regard to the height of the nozzle?

What I want to know is the proper way to draft an engine and I would thank you to let me have a reply at your earliest possible convenience.—W. C. H.

A.—I assume from your question that no trouble is experienced with the steaming qualities of the boiler and that the only question involved is the fact that more coal is being consumed since changing from lump to washed coal.

This excessive coal consumption may not be due to any fault in the drafting of the locomotive, but may be due entirely to the quality of the coal. Is this washed coal you are now using of the same quality as the lump coal previously used, that is, does it contain as many heat units or B.T.U's per pound of coal as fired as the lump coal? You can readily understand if the washed coal does not contain as many B.T.U's per pound as the lump coal that it will be necessary to burn more coal to produce the same results. If the washed coal is of the same quality as the coal previously used the extra consumption of coal may be due to excessive draft. The easiest way to overcome excessive draft is by enlarging the exhaust tip. This will not only reduce the draft but will also reduce the back pressure which is always desirable.

Answering your questions in the order asked:

(1) Petticoat pipes are not a part of the smokebox equipment on modern locomotives. In a series of tests con-

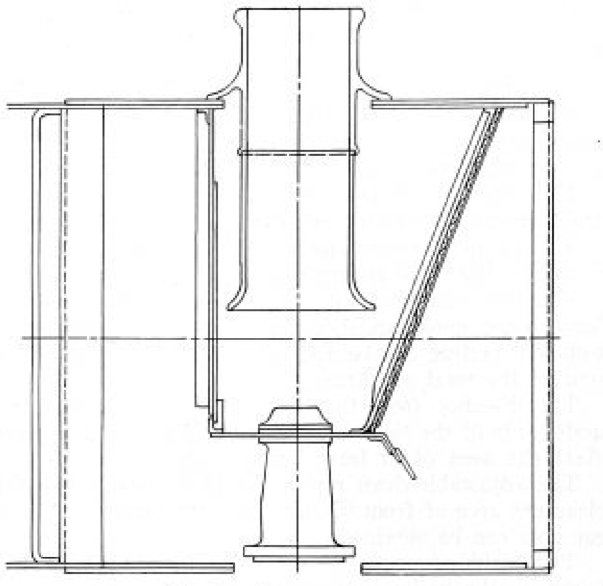
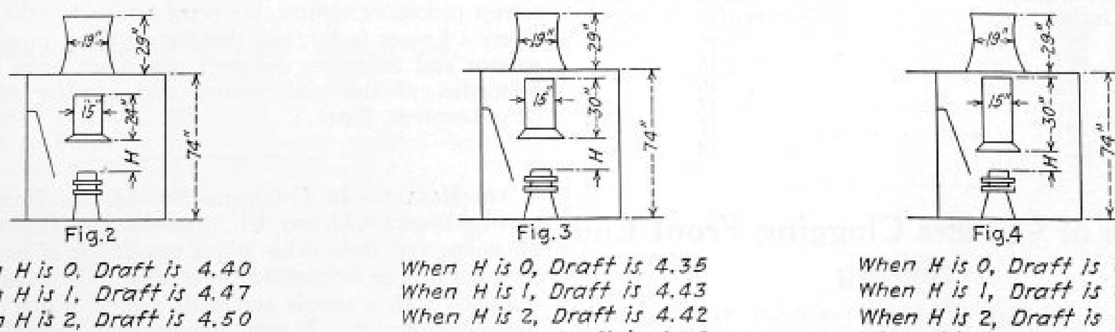


Fig. 1—Modern front end arrangement



When H is 0, Draft is 4.40
When H is 1, Draft is 4.47
When H is 2, Draft is 4.50
When H is 4, Draft is 4.40
When H is 8, Draft is 4.40
When H is 16, Draft is 4.60

When H is 0, Draft is 4.35
When H is 1, Draft is 4.43
When H is 2, Draft is 4.42
When H is 4, Draft is 4.35
When H is 8, Draft is 4.34
When H is 16, Draft is 4.50

When H is 0, Draft is 4.30
When H is 1, Draft is 4.31
When H is 2, Draft is 4.40
When H is 4, Draft is 4.30
When H is 8, Draft is 4.40

Fig. 2—Results of draft tests and front end proportions

ducted by Professor W. F. M. Goss of Purdue University in conjunction with the American Railway Master Mechanics' Association, the results of which are contained in the 1906 proceedings of that association, it was found that no combination of petticoat pipes would produce better draft than could be obtained with the use of a properly proportioned stack without the petticoat pipes. It was also found that while the presence of a petticoat pipe would improve the draft when the stack is small it will not do so when the stack is sufficiently large to serve without it.

The best front end arrangement and the one that is used on most all modern locomotives is shown in Fig. 1.

(2 and 3.) The height of the petticoat pipe above the exhaust tip or the length of the petticoat pipe is not an important factor which can be seen by reference to Figs. 2, 3 and 4 and the drafts obtained, shown below each figure, which were found by tests on boiler with front end arrangement similar to that on your locomotive.

The total difference between minimum and maximum drafts under all conditions amounted to only 0.30 inch.

The proper proportions of the modern front end as shown in Fig. 1 is approximately as follows:

The distance from the center line of the stack to the front of the smokebox should be made great enough so that sufficient netting can be applied to afford at least 125 percent of the total gas area.

The distance from the bottom of the smokebox to the under side of the table plate should be sufficient to provide clear gas area of at least 100 percent.

The adjustable draft plates should be arranged so that a clear gas area of from 60 percent to 90 percent of the total gas area can be obtained.

The inside diameter of the stack for simple engines is based on the boiler horsepower as follows:

Diameter of Stack Inches	Boiler Horsepower Superheated	Saturated
16	1,750	1,420
16½	1,940	1,570
17	2,140	1,740
17½	2,370	1,920
18	2,610	2,120
18½	2,860	2,330
19	3,140	2,550
19½	3,440	2,790
20	3,760	3,060
20½	4,100	3,340
21	4,460	3,630

The height of the stack above the smokebox should be as great as clearances and appearance of locomotive will permit.

The distance from the top of the exhaust nozzle to the bottom of the stack extension should be approximately as follows:

Diameter of Stack Inches	Distance from Top of Nozzle to Bottom of Stack, Inches
16	15
17	16
18	16
19	17
20	17
21	18

Causes of Cinders Clogging Front End Setting

Q.—I would like to have you through THE BOILER MAKER give me the reasons to the best of your ability as to what makes a locomotive plug up the front end nettings with cinders so as to kill the draft.—G. K.

A.—The condition which most generally causes plugging of front end netting, is small steam leaks in the front end, that is, steam leaks not great enough to destroy the vacuum but just sufficient to keep the netting damp causing small particles to adhere to the netting and gradually building up until the openings are entirely closed.

Other contributing causes are:

Insufficient draft.

Coal containing too much moisture, small particles of which partially burn in suspension and are carried through the tubes to the netting resulting in similar conditions as are caused by front end steam leaks.

Coal high in hydrocarbons which, when the coal is heated, are driven off in the form of a semi-liquid tarry substance which adheres to the netting and acts the same as front end steam leaks.

Netting with mesh too fine.

A Known Factor of Safety

As part of a description of the latest developments in construction of pressure vessels by oxy-acetylene welding, the tests to which a series of tanks were subjected after completion were described before the annual meeting of the International Acetylene Association in Chicago on November 17, 1927. It was planned by these tests to prove the correctness not only of the technique and workmanship but more especially of the design of these heavy containers. The tanks were made of 1¼-inch steel plate for a designed working pressure of 300 pounds per square inch.

On completion of each tank it was first given a hydrostatic test of 600 pounds per square inch (twice the designed working pressure). At this pressure all the welded seams were hammered with a 12-pound sledge. The pressure was then increased to 900 pounds per square inch (three times the designed working pressure) and held there for a given period of time.

Under this test pressure the theoretical maximum fiber stress would be about 27,000 pounds per square inch, or about 60 percent more than that called for in any existing codes for pressure vessel construction. During these tests strain gage measurements were taken at various points on the tank, which showed that this fiber stress was not exceeded appreciably even at the usual points of high stress concentration. Following completion of the hydrostatic tests the vessel was subjected to an air pressure of 450 pounds per square inch. While under this pressure all welded joints were tested with soapy water and not a single leak was indicated.

These tests were based on the desire to put into service tanks built with the *known* factor of safety of three, assured under proof test.

With tanks, pressure vessels, steam pipe lines or other construction where stress is carried by a joint, built under procedure control methods and tested in accordance with correct procedure control, the proof test makes the factor of safety a known factor; one that the designer, purchaser, inspector and insurance company can count upon as a true indication of the performance that can be expected.—*Oxy-Acetylene Tips.*

AIR HOISTS.—In Catalogue No. 15, the Hanna Engineering Works, Chicago, Ill., discusses the Hanna patented air hoists and their value where the lifting of loads has to be frequently or intermittently repeated. This hoist may be equipped with a simple automatic control which eliminates manual operation. It may also be used portably by suspension from an I-beam trolley running on an overhead rail, or it may be mounted in a fixed position. Details and illustrations of the various size and type air hoists and their operation are included in the catalogue.

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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.
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Maryland	Oklahoma	Wisconsin
Minnesota	Oregon	

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
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Memphis, Tenn.	Philadelphia, Pa.	Tampa, Fla.

SELECTED BOILER PATENTS

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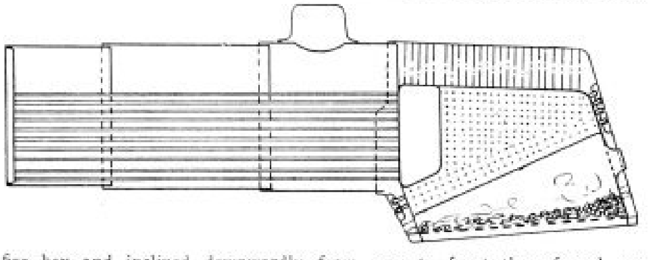
DWIGHT B. GALT, Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,644,463. JOHN B. BROWN AND JOHN P. KANE, OF PORTLAND, OREGON. LOCOMOTIVE-TYPE BOILER.

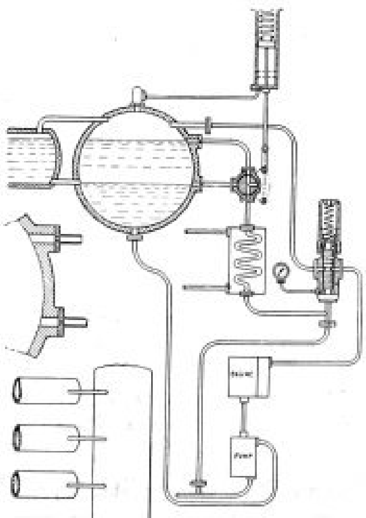
Claim—In a fire box for a locomotive type boiler, said fire box having inner sheets embodying a flue sheet, a crown sheet and a door sheet with an outer shell embodying a throat sheet and a boiler head, said outer shell cooperating with the inner sheets to form water spaces, the combination of a hollow water circulating element disposed longitudinally of the



fire box and inclined downwardly from rear to front thereof and connected to the crown sheet, the door sheet, and the flue sheet, and opening into the water spaces defined by all of said sheets, said water circulating element having spaced stayed walls, a plurality of staying means rigidly secured to the inner walls of the element at the front and rear and having elongated holes provided in their outer ends, a plurality of T irons rigidly secured to the outer sheets cooperating with the flue sheet and the door sheet opposite the open ends of the element, means connecting the staying means to the T irons through the elongated holes, and means rigidly connecting the water circulating element to the crown sheet, the flue sheet and the door sheet. Five claims.

1,646,945. FRIEDRICH WEMPE, OF CASSEL-WILHELMSHOHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT M. B. H., of CASSEL-WILHELMSHOHE, GERMANY, A CORPORATION OF GERMANY. METHOD OF AND APPARATUS FOR AUTOMATICALLY REGULATING THE WATER LEVEL IN STEAM BOILERS.

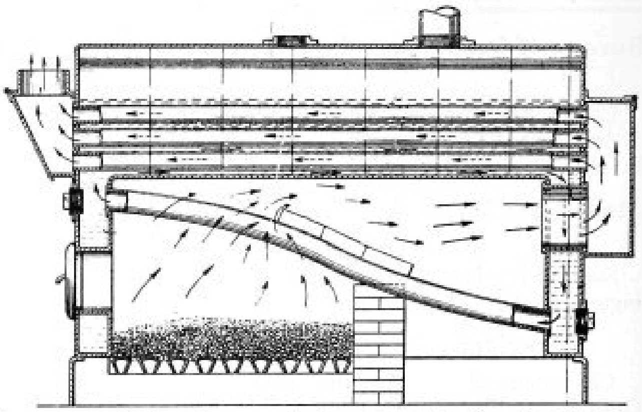
Claim—Method of automatically regulating the water level in steam boilers in which the water level fluctuates between a high and a low level



comprising checking or shutting off entirely the feed on an increase of load, utilizing the storage capacity of the space between the highest and lowest water levels by lowering the water level, maintaining the highest water level as the normal one, and using the boiler pressure as the regulating agent for the latter purpose. Nine claims.

1,642,692. CASIN W. OBERT, OF MOUNT VERNON, NEW YORK. STEAM BOILER.

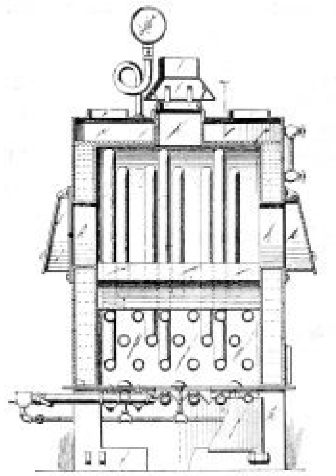
Claim. A steam boiler comprising: a tubular boiler proper; a front water leg and a rear water leg arranged at and substantially flush with the front end respectively with the rear end of the tubular boiler; a crown sheet on the tubular boiler; a plurality of comparatively narrow tubes for the combustion gas extending through the tubular boiler above the crown sheet; a fire box below the front end of the crown sheet; a combustion chamber below the other end of the crown sheet; a gas reversing box extending outside of the rear end of the tubular boiler and communicating with the before-said gas tubes; a passage through the rear water leg, connecting the combustion chamber with the gas reversing box; a gas collecting chamber at the front or exit end of the gas tubes at the outside of the tubular boiler; a single row of spaced comparatively large water circulating tubes, connecting the lowest part of the rear water leg with the upper part of the front water leg and passing through both the fire box and the combustion chamber; a separating wall between the fire box and the combustion chamber extending from the ground up to the row of water circulating tubes; a firebrick arch extending from the separating wall along the upper side of



the water circulating tubes upwardly for a limited length, adapted to force the flames of the fire box against the uppermost part of the water circulating tubes and to reflect some heat back to the fuel on the furnace grate.

1,638,163. HARRY G. KRAUS, OF ORANGE, NEW JERSEY. BOILER.

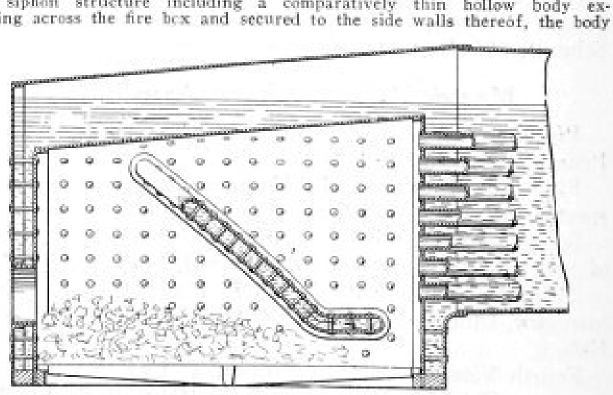
Claim 1. A boiler comprising a main casing having spaced outer and inner walls forming a water chamber between them and a water tube chamber within said inner wall open at the lower end, a plurality of spaced and substantially parallel water tubes each having one end com-



municating with the lower end of said water chamber at one side of said casing and its other end communicating with the upper end of said water chamber at the opposite side of said casing, each of said tubes having the lower portion intermediate its ends extending substantially horizontally across said water tube chamber and the other portion substantially vertically, and heating means at the lower end of said water tube chamber. Six claims.

1,646,304. GEORGE D. McLEOD, OF CHICAGO, THEODORE F. POKORSKI, OF CALUMET CITY, ILLINOIS, AND THOMAS J. HEWITT, OF HAMMOND, INDIANA. STEEL WATER ARCH AND SIPHON.

Claim. In combination with the fire box of a boiler, a combined arch and siphon structure including a comparatively thin hollow body extending across the fire box and secured to the side walls thereof, the body



being inclined downwardly toward one end of the fire box and being provided at its lower end with an extension disposed approximately horizontally, the body being provided at its upper end with lateral extensions opening through the crown sheet of the fire box, the body and the extension thereof opening through the side walls of the fire box. Three claims.

The Boiler Maker

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Contents

Meeting of Boiler Manufacturers

THE winter meeting of the American Boiler Manufacturers' Association, which was held February 7 at the Hotel Cleveland, Cleveland, Ohio, constituted the regular business session of the association which occurs each year at about this time. The activities at the annual meeting last June were considered and reports were submitted by the standing committees.

An important feature of the meeting was the talk by President S. H. Barnum, outlining the value of reports to the United States Department of Commerce as applied to the sales of the member companies. A special report by the committee on heating boilers was made. The question of adopting a symbol or trade mark for the products of the industry was considered as well as other matters of interest to the field in general.

A full account of the meeting will appear in a later issue of this magazine.

Boiler Shop Kinks Contest

DESCRIPTIONS of so many excellent devices and methods were received from shops all over the country as a result of the boiler shop kinks contest which closed January 20 that it will not be possible to announce the winners of the contest in this issue as planned.

The judges are carefully examining each kink submitted at the present time and it is expected that a decision will be reached so that the winners may be announced in the March issue of THE BOILER MAKER. The prize winning articles will also be published in that issue and all other descriptions that qualify, explaining good useful devices in all lines of boiler making, will appear each month until the last one is used.

As noted, the results of the contest have been gratifying and when the articles are published the information is bound to be of great practical value to all of our readers. The competition, as is the case with most affairs of the kind, stimulated men with ideas and belief in the value of the things they had developed to write them up and to submit them to the magazine with the hope of winning an award. Unfortunately only three individuals will be awarded the main prizes, but in addition all other kinks having merit will be paid for at full magazine rates at the time of their publication.

Now that the contest is completed, however, men who are interested in their work can still prepare kinks and submit them, because the feature is one of great value in the magazine and of material help to every man in the field. The pages of THE BOILER MAKER are open at all times to readers who have something of value to tell their fellow craftsmen and it is the sincere wish of the editors that all interested will continue to send in boiler shop kinks from time to time for publication.

Developments in the Boiler Industry

THE TREND in modern boiler construction in this country, as outlined in the article on "Characteristics of Modern Boilers" appearing elsewhere in this issue, indicates the stage of development through which the industry is now passing. Although the majority of boilers being built is still within the range of moderate pressures, nevertheless a number of concerns are becoming active in the field of high pressures.

The inroads made in the steam power plant field by the Diesel engine industry have been largely responsible for the improvement in efficiency and the wider use of the turbine plant. The concentration of high power in the form of turbine units of small size has in turn led to the necessity for supplying tremendous amounts of steam by generators of a minimum size. In addition, the turbine users have demanded higher pressures and steam temperatures to keep pace with improvements in the prime movers. Combustion efficiency has also improved and such equipment as pulverized coal burning apparatus has been adopted to still further promote efficiency and low cost of operation.

The pulverized coal burner is now being perfected for use in the Scotch marine boiler, the first trial installation having proved successful on the steamship *Mercer*, operated by the United States Shipping Board. In the same field a number of ships equipped with watertube boilers fitted to burn pulverized coal are now being planned for immediate construction.

A still further development of the past few years, in the form of a mercury type boiler, which has proven successful in power plant practice at several trial installations ashore, is now to be developed for marine work.

In the railroad field the activity in the design and construction of watertube locomotive boilers is well known. As time goes on more and more locomotives equipped with this type boiler will be put into service.

All of these developments indicate that progress is not at a standstill in the boiler industry and that as other forms of power have advanced, so too have improvements in steam generating equipment been made. Methods of manufacture, tools and equipment have all kept pace with the general advance.

For the past few years the personal element in this development has not fared as well. The manufacturers of boilers of all types have not prospered and the general slump in this field after the war has affected a great many men who make up the production personnel of the industry. There are indications that the present developments will rapidly bring about a renewal of vitality in the boiler making trade, however, and plans for the expansion of foreign markets are now under way.

The present period seems to be one of transition from the old methods of steam generation to the new. The men who take advantage of every possible means of studying the trend in the development of new types of boilers and become familiar with the requirements in connection with their construction will be best fitted to assume advanced positions in the trade as time goes on. In every line of endeavor, study and the application of knowledge to everyday work, brings advancement. Such an opportunity is before many of our readers and we recommend that they follow closely all matters dealing with the development of the boiler types of the future.

Communications

Basic Principles

TO THE EDITOR:

Basic principles are always the same. You may sometimes feel that your problems are "entirely different" and peculiar to your own plant. But not so. A heat unit in your plant is the same as a heat unit in a perfume factory. A degree Fahrenheit is the same everywhere. Water has the same characteristics at the equator as at the north pole. A boiler is a boiler whereever placed. Hence it is well to take an interest in power plant problems everywhere. Perhaps the engineer in some perfume factory has solved your own peculiar problem. It pays to broaden out and look through the other fellow's plant whenever possible. It pays to attend such a show as the recent Power Show in New York which was largely a display of basic principles. Another show will be held in Chicago this month. Attend it if possible.

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

All Watertube Locomotive Boiler Design

TO THE EDITOR:

In the December 1927 issue of THE BOILER MAKER, L. A. Rehfuss goes to more or less trouble and expense to put out a boiler design that in my personal opinion is of the same order as the Vanderbilt firebox; because in the first place, the demand for new designs calls for the increasing of the power of the locomotive unit as a whole. If a new design for 500 or 600 pounds per square inch of boiler pressure, weighs more per horsepower of locomotive than the cylinder type of fire tube boiler for 200 pounds, it is not worth working on. What the traffic men demand is high power at high speed on limited wheel loads.

The comparative cost is a secondary consideration and is not taken seriously in this survey.

Expansion stresses, mud pockets with no chance for blow-offs, inefficient arrangement of parts, limited water level surface to liberate dry saturated steam, and staybolts in high pressure service are minor objects of security compared to the lack of volume of water between the high and low water level limits in a boiler that must stand the test of service in a rolling region where the treating of feed water may not be 100 percent.

A still more potent point is the problem of chasing a "go-devil" through all of the watertubes in a roundhouse with the clear blue to attach the hoist onto when the lid is to be taken up for the exposure of the plugs that must be unscrewed to get at each individual tube.

These comments are not inserted as sarcasm, but to impress one with what the washout man is up against when he gives the labyrinth the monkey wrench and the hose. Everyone knows the cost of keeping motive power in the shops and round house and the consequent pyramiding in fixed charges on rolling stock buildings and other facilities.

I look upon Mr. Rehfuss in a very kindly light and know that he has gone a long way in the direction of forcing progress on a business world that has a Missouri mule beat a hundred ways for long-eared cussedness.

The writer has been sketching watertube locomotive boiler designs for pastime and tearing them up periodically since 1896 and is not making any criticism of what he sees as weakness in the design under discussion without being competent to substitute a construction that corrects the faults as mentioned.

In passing, it may be mentioned that no one would ever trace any relationship between his design as published and mine.

Sioux Falls, S. Dakota. F. H. Lacey.

High Pressure All Watertube Locomotive Boiler Design

To The Editor:

The comments of F. H. Lacey on the all-watertube locomotive boiler, proposed by the writer and published in the December, 1927 issue of The Boiler Maker are very interesting and illuminating. In writing that article I was hopeful that some such criticisms might be forthcoming, as it is only in this way that progress may result. Naturally it is difficult in the space at one's disposal to cover all points thoroughly or even to make what is discussed entirely clear. I am glad therefore to be able to throw a little more light on the objections urged by Mr. Lacey. Let us take them in their order.

(1) *Horsepower per unit of weight*: I find on looking over the article mentioned that I discussed the weight of the proposed boiler as compared to a boiler of "about similar power" of firetube design. This is a mistake. The phrase should have been "about similar over-all dimensions." I have since figured this question of the power to be expected from the proposed 500 pound pressure all-watertube design more in detail and may say that compared to a 200 pound firetube boiler of approximately similar over-all dimensions, the calculations show a gain in power of 23 per cent, a gain in coal economy of 18.75 per cent, while the gain in power per unit of weight of the filled boiler becomes 17 percent in favor of the watertube design.

(2) *Expansion stresses*: I do not think that any portion of the proposed boiler is subject to the same expansion stresses as are met in the firetube boiler. In the latter an unbroken line of 22 feet of tubes and 16 feet of crown sheet, or close to 40 feet of hot metal is held rigidly within a colder outside shell not subjected to the heat of the fire. If each foot expands 1/32 inch, the overall expansion would be over one inch. What holds it? Only the flexibility of the staybolt structure and tube sheets and the sagging of the tubes. In the proposed boiler the only members capable of extensive expansion are the longitudinal drums, which are not subject to excessive heat and which are not limited particularly in expansion, as far as we can see.

(3) *Mud pockets with no chance for blow outs*: I presume Mr. Lacey refers to the cross tubes at the bottom of the combustion chamber. There are, however, washout plugs located opposite the ends of these tubes.

(4) *Inefficient arrangement of parts*: Not knowing exactly to what the objection is raised, no comment will be made.

(5) *Limited water level to liberate saturated steam*: By our calculation we have 150 square feet of water level to liberate saturated steam (exclusive of steam drum surface, but inclusive of the headers), which is about 60 per cent of that in a normal firetube boiler. Owing to the fact that 500 pounds steam has a volume only 42 per cent as much per pound as 200 pound steam, we do not consider the proposed design at fault in this connection.

(6) *Staybolts in high pressure service*: This criticism, referring to the staybolted backhead, is justified. We have a sketch of a tubular backhead, which would be incorporated in any new design.

(7) *Volume of water between high and low water levels*: If the volume of water between the high and low water levels were restricted to the ordinary water glass limitations such as it is in the firetube boiler, we would agree with Mr. Lacey on this criticism. However as I explained in the article discussed, the range of water level is capable of a wider variation than it is in firetube boilers where the crown sheet must be protected at all times. In the proposed design a range of 15 inches in water level should be possible with perfect safety (which leaves the crown still covered).

(8) *Boiler top cover*: The reference to the removable cover over the top headers can be easily taken care of by making this in sliding sections so that it would not have to be lifted.

(9) *Plugholes for Cleaning*: The objection to plugholes for each watertube is well taken. In one modification of the proposed design, I have used headers carrying a double row of staggered tubes, slightly bent at the ends where they enter the headers in such a way that one large handhole serves each group of three inclined tubes. The cleaning problem is best taken care of in my opinion by incorporating a feed water purifier as a boiler accessory. In Hungary such a device lengthened the time between washouts from 5 to 54 days. The vigorous water circulation, promoted still further by the unit headers, which split the stream up into many small currents, is our final insurance against the cleaning evil.

In conclusion, I am glad that Mr. Lacey has enough faith in the watertube principle to admit that he has a design of his own. Without ever seeing it, I have no doubt that it is full of possibilities, however widely it may differ from my own. I say this because there are few problems that are not capable of several angles of approach.

Philadelphia, Pa. Louis A. Rehfuss.

Steel Plate Leveling

To the Editor:

The British locomotive has always been admired for its design from an artistic standpoint: neatness, finish, everything that tends to make an engine resemble an object of beauty instead of merely a jumble of machinery and rivets. One of the things to be admired is the finish given to the side tank plates, cab sides and tender side plates, whichever type of engine it happens to be.

We will imagine a large tank engine, the side tank and bunker outside plates, are perfectly dead level, all rivets chipped flush and filed, giving a beautiful surface on which the painter can fix his color. These outside plates which may be anything from 12 feet to 20 feet in length and about 4 feet to 5 feet in width by ¼ inch thickness, have to go through the process of flatter leveling. Let us imagine one of these plates just issued from the stores. We lay it upon the slab in front of the leveling rolls, the plate is buckled badly; a series of waves extend throughout its entire length. We run it through the rolls, giving the plate a thorough flattening and then, placing it back on the slab, we find that one edge has at least 4 inches more material than the other. The rolling has simply straightened the plate, and before we can hope for it to level out, the tight portions of the plate will have to be stretched under the flatter.

Finishing the Plate

We have two mates striking with 7-pound hammers on the flatter, up and down zig-zag on the plate, strictly avoiding the loose parts, slowly but very slowly the plate stiffens under the movement. "Oh to use the bare hammer" that would shift it quicker, but then the bruise would show as soon as the plate was varnished. No hammer marks, they are a crime. The plate is re-rolled after a certain amount of stretching has been done, but until the plate is perfectly level when stood up on edge, the flattering is continued. There is no royal road to plate stretching; no two plates are alike. Sometimes the plate is buckled in the center, then the plate will have to be stretched all around the edges until the buckle is dispersed. If the plate is loose, or buckled on the edges, then the center must be stretched to tighten the plate, or there may be a series of small buckles, then the surrounding metal will have to be treated in the same manner. Patience, and keeping an even blow on the flatter are the secrets of plate leveling.

Sussex, England. C. H. Wapham.

Spacing Damper Frames

To The Editor:

I am going to explain the easiest and quickest way of finding the centers for three dampers in a frame that lap over each other and have the correct clearance to suit, as shown in the accompanying illustration. I know this will be appreciated by many layerouts. As it is now, layerouts and even draftsmen find it quite

Method of damper frame spacing

a problem to get the centers easily and quickly. I have worked this problem out very satisfactorily.

For example—this frame is 5 feet 7 5/16 inches. Divide 67 5/16 inches by 3 spaces. This will be 22 7/16 inches. Now take off 3/4 inch from 22 7/16 inches and you will have 21 11/16 inches for centers.

This has been proven to be accurate in every case, no matter what dimensions the frame may be.

Philadelphia, Pa. Harry F. Fisher.

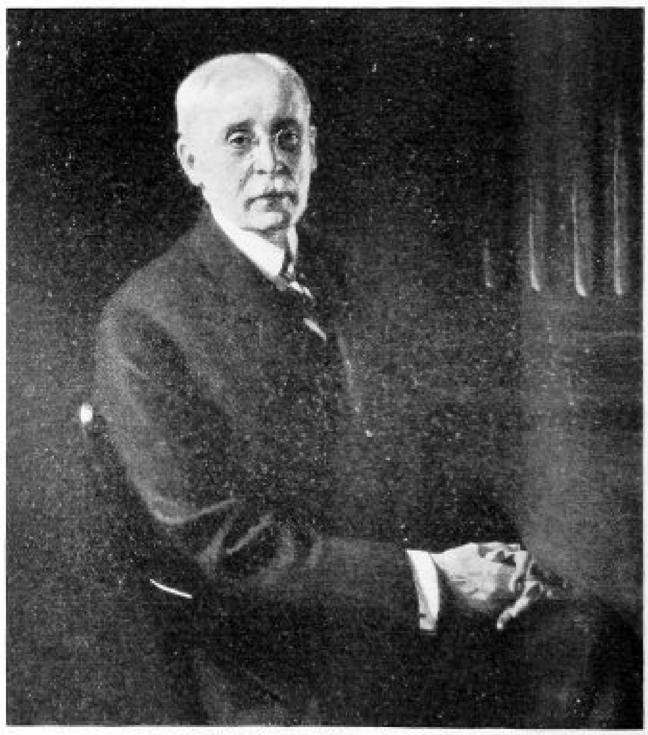
Boiler Plant for British Power Station Has New Features

The outstanding feature of the boiler plant of the new Kirkstall electricity station at Leeds, England, is that boilers of the forged steel drum type are to be used, but having riveted ends, for a pressure of 490 pounds per square inch. These are to be made locally, British makers now being definitely in the business of making thick steel boiler drums from the solid ingot. Over 600 of these drums have already been made in Germany, principally from Krupp nickel steel, 2½ inches to 4 inches thick.

The contract for the equipment of the first section of the boiler house includes three large Stirling type watertube boilers, having a normal evaporation of 160,000 pounds of water each per hour, operating at 490 pounds pressure and 750 degrees superheated steam temperature, fired throughout by pulverized fuel. Each boiler will have feed water economizers, air heaters, dust extraction apparatus, induced draft, and short steel chimneys.

E. L. Ryerson Dies

EDWARD L. Ryerson, chairman of the board of directors of Joseph T. Ryerson and Son, Inc., died at his home in Chicago on January 19. He was born at Chicago in 1854 and graduated from Yale University in 1876. Since that time he has spent his entire active life in the iron and steel business established by his father. In 1878 he was made a partner and in 1883 upon the death of his father, Mr. Ryerson



Edward L. Ryerson, Sr.

succeeded him as head of the business which was founded in 1842. In 1888 when the business was incorporated he became the first president which position he held until 1911 when he retired to become chairman of the board of directors. Through his efforts the firm, which was one of the first iron and steel jobbers, has grown to be the largest independent steel service organization in the country, with plants in eight cities. Among his other activities Mr. Ryerson was a director and member of the executive committee of the Illinois Merchants Trust Company and an active worker in the civic and cultural life of the city.

Staybolt Production in Railway Shops

The Proper threads, inspection system, gages, fixtures and machines best suited for this work

Part I

IN the minds of many railroad men, it is a question as to whether staybolts should be purchased or manufactured in the shops. It is doubtful, however, if the manufacture of staybolts in railway shops will ever be entirely abandoned, owing to the many diameters and lengths demanded on short notice in locomotive repairs. A skeleton organization, at least, must be maintained for this work. The question of purchase, ordering from a central shop or local manufacturer, must, from necessity be determined by each railway.

There has been considerable discussion as to the most desirable shape of thread, the best practice for measuring the diameter of the threads and the permissible error of lead of the staybolts. As the above factors govern largely the commercial manufacture, the question of gages and devices will first be considered.

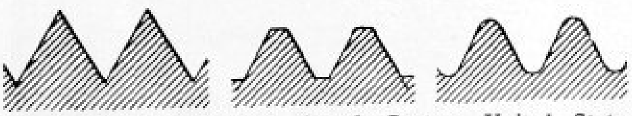


Fig. 1—Left: Sharp vee thread—Center: United States Standard thread—Right: Whitworth standard thread

Shape of Thread

Staybolts are made with either one of three forms of thread shown in Fig. 1. The sharp vee thread is supposed to have a nearly or entirely sharp top and root. The U. S. form of thread has the top and root flattened one-eighth of the pitch. This form is almost universally used in this country for bolts and screw threads. The Whitworth form of thread has a rounded top and root, which is the English standard. It is a question if any person other than the most expert can tell from the appearance which of the three thread forms has been aimed at when the staybolts are cut with regular commercial bolt cutting chasers.

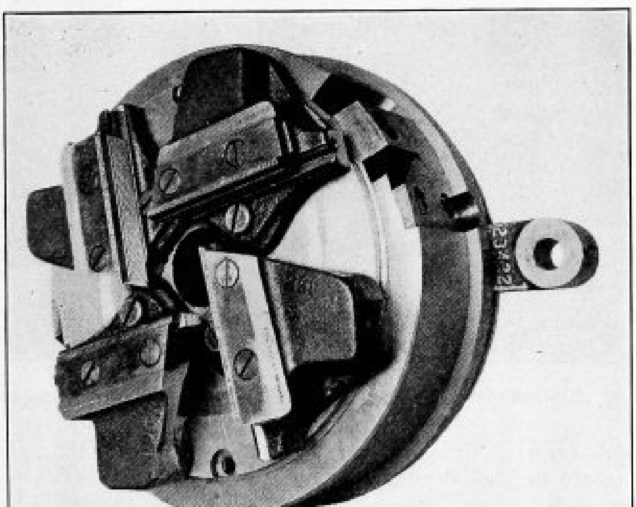


Fig. 2—Reverse taper die lead and chasers for cutting threads on staybolts

The vee threads are supposed to have a sharp or knife edge at the top and root and a 60-deg. included angle. In actual practice, the sharp top and root can not be maintained owing to manufacturing difficulties. If it were possible to make the chasers to the theoretical shape, the sharp top and root are not obtained when threading owing to the metal dragging during this operation. Therefore, the thread will more nearly resemble the Whitworth form. As there is no standard for pitch diameter of the vee form of thread, this form is gradually being done away with.

The U. S. form of thread theoretically has a flat top and root measuring one-eighth of the pitch and a 60-deg. included angle. The amount of flats for 12 threads per inch is .0104 in. or practically .010 in. A glance at a scale graduated to 100 divisions per inch or, if not at hand, a 1/64 in. scale equalling .0156 in., will serve to illustrate the small amount of the flats. It is a question if staybolt threads in actual every day practice are ever cut to the true U. S. form, owing to the metal dragging and producing a rounded top and root.

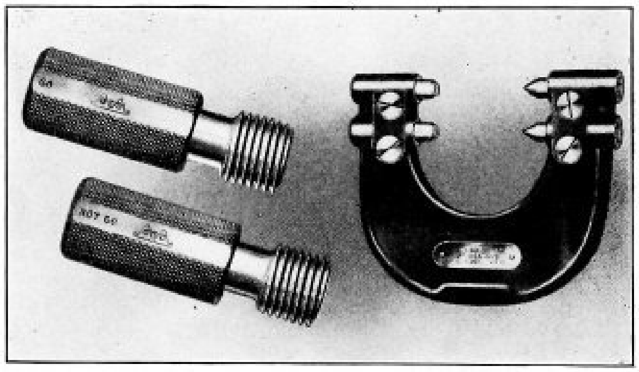


Fig. 3—A Greenfield thread limit gage and master gages used for the inspection of staybolts

The Whitworth form of thread is rounded on the top and root and has a 55-deg. included angle. With this form of thread, a staybolt may be cut closer to the prescribed form and, from a strictly theoretical point of view as far as the shape of thread is concerned it is satisfactory. However, from a staybolt manufacturing point of view it has certain objections owing to the difficulty of manufacturing the taps and dies to the correct shape.

From the above it is evident that staybolts cut to either of the three forms of threads will have similar appearances, Therefore, the form more suitable from a bolt shop, boiler shop and a tool room point of view, should be selected.

The U. S. form of thread is gradually replacing all other forms for staybolt work as it has the following advantages in its favor:

(a) The pitch diameter standards are well established.

(b) It has the approval of the tap manufacturers and the Thread Commission of the United States Department of Commerce.

(c) The thread sizes are quickly measured, making it economical to measure staybolts whether made by the railways or purchased.

(d) By adopting one standard it reduces the varieties of staybolts carried in stock by manufacturing concerns, therefore encouraging their manufacture by outside concerns.

(e) It reduces the staybolt taps to one common form of thread, making it possible for the manufacturers more quickly to fill orders.

Pitch or Lead of Thread

Twelve threads per inch is the generally accepted standard for staybolts. There has been considerable controversy as to the amount of deviation that should be allowed for a true 12-thread-per-inch lead. Some railways insist on great accuracy and demand that all staybolts be cut on machines equipped with lead screws similar to the lead screw on laths to insure correctness. Others are willing to rely on the chasers for the correctness of the lead. It is not the purpose of this article to go into the question of the allowable error in the lead of staybolts. An investigation will generally reveal the fact that the lead for the tapping of boilers from the outer to the inner sheets is subject to so many variables that reinforcements of the thread lead to staybolts is largely lost. For instance, it is the practice,

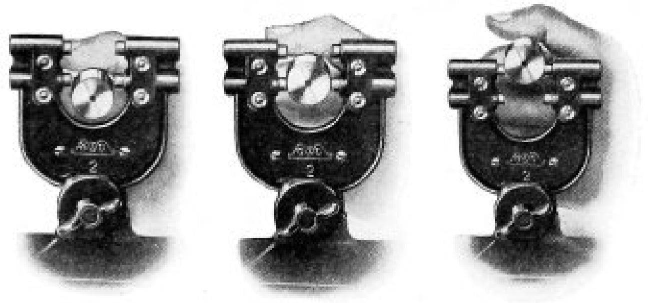


Fig. 4—A Greenfield limit gage held in a vertical position to gage the bolt by its own weight

when tappingboilers, to drive the staybolt taps with air or electric motors which may be held at any angle. When tapping downwards, the weight of the motor is on top of the tap which tends to spring or move the first sheet towards the second. At other times the conditions are reversed. One gang of men will apply more pressure, others less, springing the sheets in different amounts. The firebox is often only temporarily held in place where a slight irregularity in the method of tapping affects the lead of the tapped holes. All these varying conditions tend to destroy the accuracy of the lead between the two sheets. Under most conditions even where the entire boiler is tapped with the same tap, the lead from the outer sheet to the firebox is not the same for all holes. It would, therefore, appear that too great a refinement in correct thread pitch lead of the staybolts is largely lost owing to incorrect tapping of the boilers. It is, therefore, believed that where the staybolts are threaded with chasers in good repair, they will meet all conditions as far as the threads per inch is concerned.

Error in the Lead of Staybolt Taps

As a general proposition, when manufacturing staybolt taps, the greatest cause of error in the lead results from the hardening which is a condition difficult to control owing to different steels not acting alike during the operation. The manufacturers in conjunction with the Department of Commerce have set .003 in. as the maximum allowable error in the lead for each one-inch of tap. This limit is readily lived up to. To ask for a greater refinement only adds to the cost without compensating advantages.

Errors in Staybolt Threading

When threading staybolts without the use of lead screws the most common errors in the lead may be caused by the following:

(a) Incorrect closer leads, which may have been caused by defective hobs used when hobbing the chasers, or during the hardening operation.

(b) Chasers that have been ground too far back from the throat, allowing only a few threads for leading the bolt.

(c) Carriages on bolt threading machines for holding the bolt too heavy, or not working freely on the ways, causing the bolt to drag and increase the lead.

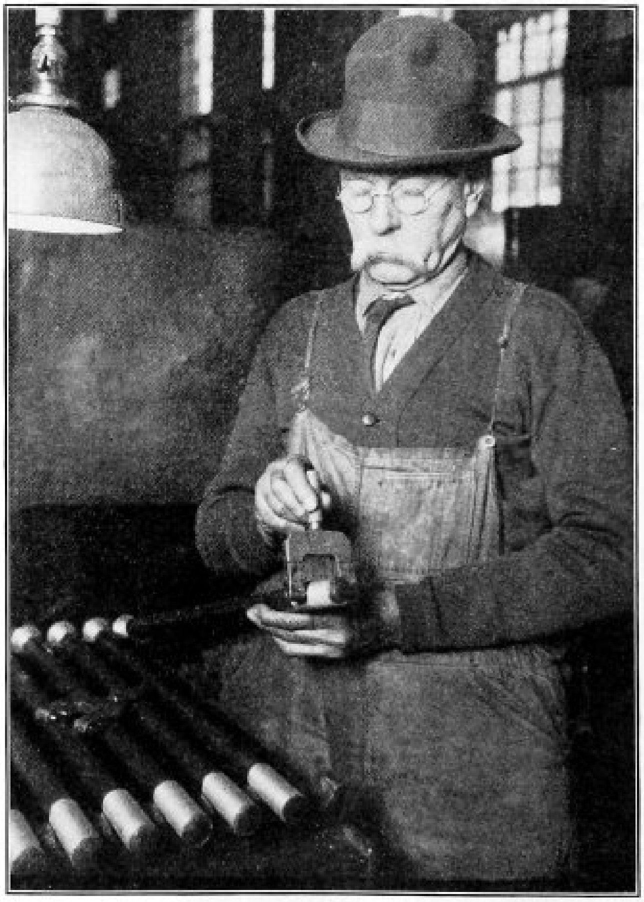


Fig. 5—Inspecting staybolt thread sizes with limit gages

A remedy for the first trouble is to insist that all chasers be held within the maximum error of .003 in. per inch of tap. A general remedy for the second is to use only full width chasers. When it is necessary to sharpen the chasers, grind only on the face or ends and do not reduce the width. In many respects chasers as shown in Fig. 2 with the threads milled on their sides are more desirable for staybolt work owing to the fact that they may be ground without altering the shape of the cutting edge, also the rake of the cutting edges can be ground as best suited for the metal to be cut. For bar iron, the front rake may be seven degrees, for soft steel possibly ten degrees.

Economical manufacture, ease of applying and satisfactory service has shown that staybolts should be threaded close to standard sizes and within certain limits in order to admit of applying any bolt of the same nominal diameter to any tapped hole of the same nominal diameter. To set the limits too close adds to the cost of manufacture. The absence of proper limits results in the improper fitting of bolts. The happy medium is limiting the sizes close enough to meet the requirements without throwing too great a burden on the shops when inspecting or adjusting the chaser dies. Furthermore, the shops should be provided with gages by which the thread sizes of the bolts may be gaged in the minimum time. The practice in some railroad shops is to gage each individual bolt at the time of manufacture and a second time by the bolt inspector. This practice results in maintaining thread sizes which

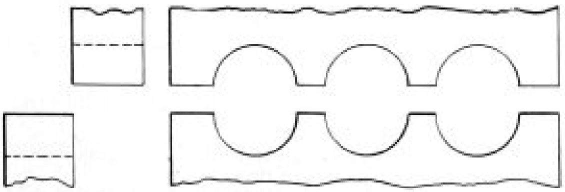


Fig. 6—Staybolt blanks are sheared at each end with these dies

admits of applying the bolts in any shop on the system. This practice is essential for central production shops.

Gaging the Pitch Diameter of Staybolts

It is now universally recognized and approved by The Bureau of Standards that the only correct method for measuring the diameter of threaded articles is on the pitch line. (The term pitch line, or pitch diameter indicates a line about midway between the top and root of the thread.) The pitch diameter for each diameter of bolt threads per inch are shown in numerous text books and trade catalogues. Table I shows the pitch diameter for 12 thread U. S. form and Whitworth staybolts of the sizes commonly used.

The pitch diameter of staybolts and staybolt taps are readily measured with thread micrometer calipers. One common form is shown in Fig. 3. These instruments are useful for the measurement of all sizes of threads and should form a part of the tool room equipment of all railroad shops. Staybolts, with certain exceptions, are threaded smaller on the pitch diameter than the basic sizes shown in Table I, in order that they may readily screw into the boiler. However, no

Table 1.—Maximum or basic pitch diameter and minimum pitch diameter based on a working limit of 0.004 inch

Diameter		U. S. F. pitch dia. inches		Whitworth pitch dia. inches	
Bolt	Inches	Basic	Min.	Basic	Min.
3/4	.750	.6959	.6919	.6967	.6927
13/16	.8125	.7584	.7544	.7592	.7552
7/8	.875	.8204	.8164	.8217	.8177
15/16	.9375	.8834	.8794	.8842	.8802
1	1.000	.9459	.9419	.9467	.9427
1 1/16	1.0625	1.0084	1.0044	1.0092	1.0052
1 1/8	1.125	1.0709	1.0669	1.0717	1.0677
1 3/16	1.1875	1.1334	1.1294	1.1342	1.1302
1 1/4	1.250	1.1959	1.1919	1.1967	1.1927

Pitch diameter of U. S. F. thread is .0541 in. less than nominal diameter.
Pitch diameter of the Whitworth thread is .0533 in. less than nominal diameter.

hard and fast rule has been definitely established for the minus limits. Balancing the threading against the fitting in the boiler sheets has shown that the pitch diameter should come between the basic sizes minus .004 in. as shown in Table I.

Thread Gages

To insure the correct thread sizes of staybolts, it is necessary to provide the machine operators with thread limit gages which must be easy to apply and require the minimum time when testing the threads. Fig. 4 shows a work thread limit pitch gage which has been found sufficiently accurate and quick to apply. The gage has two maximum or "go" points and two minimum or "not go" points, which are of a shape similar to the thread; viz. 60 deg. included angle. The gage is at time held vertically in a holder as shown in Fig. 4. When testing with the gage in a vertical position, the bolt is laid on the upper "go" points and if within the limits, passes through by its own weight but does not pass the lower "not go" points. In the event of the bolt not passing the "go" point, it shows that the thread is too large, which means that the bolt has to be rethreaded. In the event of passing the "not go" points, the bolt is rejected. In some cases, the gages are held in the hand as shown in Fig. 5. The time required for testing is principally that of handling the bolts. When considering the great improvement in the uniformity of the thread sizes following the use of these gages and the small amount of time consumed for testing, this method of staybolt inspection is a good practice which results in economy for any railway shop. Fig. 3 shows a master cylindrical gage used when setting the work gages. The work gages are frequently checked and when necessary, reset to the master gages.

Two designs of heads for crown staybolts are in common use. These are the straight threaded with button heads and the taper threaded. When threading the head end of the straight bolts, it is advisable to make use of a separate thread limit gage as shown in Fig. 3 with the minimum or "not go" points set to the basic size shown in Table I. The maximum sizes are set .004 in. larger. The head end of staybolts threaded to the gage will be about .004 in. larger than the usual staybolt with the result that they will screw tight into the firebox sheet and generally make a tight joint.

Some railways prefer the taper thread on the head end of crown staybolts in which event a limit gage is

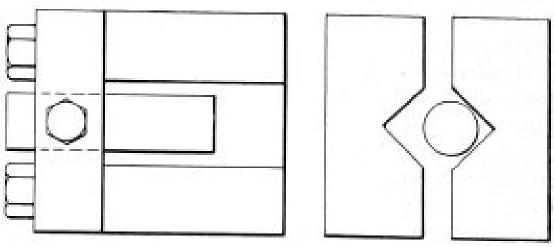


Fig. 7—A die for the cold forming of square ends on radial staybolts

used. The master and work gages are set preferably for the larger end of the taper thread.

Staybolt Manufacture

A number of ingenious devices have been developed in railway shops for the economical manufacture of staybolts. The following descriptions are confined principally to what appears to be the most advanced practices for each operation.

Shearing the blanks—One common practice is to shear the blanks to the required lengths in guillotine shears. The cutting blades used are shaped as shown in Fig. 6. The radius of the openings is about 1/64 in.

larger than the bar stock, which admits of shearing with the least distortion of the blank ends. The bars are fed up against a stop attached to the shear which admits of cutting one, two or three bars at one time.

Squaring the ends—For the purpose of driving staybolts when screwing them into the boilers, a number of practices are followed such as forming a square on one end to fit a wrench, driving the staybolt with an eccentric clamp which grips the round surface of the bolt, or threading the entire length of the bolts in which case a threaded socket wrench is used.

Cold squaring is preferably done on powerful toggle joint presses such as used in the mints for coinage purposes. The dies have square vee grooves as shown in Fig. 7. A stop is located between the dies for gaging

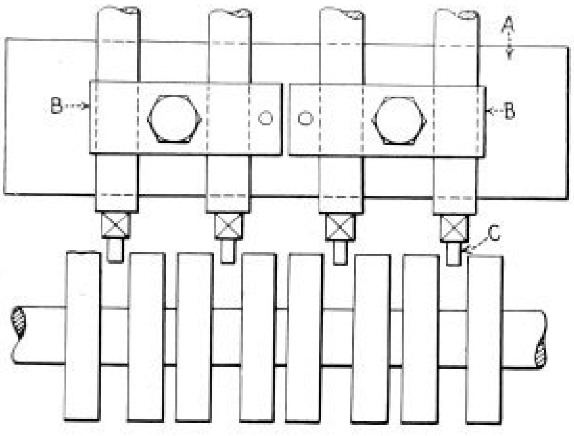


Fig. 8—A fixture for milling the square ends on four staybolts at one set-up

the distance the blanks enter. When squaring, the press runs continuously. The blanks are laid on the lower die and against the stop and as the top die descends, the ends are squared. While the squares are not perfectly formed, they answer the purpose. The press makes about 100 strokes per minute therefore the production is high. There are, however, minor objections to this method. The squared ends are not always true with the blanks which, at times, results in their running eccentric during the threading operation resulting in the chasers cutting a greater amount on one side of the blank, thus making a deep thread on one side which is incomplete on the opposite side, showing the black scale at the top of the threads. This is largely overcome by the use of a floating drive for the bolt at the time of threading.

For squaring in a forging machine, the forging dies are quite simple. The two gripping dies have half round grooves of suitable size to grip the bar similar to bolt dies. The plunger has a square hole of the correct size for forming the square. The blanks are heated, placed in the machine and headed. With the machine and dies in good repair, the squaring is in line with the blank. However, care is necessary in order to obtain the desired results. The objections are the cost of fuel for the heating as well as labor costs and changing the dies for different sizes. Where the expenditure for a special press is warranted, it is more economical to cold press the square ends.

Squaring on milling machines—In many respects, the most desirable practice is to mill the ends square. Numerous designs of holding fixtures for work of this nature have been designed, some very elaborate with indexing attachments, some without. Fig. 8 shows a fixture on which four blanks are held in vee grooves cut in the top face of the lower member *A*. In operation, four blanks are placed in the grooves, the distance being gaged by the stop *C*. The top clamps *B* are tightened securely, holding the blanks. Eight milling cutters are mounted on one arbor.

After milling the two sides on each of the four blanks, the clamps are loosened, the blanks given a quarter turn and the clamps tightened after which the other two sides are milled. The operator can generally turn the blanks and gage the second setting by the eye sufficiently accurately to meet all the requirements for work of this nature.

Owing to the sharp corners resulting from milling, it is only necessary to square about ½ in. of the blank, which is sufficient for the socket wrench on a finished surface of this nature. As the milling feed can readily be 4 in. per min., the actual time, plus the run-over is about 15 sec. for each milling operation, or, when including the loading, the time for each blank is about 20 sec.

Milling the ends of staybolts has the following advantages:

(a) The squares will be central with the blank which will reduce the chances of improper threading.

(b) Less length of stock is required, as the thread can be run closer to the squared ends.

(c) The time and expense compares favorably with forging.

Staybolts threaded their entire length—In some shops in place of squaring the ends, they are threaded their entire length and cut off to proper lengths ready for the beading operation. When screwing into the boilers a threaded socket wrench is used for this purpose. As squaring is not necessary, their manufacture will be explained later on.

Threading Staybolts

Staybolts are threaded on one, two and three-spindle bolt cutting machines, some equipped with lead screws and some without; also on vertical spindle special purpose machines. The ordinary bolt threading machines

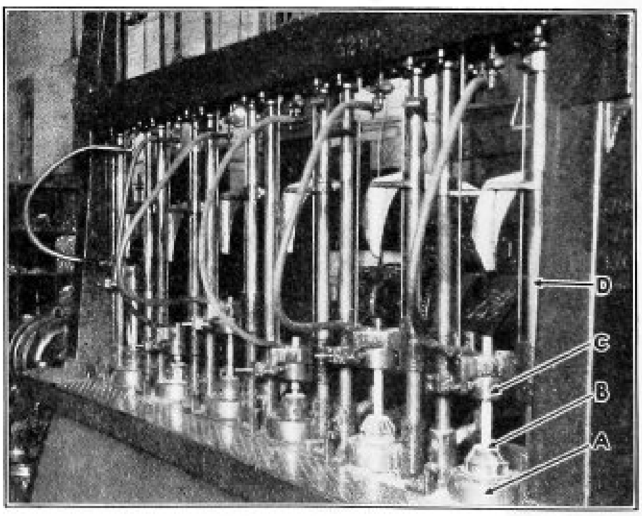


Fig. 9—Cutting the threads on three different sizes of staybolts on a six-spindle threading machine

used for this purpose are too common to require explanation. The prinicpal requirements for the work are that the machines have free moving carriages and good cutting chasers.

The vertical staybolt threading machines are less common and will, therefore, be briefly explained. One type shown in Fig. 9 which has six spindles, each of which is driven by bevel gears meshing into a common horizontal shaft located in the lower part of the machine. The bolts are driven by the square sockets *B* mounted on the upper ends of the spindles *A*. The adjustmentable self-opening die heads *C* are guided between the uprights *D*. After the completion of the threading operation of any of the spindles, the operator pulls a handle, one of which is shown at the left of the illustration which raises and closes the die head. While the die head is held in this position, the previously threaded bolt is removed by the other hand and a new blank placed in the revolving drive socket. The operator gradually releases the tension on the spade handle, the die descends, when the blank is guided into the chasers and threaded, the die head opening at the lower point of travel.

In operation, the operator places the blanks in the spindles in one, two, three order, until all are full. Generally, when threading bolts about 7 in. long by the time the last spindle is loaded, the first bolt is completed. As a result, the threading operations are practically continuous. The threads are frequently tested with the limit thread gage previously described. In the event that the threads do not meet the limits, the dies are re-adjusted. By this careful inspection, the thread sizes are readily kept within the limits of the basic sizes and .004 minus. The output is governed by the ability of the operator to feed the machine, handle the blanks to and from the machine, inspect the bolts to insure the thread sizes coming within the limits, re-adjusting the dies, etc. Owing to the number of bolts undergoing the threading operation at one time the threading often exceeds the ability of the operator to feed the machine, with the result that the cutting speed is comparatively low to insure more perfect threads.

Flexible Staybolts

Flexible staybolts are rapidly threaded on the above described machine. In place of the hollow square socket for driving the bolt, a socket or chuck suitable for driving the style common to the railroad is employed. As the threaded part of the bolt is comparatively short, the capacity of the machine is greater than the capacity of the operator to handle the bolts.

(The concluding part of this article which describes the manufacture of crown staybolts will be published in the March issue of this magazine—Editor.)

Payment for Repair Work

By Leslie Childs

WHERE a boiler maker undertakes to make repairs to boilers that are installed upon leased premises, at the request of the lessee, he should look sharply to the authority of the latter to order the repairs, if he intends to rely upon a lien law for security for the account. This is true, because the mere fact that equipment of this kind is under the control of a lessee may not give the latter any right to bind the owner of the premises for repairs.

By the same token, a boiler maker should not rely solely upon the representations of a lessee that he is acting as the agent of the owner for the statements of one claiming to be an agent may not of themselves be competent evidence of such agency. The foregoing points are of importance to boiler makers in general and, as an illustration of the possible danger in overlooking them, the California case of P. W. Wood, Inc., v. Blalack, 261 Pac. 737, may well be examined.

Apartment House Boiler Burns Out

In this case the plaintiff was called upon to make certain repairs to the boiler and heating plant of an apartment house, which was owned by the defendant. A nightman employed at the building had permitted the water to run out of the boiler, with the result that two sections, front and rear, had burned out. The damage to the boiler occurred at night, the weather was cold and immediate repairs were, under the circumstances, necessary.

Pursuant to this call, the plaintiff inspected the premises, and estimated that the cost of the repairs to the boiler would amount to about $300. Plaintiff reported his findings to the manager in charge of the apartment house and then asked about the ownership of the building. The manager informed the plaintiff that the building was being operated under a lease and that he, the manager, was one of the lessees, and told the plaintiff to go ahead with the work.

Furthermore, the plaintiff thereafter claimed that the manager assured him that he had authority to represent the defendant, owner of the building, in contracting for the repairs. Acting upon his statement, the plaintiff made the repairs. The bill was not paid and the plaintiff filed a mechanic's lien against the premises and thereafter brought the instant action to enforce this lien.

Now, at this point, it may be noted that the plaintiff made no effort to get in touch with the defendant, owner of the building, and get his O. K. for the work. In fact, the plaintiff appears to have relied solely upon the alleged statement of the manager, who was one of the lessees, that he was acting as the agent of the defendant in ordering the repairs to the boiler.

In defense to this foreclosure action, the defendant set up that he had no notice of the repairs and never gave his consent to them. In addition, the defendant showed that under the terms of the lease of the building it was the duty of the lessees to keep same in repair, at their own expense.

As against this, the plaintiff set up the alleged statement of the manager of the building that he represented the owner in ordering the repairs. The manager thereupon denied making any such statement and also pointed to the lease which bound him and his co-tenants to make the repairs. The trial court permitted the evidence of what the manager was alleged to have said to go into the record and the trial resulted in a judgment in favor of the plaintiff.

From this judgment the defendant appealed and the question of the right of the plaintiff to prove agency between the defendant and the manager by the alleged statements of the latter was placed squarely in issue. In passing upon this point, the court, in part, said:

The Language of the Court

"The declarations of one claiming to be an agent, not made under oath or in the presence of the principal and not communicated to, or acquiesced in by him, are inadmissible to prove the fact of agency. One who deals with another, upon his mere statement that he is the agent of a third person, takes upon himself the risk of being able to show that such agency existed. If instead of satisfying himself by independent investigation, he accepts such statement and is deceived, he is the victim of his own credulity. * * *"

Following the above statement of the general rule, the court turned to the facts of the instant case to determine its application thereto. In this connection, and in denying the right of the plaintiff to enforce a lien against the premises for the work done on the boiler, the court used the following language:

"In the absence * * * of proof of actual agency, or that the real owner of the premises had by his conduct so far concurred in such improvement as to be estopped to deny the validity of the lien, no lien can exist. * * * It being expressly found that the defendant (owner) had no knowledge that the work was being done, and that no agency existed, a lien could not be created under the statute, for there was no one acting under the authority of the owner who could bind him. This being so, the judgment establishing a lien cannot be sustained. * * * For the reasons given the judgment is reversed."

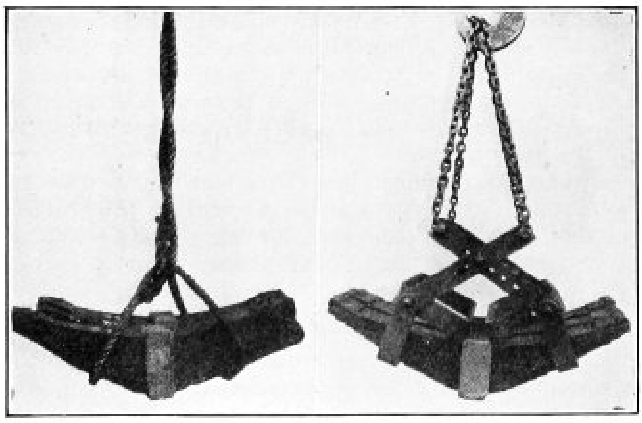
Conclusion

The foregoing case aptly illustrates the importance of care on the part of a boiler maker in doing work upon the orders of a lessee in possession of premises in the absence of authority for the work from the owner. This is of course assuming that reliance upon the lien law of the state is desired as security for the account.

Further, in undertaking work of this kind, the boiler maker should not depend solely upon the representations of a lessee in possession that he is authorized to bind the owner. For, it is clear, that such representations made in the absence of the owner and not ratified by him, may fall far short of binding him. In other words, it's up to the boiler maker to use prudence in cases of this character and make sure that the owner is bound, if the security of a lien upon the premises for the work is desired.

Safety Crane Devices for the Locomotive Shop

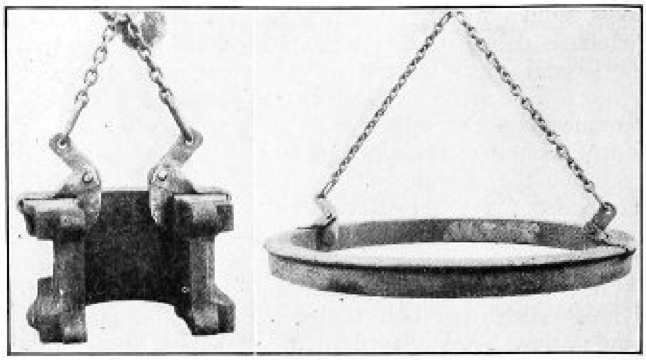
A DEFECTIVE crane hook or sling is always an accident risk. So also is crane lifting equipment which is used to lift material for which it is unsuited. The device shown in one of the illustrations is a big improvement over the old rope sling



The device shown at the right is much safer than the rope sling at the left

method. It not only assures a safe means of transportation, but it is also a time saver because it can be adjusted and applied in much shorter time than the rope sling.

The hooks, also illustrated, are a design used in many railroad shops. These hooks were made specially for



Hooks of similar design used for lifting materials

handling plate and castings. Additional types can be made to meet practically any problem in handling shop materials.

Foremanship Courses Show Increase

A great increase in the number of foreman training courses in practically all lines of industry throughout the country is shown in a survey report just issued by the Department of Manufacture of the Chamber of Commerce of the United States. The number of foremanship courses, the bulletin shows, has grown from 105 in 1925 to 933 in 1927. These figures, the department of manufacture points out, indicate that foreman training is looked upon as an agency for greater efficiency in manufacturing.

Virtually every line of industry is represented in the foreman training movement. The machinery group, not including transportation equipment, has the largest number of courses. On the basis of the number of workers employed, however, the rubber products and chemicals and allied products groups are far in the lead.

"The phenomenal growth of foreman training courses," the bulletin says, "offers encouragement to those who appreciate the great value of human efficiency in American industry and are giving these efforts sympathy and support.

"The great increase in courses within the short period from 1925 to 1927 bears eloquent testimony to the fact that today industry regards the trained foreman as a most important factor in management.

"The greater use of intricate and expensive machinery requires not only better trained attendants, but better selected and equipped foremen to lead the personnel for more effective production."

Foreman training courses are being carried on by individual manufacturers, state universities, industrial vocational agencies, chambers of commerce and manufacturer's associations. Such work can be profitably conducted in any community having industrial plants.

New Type "S" Welders

The Wilson Welder and Metals Company, Inc., of Hoboken, N. J., has announced several new features on its standard type "S" welders. There are no line connections on the front of the control board; the main switch is enclosed and mounted on the back of the board and only a dial and pointer appear on the front. The reactor is underslung and is so placed over the rear axle that it is protected from injury. A rotary switch is used in order to give close welding regulation.

Proposed High Pressure Water-tube Boiler--II*

Economies to be gained by higher pressures and temperatures in new type boilers

By Louis A. Rehfuss

LET us assume by way of comparison a 200 lb. pressure firetube locomotive boiler of normal design, equal grate area, and approximately equal overall dimensions. At normal full power, and a grate area of 92 sq. ft., such a boiler would burn 120 lb. of coal per sq. ft. of grate per hour, or 11,000 lb. in all. With this coal rate, test plant results would indicate the following log:

	Per cent
(a) Heat utilized in evaporation	58.5
(b) Loss in unburnt fuel	24.0
(c) Loss in smokebox gases	13.5
(d) Loss in radiation, etc.	4.0

In the proposed high pressure watertube boiler, while the net results should be somewhat better, it is not anticipated that it would be materially so, due to all smokebox gas losses. The more limited amount of evaporative surface in the proposed watertube design as well as the higher temperatures of the high pressure steam, would cause the smokebox gases to leave at higher temperatures. These losses, however, would be greatly minimized by the vigorous water circulation (which would increase the unit tube evaporation), by appropriate baffling (which would increase the gas velocity and length of gas travel), and finally by the superheating of heated steam temperatures within normal limits. Considering all of these factors within the light of the data made available by test plant results, the indication is that this loss in smokebox gases for the proposed watertube design should be placed at 16 per cent.

On the other hand, the design of this boiler is particularly built around an improved combustion efficiency, provision being made for an exceptionally long flame travel, as well as the use of preheated air. It is thought reasonable to estimate the unburnt fuel loss at not over 20 percent. The heat log of the watertube boiler then becomes:

	Per cent
(a) Heat utilized in evaporation	60
(b) Loss in unburnt fuel	20
(c) Loss in smokebox gases	16
(d) Radiation and other losses	4

Assuming coal at 13,500 B.t.u. per pound, we then have available for steam generation in the two boilers:

Watertube: 11,000 × .60 × 13,500 = 89,200,000 B.t.u. per hour
Firetube: 11,000 × .585 × 13,500 = 87,000,000 B.t.u. per hour

Steam Generation

The particular advantage of high pressure steam lies in the fact that as the pressure goes up, the heat of vaporization, or non-productive heat, decreases, so that the total heat contents of a pound of steam at 500 lb. pressure is virtually the same as steam at 200 lb. This is true of saturated steam, although in the superheating of the steam the specific heat is greater for higher pressure steam.

The heat required to form a pound of superheated steam in the two cases is as follows:

	500 lb. Watertube	200 lb. Firetube
Heat for saturated steam (above water at 60 deg.)	1,172	1,171
Initial superheating	90	133
Secondary superheating	90	...
	1,352 B.t.u.	1,304 B.t.u.

Assuming that a feedwater heater introduces 125 B.t.u. from exhaust steam sources, the net heat required from the fire to form a pound of steam in the two cases becomes respectively 1,227 and 1,179 B.t.u. The resultant steam formed per hour becomes, watertube, 72,700 lb.; firetube, 73,800 lb. or practically the same. It is evident from the foregoing that no substantial increase is expected in the amount of steam formation from the design of the watertube boiler. While improved combustion and improved circulation increases the amount of evaporation, this is offset by higher temperatures in the smokebox gases. To attempt to absorb this heat by the use of economizers and added evaporative surface simply means increasing the weight, cost, and size of the boiler considerably for the sake of a small increase in boiler efficiency, which is not justified when the low heating efficiency of smokebox gases is considered.

The real gain in the proposed design lies in the very much improved water rate made possible by the high pressure, aided by compound superheating. Compound superheating in its turn is made possible by the small volumes which steam occupies at high pressures, and would not be advisable for low pressures.

In the case of a modern firetube locomotive working at 200 lb. pressure the water rate would vary from 16 to 22 lb. of steam per i.hp.-hr. Let us for the sake of our calculation, assume this at 17.5 lb., which would be very good.

Now theoretically an increase in pressure from 200 lb. to 500 lb. will give a gain of 3 per cent in power. Practically, due to the inability to obtain the full expansion ratios required, as well as to higher condensation losses, it is not feasible to realize all of this gain. However, by the use of two-stage expansion and intermediate as well as initial superheating, it would be possible in the 500 lb. pressure watertube design to lower the water rate to a figure betwen 13 and 15 lb. per i.hp. hour. This is borne out by test plant results realized with a 350 lb. watertube locomotive firebox boiler.

Assuming a water rate of 14 lb. for the high pressure watertube design and 17.5 lb. for the 200 lb. firetube boiler, the probable power output of the two designs becomes (inclusive of auxiliaries):

$$\text{Watertube:} \quad (500\text{ lb.}) \ \frac{72{,}700}{14} = 5{,}190 \text{ i.hp.}$$

$$\text{Firetube:} \quad (200\text{ lb.}) \ \frac{73{,}800}{17.5} = 4{,}220 \text{ i.hp.}$$

The corresponding coal rate for the case in hand, at 120 lb. of coal per sq. ft. of grate per hour becomes:

$$\text{Watertube:} \quad \frac{11{,}000}{5{,}190} = 2.12 \text{ lb. of coal per i.hp.-hr.}$$

* The first installment of this article appeared on page 339 of the December, 1927, issue of THE BOILER MAKER.

$$\text{Firetube: } \frac{11{,}000}{4{,}220} = 2.61 \text{ lb. of coal per i.hp.-hr.}$$

The watertube high pressure design then would show a gain in power of 23 per cent and a gain in coal economy of 18.75 per cent. Figuring a five per cent increase in the weight of the water-filled boiler in the case of the watertube design, we would have a gain in power per pound of weight of 17 per cent. The reduction of this weight factor by refinements in design would be the measure of further gains in power. By the use of a tubular backhead in place of the staybolted head shown in the drawings, by the use of preheating tubes in the side walls in place of much of the firebrick, and by t' elimination of other excess weight, this weight factor could be gradually lowered.

The use of high pressure also permits the use of smaller cylinders which, compounded, makes attractive the development of multi-cylinder design, resulting in a more uniform torque action and a consequent reduction in required adhesive weight.

The advantage of a high pressure design lies as much in the opportunities it affords for increased power within given dimensional limitations as it does in the possibility of greater coal economy. Which of these two would be most important, would vary with each case.

From the Blast Furnace to the Boiler Shop *

By E. N. Treat

THE molten metal at the time of tapping from the blast furnace must be handled as a liquid. Two methods of handling this metal are generally employed each depending upon the nature of the work to be performed. Where the molten iron is to be "pigged" it may be run directly through refractory sluices to the pig mold. After it is sufficiently cooled to permit handling, it is loaded into cars for shipment or stored for use at the steel mill.

The second method most desirable for use at the steel mills is to tap the molten iron into a ladle. These ladles are steel cup shaped receptacles lined with refractory material. Where the blast furnace is located at a distance from the converter or open hearth furnaces, it is common practice to locate the ladles on low wheeled cars. At each side, the ladle is supported by a trunnion which corresponds with a heavy casting on the car. By the aid of an overhead crane or similar tipping device the contents of the ladle may be poured directly into the converter or the open hearth furnace.

Several of these ladle mounted cars are drawn in turn under the tapping sluice and filled with molten metal. When all have been filled the ladles are drawn to the point desired by a locomotive. Pouring from these ladles may be made several hours after being filled from the blast furnace. Heat sufficient to maintain the liquid in a flowing state is derived from the metal itself and assists in prolonging the liquid state by combustion of gases from the molten mass.

Should the metal desired be molded at once, the ladle may be taken directly to the pigging machine. Here, located upon an endless chain are buckets in which the molten iron is poured. Each bucket moves forward as the preceding bucket is filled, the first buckets discharging their pig of iron at a lower point in the cycle of the endless chain. Molds are covered with a preparation insuring the ingot not sticking in the mold.

Where the molten iron is to be used at once the contents of the ladle may be mixed with other material directly into the open hearth. A common practice is to pour the contents of two or more ladles from separate blast furnaces into a receptacle called a converter. At this point the metals may be mixed together, in this way one ladle high in one impurity may be mixed with that ladle high in another impurity. The effect is a reduction of the impurity of each by proportion and an added liberating effect may be had by bringing in contact impurities with affinity which in contact fuse at a much lower temperature than required alone.

The converter is a pear shaped vessel lined with a highly silicious material, at the bottom of which is located a number of openings called tueres. Through these tueres is forced air under pressure into the molten iron, the effect is a liberating of gases and a consequent reduction of chemical impurities. In order that metal may not flow into the tueres and solidify, the converter is mounted upon trunnions in essentially the same manner as the ladle used for conveying. By means of the trunnions, the converter is tipped into position and the metal is poured into the converter above the tueres; the blast of air is then admitted to the tueres and the converter lowered with the metal over the air blast. When sufficient air has been passed through the metal, the converter is again tipped and the blast shut off; the metal is then removed for further use in the open hearth furnace.

To Sir Henry Bessemer is given the credit for designing the converter. Its shape resembled a pear to some extent and could be tipped or rotated by means of a gear meshing with a smaller gear. By this means the action of the air passing through the molten bath caused manganese, silicon and carbon to be oxidized, after which an alloy of iron and manganese known as Speiglessen or ferro-manganese was added and the molten metal then teemed into molds.

The Bessemer or converter process of manufacture is considered by many to have had its day. Those who are in favor of more present day methods claim the open hearth method to be more satisfactory. Others proclaim the dawn of another day in steel manufacturing, when steel will be manufactured in a better way and on a greater scale than ever before contemplated by electricity taken direct from the air.

Each method of manufacture claims its advantages. Each manufacturer professes his product to be the most reliable. To the boiler maker is due a portion of deciding upon the merits of each material. Not only must the material be sufficiently strong, but it must possess the ability to stand repeated bending and working. The real test of material therefore lies with the expert workman who is sufficiently interested in his work to know at a glance what the most probable causes are that will bring about the failure of the material in its designated service.

* This is the second of a series of short articles on steel mill practice in handling boiler materials. The first article appeared on page 3 of the January issue.

W. C. Decker has been appointed general boiler foreman of the Illinois Central Railroad with headquarters at the Burnside Shops, Chicago, Ill. Mr. Decker was formerly boiler foreman at East St. Louis, Ill., and succeeds Henry J. Raps who recently retired.

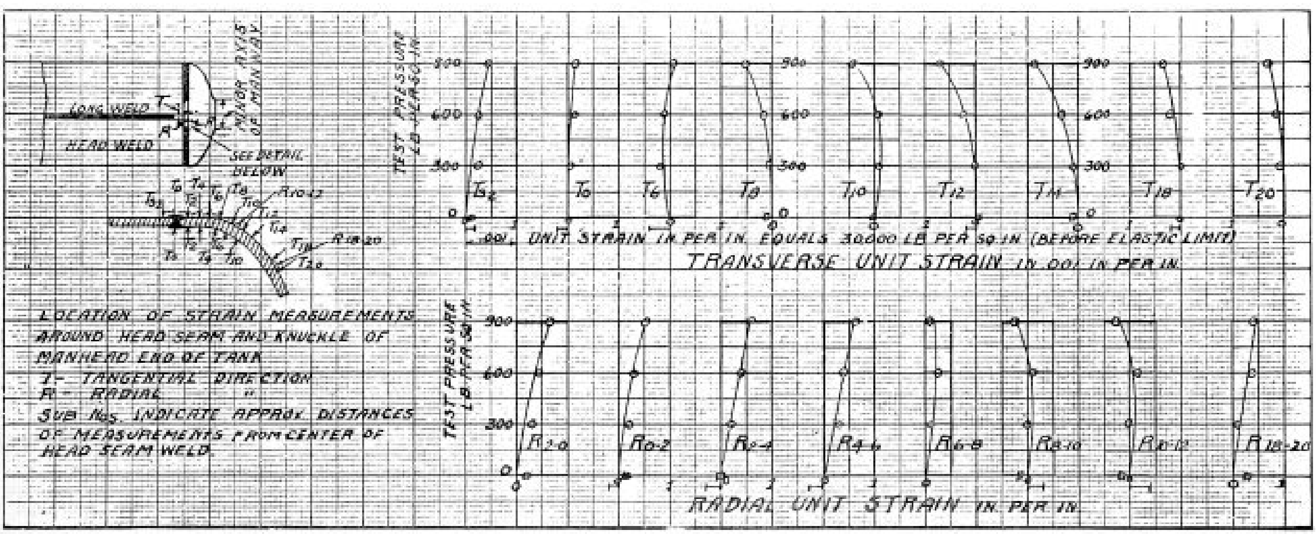
Procedure Control Methods Used in Pressure Vessel Welding*

Welding head seams of a high pressure tank—Methods of testing pressure vessels

By H. E. Rockefeller†

THE lining up of the head seam was accomplished by the use of the same wedge clamps previously mentioned in connection with the lining up of the longitudinal seams. These clamps were inserted at equi-distant points about 12 inches along the entire seam. A spacing of about ½ inch between the abutting plate edges was employed.

When the seam had been completely aligned, four tack welds were made, two welders working at points 180 degrees apart, one on the top welding on the outer vee, and the other within the shell welding the inner vee. The shell was then turned through 90 degrees and the other two tack welds made. Each tack weld was about 4 inches in length and without reinforcement.



Strain gage measurements on completed tank

Welding Head Seam

The actual welding of the head seam was accomplished in much the same manner as were the longitudinal seams. Instead of the welder moving along the seam as the welding progressed, however, the welding puddle was kept at an angle of from 10 degrees to 15 degrees off center by turning the shell as required, the welder remaining in the same position.

The method of providing for contraction was also considerably different from that employed on the longitudinal seams. In the latter case, it will be recalled that the seam was spread at the open end and allowed to contract as the weld progressed. On the girth seams, on the other hand, since an equi-distant spacing had been provided, a more rigid type of joint had to be made. Since, however, a spacing of ½ inch was provided before tacking, the weld was allowed to contract in small increments and the effect of this contraction was largely prevented from being transmitted to the unwelded portion of the seam because of the wedge clamps and tack welds used. This method prevented the locked up stresses from building up in such magnitude as to give any trouble.

In welding the second side of the double vee, furthermore, any locked up stresses caused by welding the first side were dissipated through the reheating of the welded area both by the preheating medium and the oxy-acetylene blowpipe.

The application of this method was carried on in the following manner:

The wedge clamps were removed for a distance of about 18 inches from the starting point of the weld. As the weld progressed, other wedge clamps were removed in such a way as to maintain a spacing of about ¼ inch a foot ahead of the point of welding. To do this, it was sometimes necessary to weld within about 4 inches of a wedge clamp before removing it and the upright portion of the clamp in this case acting as a wedge, had to be removed by cutting it out with the blowpipe. As the weld approached one of the tacks, however, the spacing between the plate edges naturally increased and it was therefore a comparatively simple matter to control the contraction.

Providing Ventilation

We had learned from previous experience in fabricating welded pressure vessels that as long as a cyl-

*This is the second part of a paper read before the annual meeting of the International Acetylene Association, held in Chicago, November 18, 1927. The first section of the paper appeared on page 346 of the December, 1927, issue of THE BOILER MAKER.

†Engineering Development Department of the Linde Air Products Company, New York.

indrical portion remained open at both ends, no trouble would be encountered in keeping the welder cool and providing ample ventilation. In welding the inner vee of the head seams and particularly in making the last inner vee weld, however, special ventilation facilities were provided so as to give the welder fresh air at all times. In making this weld, furthermore, two operators alternated, each welding for about twenty minutes at a time.

Test of Tank

On the completion of the tank, it was first given the regular hydrostatic test imposed on all welded pressure vessels. This consisted in applying a pressure of 600 pounds per square inch (twice the designed working pressure) and hammering all the welded seams with a 12 pound sledge. The pressure was then increased to 900 pounds (three times the designed working pressure). It might be pointed out here that since the A. S. M. E. Unfired Pressure Vessel Code allows a design fiber stress of only 5,600 pounds per square inch, the fiber stress at the required test pressure would only be 16,800 pounds per square inch. On this tank, the fiber stress at the test pressure was 27,000 pounds per square inch or about 60 percent greater than called for in the code.

During these tests, strain gauge measurements were taken at various points on the tank.

I have indicated some of the results of the strain gage measurements taken to show the satisfactory manner in which this tank acted under the test. The stresses you will note about the knuckle, which ordinarily is a point of maximum strain, did not pass the yield point. It might be said here that previous measurements taken on standard dished heads show that the yield point of the material at the knuckle would have been reached before a test pressure of 1½ times the working pressure was secured.

Following the completion of the hydrostatic test, the vessel was subjected to an air pressure of 450 pounds per square inch. Under this pressure all the welded seams were tested with soapy water and not a single leak was evidenced.

Discussion of the Factor of Safety

I have attempted to point out thus far how the factors comprising the term procedure control were applied in this given instance. It is my intention now to indicate how, by the analysis of these factors, valuable progress can be made. Let us consider the question of design. When we first started to apply procedure control methods to the construction of welded pressure vessels, we were of course dependent in question of design on general codified and accepted standards. In so far as design of heads, manhole and other outlets were concerned, therefore, we accepted the standards laid down in the A. S. M. E. Unfired Pressure Vessel Code for Riveted Construction.

The extremely high pressures to which all welded pressure vessels are subjected, backed up by strain gage measurements taken at various points on the vessels, however, brought out certain weak points in design hitherto believed to be entirely satisfactory, namely at the head, knuckles and about large outlets such as manhole openings. An extensive investigation on these two points of design were made and the resulting findings made public. As a result, we have changed our designs accordingly so as to eliminate these weak points. I believe you will agree with me that the controlling factor in any design should be based upon the weakest point in the vessel. We can, we believe, with reasonable justification, now say that we have reached a point in pressure vessel design where this object has been attained.

Another point I would like to bring to your attention concerns the test which is imposed on all welded pressure vessels constructed in accordanc with procedure control methods. You will note that we require a severe impact test at twice the design working pressure. No one realizes the severity of this test until he has actually seen it imposed. We then require the pressure to be raised to three times the designed working pressure and in so doing, test the tank to a point where we arrive at a known factor of safety of three.

Strength of Welded Vessels

The question of the uniform strength of welded construction has often been brought up by some such statement as "granting a weld can be made which will have a tensile strength of between 50,000 and 60,000 pounds per square inch or above, how can we be sure that every inch of the weld metal deposited, will have this same strength?" A reasonable answer to this question is given in the careful manner in which we supervise the welding so as to make sure that only qualified and conscientious welders are employed. To convince those skeptics, however, who will not accept the reasonableness of this statement, I believe there is no more convincing argument than that with a known factor of safety of three on the vessel, there can be no question as to its safety in operation. I say this because when we talk of factor of safety in general, we mean an assumed factor of safety and in practice, actually an unknown factor. The fact that failures in pressure vessel construction are of such small percentage is because the assumed factor of safety of five is sufficiently high in practically all instances to make allowances for every conceivable irregularity in design, construction or operation.

As we have previously pointed out, however, the vessels which are being constructed in accordance with the present codes today, have points of local stress concentration which would cause them to fail under repeated applications of a test pressure far below the assumed pressure at which the factor of safety of five is based and in many instances even below a pressure equivalent to a factor of safety of three. Are we not then justified in saying, that welded pressure vessels constructed in accordance with our procedure control methods are perfectly safe for operation?

SOOT BLOWERS.—A type of soot blower for use with horizontal return tubular and Scotch marine boilers has been described in a bulletin issued by the National Flue Cleaner Company of Groveville, N. J. A feature of these blowers is the fact that they employ a separate nozzle, in a fixed position, for each boiler tube, making it impossible for any tube to escape the scouring action of the steam or compressed air jet.

AIR HOISTS.—A catalogue illustrating and describing Hanna pneumatic hoists has been issued by the Hanna Engineering Works of Chicago, Ill. Many styles of hoists are illustrated to operate under air or water pressure and may be employed in a horizontal, vertical, movable or fixed position. Catalogue No. 15 contains interesting data for the solution of problems of material handling.

Characteristics of Modern Boilers*

Higher boiler pressures require changes in design and construction methods

By E. R. Fish †

THE successful introduction of the steam turbine and its tremendously rapid growth in use and size of units have resulted in making it the one piece of modern power plant machinery responsible for the great changes that have come about in boiler equipment. The relatively small space occupied by the steam turbine per unit of power has made it necessary to design steam producers to supply tremendous amounts of steam in such a way that a minimum of space will be occupied, which together with the progressively increasing demand of turbine manufacturers for higher steam pressures and temperatures has forced the remarkable development of both the heat producing and heat absorbing apparatus.

Changes in Shape and Design

Generally speaking, the shape and design of the pressure parts of boilers have not greatly changed from the old forms with possibly one or two exceptions. The most outstanding one of these is the steam generator, which is distinguished by the feature that it absorbs most of the heat by radiation. This is done by employing high heat head and violent turbulent combustion in combination with highly heated air. Where heat is to be absorbed rapidly by radiation it must be generated rapidly. These features characterize the steam generator.

For pressures up to 450 or 500 pounds per square inch, the older methods of riveted construction are not especially objectionable nor particularly difficult to continue. This has meant the installation of far more powerful fabricating equipment and very much greater care in methods of workmanship. The thicker plates required to carry the higher pressure preclude the possibility of many of the old boiler shop processes, such as laying up surfaces metal to metal by sledging. Precise forming by powerful tools and machine shop rather than boiler shop methods have been extensively introduced. The same qualities of material are still largely used in the fabrication of boilers for what may now be termed the more moderate pressures, although these would but a few years ago have been deemed high pressures. The dimensions of these materials, however, have grown tremendously.

For what we now call high pressures, say, 650 pounds and up, riveted construction is not advisable and other methods of making the pressure parts are being evolved. The principal one so far is the forged seamless cylinder usually having the heads integral with the shell, which makes a most excellent piece of work although exceedingly expensive.

It is probable, too that for the zone ranging from 400 to 800 pounds, forged welded vessels may be more extensively used, although this is not true to any great extent at the present writing. Vessels fabricated in this way may be made without the use of riveting of any sort, the heads, nozzles, etc. all being welded on so as to make a completed part of very good workmanship and without objectionable thicknesses due to the presence of butt straps, doubling plates, etc., as are necessary with riveted construction.

Tube thicknesses proportional to the higher pressures are necessary, but fortunately the coefficient of heat transmission of mild steel and the rate of heat absorption by water in contact with clean metallic surfaces are such that no overheating of the metal results. This is possible only by reason of the rather general use of either well treated raw feed water or the use of a very large percentage of condensate and make-up from evaporators, so that the wetted surfaces remain, over long-continued periods of time, practically clean. Fortunately, too, there has been no need to meet these modern pressure conditions by changing the method of attaching tubes to the other parts of the boilers. Rolling still amply suffices. The holding power of a tube is practically proportional to the area of contact of the tube with the circumference of the hole. This, however, is increased considerably by the use of grooves into which the wall of the tube is pressed during the rolling process. Expanding tube ends in their holes by means of roller expanders will probably continue to be the common practice. Here the ingenuity of manufacturers of tube expanders has been brought into play in evolving tools that are practicable for use with plate thicknesses of over 4 inches for 1200 to 1400 pound pressures, in which cases the holes are usually made in a special way, as well as for thicknesses of 1½ inches and 2 inches for the somewhat lower pressures. This item is only one of a myriad of practical, but highly specialized problems that have forced themselves on the boiler manufacturers and which in turn have been passed to the makers of such special tools and appurtenances as are required for the fabrication and operation of a boiler.

In building boilers with these thick plates, the use of drills is universal, punching having been entirely superseded. This refers to both rivet and tube holes.

Moderate Size, Moderate Pressure Boilers

It should not be assumed from the foregoing that high pressures are as yet universal. There is still a great demand for boilers of the more moderate pressures, not the moderate pressures of ten years ago but those of today, say, from 200 to 350 pounds, and, indeed, for still lower pressures. All of these, too, in unit sizes of from, say, 1,500 square feet of heating surface up to 15,000 square feet. Practically complete statistics of the boiler making industry gathered by the United States Department of Commerce show that for the first six months of 1927 the average size of watertube boilers was about 5,700 square feet of heating surface, which indicates that there are far more boilers of the relatively small sizes manufactured than of the very large sizes.

There is at present rather a keen rivalry between the merits of the slightly inclined straight tube watertube boilers and those of the vertical bent tube type. The use of the latter is increasing, and it is often the

* Abstract of paper presented at the First National Meeting of the A. S. M. E. Fuels Division, St. Louis, Mo.

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preferable one due to the changes in modern conditions. There is a great variety of factors to be taken into consideration in determining the preferable type of boiler for any particular case, but it is possible to build boilers of either of the types for whatever pressures may be desired.

While central station power is unquestionably being more and more extensively used for manufacturing purposes, it is also unquestionably true that most industries, particularly those where considerable amounts of steam are needed for heating and process purposes, can make their own power cheaper than they can purchase it, and it is because of this that the boiler-manufacturing industry survives. With the growing appreciation of these possibilities by consulting engineers, plant managers, operating engineers, etc. the rehabilitation of many industrial plants is being brought about.

Furnace Improvements Brought About

The high rates of combustion now so generally prevalent have made necessary tremendously enlarged dimensions of the furnace or space in which the fuel is burned. This has come about through appreciation of the fact that the combustible gases distilled from the fuel must be completely burned before any great cooling is effected. In the efforts to attain high efficiency the necessity of using the least possible amount of excess air is thoroughly recognized. This, in turn, results in exceedingly high furnace temperatures. Modern fuel burning apparatus is designed to use but a small amount of excess air as compared with the old methods. With the latter, the refractory lining of the furnace was such that it would stand the temperatures more or less satisfactorily and for periods of sufficient duration to justify its use.

Being under full boiler pressure water walls must be carefully and properly designed and arranged. The total overall dimensions of the boiler and water wall pressure parts are now, even in the case of moderate size units, so great that the problems of expansion and contraction are serious and must not be lost sight of in the general design. Changes in temperature inevitably involve changes in dimensions and not infrequently in shape, and unless adequate provision is made to accommodate these changes, serious damage is likely to result.

While the introduction of water walls was primarily stimulated for the purpose of reducing setting maintenance, it has resulted in the increase of steam making surfaces. These surfaces are heated almost entirely by radiant heat. Evaporation of water per square foot of surface of water wall tubes is far in excess of that of any of the boiler heating surface with the exception of the rows of tubes immediately exposed to the furnace.

In one sense, the water wall may be considered a part of the furnace and one of its problems, and hence concerns the designer of fuel-burning equipment, but it is also a part of the boiler manufacturer's problem, and because of this combination of circumstances close cooperation between the two is very necessary.

Inasmuch as the tremendous volumes of gas to be handled through restricted and very highly obstructed passages result in high friction loss, mechanical methods of creating drafts are generally necessary. To so baffle a boiler as to reduce the outlet temperatures to a low point results in a high draft loss, whence the practice of permitting a relatively high gas outlet temperature from the boiler and effecting a further abstraction of heat from the gases by means of economizers and air preheaters is rapidly growing. The investment represented in apparatus of this sort is far less than in the boiler proper. To the extent that the loss of heat units up the chimney is prevented, the overall efficiency is benefited.

Not infrequently both economizers and air preheaters are installed, although with a properly baffled boiler, depending upon other factors such as methods of heating feedwater by turbine bleeding, etc. one or the other is ordinarily sufficient.

Water walls have not only added to the steaming capacity of the boiler but have reduced the setting to merely a light enclosing structure in which often both firebrick and red brick may be omitted altogether, a sheet iron casing with a non-conducting lining outside of the water wall tubes being sufficient. With this arrangement radiation and air leakage have practically disappeared as one of the serious items in a heat balance.

Increase in steam temperatures beyond that due to the pressure is a mounting factor and the details of boiler design have had to be considerably modified to accommodate superheaters sufficiently large to give the desired temperatures. In order to avoid a cumbersome piece of apparatus the practice of locating superheaters in zones of relatively high temperature is becoming common, and the so-called radiant heat type located directly in the furnace is not at all unusual. This latter service is extremely severe, due to the slow heat-absorbing properties of steam, so that the shielded radiant type and the convection type of superheater in contact with gases of more moderate temperatures are the preferred ones.

Furnace Control

In order to maintain as uniform furnace conditions as may be possible, even with varying demands for steam, a number of furnace controlling systems have been designed. Many of these are exceedingly ingenious and very effective, and are promptly responsive to changing conditions. The mechanism and adjustments are for the most part rather delicate, and must therefore have intelligent care. Devices of this sort cannot be made foolproof nor to take care of themselves.

Methods of calculation of the various problems and the relationship of various factors entering into boiler operation have now been brought to a point where predictions of performance can be made—not with exactness but within narrow limits of error—that make it possible to determine beforehand fairly accurately what the results should be. Thus it is possible to design a boiler which is adapted to the service for which it is intended, and to attain that degree of dollar efficiency which the circumstances warrant.

Meeting of California Boiler Inspectors

The seventh annual convention of California Certified Boiler and Elevator Inspectors was held January 18, 19 and 20, 1928, at Los Angeles, Cal. Many subjects of interest to the field of boiler makers and operators were discussed. Papers covering features of safety were read by well versed men from their respective fields and displays of equipment were exhibited by concerns interested in elevator and boiler construction and safety.

Method of Developing a Cone Roof

Templates laid out in the drafting room speed up shop work

By D. W. Phillips

"HELLO Bill, what's troubling you this morning? Something gone wrong?"

"Oh no, Mr. B———, there's nothing down there in my quarters to go either way, right or wrong; but I don't know what to do with that bunch down there, and the Super doesn't want me to let any of them go. I guess he must have something up his sleeve for the near future.

"Anyway, we have cleaned up all the machine tools and given the housings a coat of gray paint; we have repaired the concrete floors in the boiler shop and had the pattern maker and his gang repair the floors in the machine shop and replace the broken lights in the windows; the machine shop force has gone over the hydraulic equipment and the electricians have overhauled the electrical equipment and we've repaired the gravel roofs—in fact, we have done over the whole plant and put everything in working order for a new start, so I've just come over to ask the Super to send us all home for a week at least."

"Bill, you've done fine! You've done just what should have been done months before, but you know when customers are on your neck every hour for their equipment we can't do very much in the way of upkeep and repairs, but I am sure the management will give you the right hand of fellowship in what you have done during this lull.

"Now come in and sit down, Bill, I have a good word to give you from the management, they think there is nobody on earth like you and that bunch you have down there. They had a little meeting last evening and I was invited to be present and along with other matters the construction of those 16 tanks came up. Well, Bill, every one of the heads of this concern is well nigh tickled to death with what you and your men accomplished on that contract and I'll tell you now that you fellows cut the estimated hours of labor on that job over 1,000. How about that? You and your gang are held directly responsible for those results!

"Just wait a minute, Bill, I have more good news for you. I agree with you that the Super did have something up his sleeve when he advised you to hold on to all your good men. See that print lying there, Bill?"

"Yes, what is that any way, a cone roof tank? I never saw a tank with a cone roof!"

"Well, Bill, just remember this, that there are men dying today who never died before and if you hang around this ranch a few weeks longer you will see a tank with a cone roof.

"Bill, this is a bin for storing cotton seed, the seed is discharged into the top from the conveyor running from the seeding house and they are extracted from outlets near the bottom. We have an order for two, Bill, each 70 feet inside diameter by 55 feet high, made of 3/8-inch plate throughout. Now let's give them a good job for there are more to follow. I think that this should be an easy task for you fellows down in the shop as we have ironed out all the difficulties by detailing a template for each course."

"But, Mr. B——, I don't see anything difficult about this job. It's an easy matter to lay out these templates. The whole roof is only a frustum of a right cone whose slant height intersecting with the vertical center line gives us one common center from which we sweep out all our templates, the length of these different sweeps or radii being the distance from one common center to the center of the rivet line at each lap joint in the roof."

"If that were possible, Bill, you wouldn't even have to do that in this case, as we have given you the template already laid out."

"You say, Mr. B——, 'if that were possible;' what do you mean, is it not possible?"

"Why no, Bill, and for this reason you must remember you are going to connect together a series of conical rings and, in order to do so, you must have a large and a small end; therefore, you must find a radius that will coincide with the true circumference of each diameter at the center of the rivet line. I mean by this that when you have found the true radius and have struck out the arc of both ends of your template and have laid off the circumference of the large end, you may lay a straight edge on the terminus point of your large end circumference and the center of the radius and draw a line cutting the arc of the small end. This point of intersection will determine the stretch-out circumference of the small end without further figuring at all. With a true radius you will have a smooth pitch line in your roof and the inner and outer edges of the lap will lie in contact with each other and we will have a metal to metal joint.

"Now note, if you were to use one common center for all radii, the radius for the large end of the large course would be 45 feet 8 inches, whereas the true radius is only 45 feet 5 11/16 inches (see sketch)."

"I understand that we have to figure for a large and small end, Mr. B——, but I never thought that had any bearing on the radius."

"Oh yes, Bill, and if we had used 1/2-inch plate in place of 3/8-inch our radii would have been still shorter and if we had used 3/16-inch plate they would all have been longer. You see, Bill, by taking the thickness of the material off one end and putting it on the other, changes the angle or slope in the roof line for each individual course in the roof."

"Well, Mr. B——, how do you get that radius business? You can't find it with a straight edge."

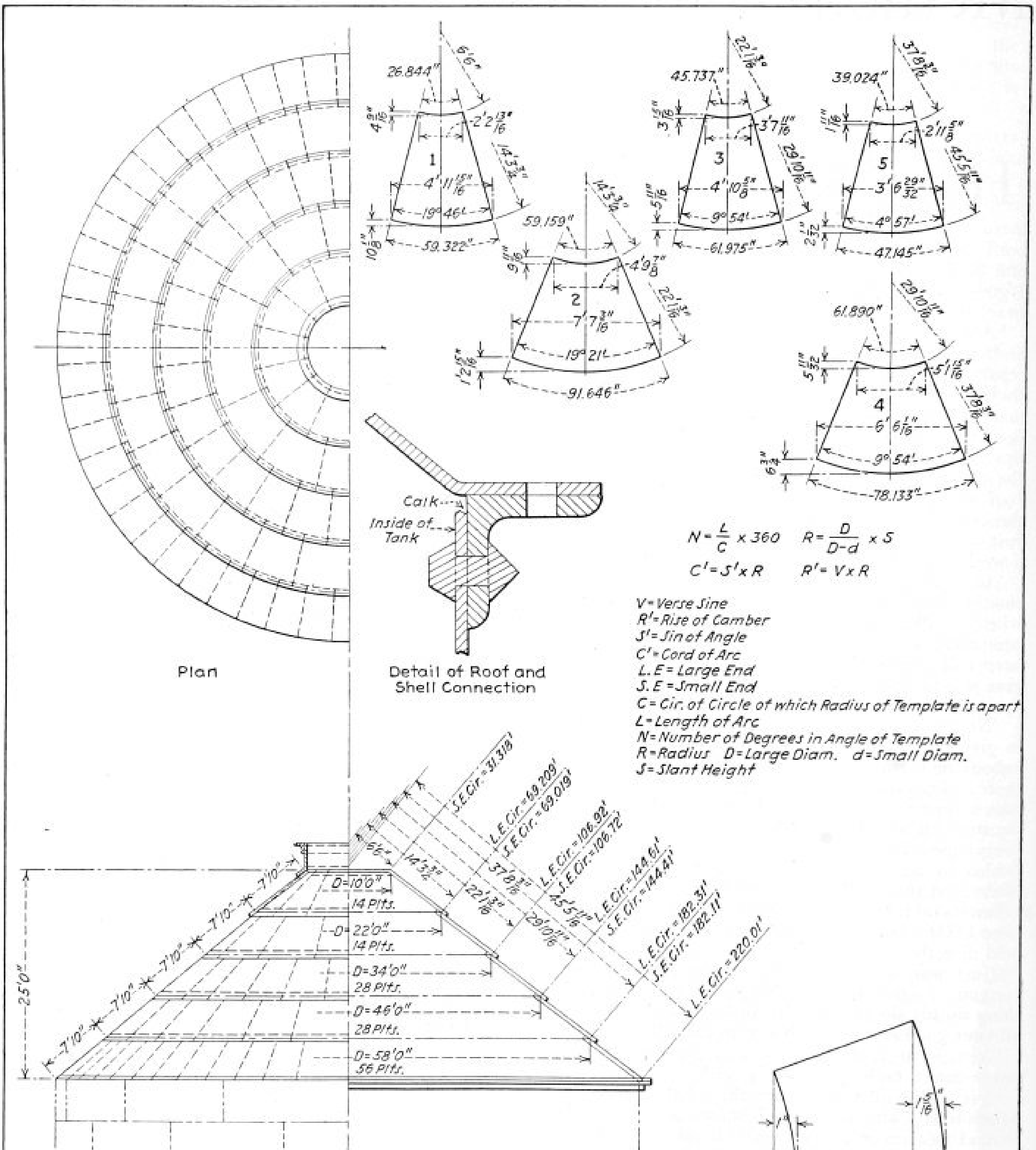
"No, Bill, the trick is purely of a mathematical determination and cannot be arrived at by any graphical process that I know of."

"Well, Mr. B——, give me an idea how you do that."

"Well it's like this, Bill, we call the large diameter D, the small diameter d; the radius we will call R and the slant height we will represent by the letter S then

$$R = \frac{D}{D - d} \times S$$

but as yet you don't know the value of S. This value is found by multiplying the vertical distance between the top and bottom of any course by itself; then adding this result to the difference of the top and bottom diameter divided by 2 and multiplied by itself; then extract the square root of the sum, the result will be the slant height or S. Now we will illustrate by taking the small or top course of our roof in our working pro-



Details of layout for conical roof

file and determining the radius for that section, then,

$$R = \frac{D}{(D - d)} \times S$$

22 feet ⅜ inch-9 feet 11⅝ inches
= 12 feet ¾ inch

then,

22 feet ⅜ inch ÷ 12 feet ¾ inch × 7 feet 10 inches
= 14 feet 3¼ inches, the radius of the top course, and Bill the radii for all the courses are obtained by the same method."

"Well, that's fine and dandy. Say, Mr. B——, jot those formulas down on a piece of paper for me, will you?

"Well so long Mr. B——."

"Hold on Bill, I want to test your thinker a little and see what effect the honor of being a great grandfather has on you. Now you know how to find all the radii for the different courses. How would you find the length of the arc formed by the radius on each end of your templates?"

"Oh, of course I would take the diameters as located by the intersection of the parallel rivet line with the original pitch line of the roof and call that the center of the thickness of my plate; then for the small end I would subtract the thickness of the plate and multiply the result by 3.1416; then for the large end I would add the thickness of the plate and multiply the result by 3.1416 and divide these results by the number of plates I want to use in each course. This would give me the length of the arc or circumference of the plate for the corresponding diameter."

"Right you are, Bill! Fine for you! Keep fit Bill, that's all there is to it. But now Bill there are some pretty long radii on this job, how would you get by if we had not detailed those templates for you? Forty-five feet is a pretty shaky distance to scribe a regular radius and even if you did this you might have to give Smith a gang of laborers to help him clear a space for the purpose. Besides that there might be a gang fitting up a job or a gang at marking off plates. In either case, or both, they would have to stop and move their work to another part of the shop which in turn might call for an overhead crane, which might be engaged in holding up a smokebox of a Scotch marine boiler while the fitter-up marks the holes for securing it to the boiler; or he may be in the act of taking a boiler shell from the bull riveter. Any of these moves would add to the cost of production besides causing some unpleasant feelings with the men making the move. We have anticipated these things in some measure and are working to eliminate as much side tracking as possible and that is the secret of doing this detail work in the office. However, we want the boys in the shop to become as familiar with the detailing as possible."

"Well, Mr. B——, I thank you for pointing out to me these possible causes for delay. It's about one man's work to keep things moving in the right direction in a large shop, but as far as striking out those radii is concerned, Smith has several methods for laying off the camber of a plate."

"Yes, I suppose he has, but if Smith has the length of the cord of the arc, and the height of the camber at the center of the arc, he is about finished with his layout when he begins."

"Just how do you find the cord, and the height of the camber, Mr. B.——?"

"In the first place, Bill, you have to find the degrees and minutes in the angle formed by the two sides of your template. To find the degrees and minutes divide the length of the arc by the circumference of the circle corresponding to the radius of your template (suppose you are dealing only with the large end of your template now) and multiply the result by 360, which result is so many degrees and some hundredths over. Multiply the hundredths by 60 and the result is minutes; and if you multiply the remainder of this last operation by 60, you get seconds.

"Now look at a table of natural sines and tangents and find the sine corresponding to half your angle. Multiply this sine just found by the radius and the result is half the cord. Multiply this by 2 and you will obtain the cord as shown by the straight line at each end of each template on the layout. Then consult the same table and find the versed sine; multiply this by the radius of your template and you have the rise of camber for your plate.

"You have just been working from the large end of your template. Now multiply the same sines by the radius of the small end and you have the cord and rise of camber for the small end.

"Now, Bill, you can readily see what advantage there is in making complete, accurate details for large work especially, and the large amount of time it will save in the shop annd the convenience in ordering the material from the mill.

"In the lower right hand corner of the sketch I have described what I believe to be a simple and exact method of laying off the camber of a plate. The cord is divided into four equal parts. I should have said, *half* the cord, and the rise of camber or versed sine represented by the small letters *a, b, c, d,* is divided into 16 equal parts regardless of what the distance might be; then the first one of the four spaces from the center line is 15/16-inch high, the next ¾-inch, the next ½-inch of the total distance represented by *a, b, c* and *d*. Then with a flexible straight edge these points are connected, thus giving us the rivet line on the plate. Study this problem well and be ready for what follows."

Improved Cutting Blowpipe

A NEW cutting blowpipe has been developed by the Oxweld Acetylene Company, New York, which will not back fire under severe operating conditions. The nozzles are interchangeable to be used on

Oxweld type C-14 cutting blow pipe

either low or medium pressure acetylene and the tubes are so designed that no bend occurs either inside or outside the handle. Valves and nozzles are similar to those used on other types of blowpipes manufactured by this concern.

S. L. LANDIS, superintendent of fuel conservation of the Missouri Pacific at St. Louis, Mo., has been appointed road foreman of engines of the Coffeyville, Conway Springs, Arkansas City and Roper districts of the Southern Kansas division, and also of the Kansas City district of the Central Kansas division, with headquarters at Osawatomie, Kan., succeeding H. J. Wade.

A New Locomotive Backhead Brace

Ball joint type brace designed to make inspection and replacement easy

By C. E. Lester

THE accompanying illustration shows a locomotive back head brace designed by the writer for the purpose of overcoming or eliminating some of the objectionable features of the present arrangement of bracing, consisting of double end jaw braces with lugs riveted to the roof sheet and tee irons riveted to the back head.

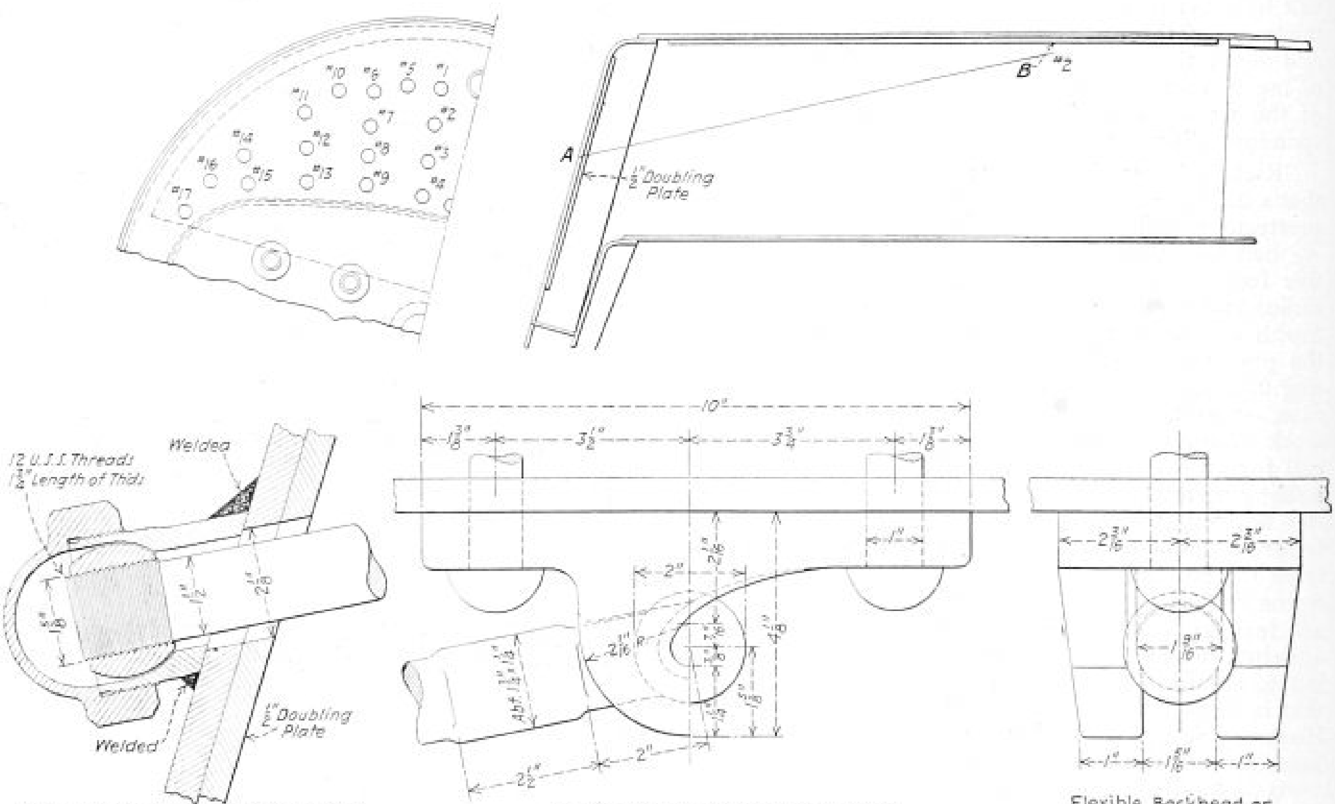
As is well known, on the breakage of a brace of the present double jaw type, a considerable amount of time, labor and material is involved. In case of breakage of one of this type, it is necessary to remove at least 2 complete rows of radial stays and all the labor and material incidental to the reapplication of these parts. Where a large locomotive of the Mallett type is involved, when the defect is found in the engine house and the locomotive is not undergoing shop repairs, this work requires tying up the locomotive for a week or more, and frequently requires the removal of all the draft appliances, superheater units, steam pipes, tee head and dry pipe in order to get the brace out and in again.

The present tee iron arrangement is cumbersome and expensive. The back head is considerably cut up with rivet holes securing the tee irons to the head. The water space is badly congested at points level with the rear end of the crown sheet, interfering with free circulation. The location of water indicating devices is difficult, due to the congestion of tee irons and rivets. There is also the liability of hinderance to the free and continuous access of water to the inlets.

The thorough inspection of the present type of brace is most difficult, uncertain and, therefore not particularly reliable.

Details of Improved Brace

The brace illustrated is not to be considered as interchangeable with the type just discussed. This type can only be used on new boilers or where a new back head is applied. It may be said, in passing, that a 1½ inch brace is about the largest of the jaw type normally used in locomotives carrying about 200 pounds per square inch steam pressure. This also indicates that a 2⅛ inch hole in the back head would be the largest hole required.



Detail Showing Method of Connection at Front of Boiler "A"

Detail Showing Method of Connection at Top of Boiler "B"

Flexible Backhead or Fronthead Brace

Structural and installation details of brace

No attempt will be made here to go into stresses as the details are simply indicative of the general scheme. The details of the brace, however, are approximately correct. Suffice to say that the arrangement of braces can readily be made to come well within the requirements of most locomotive boilers.

The design of this brace is such that after the holding claw is riveted to the roof sheet, the brace can be inserted through its hole in the back head, then carried about 3 inches forward of its final position to the flattened section of the brace, lifted up through the narrow slot in the jaw, then pulled back into position where the balled head of the bolt seats in the socket of the claw. After this, the back head sleeve is passed over the back end of the brace fixed into position, welded fast, the nut applied and adjusted. The bolt is then cut to finished length, the cap applied and the brace is ready for use.

The general design of the claw and the angularity of the brace pull precludes the possibility of a spread of the claw. The expansive movements of the boiler shell and the back head in raising steam would doubtless precede that of the braces which would automatically compensate for any lengthening of the braces and keep them continually in tension. Any type of sleeve may as well be used as the one illustrated.

In the event that a brace should break it can readily be reapplied by removing but two radial stays adjacent to the brace claw and after splitting the nut on the back end of the brace, cut off the sleeve, lift the broken end out of its claw by means of small hooks through the radial stay holes in the roof sheet. The new brace may then be inserted through the hole in the back head, pushed forward and lifted into place, the sleeve adjusted and welded, the nut and cap applied, the two radials put in and the job is done.

Objections may be raised because of covering so great an area of the back head with sleeves and caps. The elimination of nearly triple the number of tee iron rivets that there are sleeves compensates for a great deal of this area in square inches and the generous spacing of rivets and sleeves gives a greater free area for fixtures than is provided by the old method. The effect of cutting the bolt holes in the back head has but little bearing on the efficiency as the proper stresses and loads can readily be determined by the usual formulas. If additional precaution be deemed necessary the back head could be thickened a bit.

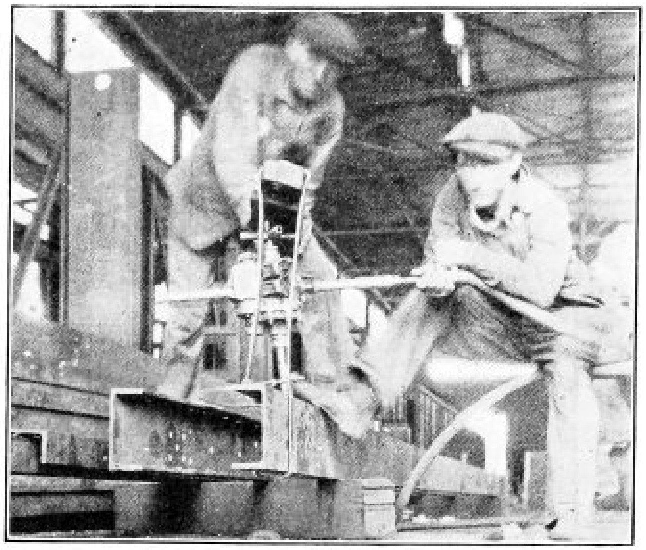
Inspection of the brace is readily and reliably made by the removal of the cap as in an ordinary flexible staybolt. The brace having a ball joint at either end is very flexible.

The principal claims for superiority over the jaw type brace are as follows: Simplicity of construction, fewer parts, cheaper construction, easier, cheaper and more reliable inspection, easier and cheaper application; less liability of breakage due to flexibility, easier and cheaper application in the event of breakage.

The principal thought uppermost in the design of this brace is the great need of a brace that can be readily inspected and in the event of breakage be reapplied with a minimum of inconvenience. The brace can be inspected without entering the boiler and can be renewed in from 3 to 6 hours which seems to fully meet the requirements.

Pressure Lever for Pneumatic Drill

When drilling channel irons which were impracticable to take to the regular drilling machine the handy pressure lever, illustrated was found useful for applying sufficient pressure to the head of the air drill. It is made of a 6-foot length of strong wood on one end of which is attached a steel plate on which to pivot the drill. At the head end of the lever, a 5-foot section of 1½-inch by ¾-inch steel is bolted with one end bent to fit under the upper flange of the channel iron and the other under the lower flange. A similar lever, with hooks of equal length, is used in boring the flat side of the channel iron.



An effective pressure lever used when drilling long channels

1000-Pound Pressure Test

In this age of machinery, the aim has always been to make fool proof mechanisms, machines that will operate with the minimum of human labor. Like human beings, however, there is always the possibility of something going wrong, and as a result mechanical devices today are equipped with countless safety devices that give warning or take care of unusual conditions.

The water column is a mechanical means of warning the power plant engineer that the water in the boiler is too high or too low. Boiler practice has advanced rapidly during the last 10 years and pressures that were once considered prohibitive are now in everyday use. These increased pressures have necessitated radical changes in water column design.

Water columns designed for 650 pounds working pressure are typical of the modern trend in such protective devices. These columns are made of forged steel with walls ⅞-inch thick. This would make it impossible to cast any flanges at the connection points. Naturally, the only way to establish inlet and outlet connections at the desired places would be to weld the flanges to the main body. Where, in low-pressure work, the pipes could be screwed into the main body, at high pressure a screwed joint will not hold, and a typical high pressure flange connection is necessary.

Tests were made to determine whether welding would solve this difficulty. Using high test patented steel rod proved completely satisfactory, and welds made with it withstood the test pressure, which amounted to 1,000 pounds per square inch—*Oxy-Acetylene Tips.*

Archie Lacy has been appointed boiler foreman of the Illinois Central Railroad with headquarters at East St. Louis, Ill. Mr. Lacy was formerly boiler inspector and succeeds W. C. Decker who has been promoted to general boiler foreman.

Mechanical Drawing and Apprentice Training Courses

By Warren Ichler

THE place of the draftsman in industry is too well established to require comment or defense. The question raised here is, whether or not the training in drafting that many apprentices receive, is suited in its entirety to the needs of the average apprentice, who is not interested in mechanical drawing as an end in itself in his training.

It would seem that any consideration of the place and weight to be assigned to mechanical drawing in the training of apprentices will have to begin with the promise that mechanical drawing, the representation of objects by outline only without attempt at perspective, cannot be considered as an adjunct or by-product of any trade, but must always be considered as a trade within itself, affecting all mechanical operations. Probably all too often even draftsmen lose sight of that fact and look upon their work as an indispensable part of some one trade or some group of trades without getting the broader viewpoint of the possibilities of their craft.

Necessarily, most draftsmen are specialty men, but this does not prevent them from acquiring a better understanding of the drafting problems of those industries related to their own special line of effort. By this, is meant, of course, the relative ease with which a finished draftsman can readjust himself to new lines of work as compared with the average mechanic's difficulties in rebuilding his craft knowledge and practices to suit changing conditions. It implies no unique knowledge on the part of the draftsman; rather, it indicates merely a more thorough standardization of the basic requirements of drafting than is possible in other vocations.

A concrete example of the foregoing thought is found in the fact that technically trained men emigrating to a foreign country seem, usually, to look to mechanical drawing as a "beginning job" or "stepping stone" to broader fields of usefulness while they adjust themselves to the language and customs of their new surroundings.

Relation of Mechanical Drawing to a Trade

As a trade, complete in itself, it is obvious that drafting cannot be fully taught in connection with—say blacksmithing or boiler making, or in fact any other trade, when another trade is the objective of the student.

Is it really desirable to do more than to impart a knowledge of how to read drawings quickly and accurately, an understanding of the tools and methods by which drawings are produced and duplicated and an understanding of the geometrical construction problems incident to the draftsman's work? Even so much instruction is rather a large order for any vocational teacher in view of the limited time at his disposal and the writer feels that not much more than the fundamentals outlined above should be attempted in the average training class for apprentices.

There will always be present in any student group those whose mentality, preparatory work and tendencies will render these training requirements too simple and too easy of accomplishment. To such students, harder work can easily be assigned without any disruption of the regular schedule of the class and without undue distraction to the instructor and to less advanced students. Advanced students can always be set to copying more elaborate drawings than those required by the course or to free-hand sketching of mechanisms, or to the designing of simple mechanisms.

We all have to remind ourselves constantly that what we are trying to do for the apprentice is to give him a clear, logical trend of thought, a good conception of the tools with which he has to work, the habit of close observation and quick analysis--mental alertness, and those traits of character which one would naturally associate with the mental and physical equipment just outlined. Since all of these things are duplicated to a certain extent in the apprentice's trade education other than his studies of mechanical drawing it is hardly necessary to do more than to point out the duplications to defend what has been said in favor of limiting the drawing courses.

Why Drawing Courses Should Be Limited

Beginning with the physical equipment and requirements of a finished craftsman, it must be noted that while mechanical drawing makes somewhat the same demands of deftness of hand and keenness of perception as do the craft standards of the average trade certainly such time as the average apprentice can spend in classroom work will not greatly enhance his natural physical equipment in these qualifications. Manual dexterity or analysis of a layout problem may not be so apparent in the shop as in the drafting room, but they are present in a high degree of perfection in every skilled mechanic.

The writer feels as much of a sense of satisfaction, for example, in the handling and "feel" of a pair of calipers as in the mastery of the compass and ruling pen of the draftsman and it is a fair assumption that this feeling is shared by all mechanics who have any sense of pride in their trade.

Simple mathematical operations, as may be necessary to the average drafting problem assigned to apprentices can as well be taught in a more limited survey of the subject;—say a course in blue-print reading.

One has to consider the design problems of drafting-rooms to cite examples where mathematical training, beyond that received in the average apprentice period, is an essential, and for those who desire such training beyond and aside from the regular apprentice courses, tutoring, night-schools, correspondence and university extension courses are nearly always available.

One of the beneficial results sometimes claimed for an extended teaching of mechanical drawing to apprentices is clarity of expression. One has only to ask the average draftsman to describe one of his own drawings to find out how little of that sort of ability he has acquired. The average shop man can give a better word-picture of almost any mechanism than can the average draftsman.

It would seem to be of doubtful value to offer or to insist on more than the mere fundamentals of mechanical drawing in apprentice classes. This view will not be popular because these courses are comparatively easily taught and are usually popular with apprentices. They are "showy" and create a good impression upon executives charged with the casual supervision of this sort of schooling.

Causes and Prevention of Corrosion*

Explanation of theory—Suggestions for treating feed waters—Corrosion resisting metals

By C. R. Texter †

CORROSION in the various parts of steam generating equipment such as feed water heaters and lines, economizer tubes, boiler tubes and plates, is often a cause of considerable expense and annoyance and unless measures are taken to guard against it, might under certain conditions cause rapid failure. In spite of all the precautionary measures taken, it is frequently noticed that corrosion in some cases is worse today than a few years ago. This is particularly true in locomotives where it is more difficult to control conditions than in stationary boilers. Therefore, many operators have been led to the conclusion that modern made pipes and tubes and other metal parts in a boiler plant are not as resistant as those made a few years ago. Such an attitude is manifestly unjust when it is considered that a number of factors have combined to make conditions increasingly more severe during the past few years. Before enumerating these factors it will be profitable to spend a little time in a brief discussion of the theory of corrosion in boilers.

The Theory of Corrosion

The electrochemical theory has been generally accepted as the one which best explains the facts of corrosion. Iron, like all other elements, has a definite, inherent tendency to go into solution when placed in contact with water. Furthermore, water dissociates into hydrogen ions and hydroxide ions. As the iron immersed in water goes into solution, it unites with the hydroxide ions of the water to form iron hydroxide. This reaction results in the liberation of hydrogen which gathers on the surface of the iron in the form of a thin, invisible film.

This film protects the metal from further solution or corrosion unless removed by some external force. This can happen in two ways: the hydrogen either may combine with the oxygen which is dissolved in most natural waters, or it may escape as gaseous hydrogen. The process is then free to continue at a rate determined by the speed with which the hydrogen is removed.

In acids, or in water containing appreciable quantities of acid, the tendency for hydrogen to plate out is much greater than in pure water and so much of it gathers on the metal surface that it is forced off in the form of bubbles. Corrosion, therefore is proportionately more rapid in acid solutions than in natural waters. In practically all boiler waters, however, the amount of dissolved oxygen is the controlling factor, although other factors are of considerable importance as will be explained later.

Boiler corrosion, as in the case of many other forms of corrosion, is rarely uniform over the entire surface of the metal and pitting is the result. This is the most destructive form of corrosion and is caused by one or more factors. Dissimilar metals in contact, such as iron and copper, set up what is known as galvanic action and pitting is the result. Impurities in the metal and strained portions of the metal will also increase the localization of corrosion. Variation in concentration or in composition of the waters in boilers tends to localize corrosion at certain areas of the surface and retard the action at others. Thus it is found that pitting is frequently intensified around the rivets and seams of a boiler where the circulation of water is poor and "concentration cells" are set up.

Factors Which Are Becoming More Severe

Chief among the factors affecting corrosion is the chemical composition of the water supplies. The concentration of population and the establishment of industrial plants on the banks of our principal rivers and lakes has so altered natural conditions that the water in many of these rivers and lakes is considerably more acid than was the case a few years ago. This is due to contamination by acid waste from galvanizing plants, coal mines, paper mills and dye works. The acidity of water supplies is also increased by the decomposition of organic matter in sewage from cities. It is needless to say that the more acid a water the more corrosive it becomes, if other conditions remain the same.

Another factor tending toward more severe corrosion in boiler plant equipment is the higher rating of boilers. There seems to be an increasing tendency to obtain more and more horsepower from boilers, which means that more water must be evaporated and therefore more water passed through all the various equipment in connection with the boilers. Since corrosion depends, among other things, upon the amount of water passing through the system, corrosion will be considerably more severe at the higher ratings than at the lower ones.

Another tendency in modern boiler practices and one which is coincident with higher rating, is to increase the pressures and consequently the temperatures. Since corrosion increases proportionately with temperature, this is another factor combining with the others mentioned to make conditions under present day practices more severe than under those of a few years ago. Much more might be written regarding the increased severity of corrosion factors but it is believed that enough has been said to show that conditions are worse today than ever. It will be more profitable to spend our time in discussing methods of controlling or changing these conditions and thus minimizing corrosion troubles if not entirely preventing them. Since it is manifestly impractical to stem the march of progress and have operators reduce pressures and temperatures as a means of minimizing corrosion, endeavors must be limited to more complete water treatment and oxygen removal and of course to careful selection of materials and their proper handling.

Boiler Water Treatment

The fact has been fairly well established that corrosion in general is less severe in hard water districts than in soft water districts. This is due to the fact that the hard waters are endowed with the propery of forming scales, many of which are protective. They prevent water from reaching the metal surface. However, although this might be a virtue under some conditions.

* Paper read at the 1927 meeting of the National Board of Boiler and Pressure Vessel Inspectors.
† Metallurgical Engineer, National Tube Company, Pittsburgh, Pa.

such as in hot water plumbing lines or even in feed water heaters, the presence of any great amount of scale in boilers is generally objectionable. Their presence not only reduces the efficiency of the boiler as a steam generating apparatus, but some of them, particularly the sulphate scales, actually increase pitting underneath their surface. Therefore softening of hard waters for boiler-use is almost universally practiced.

It is not the intention of this paper to discuss water softening to any greater extent than to state that the basis of practically all the chemical softening compounds is soda ash or soda ash and lime. The both have an alkaline reaction in water and therefore the very softening of waters for boilers incidentally neutralizes or counteracts the acidity which might be present in the water supply. It might be well to mention that the zeolite or base exchange method of softening water does not remove acids and therefore if present they should be neutralized by some other means. The general practice is to use the so called pretreatment method, which comprises partial softening by means of lime and soda ash before passing the water through the zeolite apparatus. This pretreatment not only removes any possible free acid, but also the half bound carbonic acid in the form of bicarbonates.

Treating for Acidity

Since naturally soft waters obviously do not require the addition of lime or soda as a scale preventive, any acidity must be specifically treated to prevent corrosion in boilers and feed water equipment. The common plan and perhaps one of the most efficient is to neutralize the acidity by means of caustic soda or soda ash. The amounts to be used cannot be given because the acid content varies so widely and consequently a local chemist should be consulted. Enough caustic soda or soda ash should be added to keep the water distinctly alkaline. The mere neutralization of acidity in a boiler water by no means entirely prevents corrosion. It does however considerably minimize the trouble, but so long as dissolved oxygen is present in the water, corrosion will continue.

The use of excessive alkalinity from either soda ash or caustic soda introduces a tendency toward foaming. Furthermore the presence of large amounts of caustic soda or soda ash in high pressure boilers is reported to cause embrittlement of steel. Authorities differ upon the explanation of embrittlement in boiler parts, but it undoubtedly is a certain form of corrosion. In locomotive boilers some railroads have adopted the plan of carrying an hydroxide alkalinity up to a concentration of 10 grains per gallon, with encouraging results. It should be remembered however that locomotives are working under somewhat unfavorable conditions and they can not conveniently carry heavy equipment for the prevention of corrosion.

Oxygen Removal—Deaeration

The varying demand of changing times is bringing us more and more to the use of evaporated water in modern boiler plants and as a result no protective films are formed by the water and corrosion is often severe. Experience has demonstrated however that if pure evaporated water contains no dissolved oxygen there will be no corrosion. Therefore deaeration is practiced in a great many modern power plants.

A carefully operated open feed water heater, operating at or near the boiling point of water will remove the dissolved oxygen to a residual amount of about 0.5 cubic centimeter per liter. This small amount of oxygen will not cause much damage if the water contains a little hardness. If however evaporated water is employed, the oxygen must be reduced to about 0.03 cubic centimeter per liter in order to insure proper protection. This oxygen removal can be accomplished only by the use of specially constructed deaerators which operate under a partial vacuum. Deaerators further recommend themselves by the fact that they operate at temperatures considerably lower than the boiling point of water and thus the efficiency of the economizer tubes is not lowered.

Selection of Materials

Although it is true that the subject of corrosion prevention is more successfully handled from the standpoint of water treatment, nevertheless attention should be given the kind of material used. Seamless tubes are now employed in most boilers and there seems to be some question as to whether cold drawn or hot rolled tubes should be used. Although there are no definite data upon this point, yet the indications are that cold drawn tubes ar esomewhat more susceptible to pitting than hot rolled tubes. Therefore it would seem advisable, wherever possible to use the hot rolled tubes. Considerable research is being carried on by the railroads on this point. Various alloy steels have been tried for boiler tubes and for the firebox and boiler plate. However there does not seem to be anything which will economically substitute the standard material. Stainless (high chromium) steel is resistant to corrosion under many conditions, but the expense precludes its use for any except specialized purposes.

Water Treatment for New Boilers

During the construction and installation of new boilers, more or less grease finds its way into the plates and tubes. This should be removed by adding 2½ pounds of soda ash per 1,000 gallons of water and boiling with a slow fire at atmospheric pressure for a period of at least 48 hours. After emptying the boilers they should be thoroughly washed out with clean water applied by a hose at high pressure.

Corrosion of New Metal

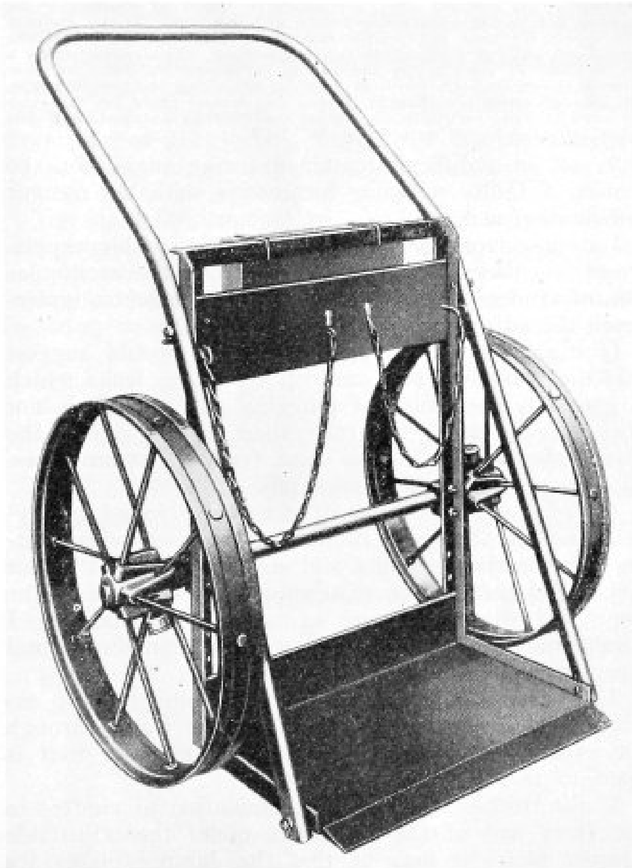
The clean unprotected metal is likely to corrode rapidly as, for example, in new boilers or in boilers which have been retubed or turbined. After the boilers have been thoroughly cleaned, by the above method, about 10 pounds of lime for every 30,000 pounds water capacity should be mixed with the cold water and run into the boiler, and from 4 to 6 pounds of lime, as milk of lime, for every 30,000 pounds water capacity should be added each day for not longer than 6 days. Milk of lime is a mixture of about 1 pound unslaked lime, or 1 1/3 pounds of hydrated lime, with 1 gallon of water. Lime additions are made, as a rule, only when the boilers are new or after retubing. The lime treatment should be completed before any other treatment is applied to the water. Lime is soluble to about 90 parts per million at 200 pounds boiler pressure (382 degrees Fahrenheit), so that the excess over this amount will be deposited as a soft scale on the metal or as sludge.

The action of the water is concentrated on areas from which the mill scale has been removed and, if this is a small portion of the whole surface, pitting may result. More uniform corrosion and longer life of the tubes may often be obtained by first pickling them free from scale, and then washing them in warm water and in milk of lime before they are installed.

New Oxy-Acetylene Truck

A NEW type two-wheel truck has been put on the market by the Oxweld Acetylene Company of New York. The feature of this new truck is the increased size of wheels to facilitate handling of the truck. Improvements have been made in the handle, wheels, hubs and grease cup lubrication is provided. The truck is provided with a tool box and may be supplied with 14 or 24-inch wheels.

The illustration shows the truck equipped with 24-inch steel wheels, having 3 by 3/8 inch grooved tires

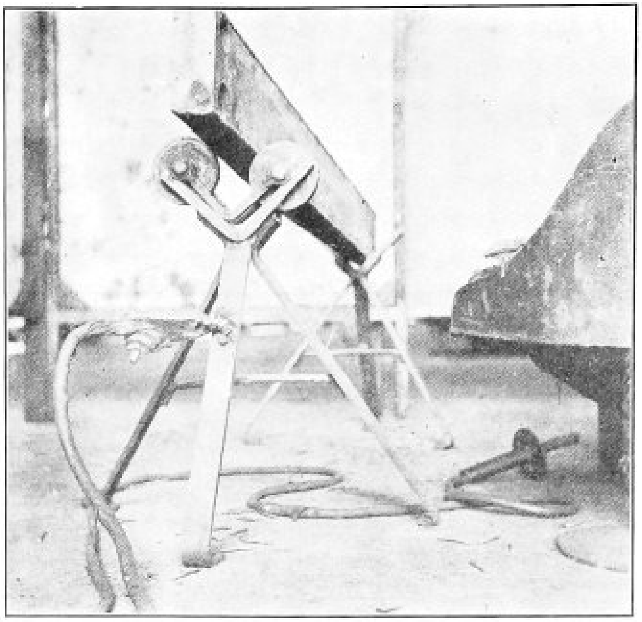


Truck with 24-inch wheels

and a cast iron hub. The hub is bored to fit the cold rolled steel axle and a grease cup is provided. Lubrication is of particular importance in field work where the truck may be hauled long distances at fairly high speed behind a motor truck.

Light Steel Trestles Make Welding Easier

AT the Denver shops of the Denver & Salt Lake, the light steel trestles, shown in the illustration, were found a great help in welding long and heavy materials which are difficult to turn when making a circumferential weld. The trestles are made of three 18-inch sections of ½-inch by 1½-inch steel, with the top ends turned outward and the bottom ends turned inward. The three pieces are welded together to form a tripod. A 20-inch section of 1-inch square steel



Two steel trestles used for welding long, flat or circular material

bent to a vee-shape, is welded into the top of the legs. The trestles are used in this form for flat material unless it is desired to weld round material, when two pairs of 3-inch rollers each held in a vee-shaped frame, are dropped into the top of the frames. The ground wire from the welding machine is attached to one of the trestle legs. The legs of the trestles are stiffened by a brace.

Safety Education

THE PROGRAM of the Committee on Education, of the Safety Section, A. R. A., for the month of February, emphasizes that part of the accident record which includes cases due to unsafe practices in shops, etc. A large colored bulletin has been issued illustrating some of the things which the careful man will avoid.

Noting the fact that 20 percent of all accidents under this head occur in the use of hand tools, the circular notes that many bruises and broken bones result from using ill-fitting wrenches. Make-shift scaffolds appear frequently in the records; a workman needs a safe scaffold for a job of five minutes, the same as he does for one of two hours. Tools falling from places where they have been left carelessly as on the running board of a locomotive, cause shop accidents. It is suggested that members of safety committees, specialize on this particular item for 30 days. The goggle problem is yet unsolved in many shops and attention is called to the successful results in shops where a man neglecting to wear goggles, when necessary, incurs liability of being dismissed.

J. H. WINFIELD, General inspector of the Eastern district of the Erie at Hornell, N. Y., has been appointed master mechanic of the Delaware and Wyoming divisions of the Erie and the Wilkes-Barre & Eastern Railroad, with headquarters at Port Jervis, N. Y., succeeding W. E. Harmison.

B. C. NICHOLSON, general foreman on the Parsons district of the Missouri-Kansas-Texas at Oklahoma City, Okla., has been promited to master mechanic of the Northwestern district, with headquarters at Wichita Falls, Tex., succeeding R. A. Walker.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by C. J. Zusy

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.*

Weight of Water in a Boiler

Q.—Suppose I have a boiler which when full of water to normal working level holds 5 English tons (11,200 pounds), how much water will it hold at 100 pounds pressure? Can you give me method of calculating water in a boiler at pressure? L. J.

A.—In order to calculate the weight of water in a boiler under pressure it is necessary to know the volume and temperature of the water.

We would assume the weight of the water in the boiler when full to the normal water level is 11,200 pounds and that the temperature of the water at atmospheric pressure is 62 degrees Fahrenheit (the temperature ordinarily taken for cold water when the actual temperature is not known). The weight of pure water at a temperature of 62 degrees Fahrenheit is 62.355 pounds per cubic foot; then the volume of water in the boiler is $11{,}200 \div 62.355 = 179.6$ cubic feet.

Knowing the number of cubic feet of water space in the boiler up to the normal working level, it is an easy matter to calculate the weight of water at any temperature when the boiler is filled to that level.

The temperature of the water can be found directly from the steam pressure. Steam is water vapor and when in the saturated state and in contact with the water, a given pressure can exist only at a certain temperature, for example, a steam pressure of 100 pounds absolute per square inch can exist only at a temperature of 328 degrees Fahrenheit. Assuming the boiler pressure to be 100 pounds per square inch gage and the atmospheric pressure at sea level 14.7 pounds per square inch; then $100 + 14.7 = 114.7$ pounds per square inch absolute pressure.

By referring to a saturated steam table, which can be found in most text books, we find that the corresponding temperature to an absolute pressure of 114.7 pounds is 338 degrees Fahrenheit.

The weight of water per cubic foot decreases as the temperature increases that is, over a temperature of 39.2 degrees Fahrenheit. At a temperature of 338 degrees Fahrenheit the weight of water per cubic foot is 56 pounds. The weight of water per cubic foot at various temperatures is found by reference to tables in text books.

The boiler as we previously found contains 179.6 cubic feet of water space up to the normal water level; then the weight of water at 100 pounds gage pressure is $179.6 \times 56 = 10{,}057$ pounds.

Steaming of Engines

Q.—Will you give me some information in regard to steaming of an engine as I have had considerable trouble with one here? It is a Baldwin 1911 type. We have had several experienced men here to investigate, but did not get any results from their suggestions. This engine makes a run of about 30 miles a trip and has to be cleaned out twice or more times in the front end. We tried lowering or raising the petticoat pipe, also reduced nozzle tip, changed screen, etc., several times but this does not seem to help. We also have tried the Baldwin Locomotive Works theory. Hoping for an early reply.—W. J. W.

A.—It is a difficult matter to make suggestions to remedy a faulty steaming locomotive with the meager information at hand.

I assume from your inquiry that the trouble experienced is either the netting plugging or the accumulation of cinders on the bottom of the smokebox underneath the adjustable damper plates.

If the trouble is plugged netting, I would suggest that the front end be examined for steam leaks which is generally the cause of plugging netting. It is not always leaks from the tube sheet which causes the trouble, but at times leaks come from the steam pipes, superheater units and exhaust pipe.

All of these leaks can of course be found by hydrostatic test, but care should be exercised when testing the superheater units and steam pipes as it is not considered good practice to subject these parts to the same hydrostatic pressure as is given the boiler. I would limit this pressure to not more than the normal steam pressure.

The exhaust pipe can be tested by plugging the exhaust pipe at the top and injecting the water through the cylinder cock at the end of the cylinder that is open to the exhaust.

If the trouble lies in the accumulation of cinders in the front end of the smokebox under the adjustable damper plates it may be that the damper plates are located too high above the bottom of the smokebox or the damper plates may be too far from the front of the smokebox. Try lowering the damper plates or extending the table plate toward the front of the smokebox.

The front end should also be examined for air leaks which often cause a serious loss in draft and may be responsible for the excess accumulation of cinders.

Bursting Pressures of Tanks

Q.—Why does a steam boiler require staybolts to reinforce it so that it will not burst, when an air tank has no bolts to reinforce it and does not burst? Also, how is one horsepower determined? Any information you may be able to give me will be greatly appreciated. R. E. W.

A.—Any cylindrical object when under an internal pressure does not require staying for the simple reason that the pressure assists the object in keeping its shape and results only in a tensional stress which can be kept within the required limits by making the sheet the proper thickness.

The staying of vertical firetube boilers is not for the purpose of supporting the shell but the stays are applied to support the inner or firebox sheet which is under an external pressure. While it is true that external pressure would not tend to change the shape of a perfect cylinder, it is impossible to obtain a perfect cylinder in practice. In boiler work the inaccuracies are very pronounced and therefore the cylinder is in danger of collapsing especially in the large diameters and therefore staybolts are required to support the cylinder which is under external pressure.

One horsepower is the equivalent of 33,000 foot pounds of work done in one minute. The term boiler horsepower as applied to boilers is not a measure of power but rather a measure of evaporation.

One boiler horsepower is equal to an evaporation of 34.5 pounds of water per hour from and at 212 degrees Fahrenheit.

At the present time manufacturers of stationary boilers generally consider 10 square feet of heating surface sufficient to evaporate 34.5 pounds of water per hour from and at 212 degrees Fahrenheit. A boiler having 1,000 square feet of heating surface would be considered a 100 horsepower boiler.

The maximum capacity of a boiler can only be determined by a boiler test and the boiler horsepower rating as given above which is generally adopted by stationary boiler manufacturers is simply a matter of convenience in rating boilers.

Circular Patches

Q.—Will you give me a formula for figuring the strength of circular patches? Ten-inch diameter patch (rivet diameter) on a 60-inch outside diameter boiler; ¾-inch patch by ¾-inch steel shell. One-inch diameter steel rivets and 1 1/16-inch holes; boiler pressure 200 pounds. The patch is put over the old shell and riveted to it—the old shell not being cut out. Hoping to receive this from you in the near future as the information is handy at this particular time. This patch is put on around a boiler check hole (3 inches in diameter) after the shell starts cracking around it.—W. J. N.

A.—I am unable to locate any rule in the boiler codes that specifically covers the method of calculating the strength of circular patches. There is, however, a rule in the A. S. M. E. Boiler Construction Code covering rules for the construction of boilers of locomotives which covers the reinforcing of injector holes as follows:

Rule L-58. All holes for injector checks, whistle and safety valves when screwed into boiler and all holes in boiler barrel, firebox, roof sheet and all unstayed surfaces when diameter of hole is over 3¼ inches and exceeds 4½ times the thickness of the plate, must be reinforced with a liner or flange riveted to boiler.

The thickness of the liner or flange must be at least 75 percent of the thickness of the plate. The rivets must have a shearing strength of at least 82 percent of the tensile strength of the metal removed.

In my opinion this rule does not adequately cover circular patches as it would not be possible to design a circular patch that would meet the requirements of the above rule and it would be of such poor proportions as to create an unsafe condition.

Fig. 1 represents a typical circular patch which has been generally used in the past for patching injector check, washout plug holes, etc., when small cracks have developed around the hole.

If circular patches are calculated by the following method there can be no question as to their safety.

The patch should be designed so that the efficiency of the patch is equal to the efficiency of the longitudinal seam in the same course.

The efficiency of the patch is the ratio which the strength of the patch bears to the strength of the solid plate equal in width to the diameter of the patch.

In the following description every method of failure is considered although it is apparent that some of the methods will not give the lowest efficiency of the patch shown. This is done to clearly illustrate the procedure necessary when calculating circular patches as the efficiency of patches of different diameters and containing a varying number of rivets may be found by different methods of failure.

Let D = diameter of patch in inches.
D_1 = diameter of rivet holes in inches.
D_2 = diameter of hole in boiler for check or plug in inches.
t = thickness of shell plate in inches.
t_1 = thickness of patch in inches.
T = tensile strength of boiler steel.
S = shearing strength of rivets.
C = crushing strength of steel plate.
d = pitch of rivets in inches.
d_1 = distance between center of rivet holes and line representing diameter of patch in inches.
d_2 = distance from center of rivet hole to end of crack in inches.
d_3 = distance from center of rivet hole to center of patch in inches.

This patch may fail in the following ways:

Case 1.

Tearing of plate through 4 rivet holes around outside of patch as shown in Fig. 2.

The Locomotive Inspection Bureau has ruled that it is not necessary to calculate the efficiency through a row of rivets containing less than four rivets.

Resistance to failure $= [(3d + 2d_1) - 4D_1] \times t \times T$

Case 2.

Tearing of plate through 6 rivet holes around outside of patch is shown in Fig. 3.

Resistance to failure $= [(5d + 2d_1) - 6d_1] \times t \times T$

Case 3.

Tearing of plate through 8 rivet holes around outside of patch as shown in Fig. 4.

Resistance to failure $= [(7d + 2d_1) - 8d_1] \times t \times T$

Case 4.

Tearing of plate through rivet holes to cracks as shown in Fig. 5, plus the shearing strength of 6 rivets in single shear.

Resistance to failure=

$$[(2d_1 + 2d_2) - 2D_1] \times t \times T + D_1^2 \times 0.7854 \times 6 \times S$$

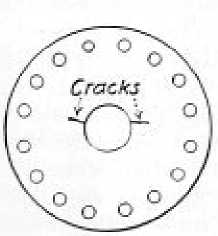


Fig. 1

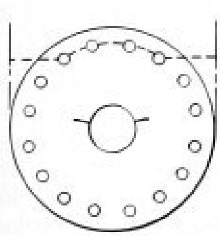


Fig. 2

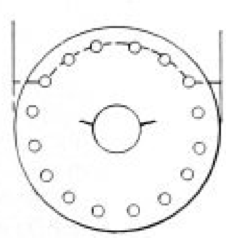


Fig. 3

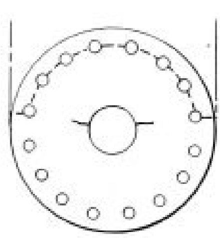


Fig. 4

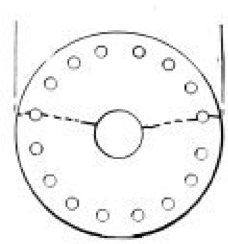


Fig. 5

Case 5.

Tearing of plate through rivet holes to cracks as shown in Fig. 5 plus the crushing strength of patch in front of 6 rivets.

Resistance to failure =

$$[(2d_1 + 2d_2) - 2D_1] \times t \times T + 6 \times D_1 \times t_1 \times C$$

Case 6.

Tearing of plate through rivet holes to crack as shown in Fig. 5 plus strength of patch through rivet holes to check or plug hole.

Resistance to failure =

$$[(2d_1 + 2d_2) - 2D_1] \times t \times T + [(2d_1 + 2d_3) - (2D_1 + D_2)] \times t \times T$$

Efficiency of patch equals least value obtained in case 1, 2, 3, 4, 5 or 6 divided by $D \times t \times T$.

In order to meet the requirements of the A. S. M. E. Boiler Code the thickness of the patch would have to be at least 75 percent of the thickness of the boiler plate and the rivet shear $D^2 \times 0.7854 \times 8 \times S$ would have to be at least equal to $0.82D \times t \times T$.

Steam Traps

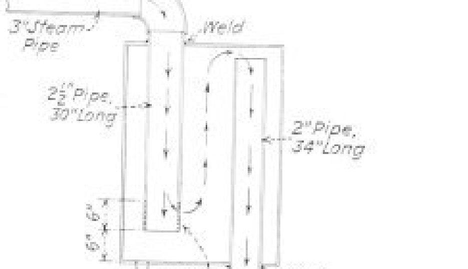
Q.—Enclosed find sketch of a steam trap which I made but which is not working entirely satisfactorily. We have an 8-inch horizontal pipe line furnishing steam to radiators and a steam hammer. Considerable water is always in the steam hammer, therefore we made a trap 10 by 36 inches and placed it in a vertical position attached to a 3-inch horizontal pipe line. As you will note, the inlet is reduced to 2½ inches and extends to within 6 inches of the bottom, but is entirely closed at the bottom and has sixty-four 7/32-inch holes in 2/3 circumference extending 6 inches from the bottom. The outlet is 2-inch pipe and extends to within 2 inches of the top of the trap. A ½-inch drum is placed directly under the inlet; this removes some of the water, but not as much as we thought it would, as a considerable amount is still being carried over into the steam hammer.

Is the inlet too close to the bottom? Should the steam escape out of the bottom instead of the side, or could a baffle be put inside to prevent the steam from carrying the water with it?

Any information you can furnish relative to this subject will be appreciated.—L. J. F.

A.—The sketch which you furnished is not what is known as a steam trap, but is a steam separator.

To obtain the best results, the steam separator should be placed as close to the steam hammer as is practical. The separator will then not only act as a steam separator, but will also act as a steam reservoir and will help to maintain a steady flow of steam to the hammer. In addition to delivering dry steam to the hammer, the separator will also provide storage space in case of a sudden influx of water which might be too great for the regular drainage system to handle.



Shop made steam trap

To improve the separator which you state is not performing satisfactorily, I would suggest that same be altered as follows:

A sloping baffle plate should be applied about 8 inches from the bottom of the separator with about a 2-inch slope. The high side of the baffle should be under the inlet pipe. The baffle plate should extend to within about ¼ inch of the side of the separator to allow the water to drain into the bottom of the separator. The inlet pipe should be left open at the bottom to insure an unrestricted flow of steam and the end of the pipe should be about 2 inches above the baffle plate.

The outlet pipe should be placed in the top or on the side as near to the top as possible.

The inlet and outlet pipes should be of the same diameter.

Boiler Heating Surface

Q.—Please inform me the correct way to find the area of the heating surface of a boiler. Would be pleased to find answer in your valuable journal, THE BOILER MAKER.—H. S.

A.—The heating surface of a boiler is that part which is exposed to the products of combustion on one side and available for the evaporation of water on the other and is always expressed in square feet.

In locomotive type boilers the heating surface is usually divided into firebox heating surface and tube heating surface.

The firebox heating surface is the outside of the firebox sheets. The heating surface of the combustion chamber and arch tubes is usually included in the firebox heating surface. It is the area calculated from measurements of the firebox sheets, above the level of the grates. less the total fire area of the tubes, the area of fire doors and the area of air inlets through the firebox sheets.

The heating surface of the fire tubes is the outside area of the tubes between the tube sheets and is found by multiplying the outside circumference of the tube, in feet, by the distance between the tube sheets, in feet and by the number of tubes expressing the result in square feet.

Double Riveted Girth Seams

Q.—Why are the girth seams on a marine boiler double riveted, and the same size boiler land operated single riveted?—H. M.

A.—The strength of the circumferential seams is based on the design of the boiler. The manner in which the heads of the boiler are supported is one of the conditions that must be considered when deciding the proper strength of the circumferential seams.

The various boiler codes do not indicate any rules that would require the difference in construction which you state exists.

If you will furnish prints of two boilers of the same proportions operating under the same steam pressure one stationary and the other marine, the marine boiler having double riveted circumferential seams and the stationary boiler having single riveted seams, I will endeavor to explain why one has single riveted circumferential seams and the other double riveted.

Ashpan Openings

Q.—I would appreciate a little information as to what proportion is used in determining the openings required in ashpans to a certain grate area—for letting the air to facilitate combustion.—W. J. N

A.—Openings in ash pan for the admission of air should be arranged so that the clear unobstructed area is at least 100 percent of the gas area of the tubes.

DON NOTT has been appointed assistant master mechanic of the Galesburg division of the Chicago, Burlington & Quincy, with headquarters at Galesburg, Ill.

Associations

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

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

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Statistician—L. C. Peal, Nashville, Tenn.

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

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

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

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

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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,

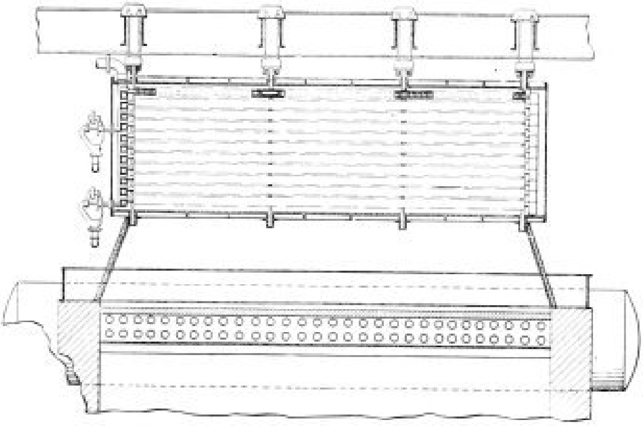
Washington Loan and Trust Building,

Washington, D. C.

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

1,632,291. EUGENE S. HIGHT, OF PEORIA, ILLINOIS, ASSIGNOR TO POWER SPECIALTY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK. ECONOMIZER BOILER.

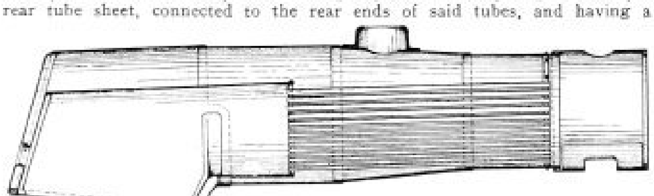
Claim—In an economizer boiler unit, the combination with a watertube boiler and its housing having a heating gas outlet at the top of the housing adjacent one side of the latter of an economizer located above the boiler and comprising a housing having a heating gas inlet adjacent said one



side of the boiler and a heating gas outlet adjacent the opposite side of the boiler and spaced away from the top of the boiler housing to provide a heat insulating space, a conduit for passing heating gases from the boiler outlet to the economizer inlet closing one side of said space, and heat insulating walls closing the other side of said space. Five claims.

1,634,787. JOHN R. MAGARVEY, OF SCHENECTADY, NEW YORK. STEAM BOILER.

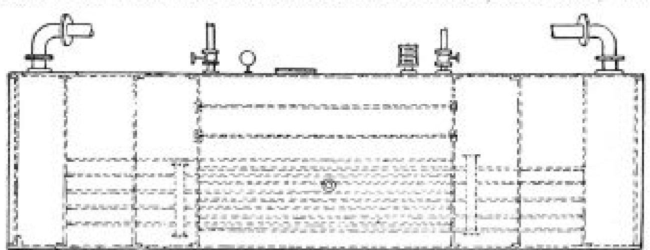
Claim—In a tubular steam boiler, the combination of a plurality of fire tubes; a front tube sheet, connected to the forward ends of said tubes; a rear tube sheet, connected to the rear ends of said tubes, and having a



flange turned inwardly, that is, on the water side thereof, from its top to the commencing point of its connection to the boiler shell, and turned in reverse direction for the remainder of its depth; and rivets, connecting said tube sheets to the boiler structure.

1,633,398. WILLIAM DONALD, OF GLASGOW, SCOTLAND. STEAM BOILER AND EVAPORATOR.

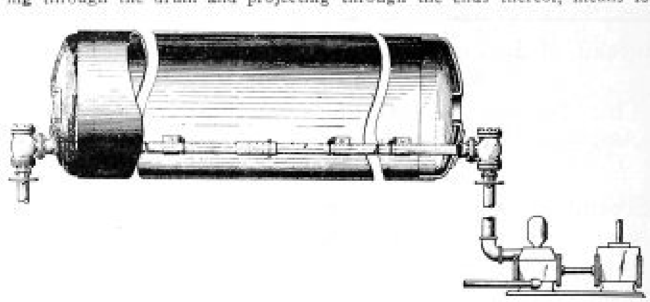
Claim—An apparatus for steam raising, boiling and evaporating liquids comprising a horizontal boiler, fire tubes extending longitudinally therethrough, smoke boxes at each end of the boiler, firing chambers located intermediate between the boiler ends and smoke boxes, substantially half



of said tubes extending from the firing chamber at one end of the boiler to the smoke box at the other end thereof, and the remainder of the fire tubes extending from the other firing chamber to the smoke box at the other end of the boiler, and burners located in both firing chambers to simultaneously supply heat to the fire tubes which terminate therein. Eight claims.

1,632,301. NATHAN E. LEWIS, OF PLAINFIELD, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY. STEAM-BOILER FEED.

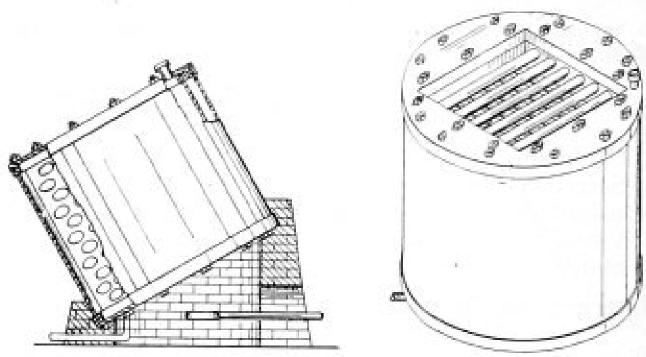
Claim—In combination, a drum for a steam boiler, a feed pipe extending through the drum and projecting through the ends thereof, means for



forcing feed water to each end of the pipe, and means for discharging the water from the pipe at a plurality of points longitudinally thereof into the drum. Seven claims.

1,633,663. EDWIN A. HARDISON, OF LOS ANGELES, CALIFORNIA, ASSIGNOR TO FIRST NATIONAL BANK & TRUST CO., OF SANTA PAULA, CALIFORNIA. HIGH-PRESSURE STEAM BOILER.

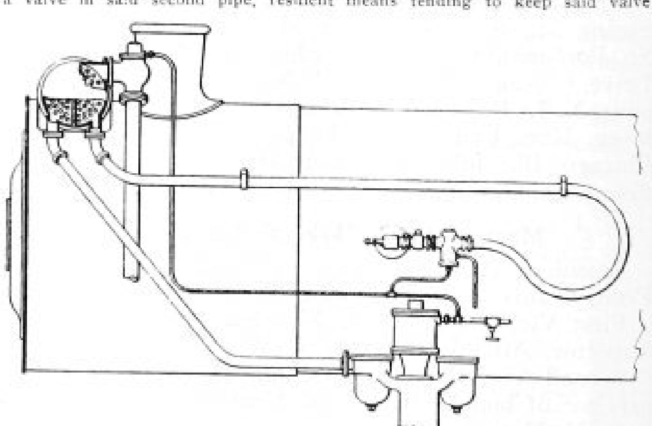
Claim—A steam boiler of the character set forth comprising a shell and two heads therefor to form a container, said heads provided with orifices and inner and outer grooved flanges; a flue open to said orifices and being



formed with four flat sides having ends seated in said inner grooved flanges, said flue forming with said shell a chamber therebetween; criss-cross tubes for said flue communicating at their ends with said chamber; a flanged beam secured to the crown of said shell and forming a track; and a carriage secured to said flue and having an anti-friction trolley adapted to travel on said track to facilitate removal of the flue container when one of the heads is detached. Two claims.

1,633,947. NEAL TRIMBLE McKEE, OF BRONXVILLE, NEW YORK, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y. FEED WATER HEATER ARRANGEMENT.

Claim—In apparatus of the class described the combination of a feed water heater for heating water for a boiler, a pipe to supply water to it, a second pipe to carry the water from the heater to the boiler, a third pipe delivering exhaust steam to the heater, a steam-driven pump delivering water to the first pipe, a valved steam-pipe supplying steam to the pump, a valve in said second pipe, resilient means tending to keep said valve



closed, steam-actuated means to open it in opposition to said resilient means, a pipe connecting said steam actuated means to the pipe supplying steam to the pump so that the steam actuated means receive steam only when the pump does, a valve in the pipe supplying heating steam to the heater, resilient means tending to close it, steam actuated means holding it open in opposition to the resilient means, and a conduit to supply steam to the last named steam actuated means at times when the pump is receiving steam; whereby no steam reaches the heater at times when the pump is not receiving steam. Two claims.

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Contents

Boiler Shop Kinks Prize Awards

THE award of the "Boiler Shop Kinks Contest" prizes as announced elsewhere in this issue has been made after a careful study of all the kinks submitted by a board of five disinterested judges. The award of the first prize of $50 to L. M. Tuthill, production department and D. P. Smith, boiler shop foreman, Chicago, Burlington and Quincy Railroad, who collaborated on the winning two kinks, was a unanimous one.

The system developed in the Havelock, Nebraska, shops of this railroad for reclaiming boiler flues shows a reduction in labor cost of 22 percent for small tubes and 34 percent for superheater flues. This saving in itself is certainly worth while and can be duplicated in practically any shop by the use of similar methods. In addition to this saving, however, the ingenuity shown in the handling of tubes and flues from one safe ending operation to the next, by means of a series of pneumatic jacks and inclined racks without manual labor deserves recognition.

The same degree of originality was exercised in the development of the "Portable Tapping and Reaming Machine" which constitutes the second of the two first prize kinks. The labor saving in this case is high and the machine offers a wide range of possible application as evidenced by the uses to which it is being put at the Havelock shops.

The second prize award of $35 was made to N. W. Martin, general boiler foreman of the Minneapolis and St. Louis Railroad at the Minneapolis shops. The two kinks submitted by Mr. Martin deal with "A Machine to Remove Scale from Locomotive Boilers by Sand Blasting" and "An Apparatus to Hold an Air Hammer While Driving Rivets Overhead into the Bottom of a Tank."

The third prize award of $20 was made to I. J. Haddon, layerout at the Acme Sheet Metal Works, Detroit, Mich. In this case the two kinks winning the prize were "Laying Out Elbows" and "Use of Rolling Molds for Laying Out Difficult Pipes."

The four kinks constituting the basis for the second and third prizes will be published in the April issue of THE BOILER MAKER.

In analyzing the subject matter of the six prize winning descriptions, it is interesting to note the wide range covered by them. A system developed for carrying through a complete operation—that of safe ending, is discussed, a number of useful time and labor saving devices for a variety of operations are dealt with, and finally an important factor in all shop operations—that of laying out, is represented.

Besides the prize winning kinks, descriptions of a great number of excellent devices and methods were received and practically all of these will appear in the magazine in the course of the next few months. At the time of publication a check in payment for each of them will be forwarded to the individual who submitted the kink.

It is hoped that interest in this matter of shop kinks will be maintained and, as the prize winning kinks and others are published, that our readers will find them of use in their own shops. It may be that a study of these descriptions will suggest modifications or additional uses for the devices and in such cases the editors will be pleased to receive information on them.

Although the contest itself has been closed, the pages of the magazine are open to any of our readers who may wish to discuss any feature of the kinks described or who would like to submit for publication any kink that he may have overlooked at the time of the contest.

Speeding Up Production

IN this day of industrial competition, the old adage, "the survival of the fittest," holds true. Success goes to the shop where the cost of production is lower than in the shops of its competitors. Some concerns may attempt to reduce their costs by using inferior material or even by reducing the wages of the men. But such a shop is doomed to failure. A temporary saving may be noticed, but in the long run, a shop operating on such a basis will suffer from economic starvation.

The cutting of costs must be made where the most good will result and where waste will be eliminated without endangering the essential operations. Such a method may be found in material control as described in the article, "Spot System of Locomotive Repairs," appearing elsewhere in this issue.

The Central Railroad of New Jersey has used this system and found it effective. By means of it, the shop has been able to reduce the cost of repairs by eliminating wastes in time, material and labor. Material control is merely waste elimination in disguise.

Under this system, by planning the work ahead, the material needed for a given job may be determined and a schedule is devised for that job. This schedule shows that work of a certain nature will proceed on a given date and that material is needed to do that job. In the past, the mechanic would look over his job, decide what was needed and with his helper go to the storeroom and get his material, tools and supplies. This required the time of a skilled workman, whereas a boy might do it equally well if he were instructed.

The new system calls for an advance estimate of all the required supplies which are ordered, fabricated and delivered to the workman when he undertakes his job. Even his tools are supplied so that no time is wasted in waiting.

In case the workman should find an error in the material group, as this estimated material is called, he may order such additional supplies by writing a regular order and placing it in a handy yard mailbox. It is then collected by a messenger boy who delivers the order to the storeroom where the order is filled and delivered.

Such a system goes a long way in eliminating waste, saving time and reducing cost. The highly paid workman should not be required to do the work of a delivery boy. Neither should he be held up by lack of material when it is needed.

If an order comes in for a number of similar boilers, the plans are studied and the whole job is divided up into a number of smaller jobs. The material required for each job is called a group and is so numbered.

In the storeroom, all the small material necessary for the erection of this group is assembled at the same time that the plate is being layed off and fabricated. At the scheduled date of erection, all the material and tools are assembled at the point of erection with no lost motion or time.

A few minutes thought and planning by the supervisory staff may save many hours' time when the job is under way. Such a saving is sufficient in some cases to spell success for the shop that will abandon old time methods and will think in terms of modern production control.

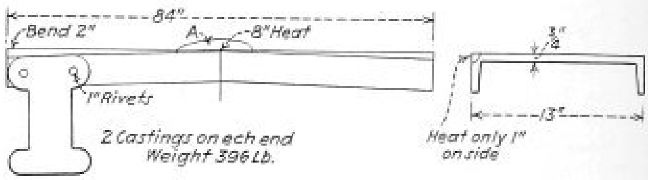
Communications

Straightening Channel Sections

TO THE EDITOR:

In heating a piece of iron on one side it will bend slightly from expansion on the side opposite to the heat, but when it cools off it will bend a great deal more. Knowing this I applied it to a job recently with gratifying results.

The job was to straighten 39 channels ¾-inch by 13 inches by 84 inches with castings riveted on as shown in the accompanying sketch and bent 2 inches out of true. The former method of doing this job was to cut out the rivets, heat the channel iron, straighten, then prop up to cool and re-rivet. The cost per channel was $8.54, or for 39 such channels, $333.06. I tried heating with an oxweld torch at *A* on the sketch for about 8 inches. While this was cooling off I took a heat exactly opposite. When I tried the straight edge I noted



Method of straightening bent channel

it had moved ¾ inch in the right direction. The next heat did the same and the third heat, though somewhat smaller, resulted in about 4 inches being out of true in the opposite direction. This small section had to be heated again to bring it back.

On doing several of these, we became so proficient that we were able to come within 1/16 inch either way which was close enough. No rivets were cut out except in the case of damaged castings. The cost of straightening the channels was $24.16, which represented a real saving. We are called upon to straighten about 450 such channels each year, so that in the course of several years quite a saving can be accomplished.

M. T. J.

From an Old-Timer

TO THE EDITOR:

I have been a subscriber to THE BOILER MAKER for a number of years and have derived great pleasure from reading it and going through the problems. At the present time I am not following the trade as I have retired. I have worked at boiler making for 50 years and will be 73 on my next birthday, so thought it was about time to stop working. I am not sending in any boiler shop kinks, but shall enjoy going around the shops to see the younger men at work.

I have always liked the trade and it certainly was a hard one some years ago when there was so much hand work, but that is pretty much a thing of the past now. At that time, when one went away several miles from the shop to do a job, it was not always pleasant. He would find things altogether different to what he expected when he left. I remember one time having to do a job at a lumber camp on two special sheets for a 2-flue boiler. I took two sheets 48 inches by 120 inches by 5/16 inch along. We had to go on a steamship about 150 miles and when I got there I found that the spiral was made the wrong way. This made me feel pretty bad for a while so I cut the sheets in two, made a big fire, and put the spiral the other way, making a good job out of them.

The boilers were then tested to 145 pounds pressure; everything was good, but when one has to do a lot of hammering, it doesn't make such a nice job as rolling a plate. In this case, however, the shop was not told which way to roll the sheet and so I thought that was the easiest thing to do.

Pinole, Calif. GEORGE HORNE.

New Boiler Water Level Control

TO THE EDITOR:

An important addition to the sphere of boiler accessories is a new device recently designed in Great Britain for maintaining a constant water level in steam boilers. If a boiler can safely be left to look after itself as regards the supply of water, the attendant is relieved of a troublesome and responsible task, which it is very difficult for him to perform as accurately and efficiently as an automatic apparatus. Consequently he has more time to devote to his other duties.

This new water level controller is external to the boiler, to which it is connected by two pipes, one entering the water space and the other the steam space. The sensitive element is a metal bar enclosed in a strong tube lying almost horizontally. Steam enters at the top end, water at the lower end and, when the boiler water is at the normal level, only part of the bar is exposed to the steam. If the level falls a little, the bar expands and forces open a small valve which allows water to escape from a chamber containing a piston and a spring. When the valve is closed the pressure of water from a tank or other source keeps the piston forced down and a steam valve controlling the steam pump closed. Relief of pressure by the action of the thermostat allows the spring to draw the piston upwards and open the valves. As soon as the level is restored, the thermostat bar, being more fully submerged, cools and contracts, closing the relief valve and allowing the water pressure to close the steam valve. The controller is adjustable and can be set to regulate the water level within ¼ inch.

London, England. G. P. BLACKALL.

Be Human—A Lesson for Foremen to Study

TO THE EDITOR:

There is a human side in our industries today that has to be reckoned with. Be human, treat your employees with due consideration. Be little enough to be big. Bear in mind your employees are floating upon the same sea of life as yourself. They are loved and respected in their homes the same as you are in your home. They are bread winners and so are you. They have ambitions, hobbies, faults, feelings, as you do. Your kindness and consideration will lighten their load and it won't cost you one red cent to be human.

What right have you to expect that you are their superior unless you can prove it? In many instances I doubt if you really are. Possibly you may be their superior from an executive or mechanical standpoint and perhaps mentally but, you will never be able to impress them of your mental superiority until you learn how to treat them. Win their confidence by being able to respect their likes and dislikes. Be interested in the welfare of their homes, families, economic problems, etc. Let a little of the big boss stuff ooze out of your system to the extent of being able to reach their level in your conversation when talking to them. Express your feelings with your eyes as well as with your voice. A word of encouragement is never amiss—and a smile is like pay day.

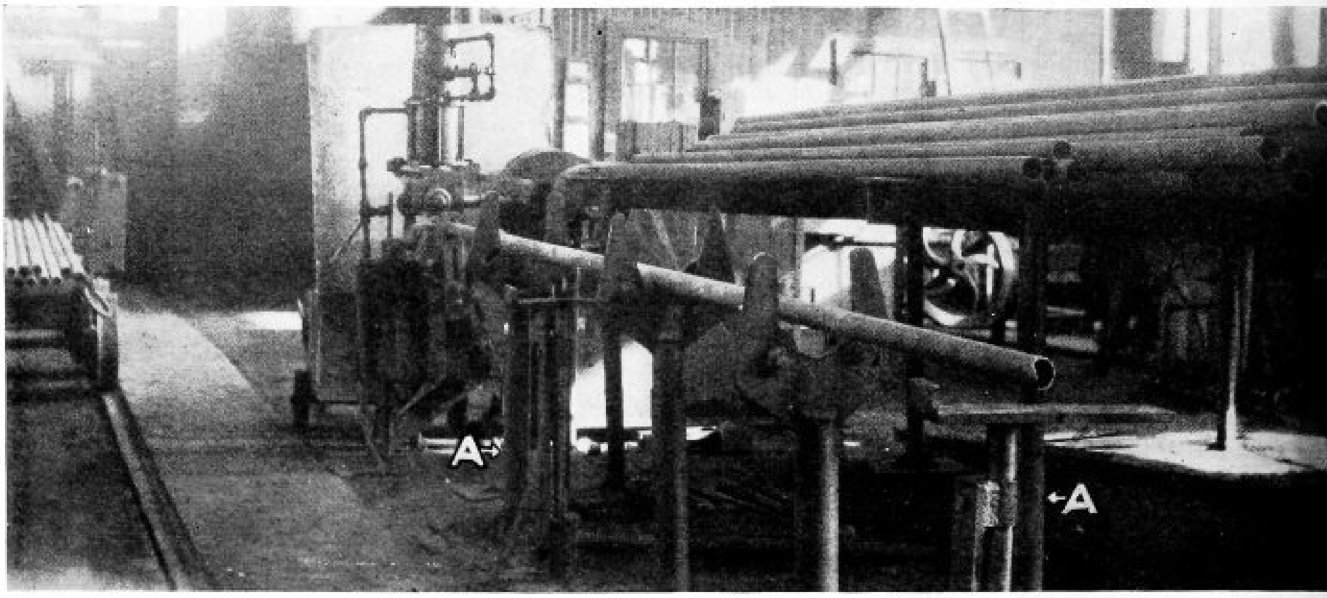
Possibly you may say this cannot be done, that you have too many men working for you and you do not have time to talk to each individual employee as you would like to do. All right, but remember this; if you don't someone else will. It is not always what we do ourselves, but it is the organization we wind around ourselves that pushes us to the front. Also remember it pays well to advertise.

You may not be able yourself to talk to all of your employees from a human standpoint, but you surely can find time to greet a few. Win their respect, confidence and admiration and they will do the rest, because, their advertising of your good qualifications will not cost you a cent; and you will be benefited to a noticeable extent. Train your subordinates to be leaders, not drivers. Call them into your office and find out just how much they know about the men who work for them. If you do not have time to do these things, you are in bad shape. There is something wrong with your art of management. You should educate members of your organization to plan and think for the welfare of the other fellow as well as for themselves. You should bring it up to the place where you can spend half your time planning new ideas and methods especially in regard to man building. Ninety-nine times out of a hundred it is a condition of the mind that holds you back.

You can positively change this mental condition whenever you so desire. Why don't you do it? Have you been on the job so long that you are in a groove? Do you ever consider the other fellow's point of view? Do you ever think his ideas are worth due consideration? Do you really listen to him when he is talking to you? Or, do you just tolerate him because you have to show some degree of politeness? Should he have a good idea, do you give him credit for it? Or, do you use it and intimate that it is your own brain child? This is very easy to do, especially if you are in a groove so deep you can't see over the top. When some one tells you something about some other person especially if it is of a detrimental character, do you take it for granted and form an opinion? Think about it if you care to, but be human and give the other fellow a chance. There are always two sides to a story—listen to them before forming an opinion. If you do not do this you are not the man that God intended you to be. You have no business being in a position to lead men. You are too narrow between the horns.

Industry has no place for the narrow-minded foreman and the sooner you find it out the better it will be for all concerned. Think along the same lines as your superior. Out think him if possible. Should he be wrong in his line of thought—you are protected due to the fact that you are advocating his policies as ordered. Should he be right, he generally advances and so do you.

Canton, Ohio. G. L. PRICE.



Flue in position for cutting and cleaning. Note the two pneumatic lifting jacks, *A*, *A*, which raise the flue to the top of the sloping rail platform.

Reclaiming Boiler Tubes and Flues at C. B. & Q. Shops

System of safe ending tubes and flues at Havelock shops cuts cost 22 percent

By L. M. Tuthill and D. P. Smith

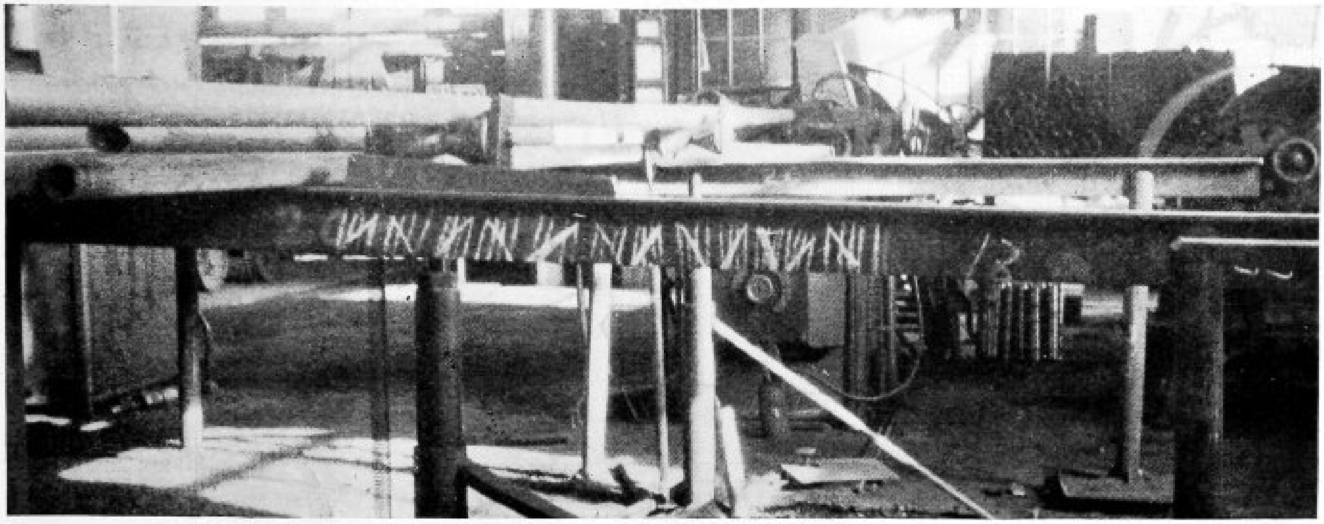
RECENT changes made in the method of reclaiming boiler tubes and flues at the Chicago, Burlington & Quincy shops at Havelock, Neb., have resulted in increased output and lower production costs. Special equipment has been installed which facilitates the handling of materials and reduces the physical effort required to perform the various operations.

The plant is designed to handle locomotive boiler tubes and flues of all sizes with one set of equipment. This equipment consists of a special machine which cuts off and cleans the flue end preparatory to welding, in from 3 to 10 seconds. The flue is then raised by 2 pneumatic lifters to a sloping rail platform where it rolls by gravity to a stop position opposite the electric flue welder. By means of pneumatically lifted rollers the flue is raised into position for welding. After welding, the release of air in the lifting device allows the flue to roll into position for rolling. After rolling, a conveyor consisting of an inclined row of ball bearing rollers carries the flue to a stop on a roller stand which is equipped with a tripping device that throws the flue into position for heating and swedging. The tripping device is operated pneumatically and controlled through a foot valve by a roller machine operator.

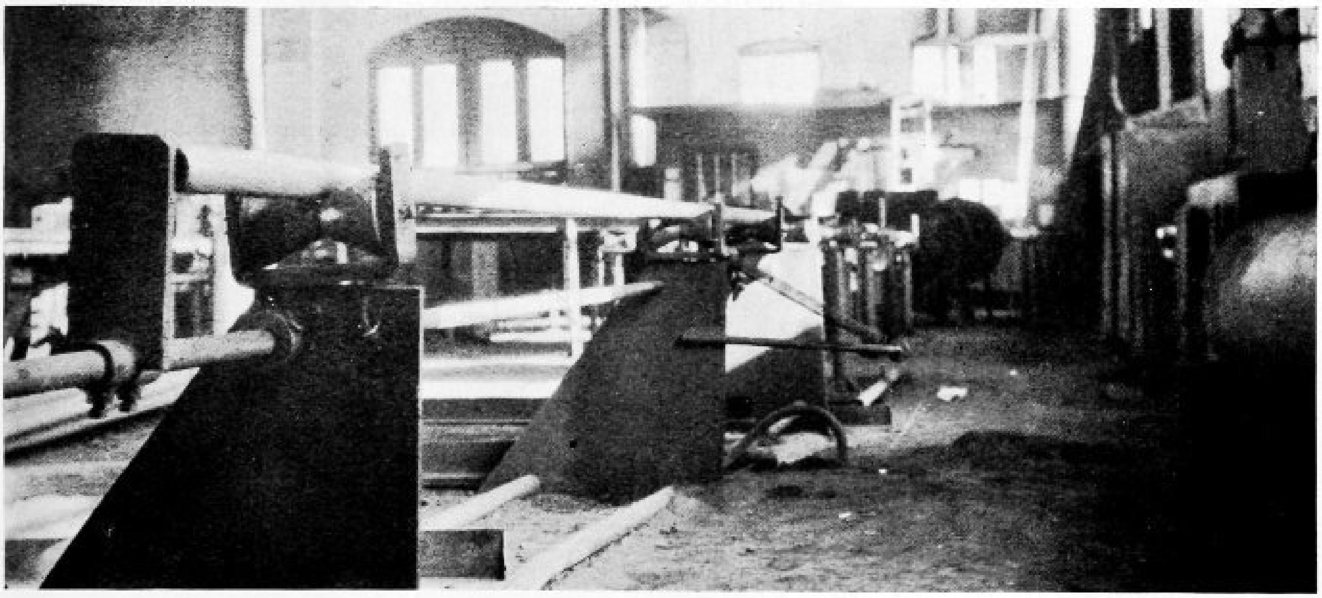
> **Boiler Shop Kinks Contest**
> **Prize Awards**
>
> **It is with pleasure that the announcement is herewith made of the prize awards for the "Boiler Shop Kinks Contest" which was conducted by The Boiler Maker beginning November 20, 1927, and ending January 20, 1928.**
>
> First Prize Award $50
>
> **L. M. Tuthill, Production Dept., and D. P. Smith, Boiler Foreman, Chicago, Burlington & Quincy R. R., Havelock, Neb.**
>
> Second Prize Award $35
>
> **N. W. Martin, General Boiler Foreman, Minneapolis & St. Louis R. R., Minneapolis, Minn.**
>
> Third Prize Award $20
>
> **I. J. Haddon, Layerout, Acme Sheet Metal Works, Detroit, Mich.**
>
> **The two articles which won first prize appear on this and succeeding pages. Next month the second and third prize winning kinks will be published.**

Description of Combination Flue Cutter and Cleaner

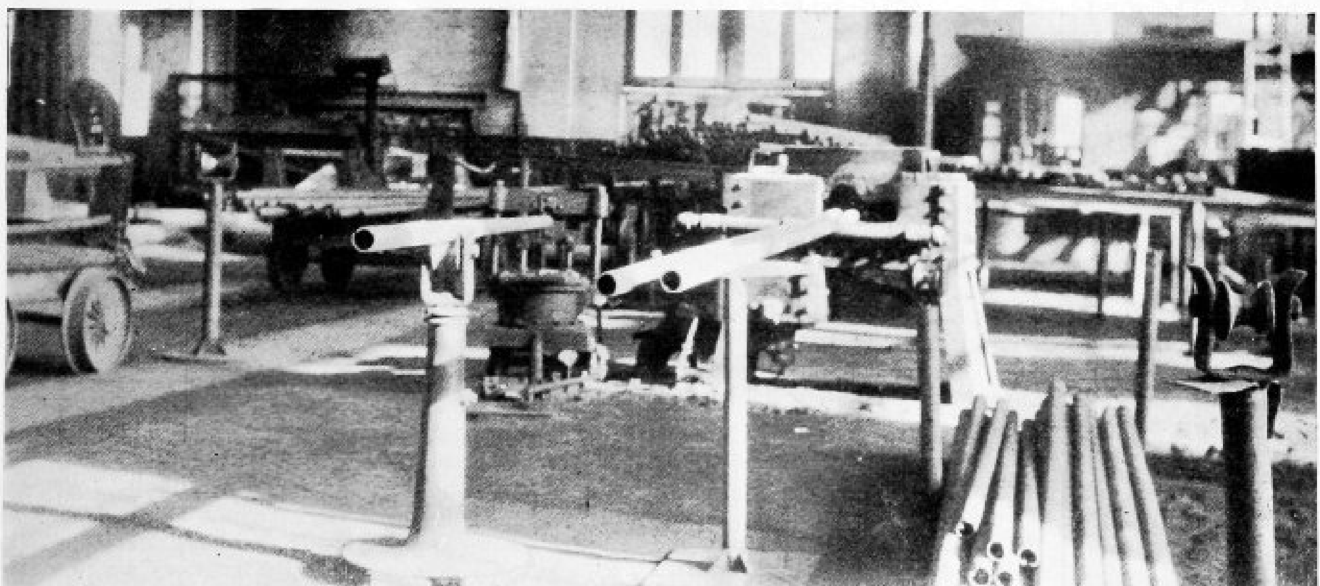
The flue cutting and cleaning machine is belt driven by a 5 horsepower electric motor. Two pairs of bevel gears transmit the rotation from the pulley shaft to the cutter spindle in such a way as not to interfere with the vertical feed movement of the cutter head which carries the rotary cutter and cutter spindle and is retained by vertical guides. The cutter is forced against the flue by an 8-inch piston



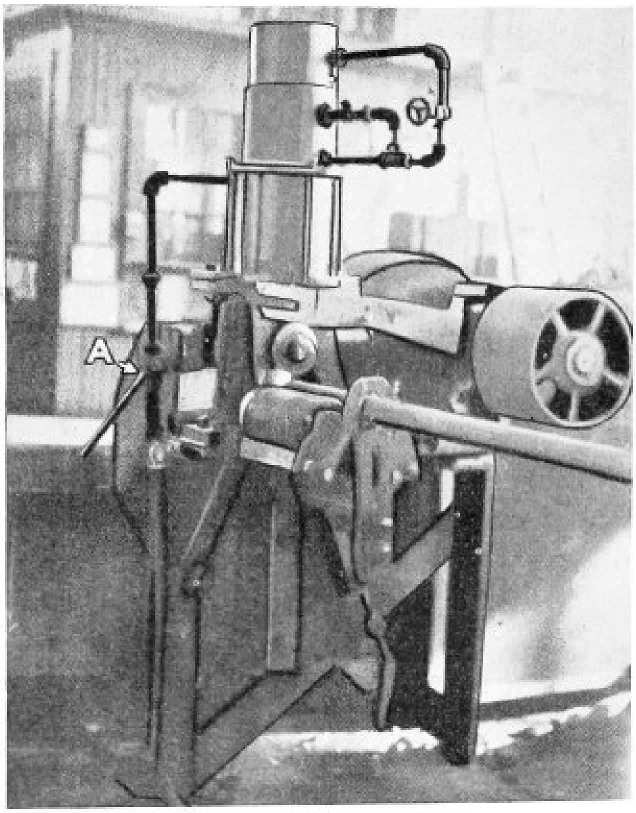
Flue in position for welding. When air is released flue rolls to next operation



After flue is rolled, it travels down inclined rollers to swedging machine



The heating furnace and swedging machine are adjacent to the tripping roller stand



Flue cutter and cleaner. Valve *A* controls downward movement of cutter

subjected to oil pressure, the oil being forced through a small orifice by air pressure which restricts the downward speed of the cutter. The flue cleaning is done by 2 rollers which support the flue while it is being cut. The rotation of the cutter is transmitted through the flue to the rollers. The rollers are 5 inches in diameter and 10 inches long and run on roller bearings. The faces of the rollers are smooth for 1-inch width just below the cutter. The remaining face of the rollers has a sharp edged spiral ridge cut around the circumference in the shape of a double thread of 1-inch lead. One roller is threaded left hand and the other right hand. The sharp edge does the cleaning while the cutter and rollers rotate. Adjustment of the machine is accomplished by raising or lowering the roller carrier.

Advantages of System

With this system of safe ending flues, a steady and uninterrupted output is obtainable with a minimum of effort on the part of the operator.

Different sizes of flues can be handled by few and simple adjustments to equipment.

All lifting is done by compressed air controlled by conveniently located valves, either hand or foot operated.

The installation of this special equipment has resulted in a labor saving of approximately 22 percent in the cost of repairing small flues and 34 percent for the superheater flues.

Frank K. Tutt, who entered the service of the **Bird-Archer Company** as a special representative during the past year, has been promoted to district manager with headquarters in the Railway Exchange, St. Louis.

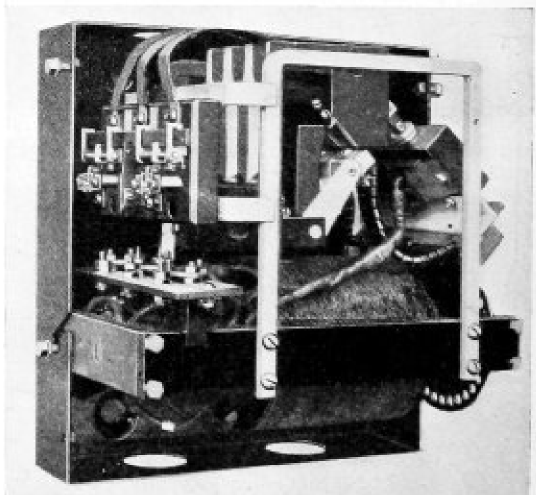
Automatic Induction Starter

A NEW automatic induction starter with two adjustable features has just been announced by the Lincoln Electric Company of Cleveland, Ohio. One of the adjustments is in the starting current and starting torque and is made by changing the position of the rotor in the regulator. This rotor is index mounted and the starting torque and starting current of the motor are increased by going to the higher numbers of the scale and decreased by going to the lower.

The other adjustment is in the current at which the throw-over takes place. The throw-over in this new starter is controlled by a retarding solenoid which is operated by the motor current. The pull of this solenoid can be adjusted by a simple lock rod arrangement carried on its plunger.

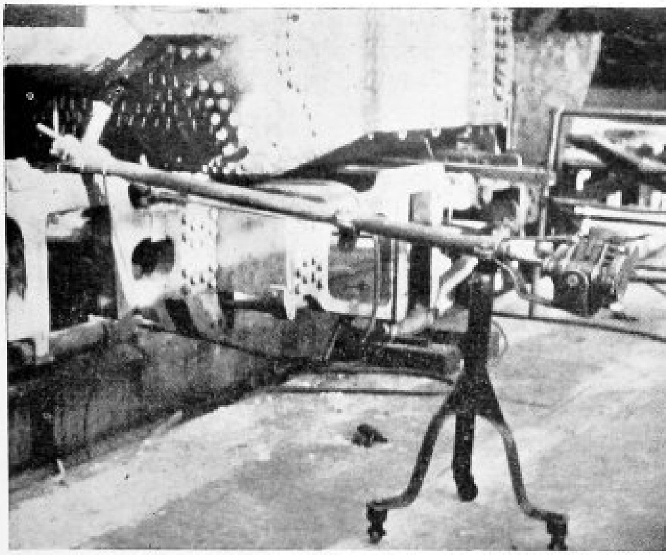
For mounting purposes the switch may be considered as consisting of three parts; namely, the back cover, the front cover and the switch itself. In mounting, the back cover is first secured to the wall. It is light and can be easily held and attached by one man. As the switch mechanism is detachable from it, it is unnecessary to handle the former while the mounting is being done. The back cover contains conduit outlets, hence the wires may be drawn in easily before the interior mechanism is set in place. After the leads are drawn the switch may be set into the back cover in such a way that the leads and the terminal blocks to which they are attached, will be easily accessible. After all connections have been made, the switch is locked in position by a screw provided for that purpose. The last operation is placing the front cover in position.

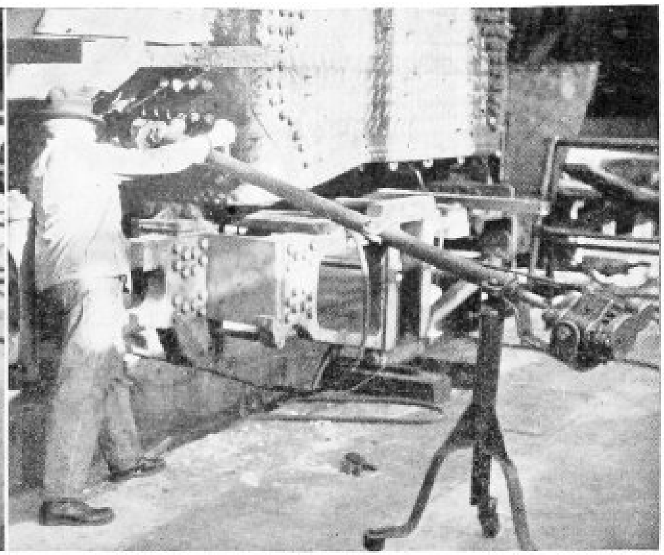
With the new Lincoln automatic induction starter the motor is controlled by the conventional start and



Induction starter with adjustable features

stop buttons. When the start button is compressed it applies the correct voltage to the motor and the starting current is held within the desired limits. After the motor comes to speed the current attained falls off. When it has fallen off to the desired amount the switch automatically sets itself in the running position without interrupting the torque of the motor. The motor is removed from the line by pushing the stop button.





Machine set up for tapping arch tube holes. A gear ratio of 1 to 22½ provides ample power for this work

Portable Tap and Reaming Machine*

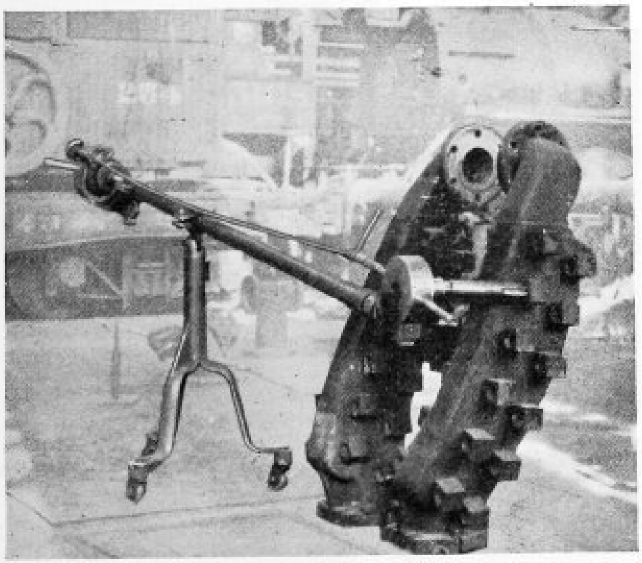
Machine designed to cut labor in operations on arch tube and washout plug holes

By L. M. Tuthill and D. P. Smith

ANY one familiar with the tapping of arch tube and washout plug holes in locomotive boilers when such work is done by hand will agree that the job takes considerable time and physical effort. To improve the quality of this work, to increase production and to eliminate to a great extent the effort required to tap large holes, a portable tapping machine has been developed at the Chicago, Burlington and Quincy shops at Havelock, Neb., which surpasses all expectations and has paid its original cost many times over in labor savings since put in operation.

The machine is used for reaming and tapping arch tube plug holes, washout plug holes, boiler check and blowoff cock holes. While originally designed for boiler work it is being used to advantage in retapping holes in Emerson superheater header blocks, reaming steam pipe joints, removing and applying elevator screw shafts and piston rods in Duplex stokers and other work that requires a machine which combines power and flexibility.

* This is the second of the two first prize kinks.



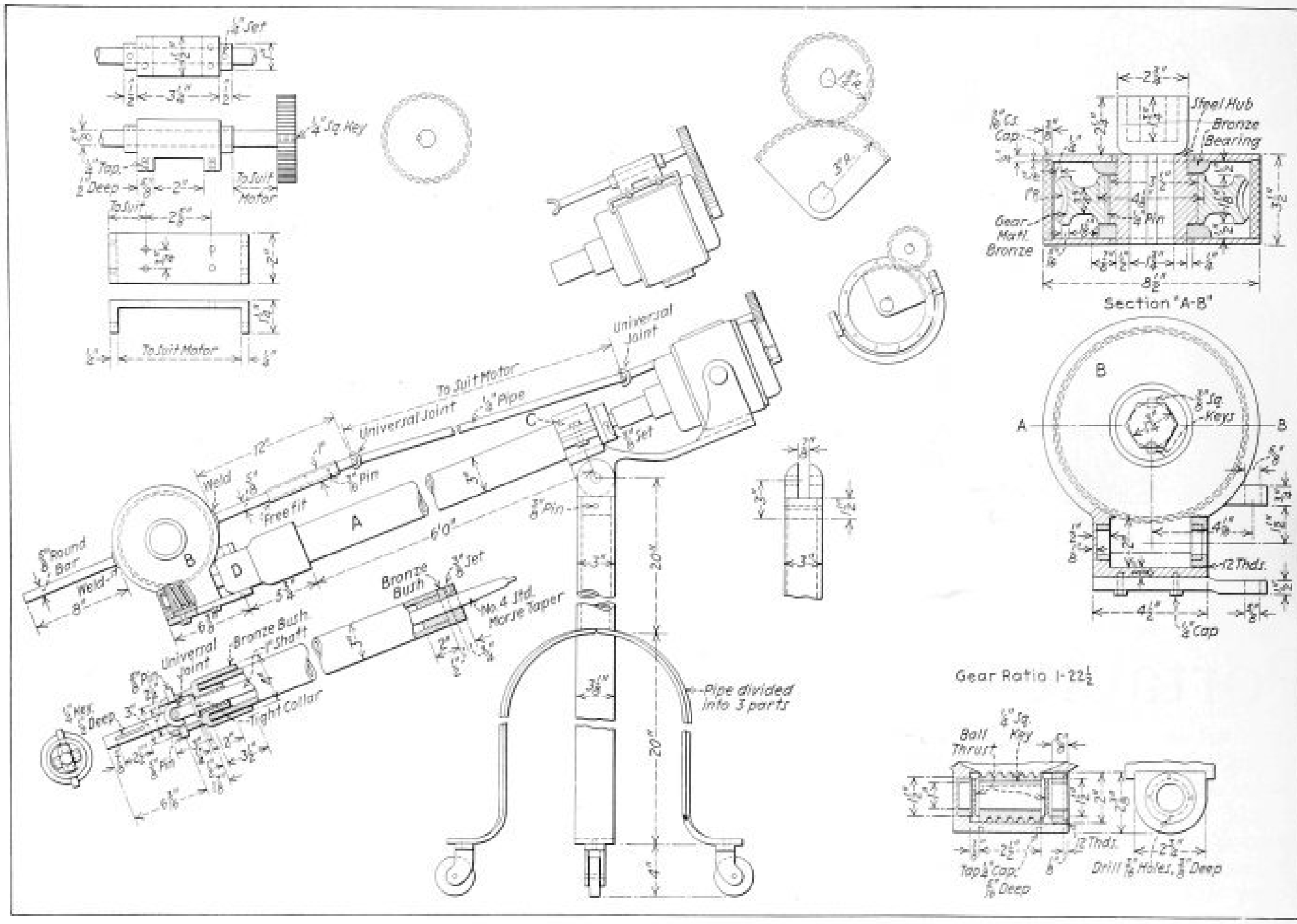
Machine in use for retapping superheater header block

Details of Machine

The principal mechanical features of this device are as follows:

A reversible No. 1 air motor is connected through tube *A* which acts as a lever between the air motor and the drive head *B*. The whole unit is supported by a three-legged stand which is bolted by a movable clamp *C* to the lever tube and can be adjusted to nearly balance the weight of the air motor and drive head. The air motor spindle is keyed to a hollow drive shaft. The latter is carried by bearings inside the lever tube. The drive shaft ends in a universal joint *D* with an extension which carries a worm. Surrounding the universal joint of the drive shaft is a flexible joint which connects the lever tube with the drive head. This permits the head to oscillate in all directions except the plane of rotation of the socket, preventing any binding of taps.

The worm on the end of the drive shaft engages with the worm gear within the housing of the drive head. The end thrust of the work is taken up in both directions by the ball thrust bearings. The worm and gear



Details of tapping and reaming machine

ratio is 2 to 45, the worm having a double thread with 1-inch lead and is made of tool steel and hardened. The worm gear has 45 teeth and is made of phosphor bronze having a steel hub which is made to permit the quick changing of the tap sockets which can be driven from either side of the head.

The whole driving mechanism is enclosed in a grease tight housing. No moving parts endanger the operator. The driving head is provided with two handles on the opposite sides, one of these carries a knurled sleeve connected by a universal jointed rod to gear sectors that rotate the motor throttle. This gives the operator full control of speed and direction of rotation of the reversible motor without moving his hands from the driving head handles. The driving head imparts a powerful and steady rotation which can be instantly stopped or reversed. This provides an ideal means for tapping or reaming large holes.

This device is inexpensive to make, has a low maintenance cost and has reduced the cost of reaming and tapping large holes from 30 to 50 percent.

The device was suggested by W. F. Ackerman, shop superintendent and developed by Karl Merting, tool room foreman of the Havelock shops.

Switch-Start Motor.—A pamphlet has been received from the Lincoln Electric Company of Cleveland, Ohio, describing the starting and operating characteristics of the Lincoln "Switch-Start" motor. No compensator or resistance switch is required and the motor may be started right across the line with the current being below that set by the N. E. L. A.

Rubber Grip for a Rivet Bucker-Up

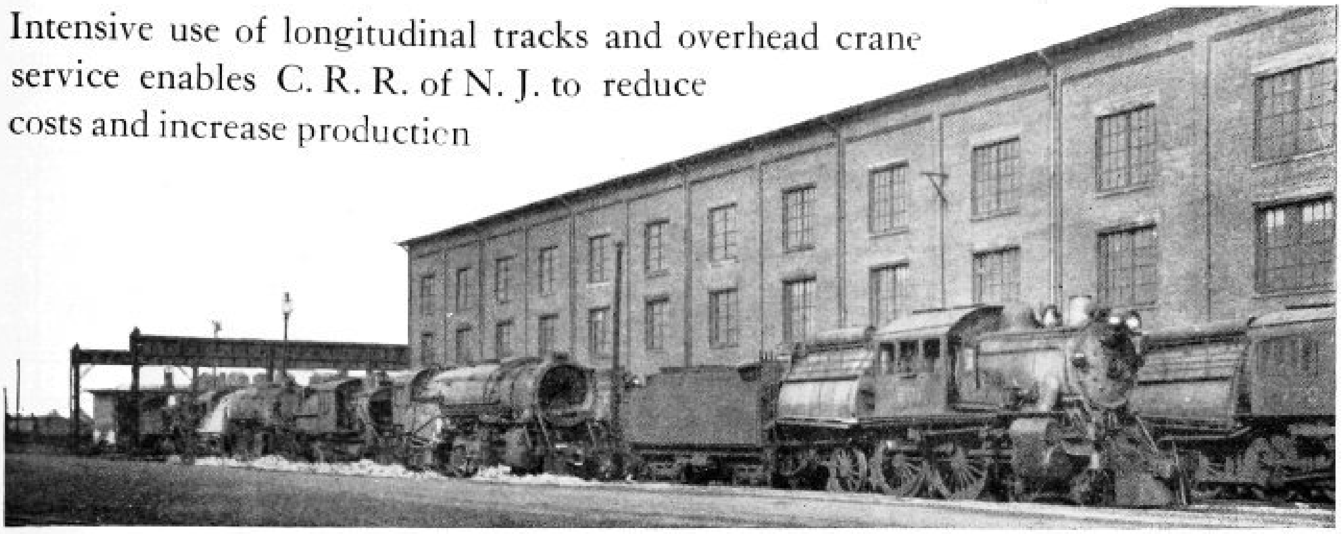
A GOOD grip on any kind of tool, and particularly on a rivet bucker, is a beneficial aid to the workman who uses it. The handle of an old rivet gun has been welded to the end of the rivet bucker shown in the

The rubber grip protects the workman's hands from bruises

illustration. A short section of the air hose was split lengthwise and slipped over the grip and secured at each end by a piece of heavy wire. This simple arrangement, besides protecting the steel worker's hands from possible burns and bruises, provides a firm grip.

Spot System of Locomotive Repairs

Intensive use of longitudinal tracks and overhead crane service enables C. R. R. of N. J. to reduce costs and increase production



Station No. 1—Locomotives are stripped outside of the shops

DURING the past year the Central Railroad of New Jersey has made a number of radical changes to the system of repairing locomotives at its back shops, Elizabethport, N. J. This repair point is located on the main line about 11 miles from its Jersey City, N. J., terminal. The Elizabethport back shop is operated in conjunction with a 24-stall enginehouse, and the plant also includes large shops for the maintenance of freight and passenger cars.

The principal locomotive back shop buildings and repair facilities were erected and installed in about 1900. The erecting, machine and boiler shops are all located in one building, which is 700 ft. long by 148 ft. wide. The erecting shop extends one-half of the entire length of the building and occupies a floor space approximately 82 ft. in width. The machine shop, tool room, and boiler shop occupy the areas as shown in the floor plan drawing of the locomotive repair shop.

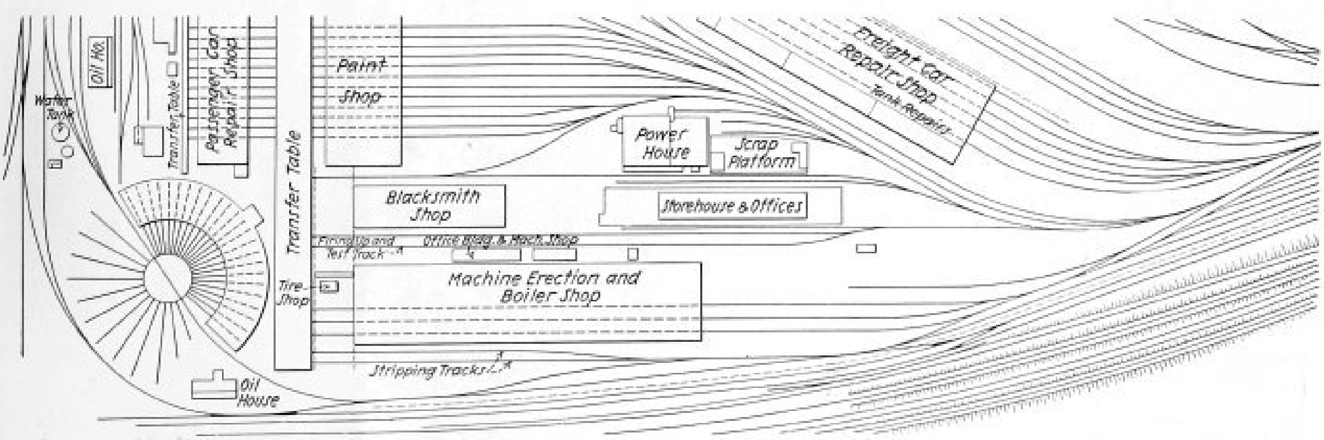
Previous to the installation of the spot repair system, the erecting shop was provided with three tracks, spaced 25 ft. center to center, which extended the entire length of the shop and out both ends of the building. Under the new system, track No. 3 was removed except for about 200 ft. at the west end of the shop. This remaining section of track is now used for wheel repairs.

Tracks Nos. 1 and 2 extend from the transfer table, through the erecting shop to a ladder track, as shown in the plan of the repair tracks and buildings. The transfer table serves the locomotive shop and the passenger car repair and paint shops.

Determining Class Repairs for Incoming Locomotives

The works manager is notified in advance by the superintendent of motive power what locomotives are due for repairs and what repairs are required. The superintendent of motive power bases his estimate on a combined study of the enginehouse work reports, inspection reports and mileage. The decision by the superintendent of motive power as to what class of repairs a locomotive is to receive is rigidly adhered to, except in occasional instances when the shop inspector finds some condition after stripping and had not previously reported that should be remedied when the locomotive goes through the shop.

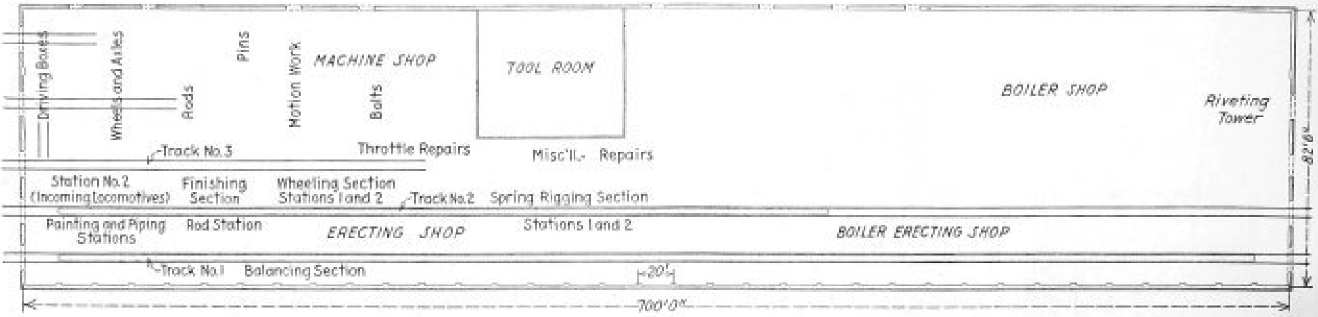
If after final inspection it is recommended that a



Layout drawing of shop repair tracks and buildings locomotive be given class two instead of class three repairs, or some other change in classification of repairs is recommended, an additional inspection is made by the works manager and interested department heads. If they agree with the shop inspector, the superintendent of motive power is notified, who authorizes the additional repairs if they meet with his approval.

Routing Locomotives and Material Through the Shop

Referring to the drawing showing the plan of the buildings and repair tracks, incoming locomotives are stripped outside on the two tracks beside the main building. This is station No. 1. These tracks extend



Location of repair sections and stations in the locomotive shop

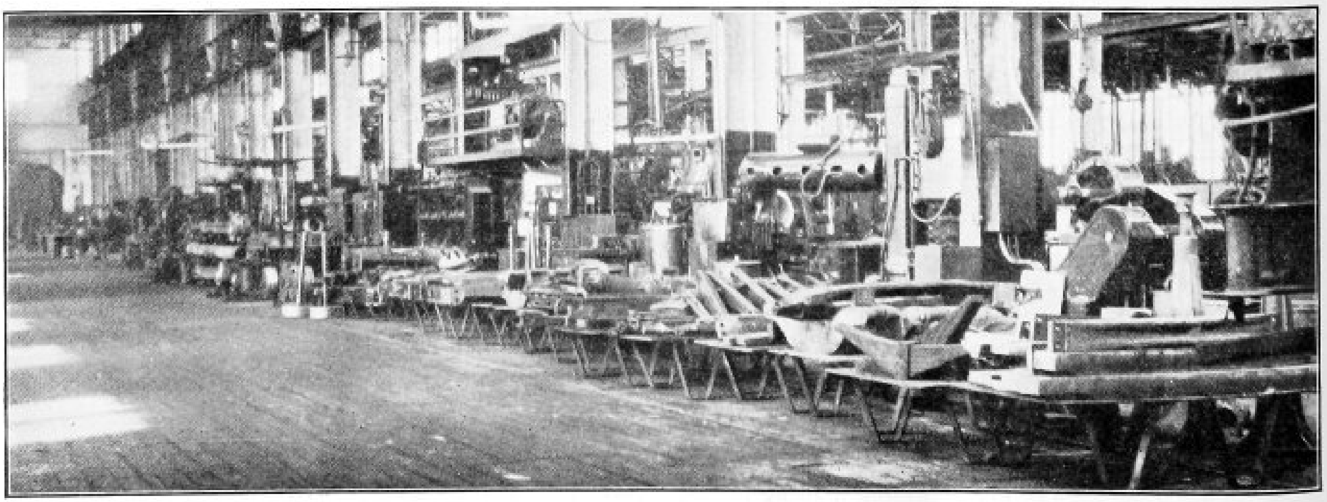
This system of determining the class of repairs for locomotives coming into the back shops, makes it essential that the enginehouse work and inspection reports be accurate and that the information be complete.

The works manager holds a meeting each day of the supervisors of the locomotive shop to discuss the progress being made on each locomotive going through the shop and to plan for the handling of work coming into the shop. In addition a material committee composed of the boiler shop, blacksmith shop, machine shop and erecting foremen, and a representative of the stores department, meets once each week to review the instructions from the superintendent of motive power and the shop inspector's reports, to ascertain the amount of work and material required for incoming locomotives. The works manager acts as chairman of this committee. In addition to the representatives of the stores and locomotive shop, representatives from the passenger and freight car departments also serve on this committee. At the material committee meetings the stores department representative checks his inventory records as to the quantity and kind of material needed and if the material is not in stock, gives an estimate as to the time required to get it.

under an overhead crane to the transfer table. The area covered by the crane extends the full width from the end of the locomotive shop to the edge of the transfer table and from the southeast end of the transfer table to the passenger car paint shop.

When a locomotive arrives at Station No. 1 which requires repairs to the tender, the latter is taken to track No. 1 in the freight car repair shop where all repairs are made to the tank, bunker, draft gears and trucks. Stoker repairs are made in a separate department in the locomotive shop.

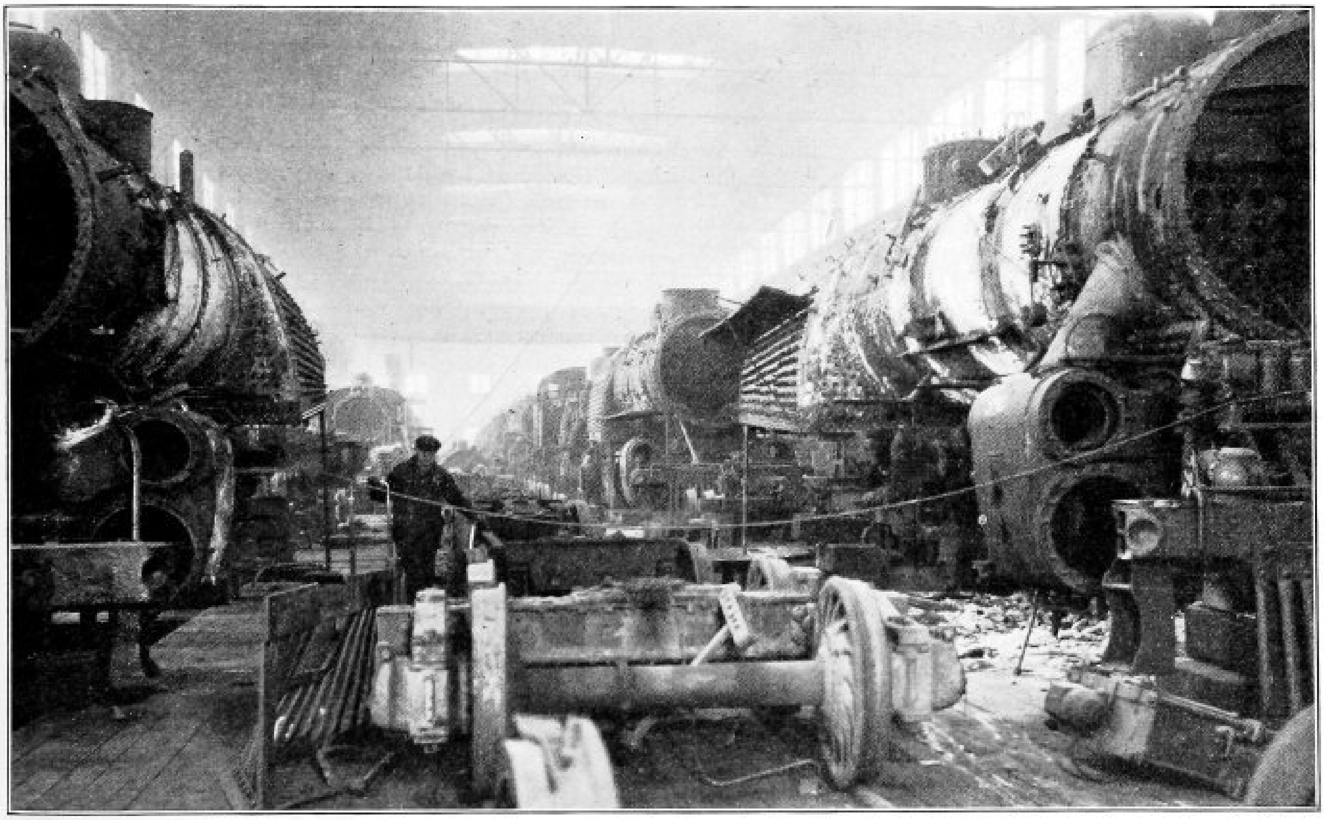
Parts removed from the locomotives at station No. 1 are marked with tin tags showing the number of the locomotive from which they were removed. They are then loaded on skids and taken to the lye vat, or are stored on the north side of the shop, next to the firing-up track. The various parts are sorted and arranged on the skids according to destination. Each skid is numbered to simplify instructions to the operator of the electric lift truck as to the destination of the various parts. Only parts from the same locomotive are placed on a skid. The gang foreman inspects the parts on each skid. For example, if skid No. 30 is loaded with pipe from locomotive No. 329, he gives an order



Skids loaded with finished parts for application to locomotives in the erecting shop to the truck operator to take skid No. 30 to the pipe shop. The pipe shop foreman knows from the information on the order, the locomotive from which the pipe was removed and keeps the material together while it is being routed through his department.

This system of grouping parts from one locomotive and routing them together through the shop, is followed as far as possible. It has been found to be advantageous in tracing material, checking to see whether repair work on different parts is progressing according to schedule, and in allocating repair costs. Finished material is loaded on skids which are spotted on the erecting shop floor, as shown in one of the illustrations, until needed. Continuing the example given in the preceding paragraph, when the erecting shop foreman is ready to apply the pipe work to locomotive No. 329, he instructs the lift truck operator to deliver skid No. 30 direct to the locomotive. This places the material where it is needed and can be applied with a minimum of handling by the pipe fitters. The same procedure is followed by the machine shop foreman and other department heads, instructions being given as to the material station, machine or bench at which the material is required.

After the locomotive has been unwheeled it is picked up by an overhead crane and placed in the balancing section on track No. 1, where all the necessary boiler work, flue setting, frame repairs, cylinder repairs, etc., are performed.



General view in erecting shop looking towards the boiler department

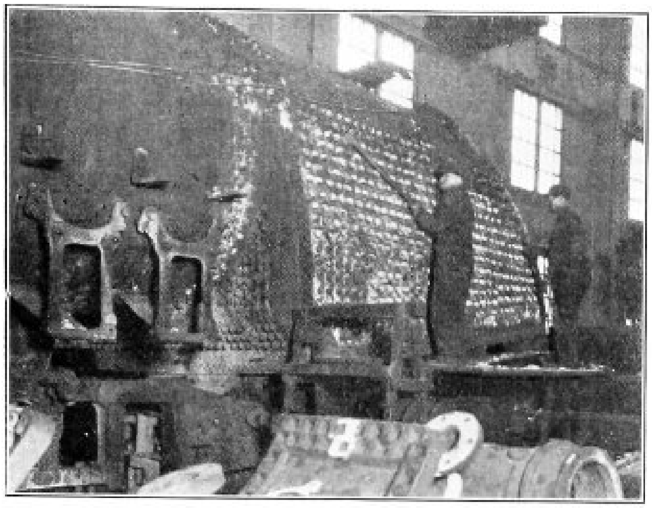
Balancing Section Provides Flexibility in Routing Work Through the Shop

Doubtless many of the readers have assumed from what has been said in the preceding paragraphs that the various stations are arranged in order from one end of the shop to the other. This is not the case. Each locomotive goes out of the shop at the same end where it was brought in. Although this apparent return movement or "back track" from the balancing section appears somewhat illogical, especially after studying the layout drawing of the repair tracks and buildings, it is, nevertheless, the most important feature in the successful operation of the spot repair system at the Elizabethport shops.

Aside from the short length of track No. 3 at station No. 2, which is used for wheel repairs, only tracks Nos. 1 and 2 extend the entire length of the shop. All of the other stations, including the balancing section, use the first two tracks. This does not include the firing-up and testing stations, both of which are outside.

Locomotives from Station No. 2 go to the balancing section on track No. 1. This section derives its name from the fact that its primary function is to balance or regulate the output of the shop. In this section locomotives coming in for class four or five repairs can be routed around those receiving class one or two repairs and turned out of the shop ahead of the order in which they came in. In addition, repairs to locomotives required for service sooner than others can be run around other locomotives going through the shop through the functioning of the balancing section.

This section includes all of track No. 1 to the boiler shop and is the turning point in the routing of the locomotive through the shop. This arrangement leaves the entire lower half of the erecting floor free for heavy boiler repairs. It also keeps all the repairs requiring machine tool work opposite the machine shop.



At work in the boiler department

No section or station name or number is assigne to the boiler shop. The boiler repairs, although occupying the lower half of the erecting shop floor, are handled as a separate department, the same as the machine shop, etc. Locomotives are moved by overhead crane from the balancing section on track No. 1 to either one of the two spring rigging stations on track No. 2. The next step is to one of the two wheeling stations. The object in having two stations each for applying spring rigging and wheels, is to allow flexibility in the handling of different classes of engines, it being easier, for example, to wheel switch engines than to wheel Mikado type locomotives. Cabs are applied in the wheeling section. On completion of this work, the locomotive is moved from the wheeling section to the rod station in the finishing section and thence to the piping and painting stations. The firing-up and testing stations are located on the northwest side of the shop. Locomotives are moved from the finishing section to the firing-up station via the transfer table.

An electric truck equipped with an 18-ft. boom is available for service at any of the various sections or stations in the erecting shop for applying air compressors, side rods, etc. This truck releases the overhead cranes for heavy service.

Spot System Requires Specialization of Working Gangs

With the installation of the spot system, it was found necessary to reorganize the working force into gangs of specialists, each gang being held responsible for the same kind of work on each locomotive going through the shop. The erecting force, including boiler and flue work, is divided into six gangs, each under the supervision of a foreman. The gang foremen report to the erecting shop foreman.

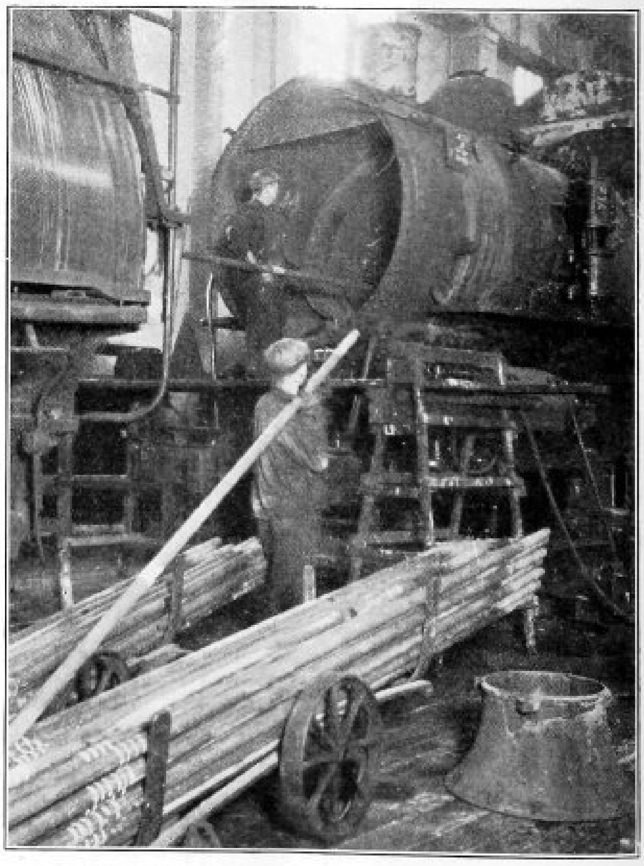
Gang No. 1, which is located at the balancing station, renews all caps, staybolts, flues, boiler patches, ash pans and front end arrangements. Gang No. 2 handles the refitting of binders and frame braces, and applies the boiler studs and all frame bolts. Gang No. 3 wheels the engines and applies the spring rigging, pedestal binders and brake rigging in the wheeling and spring rigging sections. Gang No. 4 does the piston, crosshead, valve and link motion work in the finishing section, rod station. Gang No. 5 applies the cabs, headlights, running boards, stacks, hand railing, cylinder cocks, cylinder cock rigging, couplers, pilots, steps and the main and side rods, as the locomotive moves through the wheeling and finishing sections. Gang No. 6 does all the pipe work including the injectors, bell ringers, throttles, lubricators, all air brake parts, sanders, etc., in the finishing section, pipe station.

Delivery of Material

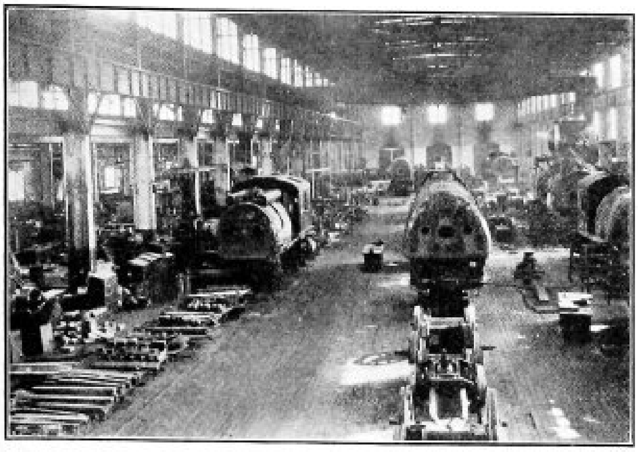
All material is delivered on material memorandums or orders, to designated stations in the shop. Each material station is designated by a number. Small metal signs, on pedestal stands, are provided at each material station for the guidance of the delivery man as well as the workman. Material memorandums or orders are placed in a small receptacle secured to the sign. The number of the station to which the material is to be delivered is marked on the order. Heavy material is stored under the overhead crane between the transfer table and repair shop buildings to facilitate handling.

The progress of all material through the shop is followed up by a material man whose sole function is to keep a constant check on work going through the shop. He reports progress as well as all delays, to the machine shop foreman, and also at the daily staff meetings. Daily and weekly reports of material shortages are made to the stores department by the general foreman. These reports are checked with the stores department, which makes an investigation and if the material is in stock, sees that deliveries are made, or in case the material has to be ordered, a delivery date is assigned.

The entire system of delivery of material, both finished and unfinished, has been co-ordinated with the object of minimum handling. Whenever possible, the material is delivered directly to the place where it is to



Installing boiler tubes in the erecting shop

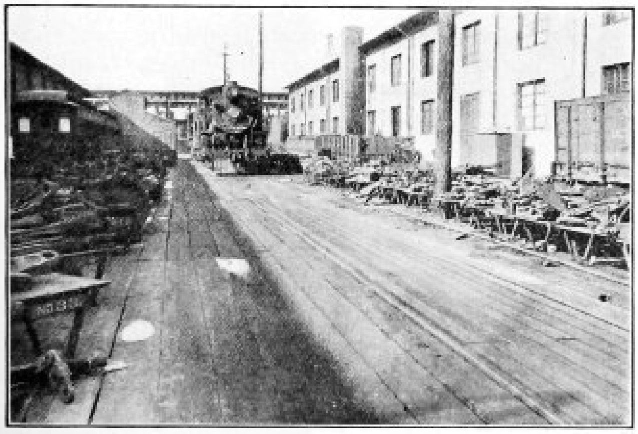


The boiler repair shop—This photograph was taken from the wheeling station

be used in the machine, or to the locomotive on which it is to be applied.

Spot System Has Effected Saving Over Former System

At the present time the Elizabethport shops have an output of 26 classified repairs per month with a total



The firing-up track—Note the skids loaded with parts waiting to go through the shop

force of 750 men. These figures, compared to the results obtained a year ago, show that the shop has obtained an increase in production of approximately 25

The erecting and machine shops

per cent. This was accomplished in the face of a reduction in force of 30 per cent. One year ago, the classified repair output was 20 locomotives with a total force of 901 men working 25 days per month.

Under the old system, 25 locomotives were placed in the shop and five gangs performed all the work on each locomotive. The introduction of the spot system, as stated in a preceding paragraph, necessitated the reorganization of the working forces into six gangs of specialists. This change not only was a big factor in reducing the cost of repairs, but the shop has also been able to turn out work of much better quality. Several innovations in the handling of repair work were introduced with the spot system. One of these was in the handling of boiler repairs. All the boiler work, including the application of flues, testing, frame repairs, cylinder work, application of frame bolts and firebox renewals, are performed with the boiler shell attached to the frame. Each boiler is filled and fired for test before the lagging is applied. This method of making repairs effected a saving of over 14 per cent over the old method in which the shell was removed entirely.

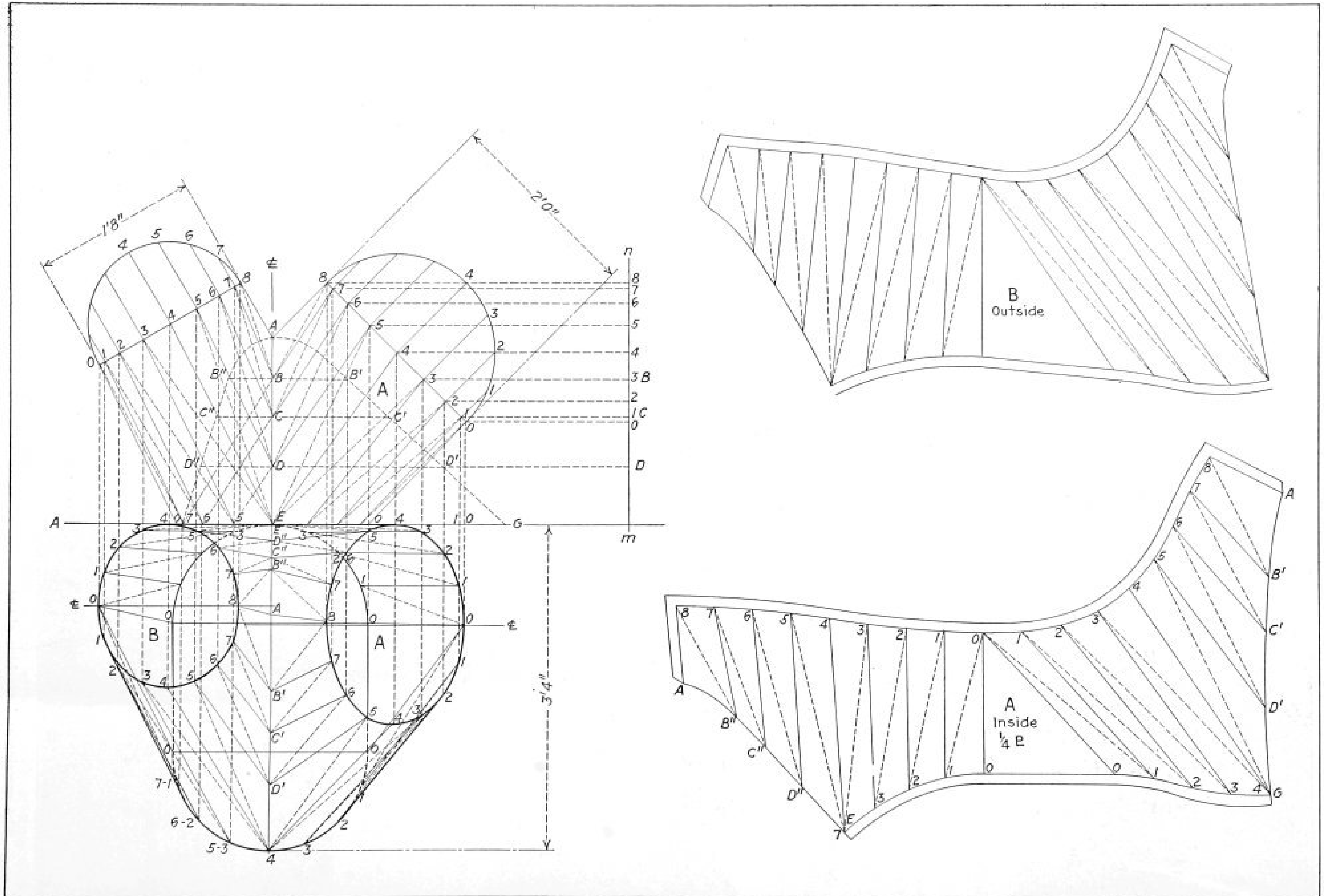
The foregoing outline of the general plan of the spot system of repairs is essential to a complete understanding of the operation of the boiler shop itself. In the April issue of The Boiler Maker, complete details of the methods employed in this department for carrying out firebox repairs will be published.

New Ryerson Officers Announced

Joseph T. Ryerson & Son, Inc., of Chicago, Ill., has recently announced the new officers of that corporation. This change was caused by the death of the late Edward L. Ryerson, former chairman of the Board of Directors. Donald M. Ryerson, vice president and general manager, has been elected chairman of the board of directors. Edward L. Ryerson, Jr., vice president in charge of plant operations and several sales divisions, succeeds his brother, Donald Ryerson, as vice president and general manager. Everett D. Graff has been elected a vice president. He joined the organization in 1906 and has held the position of assistant to the vice president in charge of purchases. Mr. Graff is one of the best posted men in the warehouse business, with 22 years' experience in various divisions of the company.

Soot Blowers.—The National soot blower for return tubular boilers is described in a bulletin issued by the National Flue Cleaner Company of Groveville, N. J. These blowers are designed for use with horizontal return tubular and Scotch marine boilers. They employ a separate nozzle, in a fixed position, for each boiler tube making it impossible for any tube to escape the scouring action of the steam jet.

Welding Outfits.—The Oxweld Acetylene Company of New York has issued a letter announcing three new Prest-O-Weld welding outfits. These are designated as the type W-101-A auto repair outfit, the type W-102-A general purpose outfit and the type W-102-B welding outfit. These outfits are made possible by the addition to the Prest-O-Weld line of two small 2-gage regulators, types R-106 and R-107 and two special blowpipe tips, one for heating and brazing and one for radiator soldering.



Method of developing and laying out the patterns for a Y connection, straight on one side

Development of a Y Connection

Method of laying out patterns by triangulation where connection is straight on one side

By D. W. Phillips

"HELLO, Foster, how are you this morning?"

"Feeling pretty well, Mr. B—. How's yourself?"

"Oh, fine, Fos, feel like a two year olo. Well, Fos, how are things progressing in the light iron shop?"

"Everything seems to be moving along as well as usual, Mr. B—, except that we are having trouble with that Y connection for the top of that heating duct you sent down three days ago."

"What's the nature of your trouble, Fos, is it too much of a problem for Wilson to lay out?"

"Right you are, Mr. B—."

"Well, Fos, suppose you ask Bill to let Smith try his hand on that Y. We would like to see some of his performance on triangulation."

"Well, Bill and I did get together on this matter and Wilson and Smith worked together for a day and a half and finally got discouraged and ashamed of their showing. They came and told Bill and me that it was too much for them."

"Well, Fos, I think you and Bill did the wrong thing by letting both of them work together on that layout. It's very confusing to have some one hanging around and breaking in every little while with a suggestion when a man is trying to get a thing like that worked out. Wilson had his chance all by himself and Smith was entitled to the same, don't you think?"

"Yes, I see now where we didn't give Smith a fair chance, I do, indeed."

"Well, Fos, our time is short on the delivery of that material and we can't very well do any more experimental work."

"Well, Mr. B—, shall we send it over to the M— Company and have them lay it out for us?"

"Oh, no, Fos, we're not conducting a specialty line, besides we would not show up our boys and even ourselves in that fashion. Fos, we are second to no concern in this country in the art of fabricating sheet iron and steel plate; we'll build anything that can be built of steel plates. I'll tell you what I'll do to help matters along, Fos, I have two letters to dictate, then I'll turn to and lay that branch out on a small scale, make a couple of prints from the layout, give one to each of those boys to take home and study, then after lunch I will come down to the shop and lay out that Y for you. It's now ten o'clock; you skip down and look things over for a bit and meet me here at 10:30, and I will show you how I do the trick."

"Fine, I'll do that."

Laying Out the Connection

"Well, Fos, I see you are on the job. Just seat yourself on that high stool and look wise for a little while. Don't lie down on that tee-square. If you do, I can't operate it.

"We will begin by drawing the line *A-B* (see accompanying illustration). On this line we will draw our elevation. Now from *E* on the base line, we will draw a line through *A* and call this the vertical center line. This line will also represent the joint between the two branches of our Y. We next determine the height of our Y at the center of the branches; line up at the desired angle then square back to the point *A* on the vertical center line. The angles of our branches are to be 45 and 30 degrees with the vertical center line respectively.

"We will now construct on the face of each of these branches, a semicircle corresponding to the size of the opening, in this case 24 inches at the right and 20 inches at the left. We next divide these half circles into an even number of spaces, say 8. Next we draw lines at right angles to the face of the branch cutting the face at the points 1, 2, 3, 4, 5, 6, 7 and 8. Then from these points just located, we drop vertical lines crossing the base line *A-B*.

"Now as the top and bottom of the Y are tangent to the same plane in the plan view, that is, straight on one side, we will draw our plan accordingly. For the plan of the branches, we will transfer the division lines in the semicircle above the corresponding lines in the plan, placing them on either side of the center line and tangent to the base line *A-B*.

"We next draw the plan view of the large end, which is oval, by drawing two semicircles on the center line *A-E* at a distance equal to the major axes of our duct, connecting with straight lines as at *O, O, O, O*. Now we divide these semicircles into 8 equal parts as we did those above and connect the corresponding points with solid lines as from 1 to 1, 2 to 2, 3 to 3 and so on. Now we will square up from the *O's* in the plan to the base line *A-B*, and thus establish the short diameter of the large end of the Y.

"Our next move will be to locate the points *B*, *C* and *D*, in the elevation. This is done by squaring up from points 1, 2 and 3 in the plan of the large end to the base line *A-B*, intersecting the same at points 5, 6 and 7. Now with a straight edge laid on 7 in the base and 7 in the elevation, mark the point *B* on the vertical center line; do the same with points 6, 6 and 5, 5 thus locating points *C* and *D*.

"Next construct the side view of the joint in the elevation as indicated by the dotted lines and curves connecting points 7, *A* and *G*, to suit your eye. I mean have it look good. The base of this plane will equal the major axis of our duct. Now with the tee square draw lines parallel with the base line through the points *A*, *B*, *C* and *D* cutting the outline of the plane as at *A*, *B'B"*, *C'C"*, *D'D"*. Now set the dividers at *B-B'* in the elevation and place the distance at *A-B'* in the plan, then take off *B-B"* in th: elevation and place this distance at *A-B"* in the plan, transferring the other points *C* and *D* in the same manner. Now connect all points in the plan with dotted lines beginning with a point on the center as from 0 to 1, 1 to 2, 2 to 3, 3 to 4 in the plan. Now take two pairs of dividers, lay off the circumference of both the branch and the circular portion of the base on a straight line and divide each circumference with each pair of dividers. Now you are ready to lay out the pattern.

"Well, Fos, the pattern is simply the result of constructing and using a series of triangles, the proper manipulation of which results in the pattern of the object in question. Now the broken lines extending down from the points on the face of our right hand branch to the base line give us the height of all the triangles of that branch, so all we have to do is to pick out the proper line in the plan to be used as a base, for the corresponding height in the elevation and vice versa.

"We might construct a line as at *M-N*, and cross over with the vertical heights of our branch and thus construct a separate diagram of triangles from which to lay out our pattern, but I prefer working right from the elevation of the object, thus saving both time and space and avoiding many chances of making a mistake.

"Our first move then toward our pattern is to set our dividers to *O-O* in the plan; then move up to the base line and plant one leg at *O'*. The other leg will necessarily reach to *O* on the base line, then we stretch up to *O* in the elevation for the line *O-O* in the pattern *A*. Next we stretch from *O* in the plan of the branch to 1, in the plan of the base (dotted line) then move up to the base line and plant one leg of the dividers at *O'*, the other cutting the base line. Then stretch up to *O* in the elevation. With this distance sweep from *O* to 1 in the pattern at the left. Now with the pair of dividers set to the circumference of the large end set at *O*, cut the point 1. Next stretch from 1 to 1 in the plan (solid line); move up to the base, set one leg at 1 on the base line, the other cutting the base. Then stretch up to 1 in the elevation. This distance gives us point 1 at the top and left in the pattern. Now cut over from *O* to 1 with the dividers. Set the circumference of the branch thus locating the point 1 at top. Continue these operations around to 5-*E*. From there on, the heights of your triangles change to correspond with 5-*D*, 6-*C* and 7-*B*. From *E*-5 on, our procedure will be from 5 down to *D*, from *D* up to 6, from 6 down to *C*, from *C* up to 7 and from 7 down to *B*, *B* up to 8, 8 down to *A*. The left hand branch is developed in precisely the same way.

"Now, Fos, it's five minutes of twelve, let's get lunch. After lunch I'll come down and bring a print for each of the boys, and lay out this Y for you. So long, Fos."

Lighting Facilities in the Boiler Shop

Practical shop lighting systems that will improve the average working conditions

By James F. Hobart

GOOD lighting of a modern boiler shop has been complicated by the use of the overhead traveller which sweeps across the entire floor area of the shops and prevents suspended arc lamps from illuminating the shop uniformly. Should the attempt be made to properly light the shop by suspending the lamps high enough to be cleared by the traveller, an enormous amount of light will be lost in the roof of the building and it is safe to assume that more than four times as much electricity will be found necessary to even passably light the shop working space than when the lamps are placed down among, or just above the workmen. As a matter of economy it is necessary to get the lights as close to the work as possible and save electricity, lamps and eyesight.

It is of little use to install lights high up and then place reflectors in position to throw the light downward. A reflector in a boiler shop is about as worthless as a high-up window. After a few weeks of use, both reflectors and window glass might as well be made of rough black steel, as of polished metal or glass. You will quickly find that it does not pay to "monkey" with reflectors, or high-up lamps in your boiler shop.

Flood Lighting

At first sight it looks as though a boiler shop could be well and pleasingly lighted by simply placing a row of floodlights along each side of the shop, just below the overhead traveller and placing the wiring of these lamps in sections, so that only such flood lights as may be required by the work on the shop floor, need be used. Such a system will certainly provide plenty of light and it will also provide plenty of expense, not only for "juice," but for the electrical equipment. Flood lights are expensive to install and to operate. They consume lots of current and carbons as well and the glare from flood lighting is bad for the eyes of the workmen. Such light is also unbalanced seemingly more so than the light from a high power arc lamp.

Traveller-Dodging Lights

The light furnished by a single arc light is far from being pleasant to perform mechanical work by. An incandescent, enclosed arc light is better but it does not furnish satisfactory illumination. When three or four arc lights are spaced overhead several feet apart, their light is good to work by and for this reason, rather closely spaced overhead lamps form a most satisfactory method of boiler shop lighting, such lamps being turned on, as will give the most effective lighting combination for the work to be done.

The man whose shop has an overhead traveller, is "out of luck" as to overhead lighting by closely spaced arc lights. However, without the overhead traveller, the shop would be still more lacking in "luck." Therefore, the lights must "catch as catch can." With this end in view, overhead, low-hanging incandescent arc lamps may be hung from little trollies, which in turn rest and run upon structural steel supports, placed just high enough to clear the upper works of the overhead traveller.

As many rows of lamps as may be considered necessary, may be used, each row upon its own steel runway. The lamps and trollies of each row are spaced as close together as is necessary. Each row of lamps is connected across two stout insulated cables, the lamps being connected in parallel or multiple, and when the lamps are spaced, the traveller is moved to one end of the shop, and the cables stretched from the far end of the shop and adjacent to, yet insulated from the traveller. The lamps are to be spaced along the entire length of the shop and made fast to the two cables in such a manner that the lamp, after having been pushed together by the traveller, will be separated and spaced by the pair of cables as the traveller moves away from the bunched lamp-trollies.

Automatic switches may be provided whereby, as each trolley is bumped by the adjacent trolley or by the traveller, the current will be cut off at each. The trolley switches work automatically in an opposite direction also, and turn current into the lamps whenever the trolleys are pulled apart from each other and from the overhead traveller. In addition to the automatic trolley switches, each lamp has its own pendant switch control which hangs down, just within reach of workmen on the shop floor. By means of the pendant controls, such lamps are turned on as may be required by the workmen.

After as many rows of lamps as desired have been installed as described above, the overhead traveller is moved to the other end of the shop and another set of trollies, lamps and cables installed, covering the entire shop floor-space similar to the rows of lamps already described. When this system is in operation, the traveller moves to and fro at the will of its operator and pushes into one end of the shop or the other, all the lamps whose trollies the traveller pushes against.

A gang of workmen having lights turned on to their comfort and satisfaction, signal the traveller to do some work for them. As the traveller approaches, it bunches the lamps ahead of it and the lighted ones are extinguished by the automatic switches. As the traveller passes over the gang of workmen, lamps from the other end of the shop are dragged into place overhead, and may be turned on by means of the pendant controls. When the traveller goes away again, the original lamps are dragged back into the overhead position, are lighted as the lamps move apart from each other and the group of workmen has its own lights again. This program will be repeated each time the traveller moves past the workmen and back again.

The disadvantage of this arrangement is, that double the number of lamps are required. There is also double the amount of wiring, of trollies and switches to be looked after and kept in working condition. But in spite of the labor and expense, the arrangement gives good lighting when and where it is wanted.

Floor Stand Lighting

However good an overhead system of boiler shop lighting, may be it can never, in the writer's estimation, be found better or more convenient than a number of high-power lamps suspended flexibly from the upper portions of floor stands made so that the lamp is within easy reach of the workmen.

Light-supporting floor stands may be constructed in a variety of ways. An "all-boiler-shop" method is, to flange down some cheap, heavy plate for bases for the stands. The bases should be 30 or 36 inches in diameter, preferably bumped-up and the flange should be turned down 3 or 4 inches—the wider the better. Drill a hole in the middle of the base which will admit a 1-inch black steel rod which should be threaded at both ends and fitted at the lower end with a centering washer and at its top with a cap through which the 1-inch rod may pass. Cut and square the ends of an old boiler tube, 3 or 4 inches in diameter. The length of the piece of tube shall be such as is required for the height of the floor stand, say, between 7 and 10 feet.

On top of the cap which covers the top end of the tube, may be placed one end of a bracket to which the incandescent arc lamp is to be attached. Or, the end of the bracket may be made to serve as a cap for the top end of the old boiler tube. The lower end of the bracket is to be bolted to the tube in a convenient manner. Thread the 1-inch rod through cap bracket, tube and base, screw the nuts tights, and the floor stand takes shape. Should more weight be found desirable in the base of the stand, cut scrap plate into disks, punch a hole in the center of each disk and place one or more upon the 1-inch rod like washers. Any required weight of base may be built up in this manner. In place of an ordinary bolt, use a husky eyebolt for fastening the lower end of the lamp-supporting bracket. The eye should be preferably, 2 to 3 inches inside diameter. When a floor stand is to be moved from one place to another, slip a chain hook from the overhead traveller through the eyebolt above described and "hoist away!"

Should a more elaborate and better looking floor stand be desired, have a pattern made and bases cast in an iron foundry, of weight and shape desired. The electrical connections upon these floor stands may be made as simple, or as elaborate as desired. Connections may be made direct to the suspended lamp or, a connection box may be placed upon, or in the stand base, from which box wires in conduit, lead up through the post of the stand and along the bracket to the lamp suspension.

Current for such stand lamps should be taken from electrical contact boxes built into and above the floor of the shop at frequent intervals all through the shop. Current should be carried to these contact boxes through underground wires. The contact boxes, built up from the shop floor about 18 to 24 inches, should contain devices for attaching the compressed air hose and also, connections for oxygen and hydrogen or acetylene gas for the welding torch and cutting torch. The electrical connections should be such that they, together with air and gas hose, come out through the sides of the box, nearly level with the floor of the shop. Wires and hose should not come out of the top of the connection box and hang from thence to the shop floor, to be cut or broken by material falling against the connecting tubes or wires.

Floor stands should be plentifully supplied and 2, 3 or 4 stands set around a job in such a manner that shadows—the bane of shop lighting—will be avoided or dissipated. Work of course, may be done by the light from a single floor stand lamp, but 3 or more lamps suitably placed around the work will prove a profitable arrangement.

Arrange the electrical connections of all floor stand lamps in such a way that, should the floor stand be picked up by the overhead traveller before the feed wires have been disconnected, that no damage will result, the wires simply pulling easily out of the lamp or the stand base connection box.

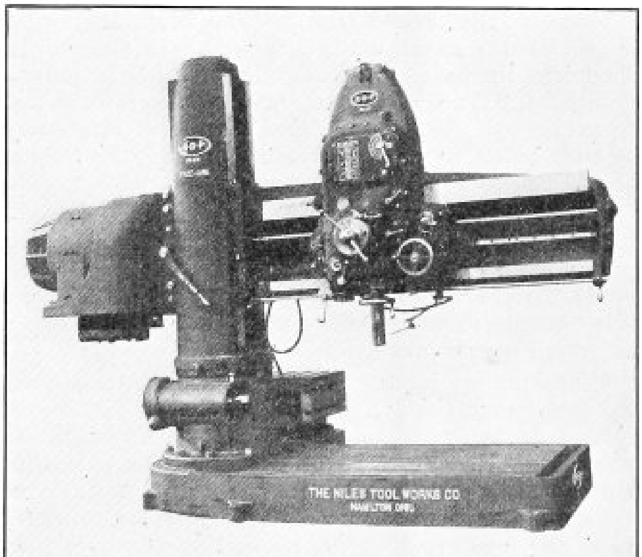
When putting together one of the floor stands, bend the long central rod slightly, that it may pass to one side of the large bolt which holds the lower end of the lamp bracket in place and which also serves as a lifting hold for moving the floor stand. Furthermore, do not place the eye bolt in line with the bracket. Instead, form the lower end of the bracket in such a manner that it extends one quarter way around the pipe column, thus permitting the eye bolt to be placed through the pipe at right angles to the bracket. The object of this construction is to cause the stand to be tilted when lifted or set down, in a direction at right angles with the lamp supporting bracket. This construction, to some extent, forces the suspended lamp to swing sidewise of the bracket direction and parallel with, instead of toward the floor stand column. This makes it easier on the suspended lamp and lessens the possibility of the lamp swinging against the pipe column when the floor stand is set down by the overhead traveller. Furthermore, make the bracket long enough so that the lamp will not swing against the column under decent handling. But, do not make the bracket any longer than is required, as the longer the bracket the more the stand tilts when lifted by the eye bolt and the more danger of undue swinging, shaking and stress upon the enclosed arc lamp.

Niles Heavy Duty Right Line Radial Drill

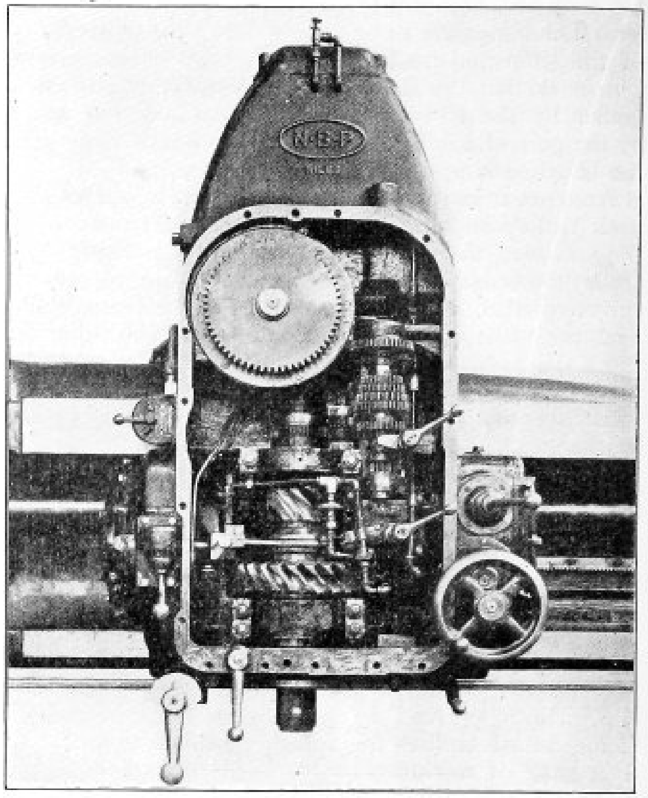
To supplement the No. 10 medium pattern right line radial drill, the Niles Tool Works Company, a division of the Niles-Bement-Pond Company, Hamilton, Ohio, has placed on the market a heavy duty radial drill which is designated as the No. 25 right line. Although retaining some of the characteristics of the No. 10 machine, the new drill embodies many changes over the lighter type.

The machine is of the plain radial type driven by a direct current variable speed motor. The drilling radius is 6 feet, but it is also planned to build the machine in 7-feet and 8-feet arm lengths. The machine is driven by a 20-horsepower motor mounted on the end of the arm behind the column and is connected to the arm shaft by a flexible coupling, the arm shaft coming directly to the head through the divided column and the center of the arm.

All speed changes are embodied in the head itself. These changes are obtained through selective sliding gears of the automotive type shifted by ball socket levers. The spindle drive, including the arm shaft, is mounted on ball and roller bearings and the sliding



A front view of the Niles No. 25 right line radial drilling machine



An interior view of the head

gears on multiple spline shafts with integral keys. There is 100 to 1 speed range, the minimum being 12 revolutions per minute, the maximum 1,200 revolutions per minute. In the direct current variable speed drive machine, this range is affected by three mechanical changes of speed, shifted by one lever, combined with the variation of the motor speed. In the alternating current constant speed drive, there are 24 spindle speeds, all obtained mechanically through the movement of three levers. Reverse or tapping and other operations is affected by reversing the motor, friction clutches for this purpose being entirely eliminated.

The final drive to the spindle is through a double set of worm gearing of special tooth form mounted at the lower end of the spindle. The smaller worm wheel takes care of the higher speeds (300 to 1,200 revolutions per minute), the larger one being an engagement for speeds from 12 to 300 revolutions per minute. These worm wheels are mounted on a sleeve on the spindle. The high speed worm wheel is engaged by a jaw clutch on the arm shaft sleeve and the low speed worm wheel by a jaw clutch on the spindle. For the high speed ratios on the direct current machine there is but one worm wheel contact between the motor and spindle. The alternating current machine has two spur gears and one worm wheel contact for the same ratios. Low speed ratios on the direct current machine go through two spur gears and one worm wheel contacts and the alternating current through four spur gears and one worm wheel contacts from the motor to the spindle. There are 16 feeds available.

The head is totally enclosed in an oil-tight and dust proof case and the gears and shafts lubricated thoroughly by a pump mounted inside the head and geared to the arm shaft. The worm gears are lubricated by pressure through two nozzles, the jets impinging di-

(Continued on page 83)

Staybolt Production in Railway Shops

Methods and types of machines generally used for the manufacture of crown staybolts

Part II

As previously mentioned in Part I of this article in some shops instead of squaring staybolt heads, the bolts are at the time of manufacture threaded their entire length. As this form of staybolt is not yet common practice in railroad shops, a description of their manufacture will be given.

When screwing this form of staybolt into the boiler, they are held in threaded socket wrenches made of tool steel, threaded to fit a certain size of bolt and hardened to increase the wear and reduce the danger of the threads breaking. A stop in the socket is set so that the bolt extends beyond each sheet about two threads or 1/6 in., or such amounts as shop practice dictates to allow for the beading.

The practice when applying the staybolts is as follows: The distance from the outside of the outer sheet to the inside of the firebox sheet is measured with a rule gage which is passed through the staybolt hole. This gage is graduated to show the length of bolt required plus the added length to admit of beading each end. The bolt is placed in the socket wrench and screwed into the boiler until the socket wrench comes flush with the sheet, after which the wrench is backed off.

In many respects, this is a desirable practice, as the bolts are located in the sheets allowing the correct amount for beading at each end. It is not necessary to cut off the bolt in the sheet, which is objected to by some boiler makers owing to distorting the threads of the sheet and bolts during the cutting-off operation. There are however, objections to this practice. It is necessary to keep on hand a large stock of bolts of the desired lengths, or provide means by which they may be economically cut off to odd lengths. However, when made by quantity production methods, the labor cost is comparatively low, also less material is required per bolt owing to omitting the square ends. This form of staybolt admits of economic manufacture direct from the bar, either on automatic screw machines or turret lathes.

Manufacture of Staybolts on Automatic Machines

The single spindle automatic forming machine, Fig. 10, is the more suitable type of automatics for this work. This class of machine has the usual devices for feeding and gripping the bar, cut-off rests, stops to gage the length of bar fed and a single plunger for holding the threading die. The single plunger takes the place of the turret common to automatic screw machines. All of the operations are controlled by cams.

As machines of this nature would be kept on this special job, the lost time of changing the set-up is small. The changing from one length to another of the same diameter only involves the re-adjustment of the dogs controlling the length of stock fed and the fast speed movement. The changes should be made in about 10 minutes. Machines of this nature may be equipped with relieving attachments for cutting away the central portion of the bolt. The output of plain radial staybolts 7 in. long would be about 30 per hour, or relieved bolts about 23 per hour, less possibly 25 per cent idle time. As one man can operate four machines, the labor cost is low.

The cycle of operations for the manufacture of staybolts on an automatic machine is as follows: The bar is fed to the stop; the chuck tightens, gripping the bar; the bar is partly cut off by the front cut-off tool and at the same time the die head starts cutting the thread. The front cutting tool backs off and out of the way of the die head. The die head continues to cut and threads to about 1 in. past the previous nick in the bar. The die opens and backs off; the bar is cut off with the tool in the back cut-off rest. The chuck opens and the machine goes through the same cycle for the next bolt.

In the above description, it will be noted that the dies run over the first partial cut-off or nicking of the bar which prevents burrs or enlargements of the threads at either end, thus permitting the staybolt to be readily screwed into the boiler or socket wrench.

This form of staybolt is also made on turret lathes as shown in Fig. 11 or on a double die crown staybolt machine. The actual time of making the bolts on automatics or hand turret machines is practically the same. For a large shop where several automatics can be kept in operation, the automatics are the more economical. However, for a small shop where frequent changing is necessary owing to lengths and diameters, the turret lathes are, as a general proposition, the more desirable. The choice of machines is governed by the number of staybolts required; the higher capital cost and lower labor cost of the automatics, versus the lower capital cost and higher labor cost for the turret lathes.

Drilling Tell-Tale Holes

For a shop in which a large number of staybolts are manufactured, it is generally economical to install special machines for the drilling of tell-tale holes owing to the fact that the first cost of a high production machine is not much greater than the several less efficient machines, such as drill presses, required to produce the same output per day. The special machines, owing to lower labor costs will, in most cases, warrant the greater investment.

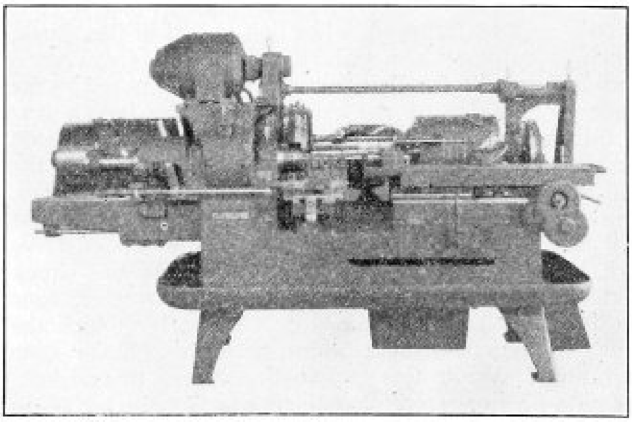


Fig. 10—An automatic machine for the manufacture of staybolts from bar stock

One of the most speedy machines now on the market for this purpose has a revolving magazine in which 12 staybolts are held during the drilling operations and also a cage in which are held 12 drill spindles. The magazine and cage revolve at a uniform rate of about one complete revolution per minute. The bolts are held in the magazine by a cam-operated chuck the jaws of

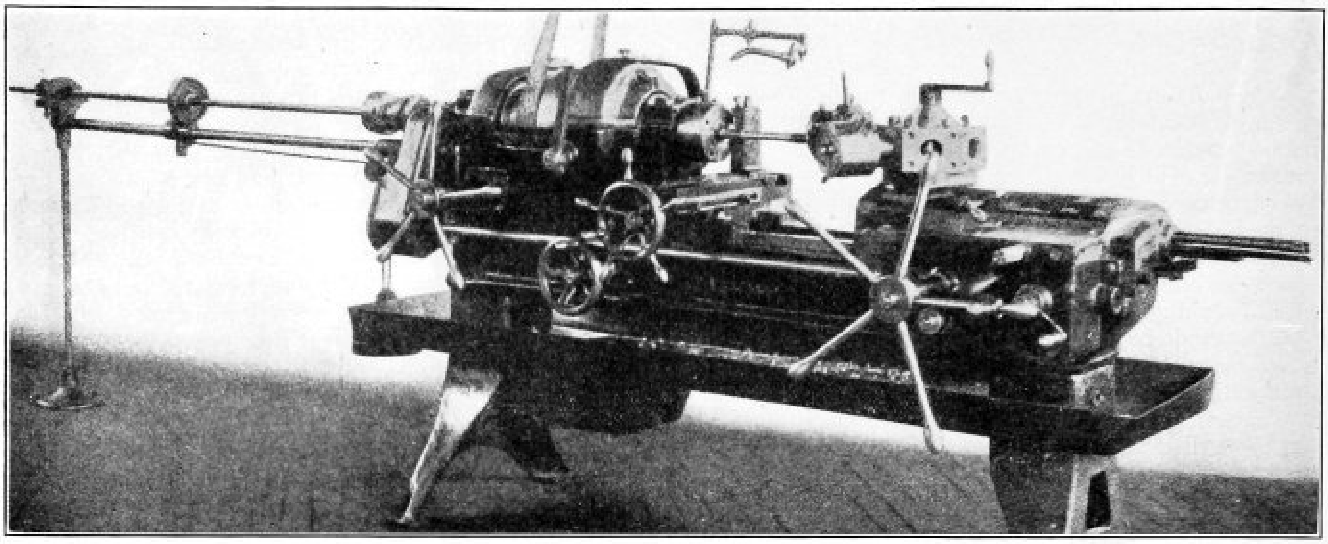


Fig. 11—Threading and cutting off staybolts on a turret lathe, thus eliminating extra handling of the bars

which are serrated 12 per in., agreeing with the threads on the bolts, which prevents their pushing backwards during the drilling operation.

Thrust collars surround the quills on each spindle. The spindles are moved horizontally in their respective bearings. A roller which rides on a cam is attached to each quill. The stationary cam has three or more lobes. As the drill spindles and cage rotate, the cam forces the drill spindles forward drilling the staybolts a given distance as the roller rides up and over each cam lobe. The spindles are pulled back by springs. Each successive lobe of the cam is of a greater elevation for the purpose of drilling to a greater depth.

To explain the cam operations, the drilling of one staybolt will be followed. The bolt is laid in the chuck, which is automatically tightened in as the cage turns. The drill spindle for that particular station is fed to the work by the rise of the cam, drilling the bolt a certain distance. The spindle passes over the first lobe on the cam and recedes for the purpose of allowing the drill to clear itself of chips. As the cage further turns, it rides on the second lobe of the cam which causes the drill to drill the bolt still deeper. This is repeated for each lobe. After the drilling is completed the chuck holding the bolt in place opens and the operator removes the drilled bolt and applies a new one after which the chuck tightens and the machine goes through the same operations. While this explanation refers to one bolt, it should be understood that the entire 12 bolts are being drilled at the same time.

The drills are guided to the bolt center by a bushing located on the cage and are flooded with oil at all times. Owing to 12 staybolts undergoing the drilling operation at one time, the output is large.

Manufacture of Crown Staybolts

Two types of crown staybolts are in general use. The button head staybolt is made from bar stock slightly less in diameter than the root of the thread. The button at the head end, the squared end and the enlargement of the tread are upset and formed while hot by one operation in a forging machine. The point end is likewise enlarged in a forging machine to a suitable diameter for either threading without turning, or to a slightly larger diameter (about 1/16 in.) to admit of turning previous to threading.

This practice is, in some shops, modified by making use of stock the full diameter of the threads; that is, 1-in. bolts are made from 1-in. stock. The button head, the square end and in some cases the threaded portion are upset in a forging machine. The stock between the threaded sections at the point and the head end is re-

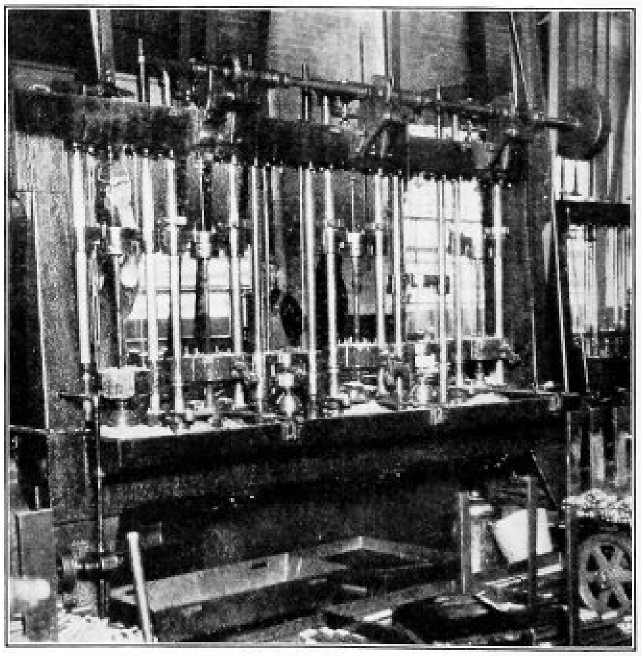


Fig. 12—Crown staybolt threading and turning machine

duced in diameter slightly smaller than the root of the thread by a turning operation.

Taper thread head end staybolts are forged from blanks similar to the button type.

Machining Operations Required for Both Types of Crownbolts

The machining operations on the above mentioned crown staybolts compare as follows: The small stock bolts require two forging machine operations. Unless great care is exercised in maintaining the forging dies in perfect alinement and in good state of repairs, the upset ends do not line with the center section, with the result that when threaded, the threads may not be concentric with the center section, which defect is, in some shops, objected to for fear of injury to the boiler sheet threads when applying. This method of manufacture takes less weight of stock and is generally lower in labor cost. With reasonable care in forging and machining, the method meets with the general requirements.

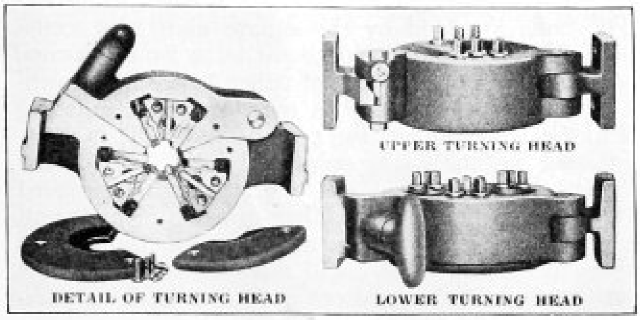


Fig. 13—Turning heads used on the machine shown in Fig. 12

When made from the larger bar stock, only one forging operation is necessary. However, the labor of reducing the central portion is added. The threads and the reduced section are readily machined in line. The relative cost of manufacture by either method is largely governed by the machines employed.

Turning and Threading on Special Purpose Machines

Owing to the large number of crown bolts required, special purpose machines are extensively employed for their manufacture. Fig. 12 shows one design of machine now used in several railroad shops. The general construction of this machine as far as the drive of the crown bolts, uprights, etc., are concerned, is similar to the machine shown in Fig. 9 in Part I of this article. As generally constructed, four of the six uprights are each equipped with two turning or cutting heads. The upper cutter head is for the purpose of turning the point end to the correct diameter for the thread. The lower head is for the head end in which the blank is turned to the correct diameter for the thread. The under side of the button head is faced, either flat or cupped and the flash left from the forging operation is removed.

The upper cutter head, shown in Fig. 13, may be opened for clearance when removing the blanks. The lower head, shown in Fig. 13, is of unique design. One half of this head is hinged and when closed, is securely held in position by a locking handle. The hinged front allows for opening while applying and removing blanks. Each of the heads are provided with adjustable cutting tools and the necessary backers or guides. These cutter heads turn the blanks in a very satisfactory manner.

Both of these cutter heads are adjustably held on two vertical rods admitting of setting either head to any location for different lengths of bolts. The two rods extend upwards to a common crosshead which is actuated by a power driven cam on a slowly revolving shaft located on the upper frame of the machine. Each individual cam is engaged by a clutch which is thrown in by pulling a lever. When the cam makes one complete turn, the clutch automatically disengages. Each of four turning stations of the machine are independently thrown into operation, the same as would be the case with four separate and distinct machines.

The two remaining stations are for the threading operations. They are each equipped with two self-opening die heads. The upper head is similar in operation to the commercial self-opening die head such as shown in Fig. 14. The lower die head is of a special design, equipped with an instantaneous trip operated by a trigger striking the flat surface under the button head end of the blank, which insures the thread extending close to the flat surface and preventing the chasers from striking this surface. Both of the die heads are raised by a friction belt and handle, the same as shown in Fig. 9. A floating socket drive for the bolts is preferably made use of to compensate for possible irregularities of the fitting of the square ends of the bolts in the socket drive.

Operations on the Machine

In referring to the turning and threading operations, only one turning and one threading station will be considered. In considering the turning operation, it will be assumed, as is actually the case owing to the cam action, that two cutter heads are in the upper position; that is, the lower head is about 2 in. above the enlargement of the blank for the thread. The upper head is above the point of the blank. The hinged half of the lower cutter head is open.

The operator places the squared head of the blank in the socket which revolves the blank. He then closes and locks the hinged half of the lower cutter head and pulls the clutch lever which engages the cam, after which the two cutter heads automatically feed downward, turning the point end to the correct diameter, turning the head end to the correct diameter for threading, facing the under side of the button head and removing the flash from the outside of the head. After a small amount of dwell to insure a satisfactory facing of the under side of the head, the two cutter heads automatically raise at a rapid rate, when the cam disengages awaiting the next operation. The operator opens the cutter heads and removes the turned blank.

In the threading operation, the two die heads of the selected station are raised by pulling the handle attached to the friction belt. The squared end of the previously turned blank is entered in the revolving socket. The die heads are lowered, the lower die passes over the point end of the blank when in an open position and is closed before reaching the head end thread. The upper die is closed by a cam on the upward movement. The point and head ends of the blank are then simultaneously threaded. The point end threading die opens at the completion of the operation. The head threading die opens when the opening trigger strikes the previously turned surface of the button head of the blank.

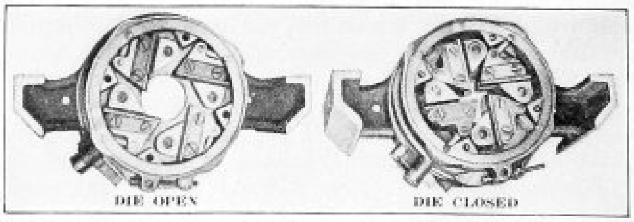


Fig. 14—Self-opening die heads arranged for threading staybolts

Like operations of turning and threading are going on in the remaining stations. The purpose of four turning and only two threading stations is to keep all stations in actual operation, it having been found that the turning time is about twice the threading time. Owing to the rapidity of the turning and threading operations, two men are at times employed on the one machine. They are kept busy applying and removing the bolts, gaging the threads, etc.

When it is desired that the threads on the point and head ends shall be in perfect pitch with each other, the

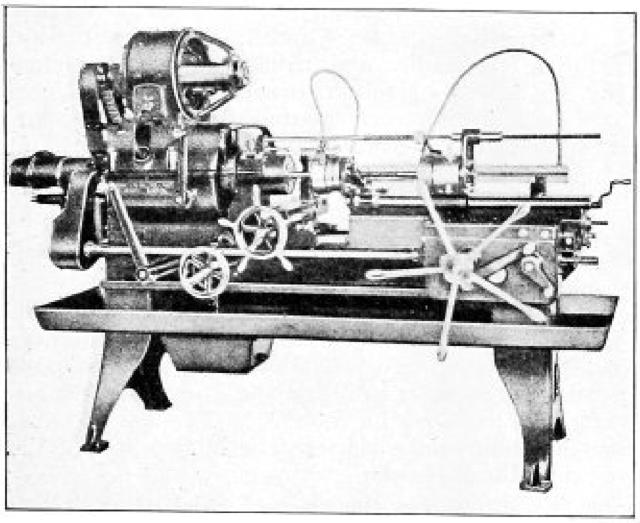


Fig. 15—A Gisholt crown staybolt turning and threading machine

two die heads are secured to two spacing bars, which hold the pitch of the two threads in perfect alinement.

Several shops make a practice of threading the point end of crown staybolts approximately .004 in. smaller than the head end. This is readily accomplished by the setting of the two die heads. Where a taper thread is called for at the head end, a taper threading die head is used.

For the smaller shops, the machines are at times modified by providing two turning stations and one threading station for crown bolts and three stations for the shorter radial staybolts.

Manufacturing on Horizontal Special Purpose Machines

Special purpose horizontal machines have been developed for the machining of crown bolts. One form is shown in Fig. 15, which may be considered as representative of a class. This machine, as far as the headstock, the tool holding slide, the cross slide, feeds and control are concerned, is similar to a turret lathe. However, the customary turret is replaced by two sockets for holding internal cutting heads, or self-opening die heads. The front socket is fixed to the slide; the rear socket is adjustable on the slide to accommodate different lengths of bolts. The internal cutter heads are adjustable for different diameters of bolts. Both the cutter head and die heads have sufficient range of openings to pass the unfinished forging while in the open position. The opening and closing of the die heads are controlled by cams located on an adjusting rod, or by hand.

For threading bolts having taper threads at the head end, a special self-opening die head is used, the opening of which is controlled by a cam which causes the dies to open gradually at a rate agreeing with the taper of the thread. When the thread is completed, the chasers open quickly, similar to the regular self-opening die head.

If it is desired that the threads on the two ends of the bolt should be in pitch relative to each other, the two die heads are set to the required distance by a master screw. Some designs of machines are equipped with fine thread adjusting screws for this purpose. A lead screw often forms a part of the machine for moving the slide which insures the correct pitch of the threads. However, when the two die heads are set to a perfect pitch, this hardly appears necessary.

The bolts are held by the square ends in a collet chuck which is opened and closed by a hand-operated lever. The head end is turned either by a single forming tool or a roughing tool in the rear and a finishing tool in the front post of the cross-slide.

In some instances, the point and head ends of the bolts are first turned in one operation, and threaded by a second operation. Another practice is to thread the point end direct from the forging. The head end is formed to the desired size and shape by the cross-slide tools, after which the head end is threaded. This practice requires only one handling of the bolts.

Machining Operations

Where it is the practice to turn the two end enlargements of the blank previous to threading, the blank is tightened in the chuck, the two turning heads are quickly moved by hand feed to about ⅛ in. from the surface to be turned, the cutter heads are closed, and the power feed engaged, turning the point and head ends at the same time. The feed is automatically disengaged at the right moment by the throw-out device.

The above practices may be modified by only turning the point end in the first operation, the head end being turned during the threading operation. However, as the point end is the longer operation, both ends may be turned in the same time. Therefore, it is under most conditions advisable to turn the point end to the thread size and the head end about 1/16 in. large to allow for the final finishing. After the turning operations, the blanks are removed and piled awaiting the threading operation.

Turning the blanks as above described, admits of a greater latitude when forging and generally results in a more perfect bolt. However, the turning operation

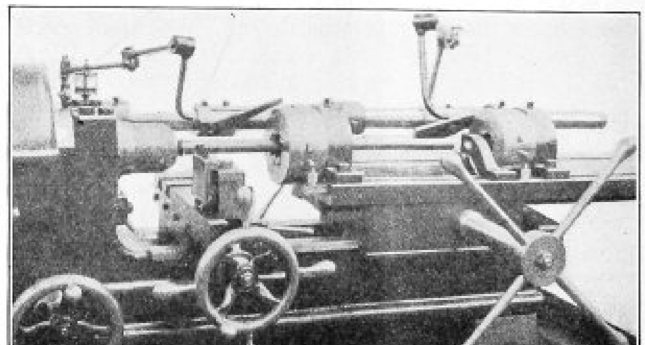


Fig. 16—A type of machine admitting of modifications for the turning of the central section of crown staybolts

is not considered as absolutely essential in shops making a practice of forging the point and head ends to close alinement with the bar stock.

Mention has been previously made of crown staybolts made from bar stock of a diameter the full size of the threads. The middle section between the two ends is turned to a size slightly smaller than the root of the thread. This practice does not appear to be general. However, where properly carried out, this practice should result in a superior grade of bolt. The relative costs compare as follows: The smaller bar stock takes two forging operations, the larger only one. With the smaller stock, it is desirable to turn the point end owing to the difficulty of forging to the correct size for the thread. With the larger stock turning the point end is not essential. With the smaller stock, turning of the middle section is not necessary; however, it is necessary with the larger stock. A greater weight of stock is required for bolts made from the larger stock. Bolts made from the larger bar stock have the advantage that with ordinary care, the threads are perfectly concentric with the reduced section.

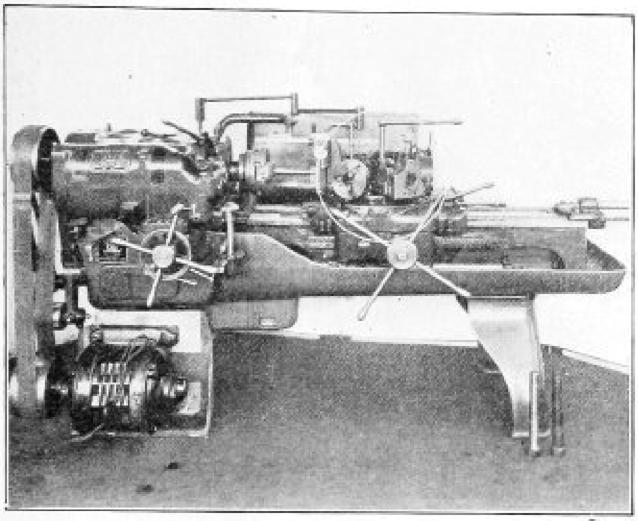


Fig. 17—The circle shows how a bar turner may be modified for turning crown staybolts

The writer has never had an opportunity to observe the actual manufacture of crown staybolts by this method, therefore, the description is largely based on similar machine operations.

The purpose of making crown bolts by reducing the central section in place of enlarging the point end is apparently to obtain a superior product and eliminate the one forging operation of enlarging the point end. The head end must, from necessity, be upset in a forging machine, at which time it would appear advisable to enlarge the stock next to the head to admit of turning previous to threading to insure a full thread in the event of the blank not running true in the machine.

Special machines for the reducing turning operation have not come to the writer's attention. However, the machine shown in Fig. 16 may be modified for this purpose by substituting two-bar turners as shown in the circle portion of Fig. 17, in place of the two die heads. The rear bar turner has backers, or rests in front of the cutting tool. These backers rest on the unturned bar stock. In operation, this bar turner would be located so that the cutting tool may be fed into the bar at the inner end of the point end thread. After feeding into the bar to the required depth, the slide feeds about 1½ in., turning a neck of the desired size for the middle section of the bolt. The front bar turner has backers or rests in the rear of the cutting tool. These are located over the previously necked surface, and the backers and cutting tool are closed to turn to the same diameter as in the previous turning. The power feed is engaged and the blank turned to the head end thread. This method should result in a true turned section, even if the blank is irregular. As the squared end is held in a collect chuck, the blank should run true at the time of the second chucking for threading.

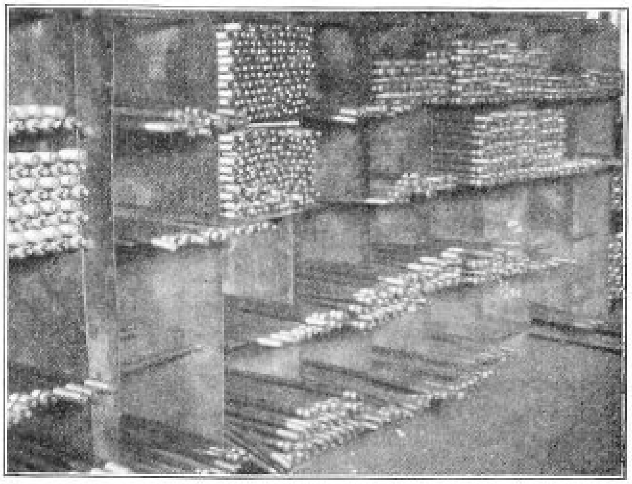


Fig. 18—Finished crown bolts piled in steel shelving

When turning on the good grade of iron or steel common for staybolts, the cutting speed can readily approach 75 ft. per min., equalling for 1-in. material, 287 r.p.m. The feed can be about 1/16 in. per revolution, equalling approximately an 18-in. feed per min. For a bolt 24 in. between the point and head end threads, the actual turning time is approximately 1 min. 20 sec. Or when allowing for the handling and changing from the back to the front bar turners, the production per machine should average from 20 to 25 per hour. During this turning operation, the head end can be rough turned by a tool in the cross-slide. The threading of the two ends would be similar to bolts made from the smaller stock. This practice of turning and threading should result in a superior bolt at a cost but little in excess of the most rapid method of manufacture. Owing to the desirability of this method of manufacture, it is worthy of careful consideration.

Use of Flux in Manufacturing Boiler Plate*

By E. N. Treat

THE term flux implies the flowing or joining of substances and in the boiler shop, or plate shop, it is used mainly in connection with the welding process. In the manufacture of steel, however, the metallurgist utilizes a flux to assist in reducing the solid materials in the furnace to the molten or liquid condition during which process a slag is formed through the combination of the flux and the impurities in the metal.

A simple comparison may be made with the cleansing agent used in the laundry. Each fabric of similar texture and soiled to the same degree requires a fixed amount of cleansing agent. So also, each metal requires its degree of flux in proportion to the charge and

*This is the third of a series of short articles on steel mill practice in handling boiler materials. The first article appeared on page 3 of the January issue, the second on page 40 of the February issue.

to the extent of the removal of impurities desired. One steel may require a slight elimination of impurities, while another material for an entirely different purpose would require the almost complete removal of all impurities believed to be detrimental to the finished product.

It is therefore necessary that the boiler maker have a working knowledge of the material and its composition chemically. Silica, quartz, borax or fluorspar and limestone are most generally used, the latter being used more extensively on account of its low cost and reliability as a cleansing agent. Borax and quartz sand generally are used by the blacksmith in joining together his materials by welding. Silica fuses at a high temperature if by itself, or if heated in contact with bodies with which it has no affinity. Limestone because of its availibility at low cost is more extensively used at steel mills.

Fluxes are used in nearly all metallurgical processes. Their characteristics are determined by the special requirements of the metal and by the quality desired. It oftentimes happens that two substances having no affinity for each other, when brought in contact with limestone readily fuse at a much lower temperature than that at which each would fuse alone or without the limestone as a fluxing agent.

Naturally, the chemical makeup of the open hearth or blast furnace fluxes should be suited to the chemical composition of the basic materials. If this is not so, the art of refining is not at its best. This point the metallurgist must decide. Since the chief object of the flux is to form a fusible mass, with the impurities to be removed, it must be used in proportions determined by analysis that will produce the desired result.

Fluorspar is said to liberate impurities in a gaseous state when in contact with the blast furnace charge, such gases being eliminated by passing out the stack. The use of fluxes in each instance is important, whatever the method may be, so long as the resultant cleansing of the metal is obtained. A specified chemical analysis of the material he wishes to use will guide the metallurgist in securing the desired fluxing agent in order that the desired quality of that product be assured.

New Welding School Opened

THE Lincoln Electric Company, Cleveland, Ohio, manufacturer of welding equipment, has reorganized and re-equipped its school of welding. The purpose of this school is the training of electric arc welders; and though each individual instruction represents a considerable expenditure no tuition or fees are charged.

In Fig. 1 the equipment of the present school is shown. It will be seen that a number of standard 200 ampere stable-arc welders have been installed in line with a series of booths in which the pupils do their work. The new arrangement has been developed to simplify, as much as possible, the student's work in familiarizing himself with welding machines and practice. The welding unit that serves each man stands directly before the booth in which he practices. All the wiring except the necessary leads to the electrode holders is concentrated in conduits and the floor space is kept clear and clean. The individual compartments are curtained by heavy material so that there may be no chance of the arcs struck by other pupils flashing the men's eyes.

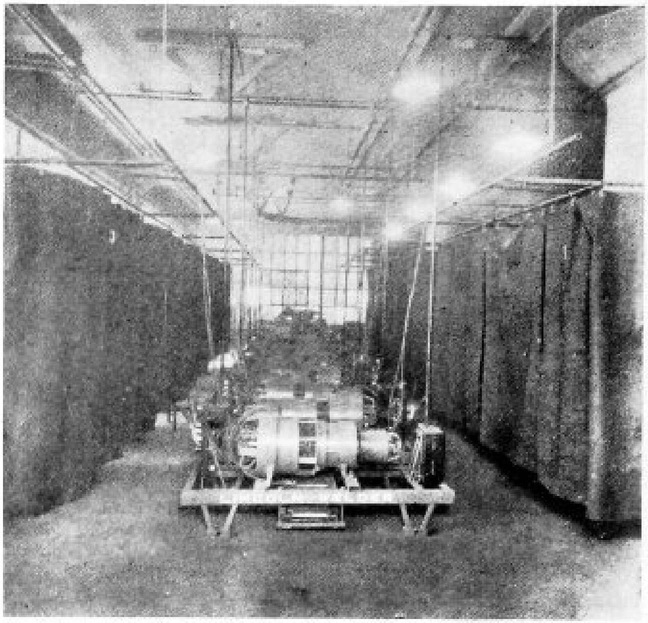


Fig. 1—View of equipment in school

The course in the Lincoln Electric Welding School takes thirty days and is given in twelve lessons. The lessons are divided under the following heads:

Lesson 1. The contact of the arc, its characteristics and manipulation.
Lesson 2. The nature of welding rods and depositing materials.
Lesson 3. The operation and care of the welding machine.
Lesson 4. The nature of vertical and overhead welding.
Lesson 5. Testing welds for porosity and strength.
Lesson 6 Welds on cast iron and their percentage of strength.
Lesson 7. The advantages and future of carbon arc welding.
Lesson 8. Welding of copper and bronze castings.
Lesson 9. The use and abuse of pressure welding.
Lesson 10. The assistance to the human element in stable-arc welding rod.
Lesson 11. The construction of welded machine tools.
Lesson 12. The simplicity and strength of welded fixtures.

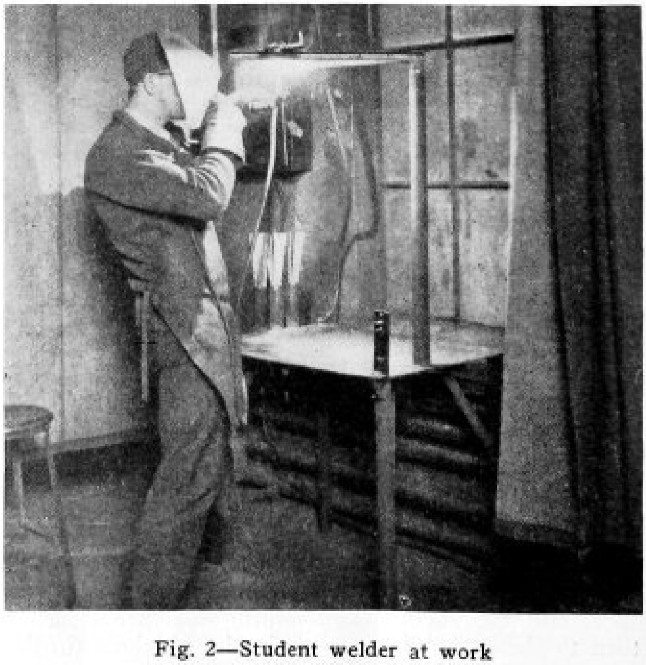


Fig. 2—Student welder at work

In Fig. 2 a student welder is shown at work. Before him is the table on which he practices. At the time the photograph was taken he was welding a piece of scrap plate overhead as practice. You will see that though his equipment is of the simplest sort, it has all been arranged for the greatest convenience.

The construction of the table should be noted, it is entirely of welded construction. The angles supporting the practice piece of steel for overhead, rotates in the pipe support so that it can be turned to meet the student's convenience. The holders for extra electrode are rather unique and consist of 2-inch pipe of about 6-inch length, welded to the top of the table as shown in the picture.

The pupils in this school work under the direction of a trained instructor who teaches them both as a class and as individuals. All the educational work comes under the general direction of A. F. Davis, vice-president of the company. With 30 days intensive training, men are able to acquire a sound working knowledge of the fundamentals of electric arc welding and are fitted to engage competently in the trade.

Heavy Duty Radial Drill

(Continued from page 76)

rectly onto the teeth contacts. Other gears and bearings are lubricated by gravity lines from a reservoir in the top of the head. The spindle is oiled separately through a sight feed oiler on top of the head. The spindle is 3⅞ inches in diameter at the driving point and is bored for a No. 6 Morse taper.

Power feed is engaged by two levers operating jaw clutches. These levers also serve to traverse the spindle by hand. A large graduated dial is provided with levers and stops, so that the feed may be tripped at the desired depth. The trips are also furnished to disconnect the feed mechanism at either end of the spindle travel.

The head is moved along the arm either by hand or by power. The power traverse is obtained through a worm gear connection from the arm shaft to the reversing frictions on the rack pinion shaft. The hand wheel is connected to the rack pinion shaft by spur gears and a jaw clutch. This clutch is interlocked with and shifted by the power friction clutch lever, so that when the frictions are in neutral, the jaw clutch is engaged, or the hand wheel is disengaged when the head is traversed by power. The rate of power traverse is 25 feet per minute.

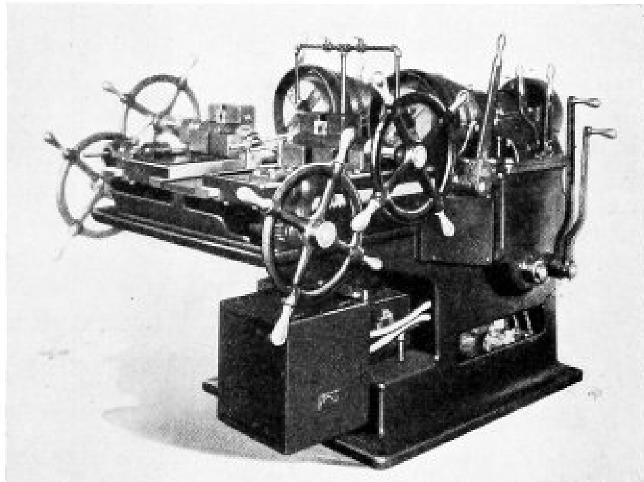
The head is supported on the arm on two adjustable ball bearing rollers sustaining the weight of the head on the top of the upper arm way. The upper way is square locked by an adjustable taper gib, the lower way by a retainer plate, with provision for a hand clamp to lock the head to the arm.

The arm is of patented design with the lower bearing surface set back to give increased tortional strength to the arm. It is supported and slides on columns on four vee ways. A single lever serves the dual purpose of elevating or lowering the arm and clamping to the column and is so arranged that when the arm is clamped, none of the elevating gears are in motion. Power for raising or lowering the arm is taken from the sliding gears on a worm shaft meshing with a gear on the arm shaft sleeve. The worm wheel runs in oil and is geared to a revolving nut on an elevating screw which is hung on a cone friction spool at the top of the column and has a toothed collar pinned to it near the top, so that when the arm reaches its highest position, the nut will engage the tooth collar and revolve the screw, thus stopping further movement of the arm. Upon striking an obstruction in a downward direction, the screw will be lifted off its seat. The arm clamp is operated by a nut and screw through an equalizing bar with a double leverage. The rate of the arm elevating traverse is 35 inches per minute.

The main body of the column is divided into two box form sections. The connection between column and pedestal is through large roller bearings and an adjustable split tapered bushing at the bottom end. A balance spring is mounted inside the column adjustable from between the column ways and made to support the weight of the machine when unclamped on a ball thrust bearing. The clamp consists of two half rings, hinged at one side and contracted by a nut and screw on the other side. These half rings are tapered on the bottom side and wedge themselves between a flange on the pedestal and a solid ring fastened to the column. Thus, the column is forced down against the top surface of the pedestal. The clamp is operated by a ¼-horsepower motor through worm gearing. The motor is controlled by a switch on the head. Provision is also made to clamp by a hand lever.

Double Head Bolt Threader

The Williams Tool Corporation of Erie, Pa., has produced a new double-geared head bolt threading machine. This new machine gives a wide range of thread production, cutting ⅜-inch to 1½-inch threads with the 1½-inch size machine; and ½ to 2-inch with the 2-inch size machine. The two heads may be operated



Double-geared head bolt threader

with 2 set-ups at the same time and may be controlled from either side of the machine. For each of the die heads, 8 spindle speeds may be selected to insure maximum production for a given size of bolt.

The electric driving motor is mounted on an adjustable base to enable the operator to adjust the driving chain. Ample lubrication is provided to each head by a chain driven pump in the base of the machine. The oil is run through a strainer and may be used over again. The machine is supplied with automatic die heads and other refinements.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by C. J. Zusy

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 typewriteen, 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.*

Bracing Heads

Q.—(1) Would like to have you explain Par. 201, A. S. M. E. Code about structural reinforcements. I do not know whether I am right in my understanding of it. (See Fig. 1.)

$P - d \times t \times$ width $= 5 - 9.375 \times 0.5 \times 3.5 = 7$ square inches.

$P - d \times t \times$ width $= 7\frac{1}{2}$ inches $- 1$ inch $\times 0.5 \times 3.5 = 11.375$ square inches.

$7 + 11.375 = 18.375$ square inches in angle.

$12{,}500 \times 18.375 = 229{,}687$ pounds.

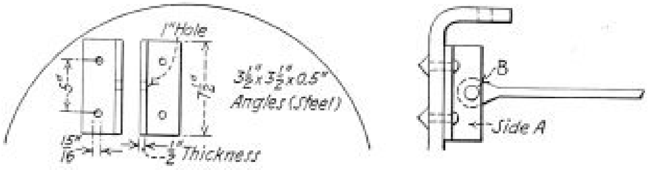


Fig. 1

That seems like a great deal of strength there or do you just figure side *A*? It looks like the weakest place would be just in front of the pin, as at *B*. The strength should be worked out at that point as $d \times t \times 12{,}500$ = weakest section, and at that point your brace would be in tension, also the rivets on the web. Would the rivet area be 12.5 times the area of the brace and so forth as in Par. 223? Would like to have you work this out as I am not sure about it.

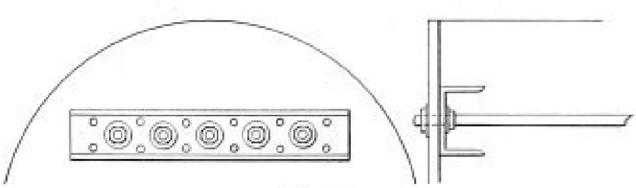


Fig. 2

(2). In Fig. 2 would you figure this form of bracing as in Par. 199? The channel beam as ¾ the combined thickness of the head and channel beam and pitch of rivets worked out all right as

$$\frac{135 \times t^2}{p^2} = P \text{ and the pitch of the stays was O. K.}$$

to carry their part of the load?—E. M.

A.—Your interpretation of paragraph P-201 of the A. S. M. E. Boiler Code is incorrect.

"P-201. *Structural reinforcements.* When channels or other structural shapes are riveted to the boiler heads for attaching through stays, the transverse stress on such members shall not exceed 12,500 pounds per square inch. In computing the stress, the section modulus of the member shall be used without addition for the strength of the plate. The spacing of the rivets over the supported surface shall be determined by the formula in paragraph P-199 using 135 for the value of C."

If the outstanding legs of the two members are fastened together so that they act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the boiler, and providing that the spacing of these rivets attaching the members to the head is approximately uniform, the members may be computed as a single beam uniformly loaded and supported at the points where the through braces are attached.

This paragraph limits the fiber stress on the structural reinforcements due to the bending action on these reinforcements.

The fiber stress on the angles as shown in your sketch, Fig. 1, may be found as follows:

The load on the brace is supported by two angles, therefore one angle supports half of the load and this

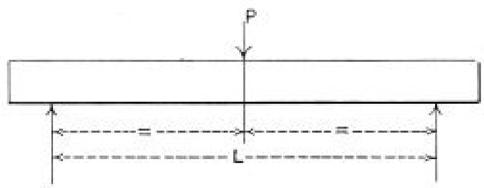


Fig. 3

load is concentrated at one point which is the brace pin hole in the angle. The angle is supported at the rivet holes. This angle may be considered as a simple beam supported at both ends as shown in Fig. 3 with load concentrated at the middle of the beam.

Let,

M = maximum bending moment under load

P = load concentrated at the middle which in this case is half the load on the brace

L = distance between supports which in this case are the rivet holes

S = Section modulus of the angle

F = stress in extreme fiber of angle section in pounds per square inch.

Then,

$$M = \frac{PL}{4}$$

and

$$F = \frac{M}{S}$$

The section modulus for any standard structural section can be found in most any structural steel handbook. The section modulus of a 3½-inch by 3½-inch by ½-inch angle with the axis parallel to one of the legs, the condition which exists on the angle in question is 1.49.

The channel reinforcement as shown in your Fig. 2 is also governed by paragraph P-201 this channel reinforcement may be considered as a beam uniformly loaded and supported at the points where the through braces are attached. In order to calculate the stress in this manner this channel iron would necessarily come under the head of a continuous beam and owing to the complicated formula used in computing a continuous

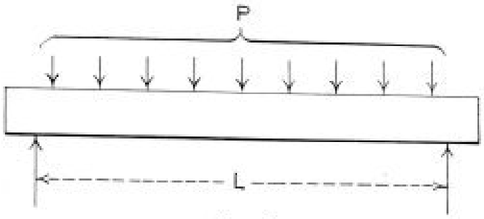


Fig. 4

beam I would suggest that the fiber stress be calculated by considering each span, that is, the portion between two braces as a beam fixed at both ends with a uniformly distributed load as shown in Fig. 4. This method of calculation will give approximate results which are on the side of safety.

Let,

M = maximum bending moment under load
P = load uniformly distributed which in this case will be half of the load on the two braces on each side of the span being considered
L = distance between supports which in this case are the braces
S = section modulus of the channel iron
F = stress in extreme fiber of channel iron section in pounds per square inch..

Then,

$$M = \frac{PL}{12}$$

and,

$$F = \frac{M}{S}$$

The spacing of the rivets over the supported surface shall be determined by the formula in paragraph P-199 using 135 for the value of C and the value of T in the formula should be the thickness of the plate only.

The combined cross-sectional area of the rivets should be at least 1¼ times the "required cross-sectional area of the brace." This means that the combined cross-sectional area of the four rivets in Fig. 1 must be at least 1¼ times the cross-sectional area of the brace.

Riveted Joint Efficiency

Q.—Some time ago a riveted joint came to my notice with a hole drilled through both butt straps and the shell of the boiler. Assuming the efficiency of said joint to be 85 percent, without the 2½-inch hole drilled in it, I would like to know:
(1). The efficiency of the joint with the hole in?
(2). How to find the efficiency of a joint with a hole of any given size drilled in it?
(3). While this does not seem to me to be good practice, what would be the ruling of the A. S. M. E. or the I. C. C. on this practice?
Hoping to see your comments in the near future in THE BOILER MAKER.—M. C. S.

A.—I cannot find any I. C. C. or A. S. M. E. rule which prohibits drilling a hole in the center of a longitudinal seam as shown in Fig. 1 and do not believe the I. C. C. or the A. S. M. E. would take exception to such practice if the seam is calculated as described below and if the efficiency thus found is at least equal to the efficiency of the seam when calculated according to the general rules covering seam calculations.

In addition to the usual methods of failure considered under the general rules covering seam calculations the following cases must be considered due to the large hole through the welt strips.

Case (1) Tearing both inside and outside welt strips through the inside row of rivets and the large hole as shown by heavy line in Fig. 1.
(2) Tearing the inside welt strip through the inside row of rivets and the large hole as shown by heavy line in Fig. 1 and shearing 4 rivets in single shear in second and third rows.
(3) Tearing the inside welt strip through the inside row of rivets and the large hole as shown by heavy line in Fig. 1 and crushing outside welt strip in front of four rivets.

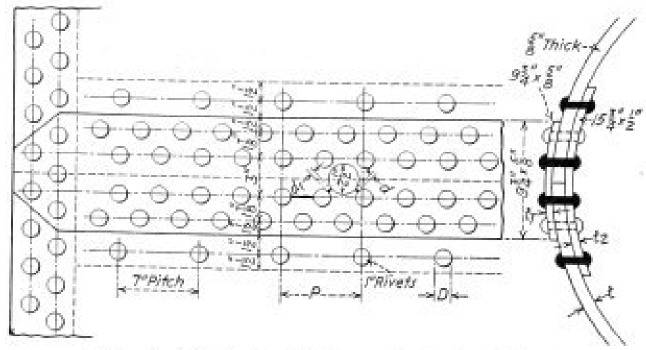


Fig. 1—Method of failure of riveted joint

Let
P = pitch of rivets in outside row, in inches
t = thickness of shell
t_1 = thickness of outside welt
t_2 = thickness of inside welt
D = diameter of rivet holes
d and d_1 = distances between large hole and rivet holes
TS = tensile strength of boiler steel
C = crushing strength of boiler steel
S = shearing strength of rivets
E = efficiency

Efficiency:

$$\text{Case (1) } E = \frac{\left(d + d_1 + \left[\frac{P}{2} - D\right]\right) \times (t_1 + t_2) \times TS}{P \times t \times TS}$$

$$\text{Case (2) } E = \frac{\left(d + d_1 + \left[\frac{P}{2} - D\right]\right) \times t_2 \times TS + 4D^2 \times 0.7854 \times S}{P \times t \times TS}$$

$$\text{Case (3) } E = \frac{\left(d + d_1 + \left[\frac{P}{2} - D\right]\right) \times t_2 \times TS + 4 \times D \times t_1 \times C}{P \times t \times TS}$$

Employing the formula to the seam, Fig. 1, assuming steel plate, steel rivets and 1-inch diameter rivet holes, we have:

$$\text{Case (1) } E = \frac{(0.5549 + 0.5549 + 2.5) \times (0.625 + 0.5) \times 55{,}000}{7 \times 0.625 \times 55{,}000}$$

= 92.8 percent.

$$\text{Case (2) } E = \frac{(0.5549 + 0.5549 + 2.5) \times 0.5 \times 55{,}000 + 4 \times 0.7854 \times 44{,}000}{7 \times .625 \times 55{,}000}$$

= 98.7 percent.

Case (3) $E = \dfrac{(0.5549 + 0.5549 + 2.5) \times 0.5 \times 55{,}000 + 4 \times 0.625 \times 95{,}000}{7 \times 0.625 \times 55{,}000}$
$= 139.9$ percent.

Layout of Baffle Plate

Q.—In answer to my question appearing in the November 1927 issue of THE BOILER MAKER, I do not thoroughly grasp the various true lengths of the eliptical end of the pipe. In your problem you say "with a radius *a-c* taken from the end view *b*, etc." Now my contention is that the spaces *a-c-e-g* in (*b*) are not true lengths because we have to take into account the connection coming around the 96-inch pipe. Spaces *a-c-e* in (*e*) would be a little larger than that taken from (*b*) and this seems to be my trouble. I may say that I developed this connection out of 5/16-inch plate similar to the way you have it developed and I was away short of my measurements. I would like you to look this over and reply at an early date. —G. C.

A.—There is an error in the description accompanying the development of a tapered pipe intersecting a cylinder as described in the November issue.

The spaces *a-c*, *c-c*, etc., as shown at (*e*) in the development are the chord distances taken from the periphery of the hole in cylinder as shown at (*f*) and not from the plan as shown at (*b*).

To develop the baffle plate, as shown in Fig. 1, it is necessary to construct a plan as shown at (*a*), end elevation (*b*) and side elevation (*c*). Owing to the shape of this plate the triangulation method is used. First divide the semicircle representing half of the upper base as shown in the plan (*a*) into a suitable number of equal spaces, twelve in this case, then divide half the periphery of the lower base as shown in the plan (*a*) into the same number of equal spaces.

Number these points of division, alternating between upper and lower bases. Draw in succession, lines alternately from the points on the lower base to the points on the upper base; a-a_1 being on the line of the diameter, draw a_1-*1*, *1-2*, *2-3*, etc. These lines should be drawn alternately full and dotted as shown. Project these division points to the elevations and again draw in the lines forming the triangles.

The surface of the baffle plate is now divided into a number of triangles and the next step is to find the true lengths of all the lines representing the sides of these triangles. The length of lines A_1-*1*, *1-2*, *2-3*, *etc.*, are found by constructing right angle triangles as shown at (*f*) and (*g*). The vertical heights of these triangles are projected from the end elevation (*b*) and the base is the distance between the points on the plan (*a*).

Example: The true length of line a_1-*1* is found by drawing a right angle triangle a_1 to *1* as shown at (*f*). The vertical height is projected from the elevation (*b*) and the base is the distance between points a_1 and *1* on the plan. The hypotenuse of the right angle triangle thus found is the true length of line a_1-*1*.

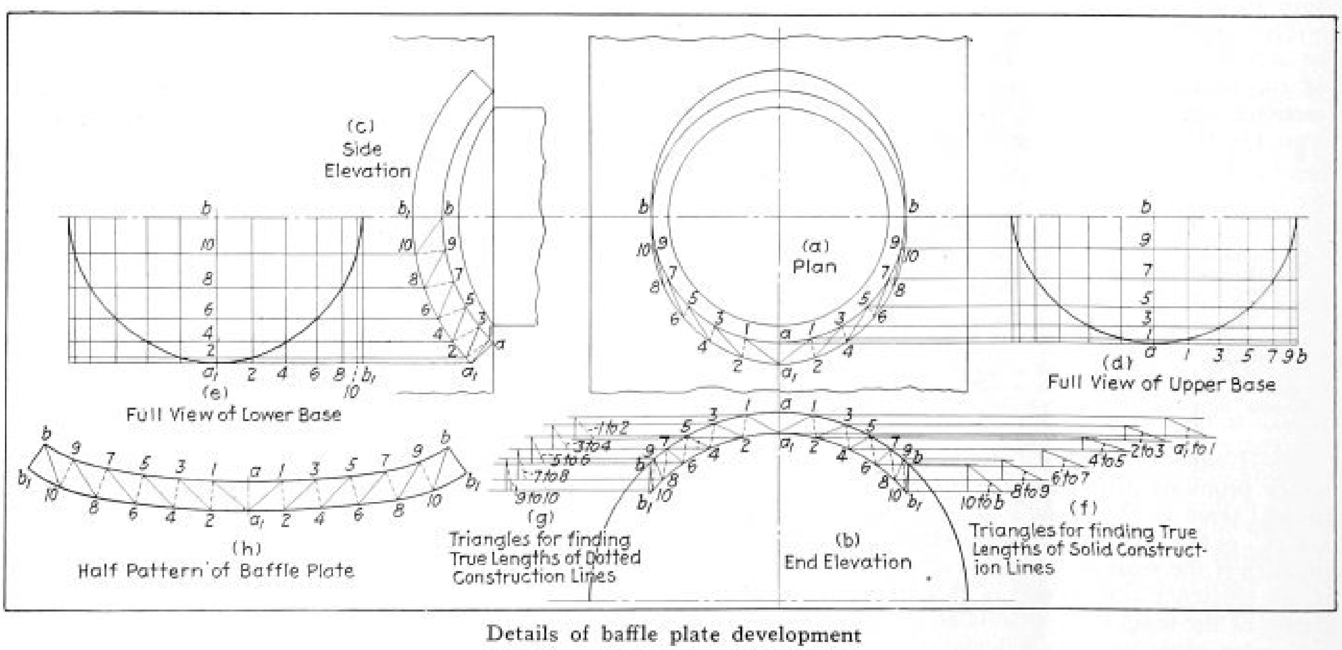
To develop the pattern, it is necessary to find the true chord distances between the points *a-1*, *1-3*, *1-2*, *2-4* etc., in the plan (*a*) as they are not shown in the plan in their true lengths. To find the true chord distances it is necessary to develop full views of the upper and lower bases as shown at (*d*) and (*e*). To develop the full views the division points are projected from the plan (*a*) and the spaces *a* to *1*, *1* to *3*, a_1 to *2*, *2* to *4*, etc., are the chord distances between these points on the end elevation (*b*).

To develop the half pattern as shown at (*h*) draw the line a-a_1 equal in length to line a-a_1 shown in side elevation (*c*) since it is there shown in its full length, next, describe an arc from a_1 as a center, with a radius equal in length to the length of the hypotenuse of the triangle a_1 to *1* as shown at (*f*); intersect this arc by an arc described from *a* as a center with a radius equal in length to the chord distance *a-1* taken from full view of upper base as shown at (*d*). This completes the triangle a-a_1-*1* as shown at (*h*). The triangle a_1-*1-2* is next constructed in a similar manner and the completion of the pattern is accomplished by a continuation of the methods described.

Oil Tank Supports

A subscriber would like to have published through these columns a table with formulas for designs of cradles or supports and their foundations suitable for small and large capacity standard horizontal oil tanks, 10,000 to 30,000 capacity.

Will any of our readers who have such information available send it to the magazine and it will appear in an early issue for the information of our correspondent and all others who may be interested in the matter.



Details of baffle plate development

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

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Statistician—L. C. Peal, Nashville, Tenn.

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

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

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

States

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,

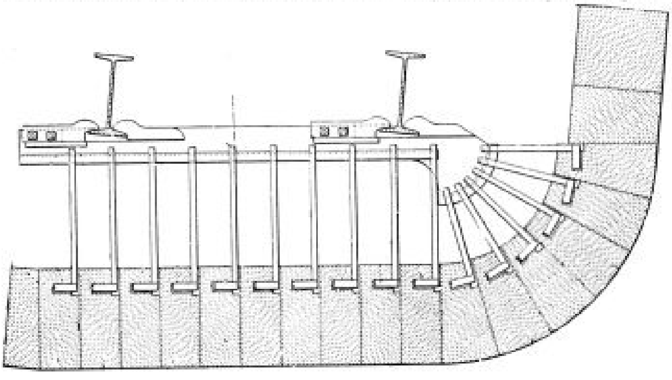
Washington Loan and Trust Building,

Washington, D. C.

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

1,636,603. LYNFORD HAMILTON, OF PHILADELPHIA, PENNSYLVANIA. FURNACE ARCH.

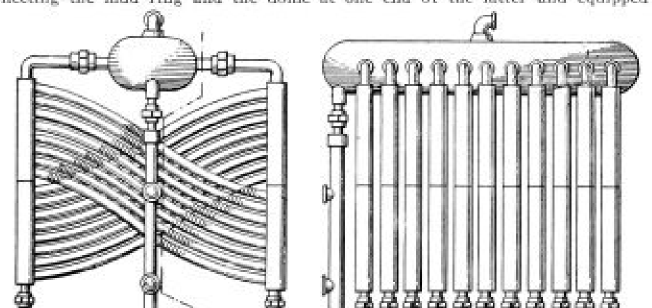
Claim.—The combination in a furnace, of two overhead transverse beams having lower flanges; a series of detachable bars; hooks on said bars engaging the lower flanges of said beams, one hook of each set being detachable, each bar having a longitudinal flange, said flange having a



beveled upper surface; a series of bricks forming the body of the arch, said bricks being spaced a considerable distance from the bar so that they can be removed without removing the bars, each brick having a recess and a hole in one side; and long hooks having undercut heads engaging the flanges of the bars and having arms extending into the holes in the bricks, the body of the hooks being located in the recesses in the bricks. Two claims.

1,637,939. WILL G. HOAGLAND, OF INDEPENDENCE, KANSAS. BOILER.

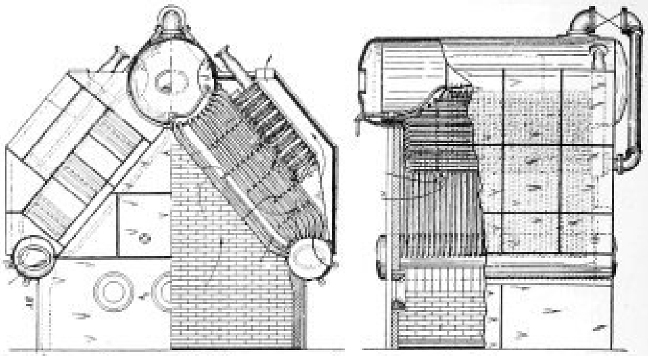
Claim.—In a boiler of the character described, a mud ring, a longitudinally extending dome located above the mud ring at a point above the center thereof and of considerably less width than the mud ring, a plurality of upright pipes connected with the sides of the mud ring, a plurality in horizontal inward extensions leading into the opposite sides of the dome, a steam outlet at the center of the top of the dome, a circulating pipe connecting the mud ring and the dome at one end of the latter and equipped



with a water inlet, and a plurality of series of tubes arranged in interfitting relation, there being two banks or series of tubes for each pair of upright pipes, one bank or series of tubes of each pair connecting at one end with the lower portion of one upright pipe and at the other end with the upper portion of the opposite upright pipe, said upright pipes bein~ provided with partitions between the connections of the banks of tubes therewith, and the tubes of one bank or series being offset to be out of alinement with those of the other series to avoid the same.

1,636,960. WILLIAM D. HOXIE, OF WESTERLY, RHODE ISLAND, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY. WATER-TUBE BOILER.

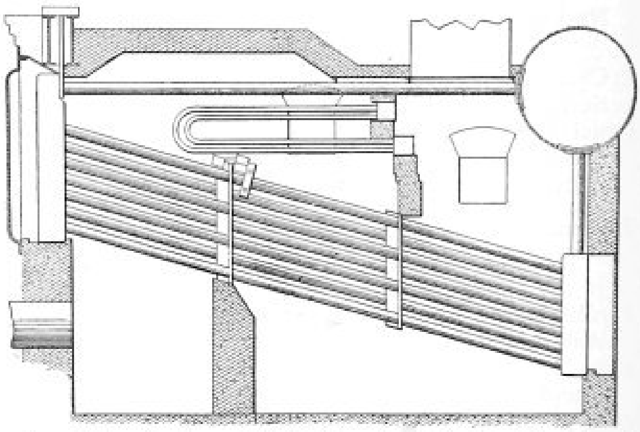
Claim—A steam boiler comprising an upper drum having a compartment therein and shorter than the length of the drum and smaller in cross-section than the cross-section of the drum, a lower drum having a compartment therein extending longitudinally of the drum for substantially the full length thereof and smaller in cross-section than the cross-section of the drum, a bank of water tubes arranged in rows across the boiler, some of the tubes of one of the rear rows of water tubes connecting said upper and lower compartments and the remaining tubes of said row connecting said lower compartment and the water space of the upper drum outside said upper compartment, a feed water inlet for said upper compartment, a furnace on one side of said bank of tubes, a superheater on the side of said bank opposite the furnace, said superheater having tubes longer than the length of said upper compartment and extending transversely across



the water tubes, and baffling arranged to direct the furnace gasses into and across the upper end of said bank, then across the superheater tubes and then again across the water tubes. Two claims.

1,636,979. HARRY SPENCER BENNETT, OF BETHLEHEM, PENNSYLVANIA, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY. WASTE HEAT BOILER.

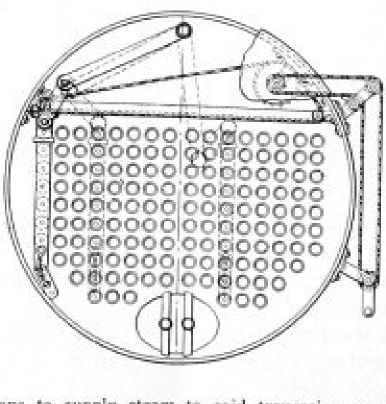
Claim.—In a steam boiler, an upper steam and water drum, horizontally inclined water tubes and connections between the same and said steam and water drum and comprising horizontal water and steam circulators, a baffle extending across the tubes, a roof located above said circulators, the



portion of the roof above said baffle being elevated substantially above the circulators and providing a free unobstructed space between the circulators and the roof, and a superheater entirely located beneath said circulators, but not extending across the space above the first pass, whereby the gases from the first pass sweep upwardly over the circulating tubes into said space and thence downwardly over said circulating tubes and over the superheater tubes to the second pass. Eight claims.

1,636,355. FRANK H. COLE, OF CHELSEA, MASSACHUSETTS. BOILER-TUBE CLEANER.

Claim.—The combination of a boiler having tubes therein and a boiler tube cleaner comprising a traversing member arranged in said boiler and provided with a plurality of delivery outlets to register with the tubes of



said boiler; means to supply steam to said traversing member; means to support said member with provision for movement, and means to impart movement to said member, said traversing member having a steam delivering end section normally in alignment with the body portion thereof but moving laterally relatively thereto at times. Four claims.

The Boiler Maker

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Contents

Annual Conventions

As is the custom at this season of the year, the attention of the various branches of the boiler making industry is called to the conventions devoted to the problems peculiar to this field. The first meeting to be held this spring will be that of the Master Boiler Makers Association at the Hotel Hollenden, Cleveland, Ohio, May 22 to 25. For the past few years each successive convention of this association has been a record breaker—more members and guests have been in attendance, more and better exhibits have been made by the manufacturers and, in fact, the work accomplished has had more far-reaching effects in the boiler shops of the country than conventions of the past. In spite of a possible slackening of activity in some of the railroad shops at the present time, this year's convention should be as fine a one as ever before. The program now being prepared is excellent and certain of the reports promise to open new fields of advanced boiler shop practice.

Member companies of the Boiler Makers Supply Men's Association are already preparing their exhibits for display at the convention and the entertainment will be as good or better than last year, which is saying a lot. To those who have not as yet reserved exhibit space, the secretary of the supply association, W. H. Dangel, urges prompt action because the desirable locations are going rapidly. Members of the Master Boiler Makers Association who have not made reservations for their hotel accommodations should do so promptly and not wait until arriving at the convention. The work of registration will be greatly facilitated if members make it a point to pay their dues and obtain their badges shortly after their arrival and not wait until the opening session of the convention to do so.

The second convention of prime importance to the field of boiler work is that of the American Boiler Manufacturers Association which will be held this year at Buckwood Inn, Shawnee, Pa., June 11 to 13.

The final annual meeting of special interest to our readers is that of the National Board of Boiler and Pressure Vessel Inspectors which will be held at Erie, Pa., June 18 to 20. No member of this body requires urging to be present at the sessions of this meeting. The growth of the organization and its excellent work in promoting uniformity in construction and inspection of boilers has been remarkable during the few years of its existence. The entire industry will be keenly interested in the proceedings this year for on the work accomplished depends in a large measure the standards to which all boilers will be held for the next twelve months.

The only suggestions that can be made to members of all these associations is for them to attend their annual meetings and accomplish just as much good for the industry in all its branches as it is possible to do. Just now the best brains that can be brought to bear on the problems concerning each section of the industry are essential if future prosperity is to be attained.

Study of Feed Waters

AMONG other subjects discussed at the mid-winter meeting of the American Boiler Manufacturers Association, held at Cleveland recently, was the participation of the association in the work now being undertaken on the study of feed waters. This work, originally inaugurated by the American Water Works Association, has been expanded to include a long list of national associations and societies, members of which have to contend with the problem of corrosion in one form or another as the result of the use of feed waters of impure qualities.

At the 1927 annual convention of the American Boiler Manufacturers Association it was decided to support the work of the general committee, but that no direct assessments would be made on members of the association. Individually, many members have responded by voluntary contributions but in order for the association to meet a commensurate portion of the expense of the studies that will be made it is essential that all member companies lend practical support.

The efforts of the general committee for the past two years have consisted in arranging an inclusive program covering all phases of the problem as well as the appointment of sub-committees and technical committees which will carry out the work on each of the individual points to be investigated. The entire program as it is planned will extend over a period of five years and a budget has been adopted to control expenses on this basis. Just as soon as the general committee feels that the necessary financial backing has been assured, the four major committees, programs for which have so far been arranged, will proceed.

The best men in the country have been retained to head the various technical committees; E. N. Speller of the National Tube Company will be chairman of the committee on corrosion; Professor Fulk will be chairman of the committee on priming and foaming and Professor Christie of Johns-Hopkins University will be chairman of the committee on embrittlement.

Progress in the prosecution of this program, which is designed to combat one of the most serious problems of economic waste in the power industry—that of corrosion, depends entirely on the speed with which the necessary financial backing is forthcoming. Members of the American Boiler Manufacturers Association are as vitally interested in this work as any other group, so no time should be lost in assuring the general committee of the individual support of the members of the boiler manufacturing industry.

This Is Your Magazine

IN the past, THE BOILER MAKER has endeavored to serve the boiler making fraternity in the manner that would be most beneficial and helpful to its readers. The columns of the magazine are open to all, to be used for acquiring knowledge in the boiler making trade or for the interchange of ideas.

The Communications column is a good place in which to comment upon articles and new developments. It is here that all sides of a question may be brought together in a sort of open forum where various points may be threshed out to the ultimate goal of an unbiased decision. An author may bring up one side of a question, but you may know of another side. Use the columns to express your ideas so that the magazine may be truly representative of the opinion held by the majority in the field.

Communications

Micrometer Calipers

TO THE EDITOR:

Historical records reveal the fact that the first shop micrometer was made by James Watts and is now in the South Kensington Museum, England. It was made an article of merchandise a few years after the close of the Civil War, in a great variety of forms for both inside and outside measurements. In boiler shop practice, the one generally used is for outside measurements, such as gaging plates, so we will confine our description to a one inch Slocomb Micrometer No. 26 with friction thimble as made by J. T. Slocomb Co., Providence, R. I.

The mechanical principle embodied in the construction is that of a screw of known pitch, advancing in a fixed nut. An opening to receive the work to be measured is afforded by the backward movement of the screw and the size of the opening is indicated by the graduations.

The screw of the micrometer is 40 threads to the inch, so that one complete turn of the thimble or from 0 to 0 on the beveled edge varies the opening 1-40 or 25/1000 of an inch. Each mark on the barrel or sleeve represents one complete turn and every fourth mark is extended and numbered 1, 2, 3, etc. Number 1 is 4 turns or 4/40 or 1/10 of an inch. The beveled edge of the thimble is graduated into 25 parts and is numbered at every fifth division 0, 5, 10, 15, 20. Moving the thimble one division with base line of the divisions on the barrel indicates that the gage screw has made 1/25 of a revolution and that the opening has been increased or decreased, whichever the case may be, 1/25 of 25/1000 or 1/1000 of an inch.

To read the "Mike," multiply the number of divisions visible on the scale of the barrel by 0.025 and add the number of divisions on the scale of the thimble from zero to the line coincident with the base line of the graduations on the barrel. Hence a thickness of 5/16 or 0.3125 would show 12 divisions on the barrel and 12½ divisions on the beveled edge of the thimble.

Oswego, N. Y. JOHN A. SHANNON.

Fundamental Principles

TO THE EDITOR:

The article on *Mechanical Drawing and Apprentice Training Courses* by Mr. Ichler in the February issue of THE BOILER MAKER, is interesting. To take the last part first, it is true that the subject is one that offers both student and instructor an opportunity "to make a showing," with relatively little effort. Anyone who has had to do with this class of work is familiar with the drawings of a monkey wrench, lathe, engine or similar piece of mechanical equipment, made by students who frequently have no concept whatever of the principles in back of the drawing they have made. One of the finest drawings of a triple-expansion engine I have ever seen was made by a bookkeeper who could hardly tell the crank shaft from the cylinder head.

In a great many cases too much stress is laid on particular problems rather than on principles, with the result that the student is unable to apply the principle of a problem he has just worked out to a similar problem differing only in shape or size. This is frequently due to the failure of the instructor to call the student's attention to the application of the principle to problems of a similar nature.

By all means the ideal to be kept in mind in the teaching of apprentices is summed up in Mr. Ichler's question. After all, what the apprentice needs is to know how to read a drawing correctly and only an elementary knowledge of how to draw one will suffice him, provided that knowledge is based on the fundamental principles. Manual skill in the use of the draftsman's tools is largely a matter of repeated practice and since a draftsman's job is not the aim of the apprentice, it would seem that he might very well forego that skill.

In fact the writer sometimes questions whether some of our other schools might not sacrifice some of the time now spent in turning out show work and devote it to a more thorough teaching of the principles and methods involved. This might not enable the class to make as much of a showing, but would give the students a much better ground work to build on.

Jersey City, N. J. JOHN J. CURREY.

Height of Camber

TO THE EDITOR:

In the February issue of THE BOILER MAKER is published a method of developing a cone roof by D. W. Phillips. I am grateful to Mr. Phillips and also to the editor of this magazine for publishing this article. I have studied this problem for some time but am at a loss to know how to obtain the lengths of camber as shown on page 46 of this article in the lower right hand corner. I can get the length of chord all right but I am at a loss to know how to find the versed sine and also how to find the additional lengths of camber as shown:

1 1/8 inches, 31/32 inch and 21/32 inch.

I will appreciate very much whatever you will do to help me out in this problem as I am very much interested in same.

MAX MILLIN.

Layout of Camber

TO THE EDITOR:

Referring to my article giving a method for developing a cone roof on page 45 of the February issue and the request for further information made by Mr. Max Millin, I note that the first difficulty is with the method of obtaining the length of the camber. In other words the method of finding the height of the arc at the center of the chord, which is the product of the versed sine multiplied by the radius of the arc. This is the radius as shown at both large and small ends of the templates as laid off in the several sketches at the top of page 46, February issue. I think Mr. Millin has allowed one important point to escape his notice, that is, the obtaining of the angle in degrees in his sketch plates as formed by the rivet lines along the sides of the templates. In order to use to advantage the versed sine you must know the degrees and minutes formed by the two sides of your plate. I have explained, in answer to Bill's question in the last paragraph on page 47 in left hand column, how to find the degrees and minutes, and have also given the formula for N on page 46. Now the versed sine corresponding to the angle found by the formula referred to above, multiplied by the radius, as found by the formula at the top of and left hand side of this page 47, will give you the length of the camber, or height of the arc, for any and all angles up to 90 degrees. Now as I have referred to a table of natural sines and tangents for the value of the versed sine, I would just state that there are tables of this character that omit the versed and coversed sines. In this case just look up the cosine of the angle in question and subtract its value from 1. The difference is the versed sine.

Now let us see what we can do toward simplifying the sketch in the lower right hand corner on page 46, and explain the fractions referred to by Mr. Millin. You will notice that the camber on the short side of the plate as indicated by $a—b$ is 1 inch, this distance being divided into 16 equal parts. You will note that the half chord is divided into 4 equal parts. The 16 parts and 4 parts form a couplet and are in direct ratio to each other when applied to this problem. When the camber is divided into 16 equal parts the half chord *must* be divided into 4 equal parts, regardless of the distance. For the first division to the right on the chord mark off on a vertical line 15 of the 16 parts, on the second division to the right mark off 12 of the 16 parts, then on the third, and last point to the right mark off 8 of the 16 parts. Now this is just what we have done with the long camber as indicated by $c—d$; 1⅛ inches is approximately 15/16 of 1 5/16 inches or 15 parts, while 31/32 inch is 12 parts, and 21/32 inch is 8 parts of 1 5/16 inches. I could have reduced these fractions to 64ths, but we are not working as close just yet. The layerout usually does not stop to figure things of this nature, as it is purely a graphical solution. He just lays off the height on the center line, both top and bottom, and takes his dividers and steps, or divides the distance up. Then he draws the vertical lines up from the 4 points in the base or chord, steps up 15 steps on the first one, 12 steps on the second one and 8 steps on the 3rd one, and then he is done. Next he takes a flexible strip, bends it around on the points just established, scribes it off with his soapstone and is through.

You of course understand that the lengths of the circular arcs are the circumferences of the various diameters as designated at the laps in the elevation of the sketch, divided by the number of plates in each course of the roof, corresponding to the radii, also marked on the elevation with the overall circumference in feet for large and small ends.

The author will be glad to answer any further points that may occur to readers in connection with the solution of this problem.

Portsmouth, Va. D. W. PHILLIPS.

British Locomotive Boiler Progress in 1927

TO THE EDITOR:

British locomotive builders, apart from the railways, were fairly busy in 1927, and in the majority of cases the orders obtained were for locomotives to be supplied to foreign railways. As regards British railways, last year witnessed some very important developments, not the least significant being the adoption by both the

Great Western and the London, Midland & Scottish Railways of the comparatively high steam pressure of 250 pounds per square inch, in each case in new non-compounds of the 4-6-0 express type. The Great Western had previously employed 225 pounds for corresponding simple engines, and the L. M. & S. from 175 pounds to 180 pounds. Another line, the London & North-Eastern, also decided to try an increase in pressure, in this instance in the Pacific class of locomotive. Recently, one of the 1923 4-6-2's was re-boilered and given a working pressure of 220 pounds representing for this type an addition of 40 pounds per square inch, and this higher pressure is to be used in 10 new Pacifics under construction at Doncaster. The long valve travel principle, applied to the rebuilt 4-6-2, is being adopted in the new engines.

The Great Western new 4-6-0 engines with 250 pounds pressure are named after Kings. They have a total heating surface (including that of a Swindon superheater) of 2,514 square feet and a grate area of 34.3 square feet. The tractive force at 85 percent of the steam pressure of 250 pounds is 40,300 pounds, or greater than that of any other British express locomotive so far built. A larger boiler having a maximum diameter of 6 feet and a barrel length of 16 feet has been provided. The center line stands 8 feet 11¼ inches, above rail level. The total weight of the engine is 89 tons of which 67½ tons are available for adhesion. As the tender weighs 46.7 tons, the aggregate weight of the locomotive and tender is 135.7 tons.

The high pressure 4-6-0 express engines of the London, Midland & Scottish Railway, which were designed by Sir Henry Fowler, have 3 cylinders, each 18 inches by 26 inches. The boiler barrel measures 5 feet 9 inches in diameter by 14 feet ⅜ inch in length and has a total heating surface of 2,529 square feet. It is equipped with a 27-element superheater providing 445 square feet of heating surface. In working order the weight of each engine is about 85 tons and that of the tender is 42.7 tons, making a total for both of 127.7 tons. At 85 percent of the boiler pressure the tractive effort is 33,150 pounds.

Three Garratt freight locomotives, 2-6-0-0-6-2, were put into operation recently. They were constructed to the specification of Sir Henry Fowler and have a total weight of 148¾ tons. The cylinders, 2 to each unit, are 18½ inches by 26 inches and the diameter of the two groups of 6-coupled wheels is 5 feet 3 inches. The boiler has a total heating surface of 2,637 square feet, a grate area of 44.5 square feet, and a steam pressure of 190 pounds. The tractive force at 85 percent of the pressure is 45,620 pounds.

The new Pacific locomotives under construction will have 220 pounds pressure, compared with the former figure of 180 pounds, and they will be generally similar to a 4-6-2 turned out in 1924, and rebuilt during the summer of 1927 with a new boiler carrying the higher pressure just mentioned. The tractive force is increased by the new pressure from 29,835 pounds to 36,465 pounds at 85 percent. As regards size, the boiler is the same as the old one and the total heating surface is also practically identical, although its allocation is different. The evaporative surface has been reduced by about 200 square feet, a virtually equal amount being added to the superheater, which has been enlarged from 32 to 43 elements. The combined heating surface of the high pressure boiler is 3,442 square feet, for 706 square feet of which the superheater is responsible. The grate area is 41.25 square feet. As rebuilt, this type weighs 96.25 tons. The weight of the 8-wheeled tender is 56.3 tons, the engine and tender together thus weighing 152.55 tons.

As regards the Sentinel-Cammell rail coaches now being supplied to British railways, it may be mentioned that the boiler which is fixed at the outer end of the engine framing, is of the vertical type, and is fitted with a superheater coil and cross watertubes. The steam pressure varies from 230 pounds to 275 pounds per square inch. The independent Sentinel locomotives are similar, but some have 2 engine units.

The Clayton steam rail cars, which are also now being adopted for use by British railroads, have 2 cylinders, 6¾ inches by 10 inches. They are horizontal. The cars of this pattern built for the London & North-Eastern Railway weigh 28 tons with fuel and water. The boiler is vertical and works at 275 pounds per square inch. Both the Sentinel and the Clayton rail coaches can be operated from either end.

London, England. G. P. BLACKALL.

Power of the Sun

By W. F. Schaphorst

WHERE will the power plant of the far future obtain its power? We frequently read about the enormous power transmitted to the earth by the sun. There is considerable difference of opinion among authorities as to just how great that power is. I would like to know the exact quantity myself. For example, the following was written by the late Colonel E. D. Meier, boiler manufacturer and president of the American Society of Mechanical Engineers.

> "Remembering, then, that this sun-energy reaches us only one-half of each day, we may, whenever we learn how, pick up on every acre an average of 175 horsepower during each hour of daylight, as a surplus which nature does not require for her work of food making."

In a paper recently read before the American Chemical Society, Henry L. Doherty, the power magnate said:

> "The sun delivers as much as 6 British Thermal Units per minute per square foot of area. If this could all be recovered as power without loss it would in one minute equal all the power we now use in the United States in one year."

There are 43,560 square feet in an acre and 42.21 British Thermal Units per minute is equivalent to one horsepower. Therefore, according to Mr. Doherty, the sun delivers 6,160 horsepower per acre to the earth.

Robert T. Aitken of the Lick Observatory says:—

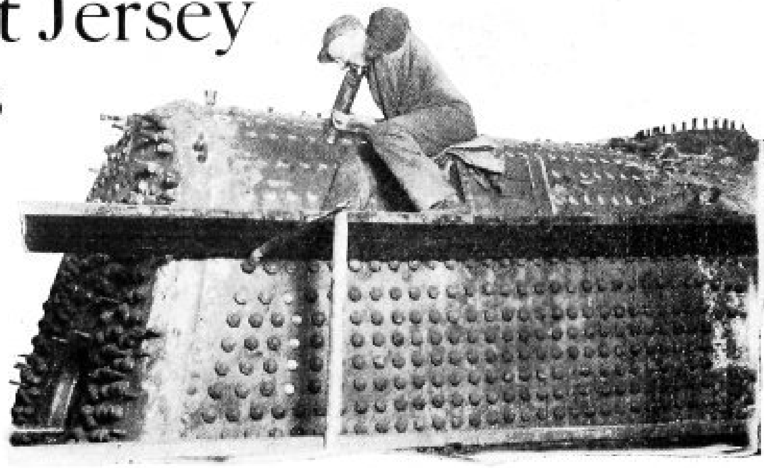
> "Every acre of the earth's surface which is exposed to the vertical rays of the sun is constantly receiving energy at the rate of four thousand horsepower."

All of this is interesting, and I am sure other readers would like to know more about the actual energy transmitted to the earth per acre. It is estimated that the sun is continually radiating into space 1,000,000,000,000,000,000,000,000 horsepower.

Scarfing Sheet Corners

WHEN using a fuller and flatter on sheet corners to thin the lap between courses, be careful not to thin the sheet in the least, beyond where the outside sheet will lap; because doing so, actually weakens the boiler shell at that point. To be sure, the weakening is very slight and can hardly be calculated, but when making the best boiler possible, we must avoid each and every little thing that can rob a boiler of even the most minute portion of strength or efficiency.

Boiler Repairs at Jersey Central Shops



Class 2 repairs carried out without removing boiler from frames at saving of 14 percent

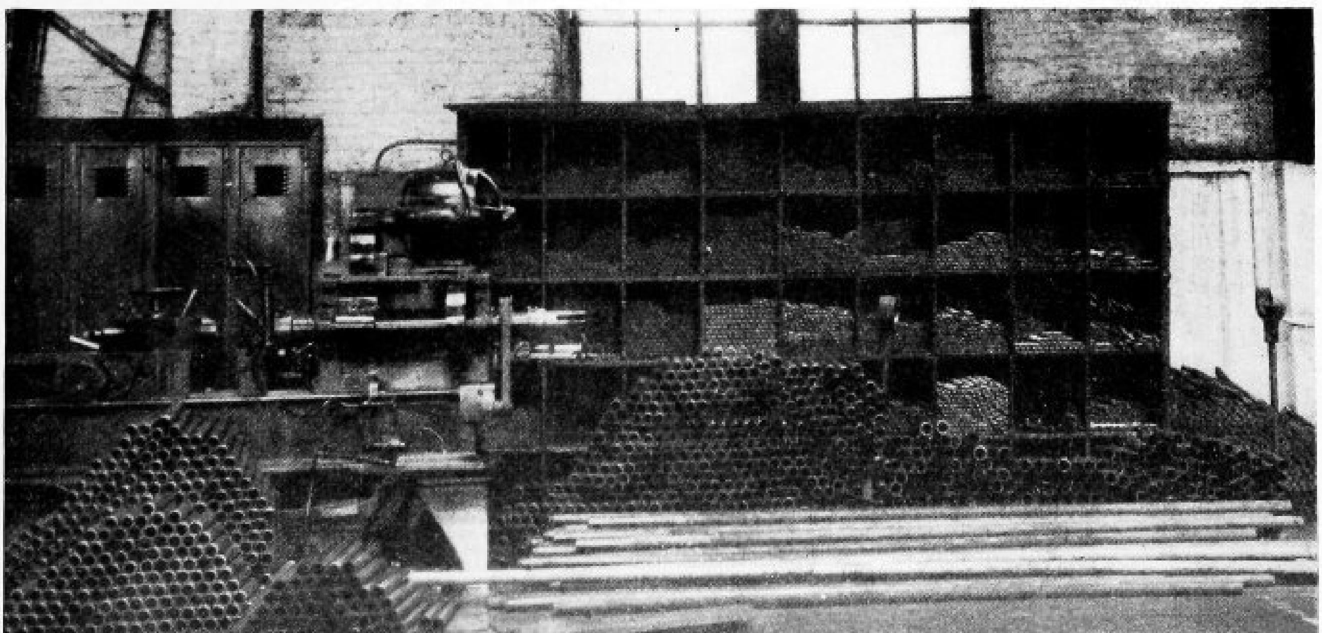
WITH an understanding of the spot system as applied generally to locomotive repairs at the Elizabethport, N. J., shops of the Centrai Railroad of New Jersey and outlined in the article appearing on page 67 of the March issue of THE BOILER MAKER, our readers will be able to appreciate the excellent work that the boiler department is accomplishing as detailed in the present article.

When the spot system was inaugurated in the shops a few months ago, the method of carrying out complete firebox renewals was also changed. In the interests of efficiency and economy all but a very few special firebox jobs are now carried out with the boiler on the frames. In fact nine-tenths of all work in the entire shop is done without removing the boiler from the frames.

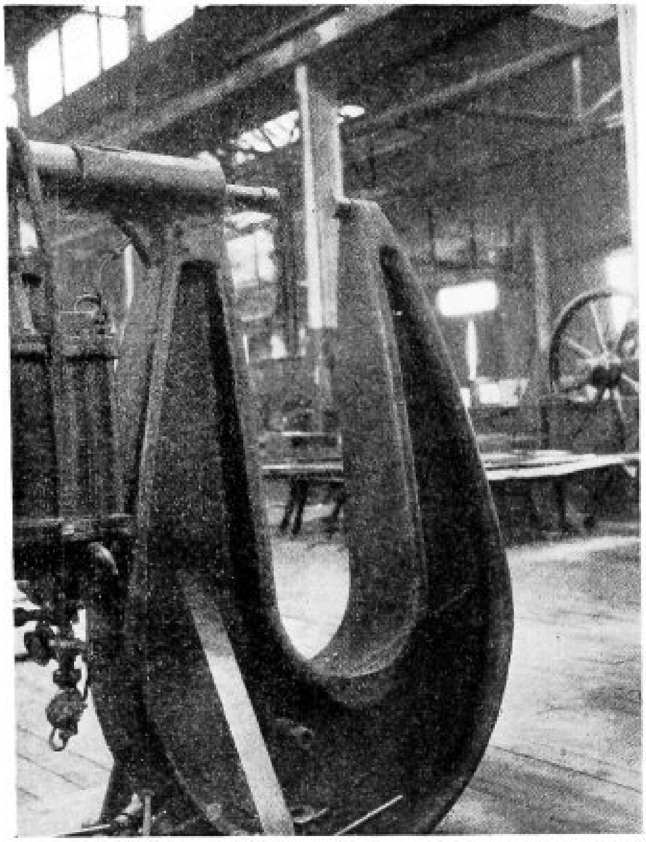
Class 2 repairs only are brought into the boiler department which is located at the south end of the main shop and occupies probably half of the floor space. Two tracks extend from the erecting floor into this department, along the west side, while the center of the shop is devoted to assembly of materials, erection of firebox parts, installation of the few fireboxes where boilers are removed from the frames and the like. The remainder of the space along the east side of the plant is occupied by boiler shop tools, the laying out floor, the staybolt department, material racks, tool room, and the flanging and riveting departments.

Shop Organization

The office of the master boiler maker and his assistants is located in the southwest corner of the shop. Under the master boiler maker is one assistant who devotes most of his time to boiler work on the erecting floor and the layerout who also acts as an assistant. The boiler shop staff consists of the layerout mentioned, a flange turner, one man on the punch and shears, three boiler makers handling the fitting up and applying of fireboxes and one advanced helper. There are two staybolt crews consisting of one boiler maker and one helper each. Two men handle removal and installation of flue work throughout the entire shop, one being a boiler maker and one a helper. The flue safe ending department consists of one smith, one boiler maker and three helpers. The work of this department



View of the safe end and staybolt stock department



Pneumatic riveter with 48-inch gap

begins at the cleaning operation. The stripping gang which removes the flues, deposits them in truck loads at the rattler outside the shop.

In the erecting shop boiler force there are nine boiler makers, one advanced helper, one boiler washer and his helper, one tester and seven helpers. This crew carries out all class 3 boiler repairs in the erecting shop; flue renewals, flexible cap removal, new door sheets, half side sheets and all testing.

The remaining men doing boiler work, among other duties, are the welders of which there are six. These men do whatever welding in the mechanical department that is necessary and all burning, cutting, new firebox welding, patch work of all kinds and the like.

Equipment in the Boiler Shop

The machine tool equipment in the boiler shop includes the following:

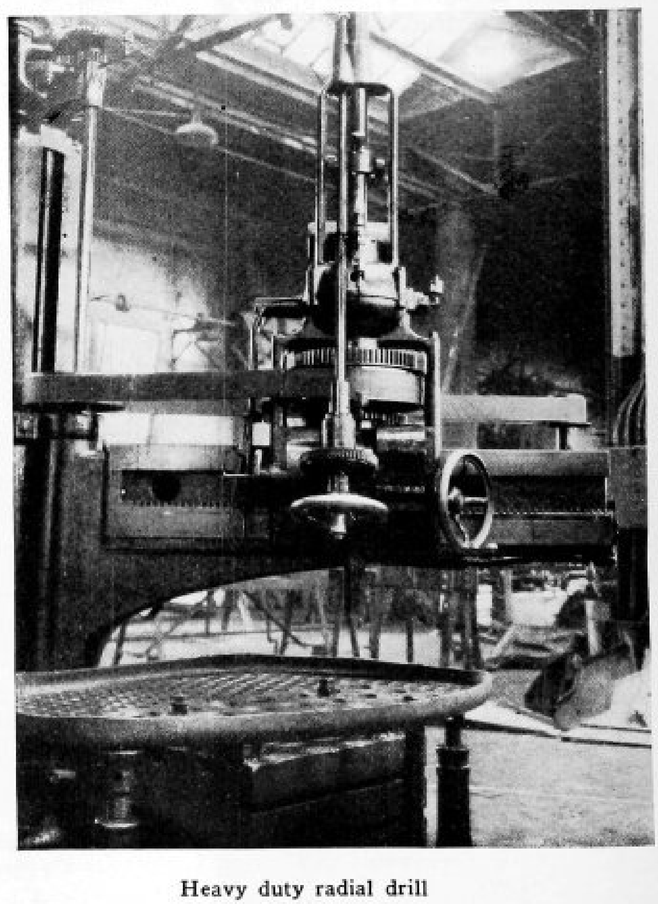
1—Cleveland horizontal punch, 24-inch throat
1—Cleveland horizontal punch, 36-inch throat
1—Hilles and Jones punch, 56-inch throat
1—Hilles and Jones shear 56-inch throat
1—McCabe cold flanging machine, capacity cold one-half inch plate; annealed ⅝-inch plate
1—Flanging clamp, 12 feet capacity
1—Flue swedger (shop made) for 2-inch tubes.
1—Large Draper flue welder
1—Small Draper flue welder
1—Bending rolls, 16 feet 2 inches; top roll 26 inches diameter, two bottom rolls 15 inches diameter
1—Hilles and Jones rolls, 10 feet; top roll 10 inches diameter, two bottom rolls 8 inches diameter
1—Small hand rolls, 42 inches; top roll 8 inches, bottom rolls 6 inches
1—Tell-tale staybolt drill (shop made) 2 heads
1—Pedrick and Ayer pneumatic riveter, 48-inch throat
1—Bull riveter, 6 feet 1 inch gap
1—Bickford drill press, up to 5½-inch cutter
1—Niles-Bement-Pond drill press, up to 5½-inch cutter
1—Walter H. Foster Company staybolt machine, 6 heads; 4 for straight bolts; one for turning, one for threading taper bolts
1—Pneumatic grip machine which cuts off and scarfs flues at same time (shop made)
1—Wet type flue rattler
1—Small shop made flanging press, 3 heads

Two main shop electric cranes of 75 tons capacity each, serve the boiler department and numerous post jib cranes each of about 2 tons capacity adjacent to the machines are used to advantage in serving material in production operations. In the riveting department, a 15-ton electric crane serves the bull machine. Although not elaborate, the equipment of the shop is complete for any work being carried through the shop and the arrangement is such that material being fabricated is carried through the machining operations with a minimum of handling.

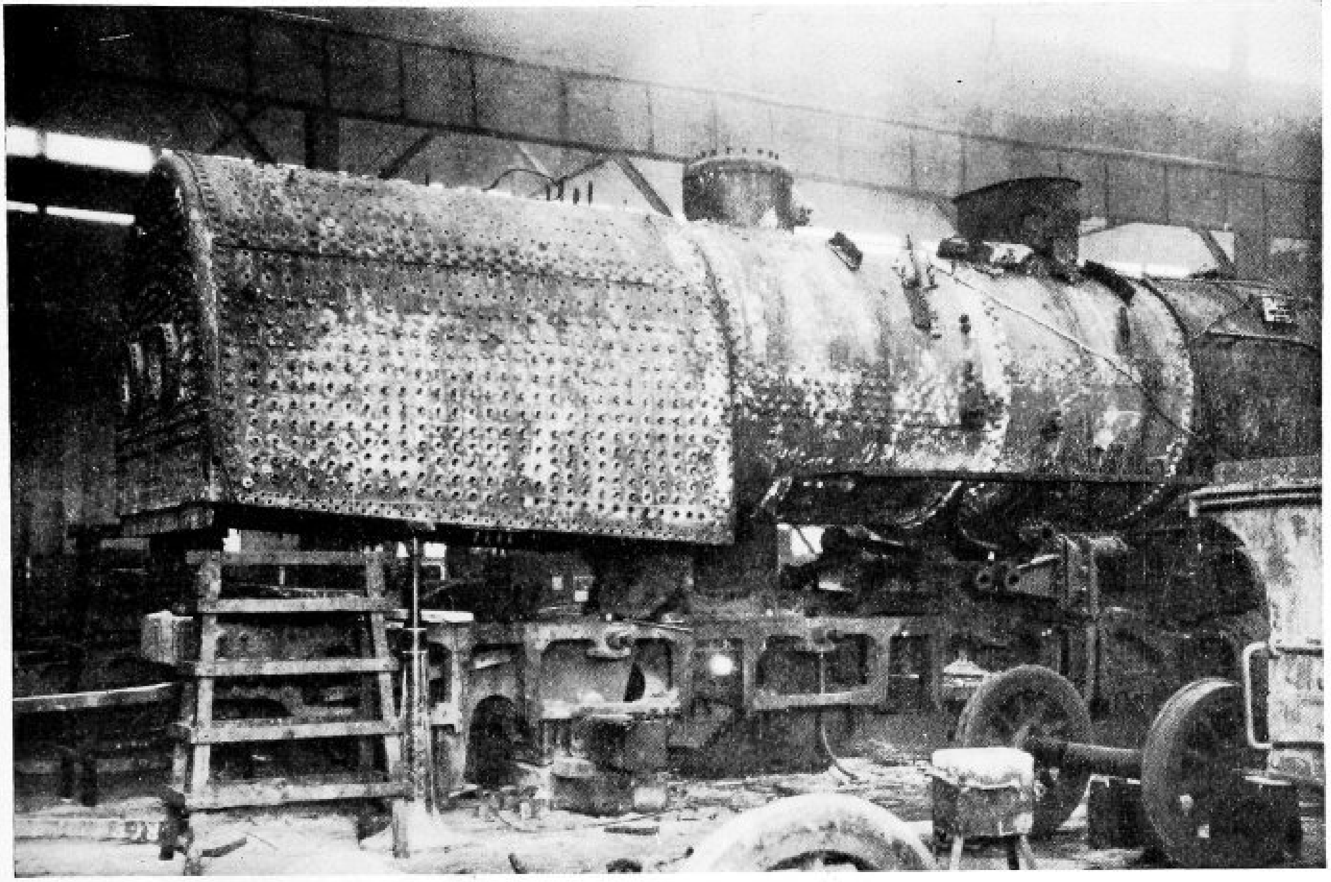
Firebox Work

The boiler shop is devoted entirely to firebox and heavy boiler repair work. As previously noted all work is carried out without removing the boiler from the frames with the exception of those boilers which require shell work such as patches, new courses and the like. In such cases the boiler is removed and the work is carried out in the usual way.

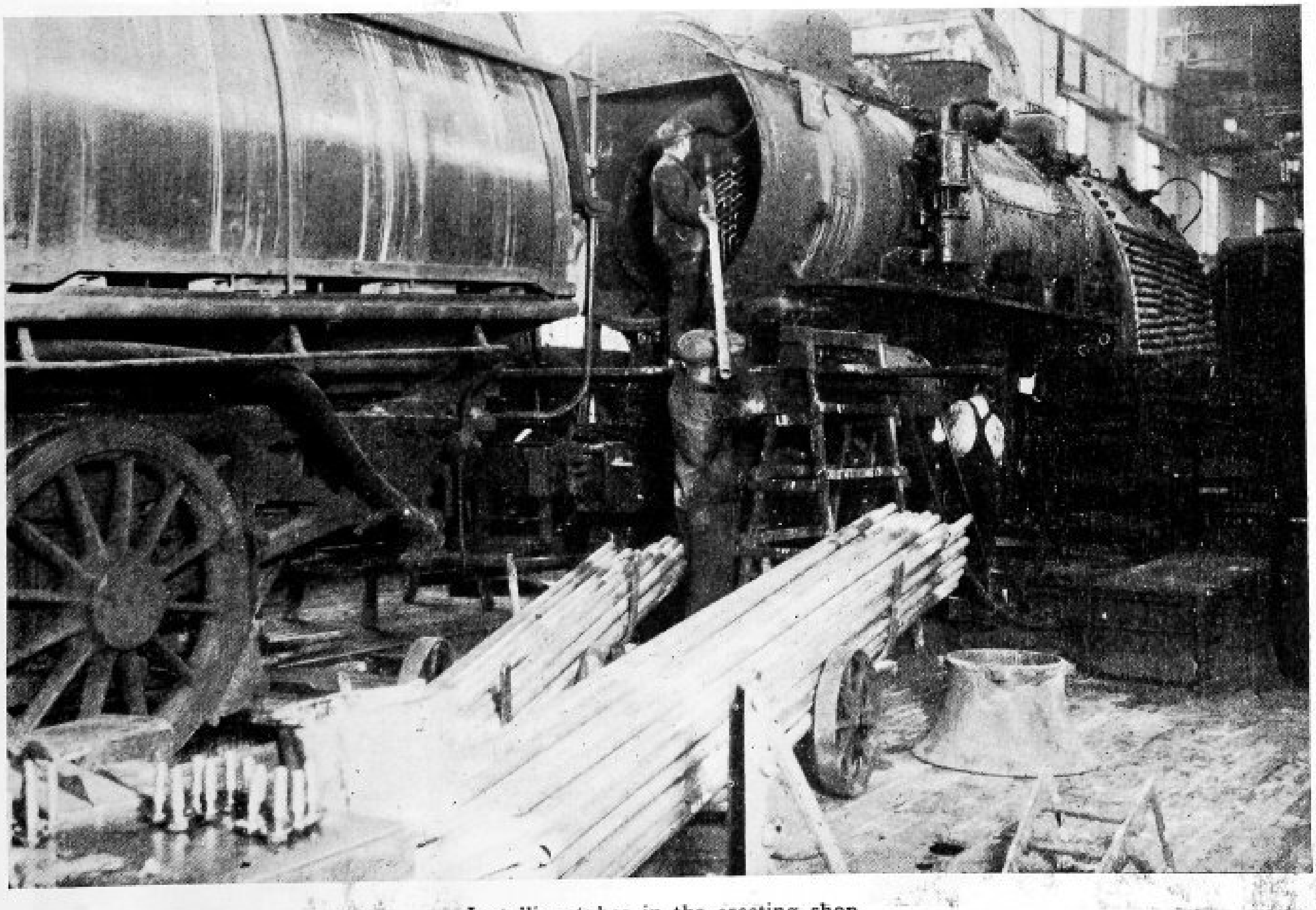
For firebox repairs where the boiler is not removed from the frames, the first operation is to remove the caps from the flexible staybolts. The mud ring rivets are next burned off and the firebox connections burned



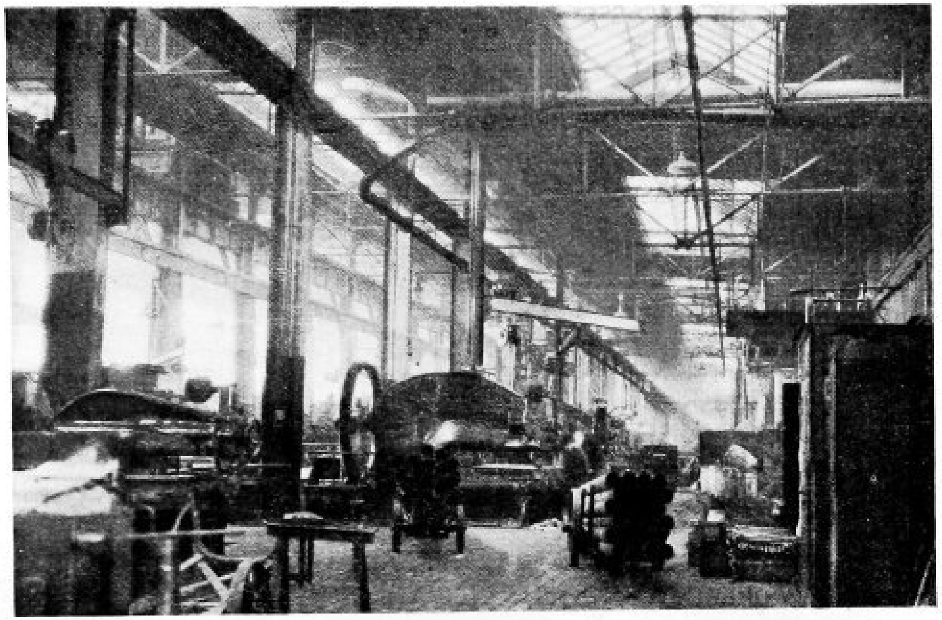
Heavy duty radial drill



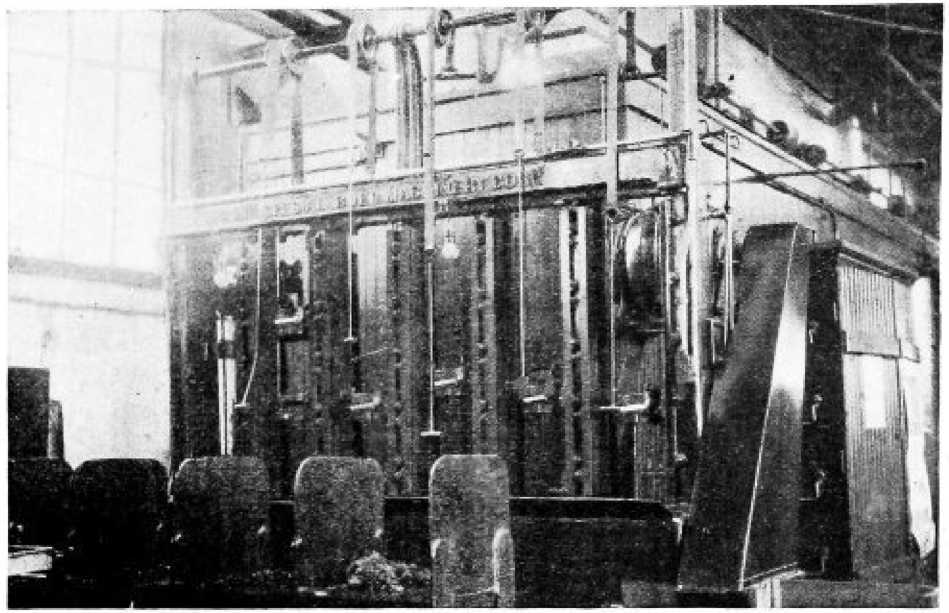
All firebox work carried out with boiler on the frames



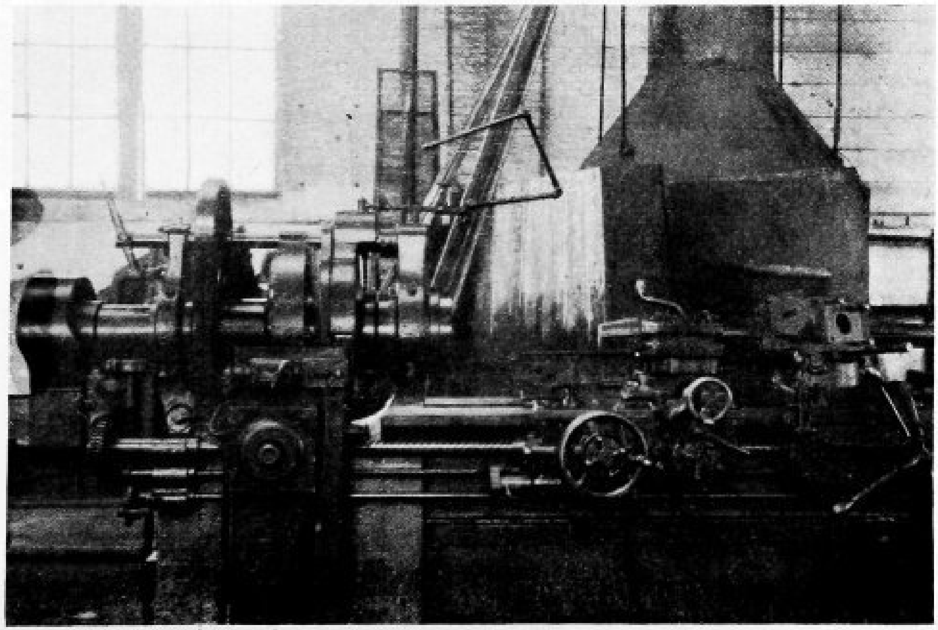
Installing tubes in the erecting shop



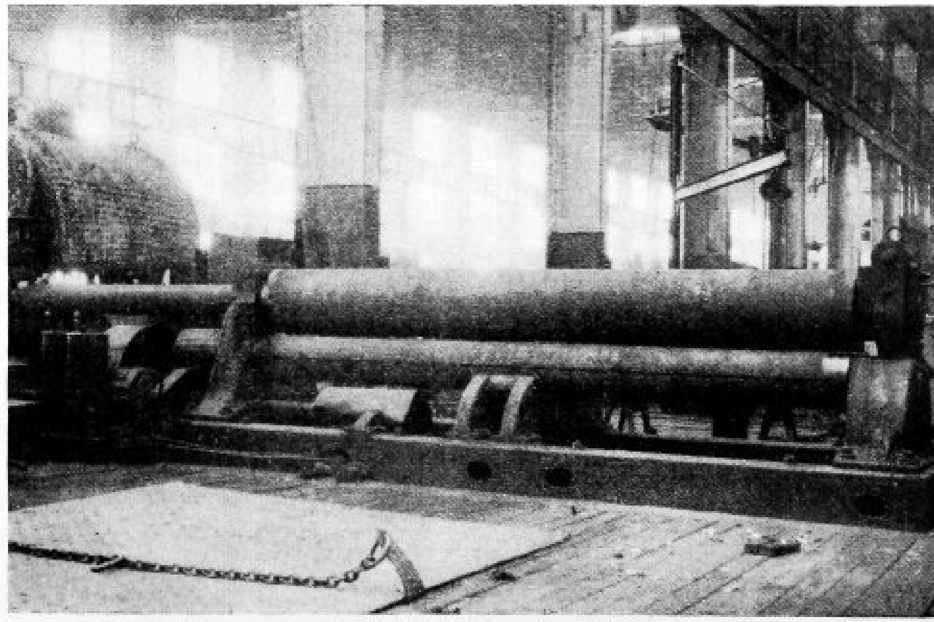
Heavy boiler machinery



Six-head staybolt machine



Combined tube cutting and reaming machine



Bending rolls for heavy plate work

out. The mud ring with the wrapper sheet and outside throat connections and back head are all left intact on the frames. The flues are removed in the erecting shop before the boiler is brought into the boiler department. The expansion plate is also removed so that the old firebox sheets may be slipped out of the wrapper sheet over the frame.

The boiler is next thoroughly scaled and inspected. While this operation is proceeding, the layerout works on the new firebox and any other sheets that require fabricating. These sheets are punched and flanged as required. All fabricated sheets are annealed after punching. The flanges are also annealed, the annealing furnace, having inside dimensions of 12 feet by 17 feet, is oil fired and will accommodate any of the sheets fabricated in the shop. The McCabe flanging machine is used to advantage in this shop, sheets being flanged cold up to ½-inch thickness and annealed up to ⅝-inch plate.

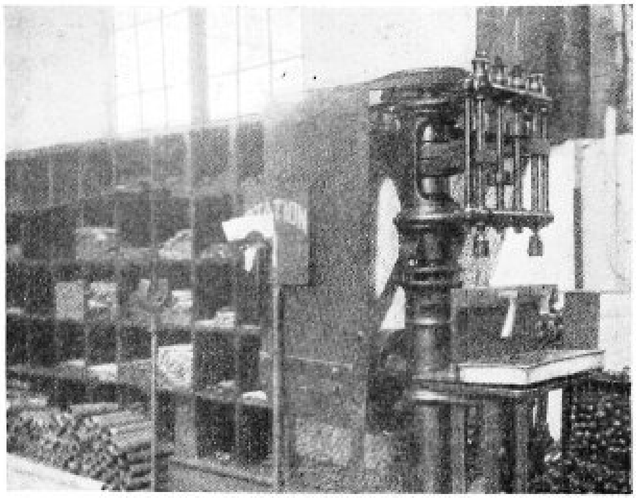
In assembling the sheets in the boiler on the frames, the operations as carried out for a Mikado locomotive are typical and will be outlined.

First the door sheet is applied and bolted in place to the mud ring. The crown sheet is then inserted over the frames and lifted into the top of the boiler where it is bolted up out of the way with long bolts through the wrapper sheet.

The throat, flue sheet and combustion chamber next in the process of assembly are fitted up and welded on the floor after which this unit is applied. The side sheets are bolted up to the mud ring. The door sheet is then fitted to the crown and side sheets which are also fitted to the throat and flue sheet ready for welding. The side sheets are welded to the crown 18 inches below the highest point of the crown. All sheets in the boiler are welded together, no rivets being used. Mud ring holes are next reamed and the sheets laid up for riveting and calking. The firebox is then ready for the application of staybolts, sling stays, braces, throat braces and finally the installation of flues.

New Outside Throat Sheet

Where a new outside throat sheet is required, the connection rivets are first burned off with the oxyacetylene torch and the rivets backed out. The back end of the boiler is then burned off the throat sheet at the outside wrapper sheet. The old throat is taken to the laying out department and leveled up on a surface plate where the outline is made by projecting points on it, down to the surface plate. The new



Corner of the staybolt department

sheet laid out and flanged from the boiler drawings is then placed on the surface plate and checked with the outline of the old one. Three holes are drilled in the bottom and three in the top for connection to the shell and nine holes drilled for connection to the mud ring.

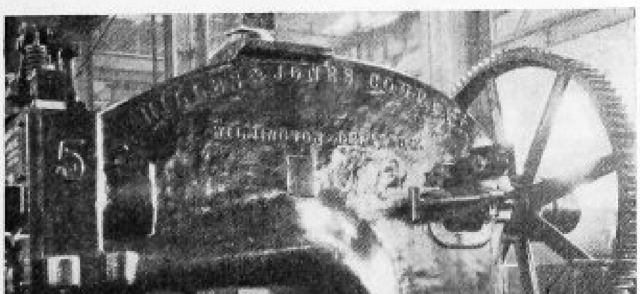
The throat sheet is then applied and bolted in place to the wrapper sheet and to the mud ring. The holes are then marked off on the new sheet, which is removed and the flange holes punched and the holes drilled for the flexible bolts.

In cases where the wrapper sheet has been removed, the outside throat sheet is bolted on and the riveting is done on the bull machine. Where the back head has also been removed, it is also bolted to the wrapper sheet and the entire assembly is driven on the bull machine.

If the back head and wrapper sheet have not been removed, the throat rivets are driven with air hammers. In cases where shell work is required, the boiler is removed from the frames in the erecting department and brought by the shop crane to the boiler section where repairs are carried out in the customary manner, fireboxes being assembled complete, and dropped into place, the mud ring fitted and connections made.

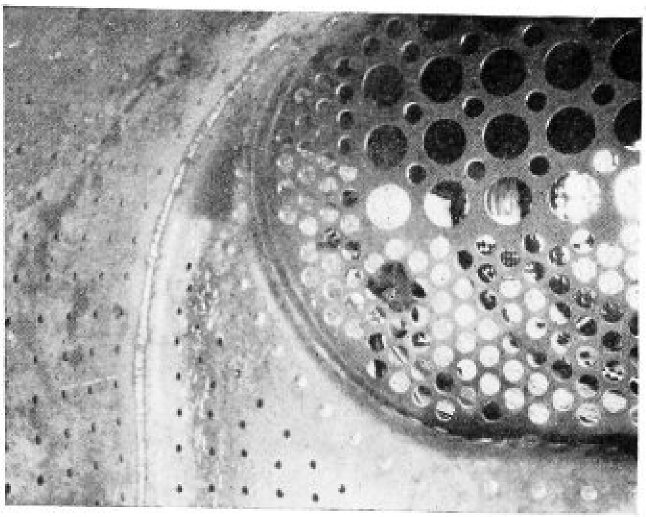
Flue Work

In the case of superheater flues, the reduced sec-



Punching machine, 56-inch throat

Shearing machine, 56-inch throat



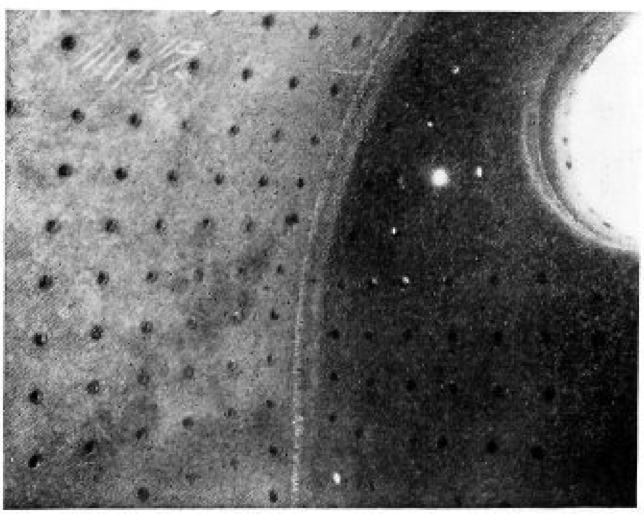
Fireboxes are completely welded

tion safe end is welded on with the oxy-acetylene torch. When this safe end becomes too long, a large end is applied by heating in the oil furnace and welding on the Draper machine. It is then swedged down to the proper diameter. When it is necessary to apply a large safe end in this manner all previous welds are cut off and the single safe end made.

On small tubes, four welds are allowed. The safe ending operations follow in general customary practice. A combined cutting off and scarfing machine, which was made in the shop from an old lathe, is used. This machine cuts off and scarfs tubes on the inside, the safe end being applied on the outside. Draper air operated welding hammers are used. All tubes are tested hydrostatically. When working to capacity the flue shop handles about 5,000 tubes and flues a month.

So far as possible, all boiler work is on a piece work basis. This includes all flue work, firebox work, staybolt removal and installation, flanging and the like. It has not as yet been possible to make the studies necessary for establishing piece work on front ends, ash pans, grates and a few other miscellaneous operations.

Wherever it can be done, men are kept on the same work, but because of the variety of repairs required, it is not always possible to do this. The result is that practically all of the men in the boiler shop, although specialists in certain operations, have a general knowledge of boiler and plate work which accomplishes excellent results and in general promotes the efficiency of the shop crew.



Welded connection at side sheet and door sheet

The capacity of the shop is about 30 classified repairs a month including three class 2 repairs, in addition to a considerable amount of miscellaneous work for the railroad and outside contract jobs.

It might be said in closing that this method of making repairs on the frames has effected a saving of more than 14 percent over the old method of removing the boiler. This, together with a number of innovations introduced with the spot system previously described, has enabled the shop to obtain an increase in production of nearly 60 percent. This saving was accomplished in the face of a reduction of one day in the number of working days per month and a reduction in force of nearly 17 percent. The total force at present employed in the Elizabethport shops includes about 750 men.

Exhibitors at Master Boiler Makers Convention

ONE of the features at the annual convention of the Master Boiler Makers Associaion to be held at the Hollenden Hotel, Cleveland, Ohio, May 22 to 25, will be the supply men's exhibit. The list of exhibitors up to March 26 is as follows:

Air Reduction Sales Company, New York.
American Arch Company, Inc., New York.
American Locomotive Company, Chicago, Ill.
Arrow Tools, Inc., Chicago, Ill.
Automatic Expander Company, Milwaukee, Wis.
Bethlehem Steel Company, Bethlehem, Pa.
The Boiler Maker, New York.
The Bird-Archer Company, New York.
W. I. Brubaker & Bros. Company, New York.
The Burden Iron Company, New York.
A. M. Castle & Company, Chicago, Ill.
Central Alloy Steel Corporation, Massillon, Ohio.
The Champion Rivet Company, Cleveland, Ohio.
Chicago Eye Shield Company, Chicago, Ill.
Chicago Pneumatic Tool Company, New York.
The Cleveland Pneumatic Tool Company, Cleveland, Ohio.
The Cleveland Steel Tool Company, Cleveland, Ohio.
Dearborn Chemical Company, Chicago, Ill.
Detroit Seamless Steel Tubes Company, Detroit, Mich.
Ewald Iron Company, Louisville, Ky.
J. Faessler Manufacturing Company, Moberly, Mo.
Flannery Bolt Company, Pittsburgh, Pa.
Forster Paint & Manufacturing Company, Winona, Minn.
Garratt-Callahan Company, Chicago, Ill.
Globe Steel Tubes Company, Milwaukee, Wis.
Housley Flue Connection Corporation, Indianapolis, Ind.
Huron Manufacturing Company, Detroit, Mich.
Independent Pneumatic Tool Company, Chicago, Ill.
Ingersoll-Rand Company, Cleveland, Ohio.
William H. Keller, Inc., Grand Haven, Mich.
Krebs Manufacturing Company, Chicago, Ill.
Locomotive Firebox Company, Chicago, Ill.
Lovejoy Tool Works, Chicago, Ill.
Lukens Steel Company, New York.
McCabe Manufacturing Company, Lawrence, Mass.
Mudge & Company, Chicago, Ill.
National Tube Company, Pittsburgh, Pa.
Old Dominion Iron & Steel Works, Belle Isle, Richmond, Va.
The Oxweld Railroad Service Company, Chicago, Ill.
Penn Iron & Steel Company, Creighton, Pa.
Pittsburgh Steel Products Company, Pittsburgh, Pa.
Pratt & Whitney Company, Hartford, Conn.
The Prime Manufacturing Company, Milwaukee, Wis.
Rome Iron Mills, Inc., New York.
Jos. T. Ryerson & Son, Chicago, Ill.
Scully Steel & Iron Company, Chicago, Ill.
The Superheater Company, New York.
The Talmadge Manufacturing Company, Cleveland, Ohio.
Torchweld Equipment Company, Chicago, Ill.

An Air Hammer Holder

An apparatus for use while driving rivets overhead into the bottom of a tank

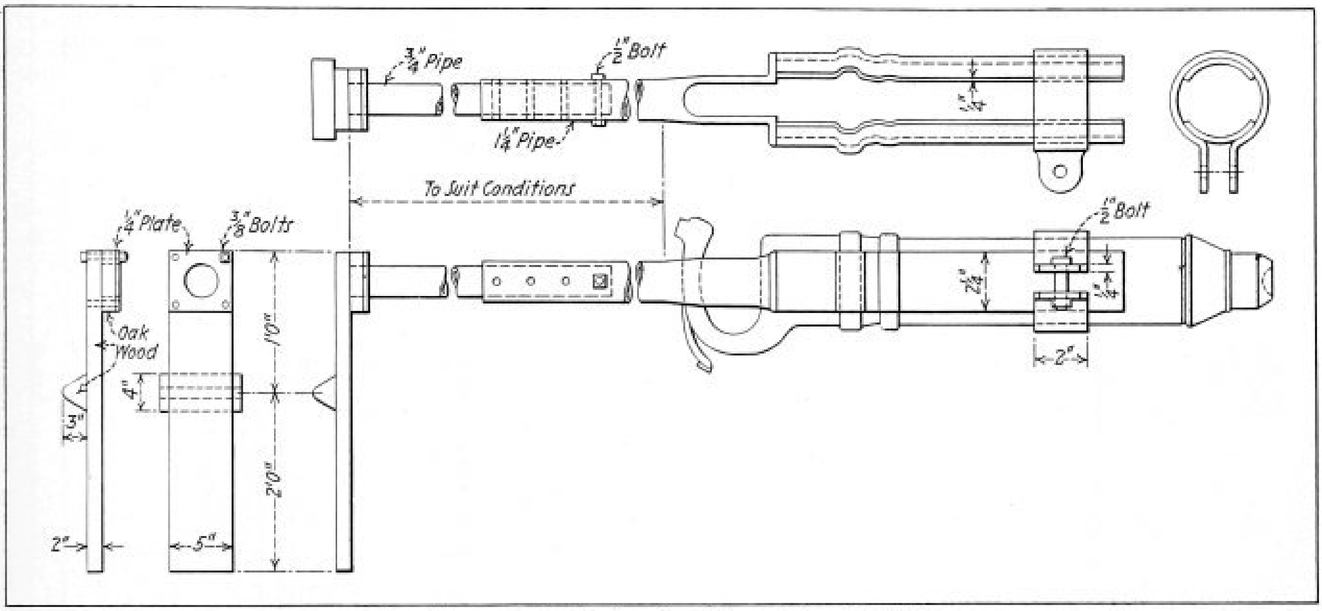
By N. W. Martin

Second Prize Boiler Shop Kinks Contest

THIS is a simple arrangement to hold a No. 60 pneumatic hammer which is held firmly in place by the clamp around the barrel of the hammer. The bottom part is composed of two pieces of pipe (one within the other) the larger or top pipe being welded to the hammer frame and the small pipe sliding into the larger pipe. Both pipes have holes drilled through them at a distance of 1 inch apart, which permits the adjustment of the apparatus to length.

The foot pedal in which the hammer rests is composed of wood and provides a leverage whereby the foot easily holds the hammer at its proper place to drive the rivets and is easily shifted about on the floor.

We find that by using this tool a much better job is done in driving rivets and a great many more rivets can be driven in an hour than by the old method of holding up the hammer by hand, which is extremely tiring to the operator.



The air hammer holder is adjustable and simple in design

Sand Blasting Locomotive Boilers

One-man machine developed at M. & St. L. R. R. shops to cut cost of scaling boilers

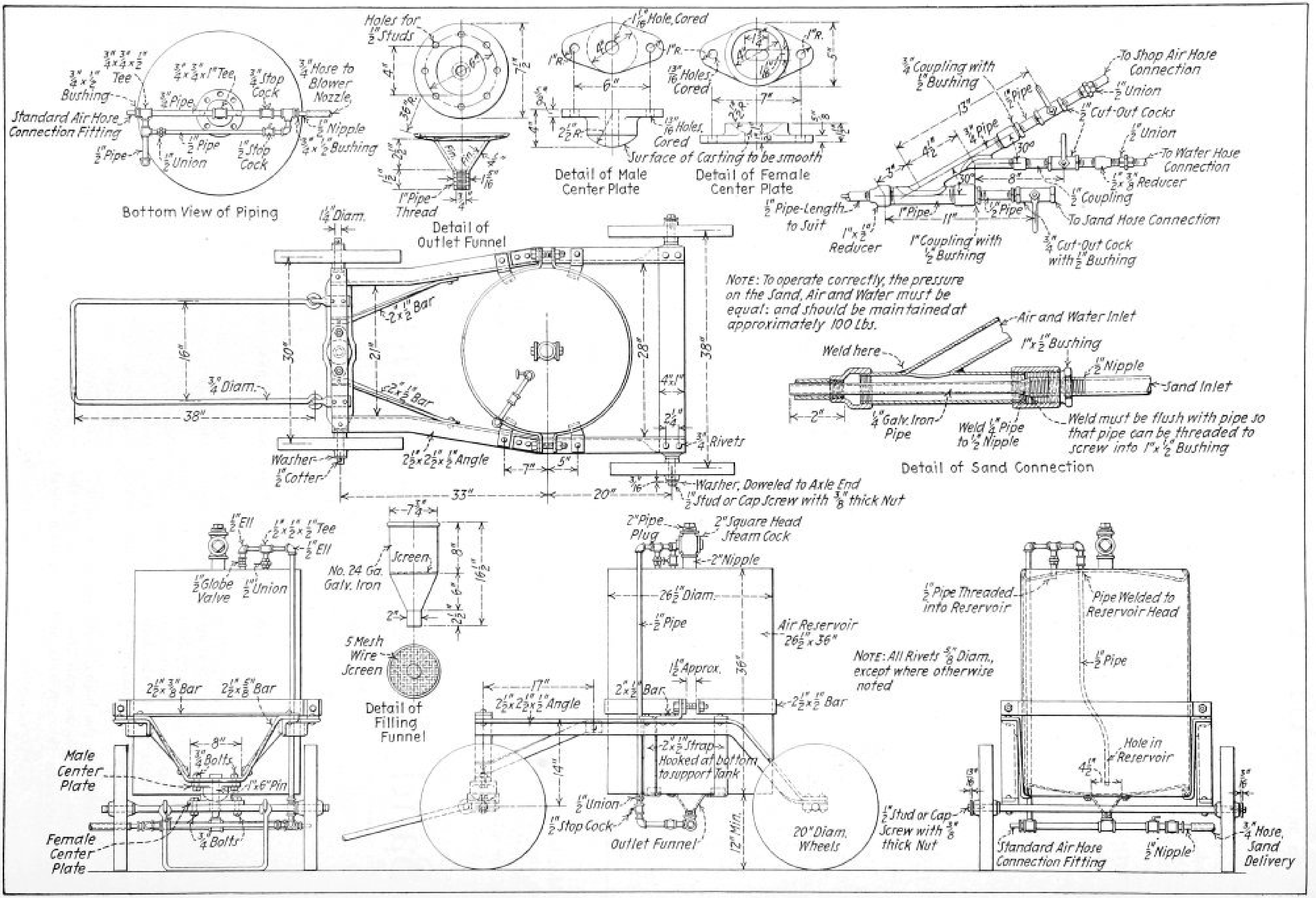
By N. W. Martin

Second Prize Boiler Shop Kinks Contest

ON OUR road we have developed a sand blasting apparatus for the scaling of locomotive boilers after all the flues have been removed or when the small flues have been removed and the superheater flues have been left in. In the latter case, the superheater flues are also sand blasted while they are in the boiler.

We not only scale the boiler shell, but by using different lengths of pipe, we scale the water space of the firebox in between the staybolts and the crown sheet in between the crown stays. This work is all done in the shop as the boilers stand over the pits.

The apparatus consists of a tank to hold the sand, three lengths of hose and a nozzle in which is mixed the air, water and sand used in cleaning the scale off the sheets. The tank may be any size, but must be built strong enough to carry the shop air pressure. This tank is mounted on wheels so that we can carry it about the shop wherever it is needed. As can be seen from the drawing, the tank is so piped and con-



Details of one man sand blast machine

nected to the shop air line that a steady flow of sand runs from the outlet in the bottom of the tank to the sand hose which in turn is carried up to the nozzle.

Three lengths of hose are used to convey the air, water and sand to the nozzle. The air and the water hose run directly from their shop connections to the nozzle, while the sand hose runs from the bottom of the sand tank to the nozzle. At the nozzle, air and water are brought together into one pipe and are in turn forced into a chamber around the sand pipe following the sand pipe to its opening where the sand, water and air are mixed together as they flow through the outlet pipe. This pipe may be of any suitable length to meet the requirements, but no longer than is necessary.

As will be seen by a study of the nozzle, the water does not touch or come in contact with the sand until it starts through the outlet pipe. This feature prevents the clogging of the nozzle with wet sand and the best results are obtained when the air and water pressures are equal or as nearly so as it is possible to have them.

Operation of the Machine

This is a one-man machine and that is the reason why so many valves are used on the air tank and on the nozzle. When starting to use this apparatus, the valves on the nozzle are all closed and the valves on the tank and the hose connections are opened to let in the air pressure and allow the sand to flow freely. The valves of the air and water hose that lead to the nozzle are turned on at their shop connections. After this has been done, the operator is ready to enter the boiler through the dome with the nozzle and the hose. After he has entered the boiler and is ready to begin blasting, the sand valve is first opened then the water and the air valves are opened and regulated by the operator to meet his needs. Only a short time is required for the operator to learn the exact mixture necessary to give the best results.

The operator should be outfitted with a complete rubber suit, hat and rubber boots and should have a water proofed electric light extension for his use; also a pair of close fitting safety goggles. As a safety measure for the other employees, a piece of canvas is hung over the front flue sheet in the smokebox and over the door hole of the back head. This keeps the sand from flying around the shop.

Before the development of this machine, the time of scaling a Mikado boiler with air tools was at least 16 hours and two men were used at a cost of $16.64. With the sandblast, the time is from 5 to 8 hours at a cost of not over $5 so that it can readily be seen that this apparatus is both a time and money saver.

Use of Rolling Molds for Laying Out Difficult Pipes

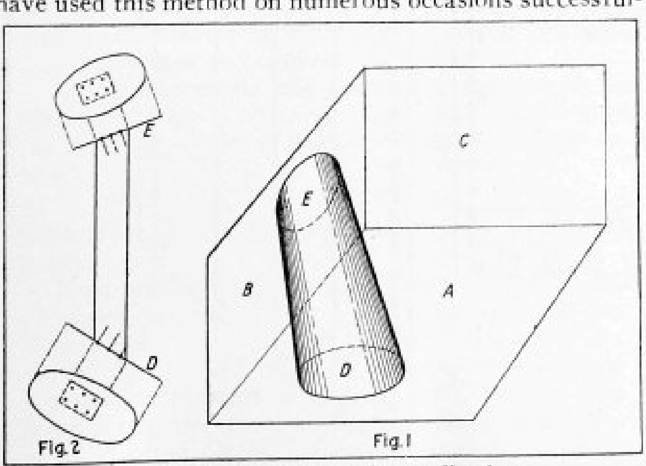
Simplified method of making templates for developing patterns for pipes of any size or shape

By I. J. Haddon

Third Prize Boiler Shop Kinks Contest

It often happens that pipe connections have to be made when it would be difficult to lay out the pipe by triangulation or geometrical means on account of its position and shape. For the want of a better name or term I am calling this method the "rolling mold."

By the use of the rolling mold, *any* pipe irrespective of its shape or position, may be laid out accurately. I have used this method on numerous occasions successfully. To give the reader a better idea of the subject I have drawn it in perspective as shown in Fig. 1.



The rolling mold and its application

Just imagine that *A*, *B* and *C* are the floor and two walls of a building and in the floor there is a hole *D* and in the wall *B* there is a hole *E*. It does not matter in what part of the wall or floor the holes are located, neither does it matter what the shape is of either of the holes; they might be round, square, elliptical, oblong, rhomboid, one larger than the other, one square and one elliptical. In fact, no matter what the shape or size for either of them, this rolling mold will lay the job out correctly. In Fig. 1 will also be seen the perspective of the pipe connection to the holes *E* and *D*.

Now, all that has to be done is to lay out this pipe as follows:

Cut out a piece of say 1/16-inch gage sheet iron, or wood, the size of each hole, and then connect these to a piece of lumber, say 2 inches by 4 inches, with nails as shown in Fig. 2, after cutting the lumber to the proper length and with the proper bevels. Then lay this mold on the plate from which the pipe is to be made and roll it, at the same time marking lines with a piece of soapstone where the end pieces bear on the plate.

If a mark is put upon the plate at each end, where the mold lies and a line be drawn to connect the marks, this line will be a rolling or bending line and will lie level on the pipe after bending. Each of the 1/16-inch plates should be cut to size to represent the center of the thickness of the pipe; that is, suppose one of the elliptical ends of the pipe has to be say 16 inches by 12 inches and the material the pipe has to be made of say 3/8-inch, then the size of the 1/16-inch elliptical sheet would be cut 15 5/8 inces by 11 5/8 inches.

To thoroughly understand and appreciate the usefulness of this method, I would suggest that readers obtain a piece of say 2-inch by 1-inch lumber about 6 inches long. Saw it to a bevel at each end, any bevel and at any angle. Then cut a piece of sheet metal, any shape, but of course, larger than the piece of lumber, say oblong 4 inches by 3 inches and nail it to one end, in any position and cut a piece for the other end, say elliptical in shape, and nail that on. Now roll this mold on a sheet of paper, pressing sufficiently hard so that the sheet metal will make an impression on it. Now cut out the paper where marked and bend the paper to the shape required, it will be found to represent the pipe exactly. By doing this, you will also easily follow what I described as rolling or bending lines.

I might also say I was the originator of this method and have used it for more than twentyyears.

Method of Laying Out Elbows

A simplified template may be used to develop rakes in pipe of any diameter

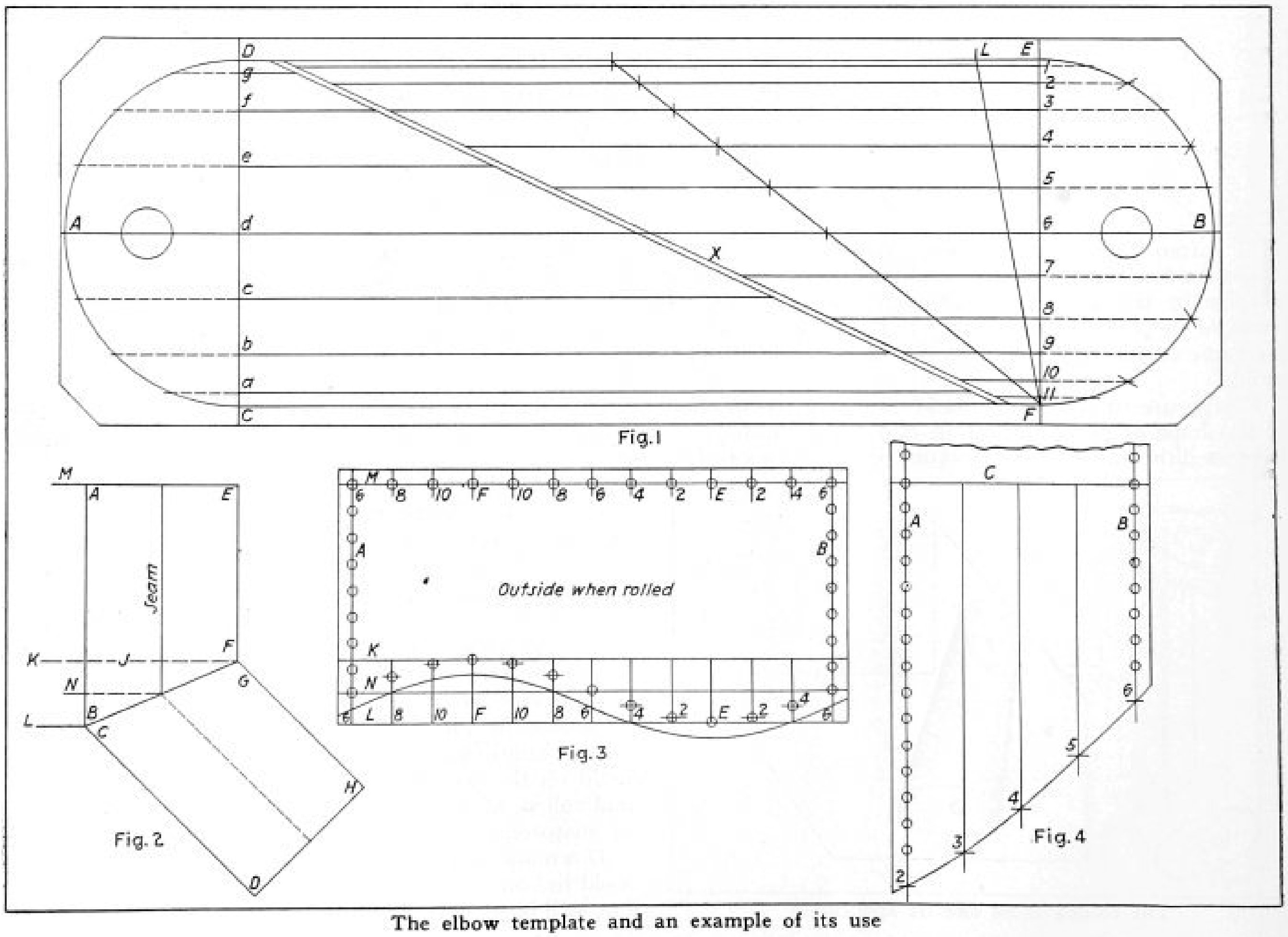
By I. J. Haddon

Third Prize Boiler Shop Kinks Contest

For many years the usual method for laying out an elbow has been to draw the profile then draw a circle the same diameter as the pipe, divide around the circle and drop the lines down on the miter line. This method is quite correct, but everyone does not know that it is unnecessary to draw the circle the same size as the pipe.

Now if a drawing of Fig. 1 is made on a piece of sheet zinc of other suitable material and the lines scratched in deeply so as to be permanent, this drawing may then be used to obtain the layout of *any elbow* without drawing the circle aforementioned; in fact, the only thing necessary to know is the height of the rake as *K-L*, Fig. 2.

The layout of the bottom circle of plates in a ship's smokestack, with *any* number of plates in the circle



The elbow template and an example of its use

may be laid out, plate by plate, from the pile. It is not necessary to lay the total number of plates down on the floor, neither is it necessary to draw any circle at all, as I will explain. I would advise anyone having elbows to lay out to first make this pattern—he will find it as handy and useful as a square.

First cut out a piece of sheet zinc, or a smoothly planed board, size say about 20 inches by 7 inches; my reason for suggesting these sizes is so that the lines will be distinct, one from another, but *any width* would do.

Draw the center line *A-B*, Fig. 1. Draw the lines *C-D*, and *E-F* at right angles to *A-B* and about 14 inches apart. With 6 and *D* respectively as centers, describe semicircles with about 3 inches radius each. Divide the semicircle at one end into 12 equal parts and the other semicircle into 8 equal parts. Join *D-E* and *C-F*. Draw the two close lines as shown at *X* terminating on the lines *D-E* and *C-F*, and about ½-inch from *D* and *F*, as shown. Now draw lines from the semicircles parallel to *D-E* and terminating at the lines *X* as shown. The board is now ready to use in the layout of *any elbow*. A hole at the end could be put in so that this template may be hung up in the shop when not in use.

To lay out the pattern for the pipe, Fig. 2, draw the lines *A-B*, *C-D* at the angle required. Draw *E-F* and *G-H* parallel to *A-B* and *C-D* and a distance apart equal to the diameter of the pipe, draw the miter line as shown. Draw the line *J* at right angles to *A-B*. This will give us *K-L* as the depth of rake.

If the diameter of the pipe is so large as not to be laid down conveniently as shown, any proportion of the pipe may be laid down, and the distance *K-L* found by multiplying accordingly; that is, if the lines *A-B* and *E-F* were drawn a distance apart equal to say ¼ of the diameter of the pipe, then *K-L* would be ¼ of the actual rake required and would have to be multiplied by 4.

Having found *K-L*, measure off from *E* on the board, Fig. 1, to *L* the distance *K-L*, Fig. 2 and draw the line *L-F*. This line will cross the other lines exactly as if a circle had been drawn on *A-E*, Fig. 2, and lines dropped down as usual.

To lay out the pattern, Fig. 3, square off the plate, draw the lines *A-B* and a distance apart equal to the circumference of the pipe. Draw the lines *L*, *N*, *K* and *M* equal to *L*, *N*, *K* and *M*, Fig. 2, then divide the line 6-6 into 12 equal parts, drawing perpendicular lines as shown.

Now measure down from the line *E-F* on the board, Fig. 1, the respective distances and set them off from the line *K*, Fig. 3, as shown. The points obtained would represent the center of holes as shown. Allow the necessary laps to complete the layout.

Fig. 4 represents one plate of a smokestack whose diameter is say 6 feet and whose rake is say 1¼ inches to the foot, which is the usual rake for ships' smokestacks.

$$6 \times 1\tfrac{1}{4} = 7\tfrac{1}{2}$$

Therefore, 7½ inches is the total depth of rake in the stack.

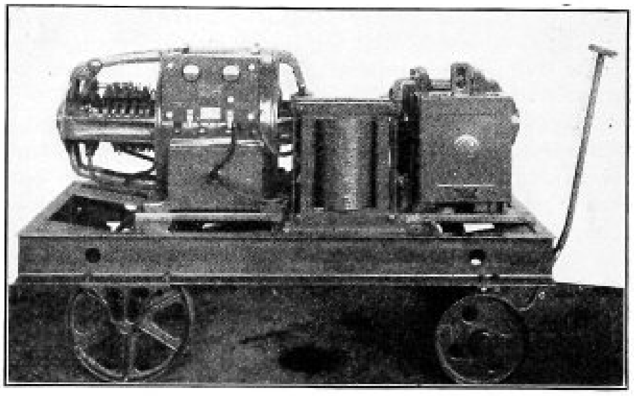
Now we will suppose the stack has to be made in 6 plates in the circle. First measure down on the board from *E* 7½ inches as shown and draw the line to *F*. As the board has 24 divisions to the whole circle, each of the 6 plates will have 4 divisions. We will assume that the seams are to come at 10, 6 and 2, which are the usual places. Then lay out one of the plates from the pile, as plate 2 to 6.

Draw the lines *A* and *B*, Fig. 4 at a distance apart of 3 feet 1 11/16 inches, this length being 1/6 of the whole circumference; then draw the line *C* at right angles to *A* and *B* and divide it into 4 spaces as shown. Draw lines parallel to *A* and *B* as shown and measure off along the lines the respective distances as obtained from the board. Draw a fair curve through these points; mark in seam holes and allow on lap to complete.

The opposite end of the board, Fig. 1, is divided into 8 spaces; by using this end of the board you will divide the plate into 8 or 16 parts. If you wished to have 16 holes in the elbow of the pipe, Fig. 2, the depth of rake would be marked on the board at this end.

Single-Operator Arc Welder Delivers 300 Amperes

A SINGLE-OPERATOR welder rated at 300 amperes, one hour, 50 degrees centigrade temperature rise is announced by the General Electric Company, Schenectady, N. Y., as the latest addition to its standard line of welding equipment. This



The field control in the generator of the General Electric WD-300-A arc welder has been eliminated

machine includes a four-bearing, ball-bearing, motor generator set with a flexible coupling.

With this equipment, a rapid and simple interchange of motors may be made by the user. As a result, inspection, maintenance, renewals and changes caused by changes in the supply circuit can be simplified.

The driving motor is a 15 horsepower, 40 degree centigrade, continuous-rated unit. This conforms with the recent ruling of the National Electric Manufacturers Association. The generator is so designed that the field control is unnecessary and is eliminated. The generator panel includes an ammeter and a volt-meter, but not the customary field rheostat. The meters used have a metal front except for the glass over the scale, thus minimizing the possibility of breakage.

The motor starters for the 60, 50 and 25-cycle motors are of the enclosed magnetic type, while those for the 25-cycle motors are enclosed resistor starters. The direct-current motors use a simple resistance starter with a line switch. Starting current is maintained in each case well within N.E.L.A. requirements.

The generator is designed to permit belt, motor or engine drive, and will be designed for either stationary or portable use. It can be used as both a manufacturing and a repair tool, for service in foundries, locomotive and car shops, shipyards, marine repair yards, tank shops, general machine shops and in any other field where iron or steel is used. It bears the General Electric designation WD-300-A.

Boiler Performance Guarantees

Report of special committee of American Boiler Manufacturers Association at mid-winter meeting

THE 39th annual convention of the American Boiler Manufacturers Association, held at French Lick Springs, Ind., in June, 1927, instructed the committee on boiler performance guarantees to prepare and present a standard form of predicted performance or guarantees for use of the association when and if such predicted performances or guarantees are required to be made in connection with boiler proposals or boiler contracts.

The committee recommends the form given below which, of course, may be altered to conform to the members' own ideas as to phraseology, providing the vital parts are included.

Following this practice will provide protection for the bidder or contractor as well as the purchaser, in that misunderstandings will be thereby avoided.

The Stoker Manufacturers Association has agreed that the contractor for fuel burning apparatus should make over-all guarantees such as efficiency, percent of CO_2, etc., but insists that the boiler manufacturer specify the outlet gas temperature or, lacking that, an arbitrary outlet temperature will be assumed.

In making any performance guarantees, the boiler manufacturer must specify what the combustion characteristics shall be and on the basis of which he calculates the probable outlet gas temperature, draft loss through the boiler, boiler capacity, degree of superheat, etc. Predictions or guarantees of boiler performance should be limited to such items and the making of any others should be strongly resisted.

It is probable that some specifications will require the boiler manufacturer to cover items that properly belong to the manufacturer of the fuel burning apparatus, but if the basic data is specified, guarantees of efficiency can be relatively easily calculated. It is, of course, impossible for the boiler manufacturer to guarantee those items which are absolutely dependent upon the performance of the fuel burning equipment, unless, perchance, he has to include that equipment in the contract and in which case he would naturally get from the manufacturer of the fuel burning equipment, guarantees covering that part of the installation.

There will always inevitably be some items in the heat balance that have to be apportioned between the boiler and the furnace, the principal one of which is radiation and unaccounted for. Ordinarily, the one who makes the efficiency guarantee would include that in his calculations.

What follows is a suggested guide for the wording of a performance prediction or guarantee, as regards the boiler only: It is understood and agreed:—

1. That the stoker (or other combustion apparatus) and furnace as installed, shall be capable of burning sufficient fuel to enable the desired capacities to be developed and will maintain conditions not less favorable than those indicated in (7) and (8).

2. That the draft supplied shall be ample to remove the products of combustion and be such as to cause a suction in all portions of the boiler setting at whatever capacity the boiler may be operated.

3. That combustion will be completed in the furnace to the extent that there shall be no smoke darker than No. 1 Ringleman chart and that the average CO in the gases will not exceed .1 percent or the CO_2 vary more than one point from the average. The gases shall be sampled uniformly across the width of the boiler after having passed over the first 20 percent of the boiler heating surface or at the top of the first pass. There shall be no delayed combustion present at this point or at any point beyond.

4. That baffles and brickwork shall be in first class condition, that the boiler and superheater shall be clean inside and out, and that they shall be properly operated in all respects.

5. That the measure of performance of the equipment shall be based upon observations made in accordance with the latest Power Test Code of the A. S. M. E.

6. That the following tolerances will be allowed:

Efficiency (if required of boiler manufacturer) .... minus 1 point.
Exit flue gas temperature ..... plus 5 percent.
Superheat .... plus or minus 10 degrees.
Draft loss .... plus 10 percent
Pressure drop through superheater .... plus 10 percent
Quality of steam .... plus 2 points.
(Or other values that may be agreed on. See par. Precision of Results)

7. That the fuel shall have an analysis not less favorable than the following:

Here give analysis of the fuel, including the heating value and British thermal units.

8. That the following conditions shall be not less favorable than:

CO_2 .... percent.
Total unburned carbon .... percent. of total fuel
Radiation and unaccounted .... percent of total B.T.U.

Then, on the basis of the foregoing, the expected performance figures or guarantees, when making .... pounds of steam per hour, will be:

Efficiency (if required of boiler manufacturer) ... percent.
Exit flue gas temperature .... degrees.
Superheat .... degrees.
Draft loss through boiler .... inches
Pressure drop through superheater .... pounds.
Quality of steam .... percent.

Not infrequently the various characteristics are asked for at different rates of steaming, in which cases there would naturally be several columns of the various items relating to the corresponding capacities.

The qualifications dealing with reasonably constant CO_2 across the setting (3) are to guard against any laning action of the gases through the setting, which is strictly a combustion condition. It may be that the purchaser or manufacturer of the fuel burning equipment will object to the term "complete combustion in the furnace," and may be justified in so doing, for not infrequently combustion continues while the gases are passing over the first part of the heating surface, although it is by far the best practice to have combustion complete before the gases enter the heating surface of the boiler. It is highly advisable to recognize the possibility of so-called secondary combustion, which is more likely to occur at high ratings and which, of course, raises the exit gas temperature very greatly. If there is any indication at all of CO, it is evidence of incomplete combustion and there must inevitably be other combustible gases which are difficult if not impossible of ready determination. The quantity of CO, therefore, cannot even approximately be used to determine heat loss, and the presence of that gas in quantity should nullify a test. Hence, the limitation of CO.

When superheaters are used, the quality of steam is not ordinarily called for, particularly if the superheater is furnished by the boiler manufacturer. If such is not the case, however, or if no superheater is used, the quality of steam is usually wanted.

The qualifications referred to in (4) as tolerances are necessary for the following reasons:

(a) Because of inaccuracies in making the various measurements in the course of testing.

(b) Because of the difficulty of actually determining just what draft losses are needed to meet combustion conditions.

(c) Because of difficulty in designing a superheater to give exactly the degree of superheat specified.

Particular attention is called to the explanatory clauses in the A. S. M. E. Boiler Test Code, which deals with the practical limitations in making boiler tests and the probabilities of error, and which we quote as follows:

"*Precision of Results.* Boiler testing should not be undertaken by any one who has not had some training under an experienced testing engineer if reliable results are to be expected. The whole subject should be thoroughly understood, both theoretically and practically. Accurate tests depend very largely upon the care and faithfulness of the observers. It is much easier to make mistakes than is realized by those who are not familiar with practical testing.

"The absolute accuracy of the results of a boiler test, even when conducted with the greatest care, is doubtful, but there is as yet no possible basis upon which to determine what the probable limits of error might be. It is generally conceded, however, that there are several sources of indeterminate error. The limits of accuracy of a test may very reasonably be taken to be within plus or minus 3 per cent."

. . . .

"*Guarantee Tests.* It is therefore quite logical in the case of guarantee tests that substantial compliance with the guarantee be accepted as full compliance therewith. A limit of tolerance should be agreed upon beforehand by the parties to the test. The amount of this tolerance might well bear some relation to the care exercised in arranging the details and in the conducting of the test."

From the above you will note that the code specifically provides for a tolerance of 3 percent in test results and also suggests that substantial compliance of test results with guarantees should be regarded as full compliance therewith.

In view of the tolerance mentioned, "substantial compliance" would naturally be results that come within the above limit.

However, there may be those that object to an allowance as great as 3 percent, in which case an understanding beforehand should be had as to what limits of variation will be permitted. There is no doubt there should be a tolerance provided for. This should preferably be discussed with the customer by the sales engineer when a sale is effected and not be deferred until the time for testing arrives. Preliminary tests should be made before making formal tests in order that proper adjustments of the apparatus can be made. These preliminary tests might very properly be made the basis for an agreement as to the tolerances to be permitted.

In the event of test being made to demonstrate the guarantee, it is highly advisable that the contract should provide that the purchaser supplies the fuel and water for the tests, the necessary means for weighing the fuel and water, the operators and observers for making the test, which, however, is to be conducted by a representative of the vendor, whose time and expenses are also to be borne by the purchaser. The other necessary testing instruments such as draft gages, steam calorimeters, thermometers, pyrometers, pressure gages, etc., may be arranged to be supplied by either the purchaser or vendor, as circumstances dictate.

The committee consisted of E. R. Fish, chairman, A. G. Pratt, Wm. Jacobi and A. C. Weigel.

Cost Accounting *

A COST department has one excuse, and one excuse only, for existence, namely, the increasing of a company's profits. This fact is frequently lost sight of and we sometimes think that there are cost systems in existence which are of little service, except as a basis for certain reports required by our tax laws.

We would suggest that if there is any question in your mind about the efficiency of your own cost department that you put the above facts squarely up to the men in charge and we might add that we believe if you can get the same point across to your manufacturing department, you will have succeeded in greatly increasing the value of the work of your cost department.

The first step which the cost department takes is, as its name implies, to give you the supposed actual cost of a job in order that you can be sure that the estimate on which your selling price was based covers all of your costs; therefore the work of the cost department must be reduced to figures and schedules which are effective tools for your estimating department. If their records are purely historical, they are practically valueless. If they are not in clean cut shape for the use of your estimating department they are just as much of a handicap to you as a poorly ground, poorly tempered and badly worn lathe tool is to your machinist.

Your total costs are to be divided into three major classes:

1st. Direct material costs.

2nd. Direct labor costs.

3rd. Operating expense items.

The unsatisfactory price situation which exists in our business today leads your committee to question whether all of our cost departments are giving the proper information regarding all of these items of cost in such shape that it is being properly used.

Your committee has therefore concluded that it may be of some real service to the association if it can throw some light on certain expense items and their proper allocation. We have therefore asked the secretary to send to each member a questionnaire to which we would ask that you give very careful attention and to return your replies as soon as possible. These will be tabulated and analyzed and it is contemplated that a full report can be made at the June meeting.

These questions are designed to bring out the different members' opinions of what expenses incidental to your various businesses can be overlooked in estimating costs on which prices are fixed in a competitive market. If some of our members are omitting certain costs in arriving at prices which the majority of our members think should not be omitted, and if through a discussion of the matter they can be convinced that they are wrong, we should be doing a

* Report of American Boiler Manufacturers' Association Cost Accounting Committee at the mid-winter meeting, Cleveland, O., February 7.

great service both to our fellow members and ourselves.

Some consideration has been given by your committee to the subject of a uniform cost system for all members of the association. The possibility has been suggested of employing an accountant whose duty it would be to visit each member's plant once a month to assist in determining certain uniformly arrived at figures and tabulate these into an average against which the members could check the results which they are obtaining. It is conceivable that such a man could be of great assistance to many individuals and could help to eliminate variations in practice which are detrimental to us both individually and collectively. No information regarding any individual would of course reach any other individual, except the general average of all participants.

Your committee is of the opinion that we are not as an association ready for such an activity at this time, but would very much appreciate a brief expression of opinion on the subject.

This report was submitted by a committee composed of C. W. Edgerton, chairman, W. C. Connelly and J. S. Hammerslough.

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, 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 records of the interpretations of the committee in Cases Nos. 556 (reopened), 567, 570-575, inclusive, as formulated at the meeting of December 2, 1927, all having been approved by the council. In accordance with established practice, names of inquirers have been omitted.

Case No. 556. (Reopened) *Inquiry:* Is it permissible to connect a steam generating unit, constructed in accordance with the requirements of the Code for Miniature Boilers, directly to a cast-iron-body vulcanizer by means of a close connection? It is to be noted that the entire apparatus is to be tested hydrostatically to a pressure of 600 pounds per square inch; that the working pressure is not to exceed 100 pounds per square inch; that the water level is to be maintained within the generator; and that the combination is to be operated as a closed system, without extraction of steam, which makes it necessary that no valve come between the steam generator and the vulcanizer.

Reply: It is the opinion of the committee that a vulcanizer so connected should not be considered as a part of the steam boiler and that the code applies only to the steam generating unit. The combination described should not conflict with the requirements of the code, as a stop valve between the steam generator and the vulcanizer in a closed system is not required. The opening between the generator and the vulcanizer should not exceed 2 inches nominal pipe size.

Case No. 567. *Inquiry:* If a furnace 38 inches or less in diameter of proper thickness for the required working pressure without staying is fitted with one or more rows of staybolts, should the ordinary rules which involve the full area supported by the staybolt and the allowable stress on the staybolt be applied in determining the diameter of the staybolt?

Reply: If staybolts are used as specified in the inquiry, the requirements in the code for the stress allowed and the spacing of the staybolts may be disregarded.

Case No. 570. *Inquiry:* Is it permissible under the requirement of Par. P-293 of the code, to use a straight through-blow valve which operates with a lever controlled cross sliding disk, the lever being fitted with a special bracket and locking device that permits it to be locked in open position and shows clearly by an index when the lever is in such open position? As the code rule requires that a shut-off valve in the connection to a water column shall be either an outside-screw-and-yoke type gate valve or a stopcock, can a straight through-blow valve as above described be classified as a stopcock?

Reply: The intent of Par. P-293 was that the shut-off valve in a connection to a water column shall not only be of the through-blow type so as to prevent the accumulation of scale and sediment, but also be of such a type of construction that the operating mechanism will show by its position whether it is open or closed, and can be locked in open position. If the construction of the valve referred to is such that it will meet the two requirements, it is the opinion of the committee that it will meet the intent of the rule in Par. P-293.

Case No. 571. *Inquiry:* Is it permissible under the rules of the Power Boiler Code pertaining to the construction of nozzles, to attach a 10-inch nozzle to a boiler drum by the forge welding process? Attention is called to the fact that whereas the required thickness of the drum referred to is 1.05 inches, a plate thickness of 1¼ inches is being used so that the additional thickness will act as a reinforcement for the outlet.

Reply: Par. P-268 of the code formerly called for the attachment of a nozzle to a boiler shell or drum by riveting, but it is pointed out that a recent revision of this paragraph has eliminated this specific requirement for riveting and broadened the rule so that forge welding is admissible. It is the opinion of the committee that for the conditions specified the nozzle can be attached by forge welding, in view of the fact that the stress in the metal of the drum at the working pressure adjacent to the nozzle has been determined by test and found to be within the code limits.

Case No. 572. *Inquiry:* Is it permissible to calculate the strength of the tube ligaments in forge welded boiler drums on the basis of the minimum ultimate strength stamped on the plate, provided that this does not give a higher maximum allowable working pressure than that corresponding to the weld?

Reply: It is the opinion of the committee that in calculating the strength of tube ligaments in drums where the shell thickness is greater than that required for the working pressure, it is only necessary to refer the calculations to the plate thickness in that portion which is pierced by the tube holes.

Case No. 573. *Inquiry*: Does Par. P-260 of the code mean that the reinforcement of a shell for a manhole opening shall be so proportioned as to be equal to the net efficiency of the longitudinal seam, or shall it be equivalent to the entire net area of metal removed?

Reply: Par. P-260 requires that the reinforcement of a manhole opening shall be based upon the tensile strength of the maximum amount of shell plate removed by the opening, and the rivet holes for the reinforcement, on any longitudinal line, but it is the opinion of the committee that the tensile strength required for the full amount of metal removed shall be computed from the formula in Par. P-180, taking no account of the effect of the efficiency of the longitudinal joint.

Case No. 574. *Inquiry*: Is it permissible, under the requirement of Par. M-14 of the code, to use gage cocks in place of a glass water gage on the steam generating unit of vulcanizers operated on the closed system? Or would it be acceptable under this rule to make use of a glass water level indicator formed of a bull's eye set into the side of the steam generator?

Reply: The requirement in Par. M-14 for a glass water gage for determining the water level is mandatory and thus gage cocks will not be acceptable in lieu thereof. It is the opinion of the committee that a glass bull's eye which is of sufficient size to indicate whether there is a proper amount of water in the boiler, and which is properly inserted in the side of the steam generating unit, may be considered as an equivalent of a glass water gage where the steam generating unit is of such size that an ordinary type of water glass cannot be applied.

Case No. 575. *Inquiry*: Will a seamless steel boiler tube made from material produced by the open hearth process and of the following chemical composition conform with the requirements of the Boiler Code?

Carbon	Not over 0.05
Manganese	0.20 to 0.30
Sulphur	Not over 0.04
Phosphorous	Not over 0.02
Copper	Over 0.20
Molybdenum	Over 0.07

It is to be noted that these tubes will successfully withstand all the tests prescribed for seamless tubes in the tube specifications in the code and that while the carbon and manganese contents are both lower than those specified for Grade A material, they are both higher than is permitted for Grade B material.

Reply: It is the opinion of the committee that alloying elements may be permitted in seamless steel boiler tubes, in which case the limits of carbon and manganese may be reduced below those specified for Grade A material in Par. S-94*b*, provided that such tubes shall meet all of the physical tests specified for boiler tubes, and provided further that the tensile strength of the material shall in no case be less than 45,000 pounds per square inch, which is the basis of stress used in the formula of Table P-2 of the code.

Case No. 577. *Inquiry*: Does Par. P-195 of the Code mean that when a dished head has a flanged access hole of any size, the plate must be increased ⅛ inch in thickness, or is the ⅛ inch increase required only when the hole is large enough to admit a man?

Reply: The requirement in Par. P-195 for the increase of ⅛ inch in thickness refers specifically to access openings of sufficient size to admit of entrance to the interior, but it is the opinion of the committee that in any case where an access opening exceeds 6 inches in any dimension, the head should be reinforced by the increase of ⅛ inch in thickness.

Case No. 579. *Inquiry*: Is it permissible, under the requirements of Par. M-7 of the Code, to attach the heads to the shells of miniature fire tube boilers by fusion welding if the stress on the heads is supported by through staybolting or suitable stay tubes?

Reply: Par. M-7 of the Code permits of the use of fusion welded joints only where the stress is carried by other construction which conforms to the requirements of the Code. It has been proposed to revise the requirement of Par. M-7 pertaining to the construction of head joints of fire tube boilers by the addition of the following:

The joints between the heads of miniature fire tube boilers and the cylindrical shells may be sealed by fusion welding provided the shell is chamfered to receive the head, and the staybolts or stay tubes are inserted between the heads with their centers on a circle which comes not over one third the maximum allowable pitch from the inside of the shell, and said staybolts or stay tubes are spaced apart on said circle at distances not over one half the maximum allowable pitch. The maximum allowable pitch referred to is that considering the head as a stayed surface. A tube two gages thicker than required for the maximum allowable working pressure, which is rolled into the head and beaded, may be considered the equivalent of a stay.

Laying Out At the Steel Mill *

By E. N. Treat

The plate arriving at the laying out beds from the straightening rolls is usually practically flat. From it must be cut the plates varying in size and shape to meet the requirements of the customer's order. Test coupons must be cut outside of the plate sizes. With dividers and large squares the layerout walks over the plate which is not yet cool, marking where each cut of the shears is to be made. Shoes with rubber heels are not ideal for walking over hot plates therefore wooden soles are provided for the layerout.

The outer edges of the unsheared plate are uneven. These outer edges are called crop and are discarded from the material to fill the order after shearing. At times the discard is excessive and were it possible to make use of this discard commercially it would greatly reduce the expanse of plate manufacture.

Marking the Plates

Information from the mill contains the thickness, length and widths or diameters. The heat and ingot number and manufacturers order number are painted on the upper side of the plate in a central location with white paint, in order that it may readily be seen while in transit through the mill. The name of the manufacturer, place where manufactured, heat and ingot number, and the tensile strength the manufacturer believes it to possess must be stamped into the plate by means of hard steel stamps, the numbers and letters of which are usually ⅜-in. high.

Test pieces or coupons must be stamped with the heat and ingot number at one side near an end and at the other side and end is stamped the mill order number. Circular ring or match marks must be stamped over the

* This is the fourth of a series of short articles on steel mill practice in handling boiler materials. The first article appeared on page 3 of the January issue, the second on page 40 of the February issue, and the third on page 81 of the March issue.

line of shearing in such a way as to leave part of the circular stamp upon the coupon and the other part of the circular ring mark on the plate.

The name and location of the manufacturer is stamped in diagonal corners of the plate. Under this stamping is the heat and ingot number and tensile strength. This stamping is important for without this information future identification may be impossible.

Coupons must be taken from the plate for testing; the location and number being determined by the inspection rules under which it is to be inspected and tested. This feature many times causes loss of material as numerous coupons must be taken from different locations simply for the reason that there is an undecided lack of uniformity of rules. A boiler built for a city for use in a steam vessel within the confines of the city where state and city rules differ may require different test coupons. Should the builder employ an inspector to meet requirements thought best by him, additional requirements would be exacted. Should a classification society be employed to classify the vessel the latter requirements may differ entirely.

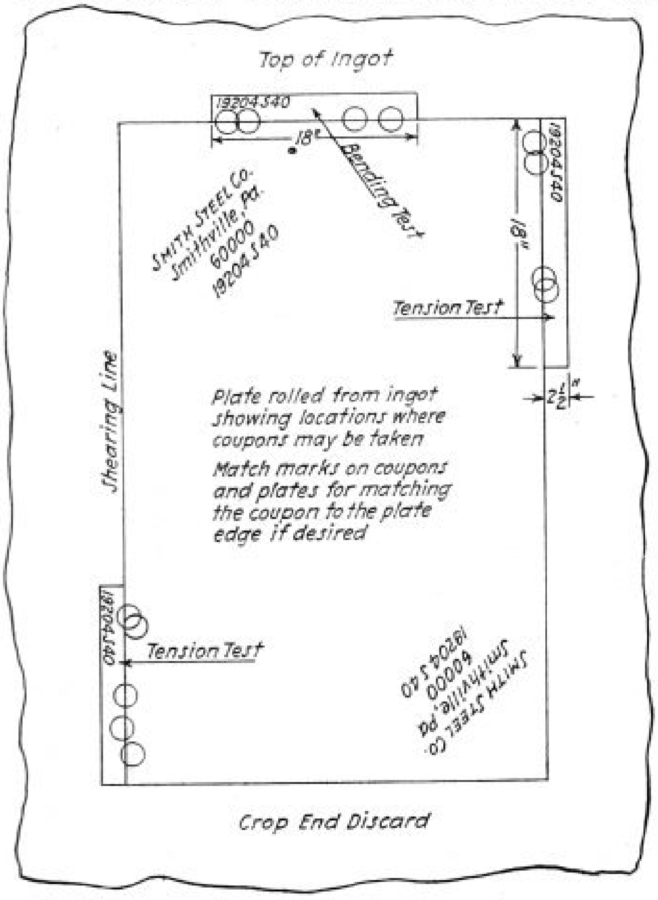


Plate layout on ingot showing locations of test coupons

Rules Governing Materials

This lack of uniformity of rules governing class material is a thorn in the side of the manufacturer. At times it seems as though all cannot be satisfied, for a requirement modified by one set of rules may be exceptionally rigid under another code. Cities and states differ, the city within the state adheres to its rule, perhaps long obsolete. States may have no requirements for boiler construction. Discarded boilers of one state may be used in another state not having rules governing the construction and operation of so particular a vessel as the steam boiler. Each subdivision maintains its faith in its own rules. All cannot be best, but the manufacturer of the steel boiler plate must meet all codes if he wishes to sell his product.

The code of the American Society of Mechanical Engineers has been adopted by several states and municipalities. This code seems to appeal more strongly and probably has been the means of uniformity among more subdivisions than any other code of boiler rules. The requirements of this society for boiler material is one tension and one bend test. The bend test specimen is to be taken from the middle top of the finished rolled material and the tension test coupon is to be taken from the lower longitudinal section.

Requirements for Marine Boilers

Classification societies of marine material observe their own rules and regulations. The purchaser of the material may insist that the material conform to the requirements of another code and, as often happens, the manufacturer of the material may be required to submits tests from several different locations to conform to the rules of the various inspectors. This procedure is a decidedly trying feature to the manufacturer who would without doubt welcome class material uniformity.

It may readily be seen that the selection of test coupons is an important part of the laying out procedure. It does not matter if the plate is 12 inches square, and the combined superficial area required for the test coupon exceeds the superficial area of the plate; coupons must be taken to conform to the various codes employed.

The heat and ingot number is usually stamped near the name and location of the manufacturer. These are stamped at diagonal corners of the plate and usually at least 18 inches from the corner. The heat and ingot number is of utmost importance. From it the entire history of the plate may be had providing the name of the manufacturer or stamping peculiar to the manufacturer is known. The heat number may be formed in parts of numbers or letters, each part representing a procedure in connection with the finished plate. For instance, the heat number may be 19204S-40. Separating this number into individual parts may disclose the information that 19 was the number of charges from open hearth furnace number 20. The month the charge was poured is April, the fourth month. The letter S indicates the year, and 40 represents the fortieth ingot poured from the charge.

It is most important in receiving material at the shop, to check off the heat and ingot numbers, and serial number where used. Not only is this procedure necessary at the time the material is received at the shop, but, by preserving this information, it may prove of value years after should information be desired concerning the material. Without heat or ingot and serial number there is usually little hope for data concerning an obsolete construction.

Tensile strength is usually stamped before the tests are run. It is usually representative of the customer's minimum requirement of his order and, until the test coupons are broken, represents the strength the manufacturer believes the material to possess. After the tests are broken and a record is established, it may prove excessive or short of the stipulated range.

Many steel mills require a 100,000-pound range to work on. That is to say, where the customers order specifies a minimum tensile strength of 50,000 pounds per square inch, the upper limit is desired at not less than 60,000 pounds. This variation is not excessive where top and bottom longitudinal test coupons are desired.

Testing Welds Under Field Conditions*

Several new developments that simplify the problem of maintaining a constant check on operators' ability

PERIODIC testing of a welder's ability is one of the important points in procedure control. Where welding is done under shop conditions, the method of testing welders is relatively simple. At regular intervals the welders are required to prepare test coupons, and these are sent to the nearest testing laboratory for a complete report on tensile strength and other properties of the welds, thus maintaining a constant check on the work.

Where welding is done in the field, as in pipe line construction for example, testing is more difficult. The time required to send test coupons to the laboratory may interfere seriously with the effectiveness of this method of checking. One of the simplest tests to apply is that of bending the welded coupon in a vise until the first signs of fracture are noticed. In evaluating the results of such a bending test, it has been customary in the past to measure the angle of the bend. This method as standardized by the American Welding Society necessitates the use of a large machine in order to make the bend under completely standardized conditions. Recent investigations have shown that the measurement of elongation rather than angle of bend is a more accurate indication of the quality of the weld.

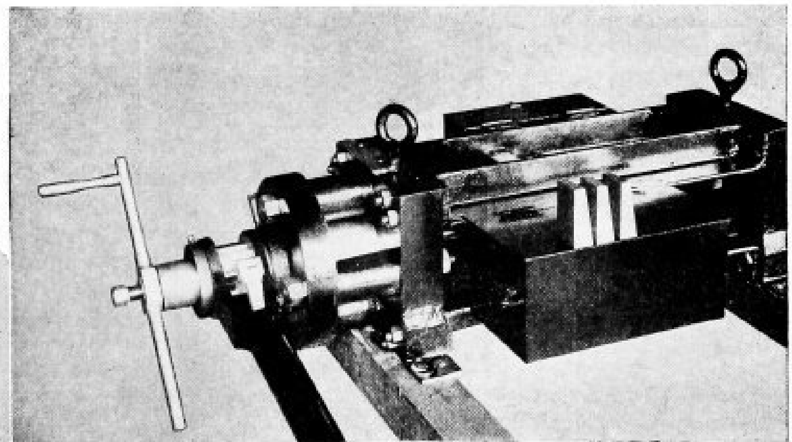


Fig.1.—Portable tensile test machine

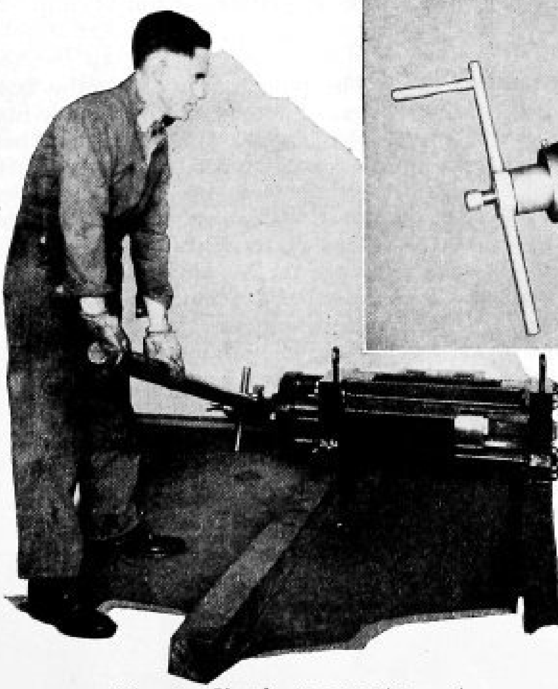


Fig. 2.—Simple to operate

This means that the bend test can now be applied under field conditions in such a way as to give numerical results. All that is necessary is to put gage marks on either side of the weld and then bend the specimen. It has been found that the best results may be obtained by first starting the bend about ½ inch from each side of the weld by light hammering. The specimen is then inserted in the vise so as to bring pressure on the ends, which causes the coupon to take on a uniform curvature as the vise is tightened. Bending is carried to the first sign of cracking, after which elongation may be easily measured by a flexible scale. The gage marks should preferably be small punch marks which do not initiate cracks. From the increase in the distance between the gage marks after bending, the percent elongation may be very easily calculated. As an indication of what may be expected in an average weld, the elongation should be in the neighborhood of 20 per cent for a weld made in mild steel plate.

As a further aid in testing operators under field conditions, there has been developed recently a portable tensile testing machine which can be carried as part of the equipment of a large welding crew, or can be kept as part of the facilities of any central welding shop. This machine will take a short tensile test specimen similar to that used in the regular testing laboratory machines. Such a machine can supplement the results obtained by the bending test.

In pipe line work some method of cutting test specimens from welds in the line itself is very desirable. One oil company has obtained splendid results with a portable keyway slotting machine fitted with two thin milling cutters and a spacer in place of the broad milling cutter used in normal operation. The procedure of handling this weld cutting machine may be along the following lines:

Within a day or two of a man's employment, the chief inspector will mark out one of his welds and may mark a particular spot on the weld, such as the final tie-in. Then in due course of taking weld samples, the slotting machine is brought to this weld and set up on the pipe at any reasonable angle, from a 45-degree on either side to the upright position. The chain is tightly secured, and the hold back attachment (if used) is also set.

Two men then operate the handles which transmit power through gearing to the milling cutters. According to the advice of the manufacturer, the latter should

* Published through the courtesy of *Oxy-Acetylene Tips*.

be oiled occasionally to facilitate the cutting operation.

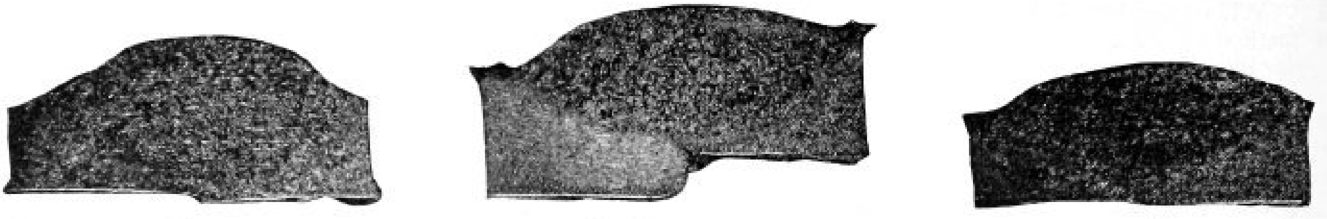
The inspector or the man in charge of the machine squad should operate the feeding device for driving the cutting wheel into the metal. Too rapid a rate of feeding may cause the cutter to bind, which will result in breaking teeth or breaking the cutting wheel itself. The operation of cutting a single specimen should not exceed ten minutes on pipe ⅜-inch thick.

When the cut has been made, a small drill, a cold chisel, or a cutting blowpipe can be used to cut across the ends of the specimen so that it can be removed. The welder's number should be stamped on one side for identification. The specimen should then be rubbed on a file held flat in a vise or backed up by a flat surface. This will give a flat surface finish on one side of the specimen, whereas the opposite procedure of rubbing a file over the specimen will not. Subsequently to filing, the specimen should be lightly rubbed on fine emery paper, and then should be etched in a 10 percent solution of either ammonium persulphate or 10 percent nitric acid. Ammonium persulphate is recommended, as the solution does not burn the hands like nitric acid. It is also much easier to handle as it can be transported dry until ready to use, when the required amount is simply dissolved in water to form the solution.

Specimen *A* is an excellent weld, having good penetration and good sound deposited metal.

Specimen *B* shows improper alinement of the pipe and lack of penetration. Such a specimen would indicate that the foreman's attention should be called to the work of the tacker. Incidentally, a welder should not undertake to weld improperly lined up material but should call his foreman's attention to the situation.

Specimen *C* shows a crack from the bottom of the weld which was probably made by improper tieing in. Any such indication in a test specimen should call for study by the chief inspector and foreman. Such a crack in a pipe weld would probably result in a short check about 1½ inches long, which type of flaw has given much trouble on large diameter lines and can be corrected by proper procedure.



A B C

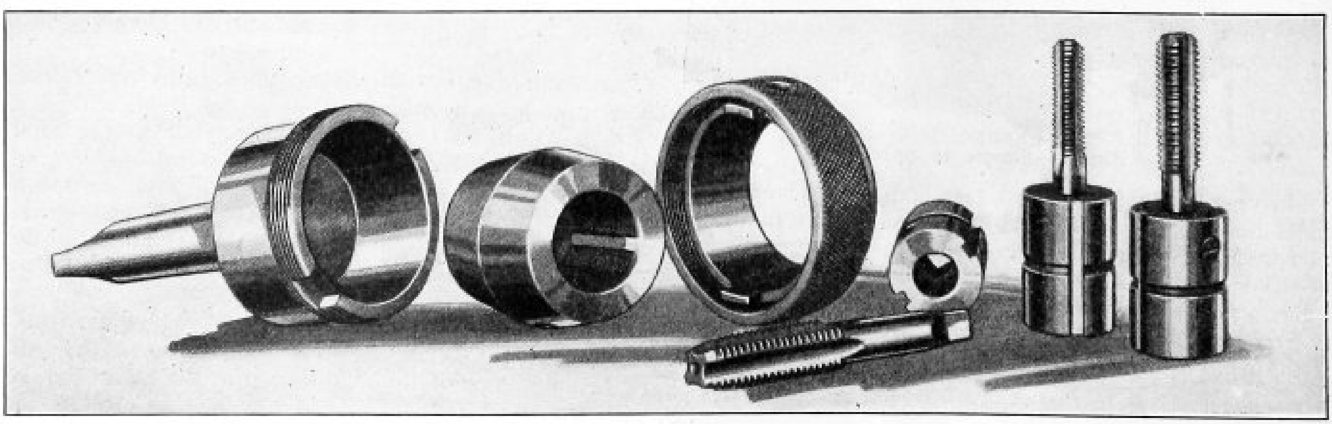
Fig. 3.—Test specimens after etching

Tap Holder Designed to Prevent Breakage

A HOLDER designed to prevent tap breakage on machine tapping has been placed on the market by the McCroskey Tool Corporation, Meadville, Pa. It fits directly into the spindle of a drilling machine, the turret of a turret lathe, an engine lathe tail stock, or the spindle of an electric drill. It is compact and reduces to a minimum the overhang below the spindle. The holder enables the operator to drive the tap up to its full capacity. Just as soon as this point is passed, or the tap meets an obstruction, or hits the bottom of a blind hole, the friction slips and the tap stops.

There are only 5 parts, including the bushing that holds the tap. The plug that receives the bushing is tapered both ways. Each taper fits into a fiber-lined cup. The knurled collar is a differential nut that draws the lower cup toward the upper to increase the friction. The ratio of the threads in the collar provides for a sensitive and positive adjustment of friction. The tap is driven by the square end and the bushing is driven by two keys and floats in the holder. It is held in place by a ball and spring retainer. Should the spindle be raised too rapidly in backing out the tap, the bushing will be drawn out of the holder without injury to the tap.

The holder and bushings are made in three different sizes. The three sizes combined, handle the standard hand taps from 3/16 inches to 1¼ inches, and pipe taps from ⅛ inch to 1 inch. Special bushings for taps with special shanks and for setting nuts can also be furnished.

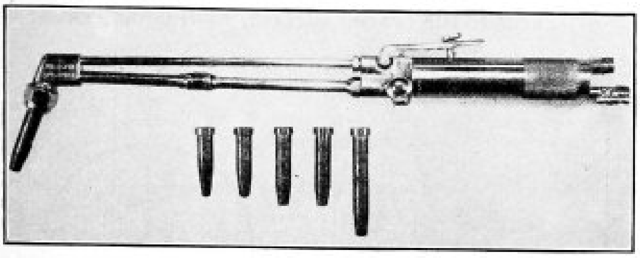


The parts of the McCroskey tap holder

Combination Cutting and Welding Torch

THE Alexander Milburn Company, 1428 West street, Baltimore, Md., has recently developed a light weight torch which cuts or welds by the interchange of tips. It is made to operate with either oxygen and acetylene, oxygen and hydrogen or other gases.

This torch, designated as the Milburn type RI, has all the salient features of the Milburn combination cutting and welding torch, type NI. The Type RI torch is extremely light in weight for the wide range of work it performs, weighing only 40 ounces. This weight is advantageous to the operator for continuous work. The torch welds the lightest or heaviest metals and cuts up to 12 inches in thickness.



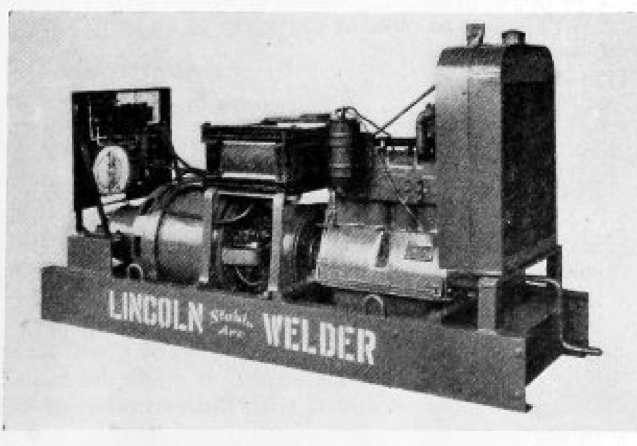
The Milburn light weight combination cutting and welding torch

The torch has only two gas tubes, made of stainless steel, instead of three tubes. The high pressure cutting oxygen thumb button remains fixed in either the open or closed position without sustained pressure from the thumb. The forged bronze torch head and valves have a tensile strength of 60,000 pounds per square inch. All of the valves are readily accessible. The super-mixing of gases results in a neutral, uniform flame as well as in the elimination of flashbacks.

Gas Engine Driven Welder

THE Lincoln Electric Company, Cleveland, Ohio, has announced a new model of the "Stable-Arc" welder, known as the S-1960 Model.

The new unit has a rating of 200 amperes according to N. E. M. A. standards, with a current range for welding duty of from 50 to 300 amperes and operates at a speed of 1,500 revolutions per minute. Motive power is provided by a four cylinder Continental Red Seal engine, type H-9.



The new gas engine driven welder unit

The welding generator and engine are mounted on a structural base welded into a solid piece of steel. This welded steel base provides a maximum stiffness and rigidity with a minimum weight, the whole unit weighing only 1,580 pounds and being only 76 inches long by 25 inches wide.

The complete magnetic circuit of the generator is of laminated steel structure, thus increasing the stability of the arc, which is highly desirable in work for which this unit was brought out, because many times welding must be done in a vertical plane and frequently overhead.

A steel switchboard is also provided in place of the usual slate or composition board, thus still further reducing the possibility of damage in the field.

Examination for Boiler Inspector

THE United States Civil Service Commission announces the following open competitive examination for the position of local and assistant inspector of boilers.

Applications must be on file with the Civil Service Commission at Washington, D. C., not later than April 14. The date for assembling of competitors will be stated on their admission cards, and will be about ten days after the close of receipt of applications.

The examination is to fill vacancies in the Steamboat-Inspection Service and in positions requiring similar qualifications. The entrance salary is $2,700 a year. A probationary period of six months is required; advancement after that depends upon individual efficiency, increased usefulness and the occurrence of vacancies in higher positions.

Competitors will be rated on letter writing; arithmetic, including problems in common and decimal fractions, mensuration, and square root; questions relating to boilers, engines, motors, and machinery of vessels, strength of boiler material, and inspection; and their experience.

Full information may be obtained from the United States Civil Service Commission at Washington, D. C., or the secretary of the United States civil service board of examiners at the post office or customhouse in any city.

New Method of Making Crane Rings

SUPERINTENDENTS of shops using cranes for heavy lifting will be interested in a new type of sling-chain ring for which the developers claim distinct advantages over the welded rings of refined bar iron now in general use.

In lifting a heavy part it is customary to pass a sling-chain around it and fasten the ring over the crane hook. These rings have been known to fail, even under apparently safe loads, because of incomplete welding or because the metal was crystallized by the heat of welding.

The new type of ring is said to be free from these weaknesses. It is made by winding many turns of wire around a spool to form a blank which, after heating, is formed into a homogeneous mass by means of dies and a powerful press.—*The Locomotive.*

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by C. J. Zusy

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.*

Location of Welt Strip

Q.—Will you explain to me the reason for placing the widest welt or cover plate on the inside of a longitudinal joint in a pressure boiler?—N. O.

A.—The location of the wide welt strip, that is, whether on the inside or outside of the shell, is governed entirely by the necessity of placing the narrow welt strip in the most accessible location and in no way affects the strength of the boiler.

It is impossible to calk the wide welt strip, due to distance between rivets being too large to provide a good calking edge. The wide welt strip must therefore be placed on the inside of the shell so that the narrow welt strip with the small pitching, which is suitable for calking, can be placed on the outside where it is readily accessible at all times for calking.

Squaring Plate—Butt Strap Centerline —Cylinder Layout

Q.—(1). In squaring a large plate with a steel square without the use of lines, if *A* and *B* are square, as in Fig. 1, the plate would be O.K. If *A* is not square and *B* and *C* were, would you call *A* and *B* the base and work from *C* to *D* and *B* to *A*?

(2). Where should the centerline of a butt strap come on a horizontal return tubular boiler; also what should be the distance for braces from *A-B-C-D*?

(3). In laying out a cylinder, we find the stretchout of the plate by working from the neutral diameter. In laying out the distance *A-B* = 20 inches outside of plate, I notice the layerout does not allow for this, he measures off 20 inches on the plate which should be approximately 19¾ inches. Which would you call the correct measurement, 19¾ inches or 20 inches?—F. B. P.

A.—(1). A steel square cannot be depended upon to determine the direction of a long line as the lengths of the sides are too short. If it is necessary to square a large plate without the use of a geometrical construction, I would recommend using the long dimension, either *A-B* or *C-D* as shown in Fig. 1, as the base, and square your plate from this edge.

(2). The center line of a longitudinal seam on a horizontal return tubular boiler is usually placed in the center of a circumferential pitch when the circumferential seam is single riveted and on the center of a rivet hole when the circumferential seam is double riveted. The longitudinal seam should be located so that no part of the seam comes in contact with the products of combustion.

The distances *A, B* and *C* as shown in Fig. 2 are governed by paragraph P-203a of the A. S. M. E. Boiler Construction Code which reads as follows:

P-203a. The maximum spacing between centers of rivets or between the edges of tube holes and the centers of rivets attaching the crowfeet of braces to the braced surface, shall be determined

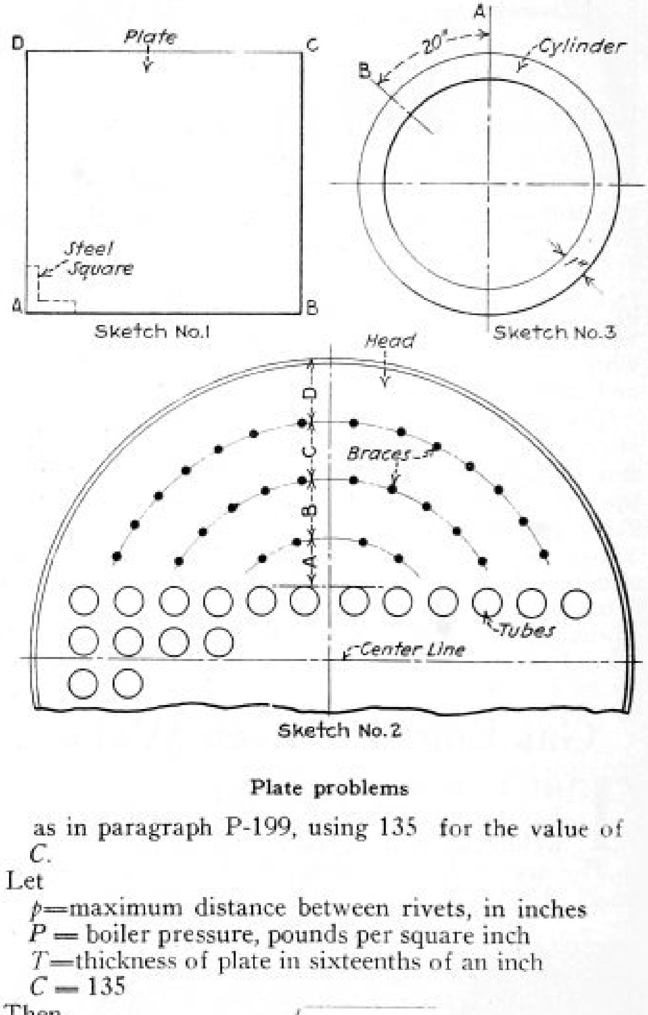


Plate problems

as in paragraph P-199, using 135 for the value of *C*.

Let

p=maximum distance between rivets, in inches

P = boiler pressure, pounds per square inch

T=thickness of plate in sixteenths of an inch

C = 135

Then

$$p=\sqrt{\frac{c \times T^2}{P}}$$

The distance *D* is governed by paragraph P-203c.

P-203c. The maximum spacing between the inner surface of the shell and lines parallel to the surface of the shell passing through the centers of the rivets attaching the crowfeet of braces to the head, shall be determined by the formula in paragraph P-199, using 175 for the value of *C*.

The calculation for dimension *D* is made the same as for dimensions *A, B* and *C* with the exception of substituting 175 for the value of *C* instead of 135.

(3). If an accurate distance of 20 inches measured on the outside of the cylinder is required, allowances will have to be made when laying out the distance on the flat plate.

It may be that the 20-inch dimension which you refer to shown in Fig. 3, is an unimportant dimension and the additional increased distance of approximately ¼ inch which would be gained by laying out 20 inches on the flat plate is negligible.

Bending Angles

Q.—We have had considerable trouble in trying to figure out a formula whereby we can punch angles before they are bent and after they are bent to given radii, for them to be the desired length. Following are the results of a few test angles run through the hydraulic bending machine, lines being put on the angles before they were bent and then bent to the desired radii, afterwards measured on the back of angles and the lengths given. Possibly from these few tests you may be able to dope out a formula whereby we can figure out other size angles beside the ones here listed.

Angle	Radius	Size of Angle	Length Before Bending	Length After Bending
No. 1	15 feet	6 × 6 × ⅜	30 feet 10 1/32 inches	31 feet 0 1/32 inch
No. 2	15 feet	6 × 6 × ⅜	30 feet 10 1/32 inches	31 feet 0 1/32 inch
No. 3	11 feet	6 × 3½ × ⅜	20 feet	20 feet 4⅜ inches
No. 4	30½ feet	3½ × 3½ × 5/16	20 feet	20 feet 0 9/16 inch

All of the above angles were measured exactly. The angles were straight when "before" lengths were put on. All of the "after" lengths were exact also; now if you should need any more dope on these angles kindly let me know, as we would like to have a formula whereby we could figure all angles.—A. P.

A.—No formula can be devised that will give accurate results, due to the variations in the physical characteristics of the material, and the workmanship, first in the manufacturing of the angle and then in the bending.

The following formula, which is theoretically correct, for all size angles, bent as shown in Fig. 1, gives different

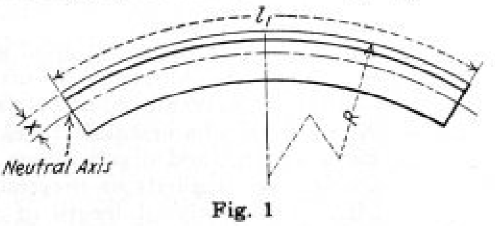


Fig. 1

results from those which you obtained by tests. These differences are due to the variations in the angles as stated above.

Let l = length of angle when straight, in inches;
l_1 = length of outer leg of angle after bending, in inches;
R = radius of outside leg of angle, in inches;
x = distance from outer leg of angle to neutral axis parallel to outer leg, in inches. This dimension can readily be obtained from any structural steel handbook;
π = pi = 3.1416.

$$\text{Then } l_1 = \left(\frac{l}{(R - x)2\pi}\right)2\pi R$$

This formula applied to the angles which you tested, would give results as follows:

Angles No. 1 and 2

$$\left(\frac{370.03125}{(180 - 1.64)2 \times 3.1416}\right)2 \times 3.1416 \times 180 = 373.43$$

inches = 31 feet 1 7/16 inches.

Angle No. 3

$$\left(\frac{240}{(132 - 2.04)2 \times 3.1416}\right)2 \times 3.1416 \times 132 = 243.76$$

inches = 20 feet 3 49/64 inches.

Angle No. 4

$$\left(\frac{240}{(366 - .99)2 \times 3.1416}\right)2 \times 3.1416 \times 366 = 240.65$$

inches = 20 ft. 0 21/32 inch.

The values of x used in the above calculations were taken from tables of standard angles.

The tests which you recorded are not extensive enough to select empirical values for x. I would suggest that you keep records of all angles which you bend and when records for a considerable number of each size angle are obtained, it may be possible to arrive at values that will give closer results than by using the center of gravity as taken from handbooks.

Locomotive and Boiler Inspectors Handbook

Q.—I have a book called "Locomotive and Boiler Inspectors Handbook" by A. J. O'Neil. Would you please give me the following information: Does everything in this compete with the government law and is it unlawful to violate any of the said articles in the book? For instance, under the heading of "Welding to the Wrapper Sheet of Boiler," would it be unlawful to apply a patch to the wrapper sheet and not reinforcing it on the water side? If there is a crack or a mud burn in the door hole flange, is it unlawful to put on a patch smaller than that described in the book by welding it or could you put a smaller patch on with patch bolts? Should every government inspector know all such rules as are in the book?

The reason I am asking these questions is: I have seen several patches applied to the wrapper sheet with a vertical weld and they were not reinforced on the inside or waterside and fire door hole patches, just taking in one row of staybolts and some smaller. Would it be permissible to apply a patch to the crown sheet with rivets or patch bolts and welding the calking edge.—V. J. G.

A.—I have not checked the entire contents of this book to ascertain if there are any rules conflicting with the federal law but I believe it is safe to assume there are no conflictions. After a hurried glance through this book I would summarize the various chapters as follows:

Chapters one to six inclusive, are no doubt accurate copies of the "Laws, Rules and Instructions for Inspection and Testing of Steam Locomotives and Tenders and their Appurtenances with Interpretations, Rulings and Explanations on questions raised regarding the above laws" issued by the Bureau of Locomotive Inspection, Interstate Commerce Commission. These chapters must be adhered to as they are Interstate Commerce law.

Chapter seven covers questions and answers for boiler and locomotive inspectors, which in the opinion of the author are helpful to those engaged in this work and also those who are about to take examinations to become inspectors.

Chapter eight, Autogenous Welding. I do not know of any existing I. C. C. rules covering autogenous welding practices for locomotive boilers. However, the Bureau of Locomotive Inspection has on several occasions made recommendations, but, to my knowledge, no definite rules have ever been adopted.

In the absence of any definite I. C. C. rules covering autogenous welding practices for locomotive boilers, it is apparent that the rules in this book are not obligatory and are probably practices which the author considers good practice backed up by his years of experience in the boiler line. However, opinions differ and certain practices which the author would condemn may be accepted as good practice by other authorities, for instance, patching on flat surfaces of wrapper sheet and backhead is being done by various roads without any reinforcements. Small fire cracks in door hole flanges are welded and door hole mud burns are often repaired by welding in smaller patches than are described in this book. Crown sheet patches are often applied by autogenous butt welding and in fact this is standard practice on a number of roads.

Welding seams or fractures in the curve of portion of the wrapper sheet without reinforcements is condemned by all authorities as no welding should be permitted on any part of a boiler where the strain to which the structure is subjected is not carried by other construction.

Chapter nine briefly covers A. R. A. boiler material specifications. These specifications need not be followed unless desired.

Chapter ten covers typical boiler joints in every day use and also various designs of patches which the author considers good practice. These designs of boiler patches need not be used, in fact any design that will give the proper strength is satisfactory.

Chapter eleven simply illustrates various locomotive appurtenances and in some cases the procedure followed in making inspection.

Strength of Press Head

Q.—Enclosed find sketch of resistance head of hydraulic press. This head failed recently through center. I would like to have a rule worked out showing how to determine the strength of this head when made of steel or cast iron.—W. N. S.

A.—To calculate the fiber stress in the resistance head as shown in Fig. 1, consider the head as a beam supported at both ends with two symmetrical loads.

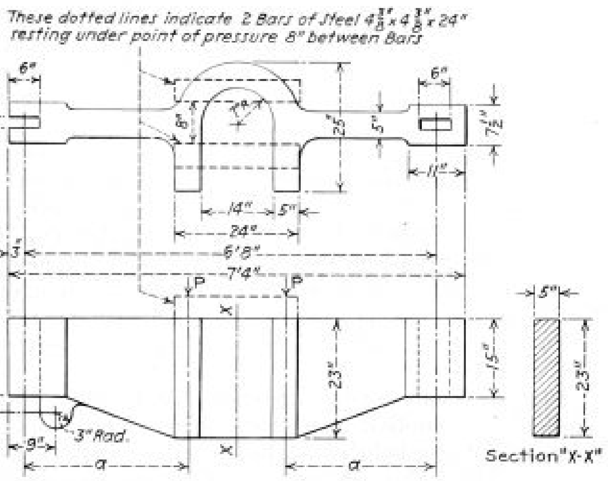


Fig. 1.—Resistance head of hydraulic press

The maximum bending moment is at the center of the beam and is found as follows:

Let m = maximum bending moment at center of beam

P = load concentrated at one point in pounds, which in this case is half the pressure exerted by the press

a = distance from support to load, in inches, which in this case is $30\frac{1}{2}$ inches

S = section modulus

p = stress in extreme fiber of section in pounds per square inch

$$\text{Then } m = Pa$$

$$\text{and } p = \frac{m}{S}$$

The formula for the section modulus of a rectangular section with the neutral axis through the center of gravity is

$$\frac{bd^2}{6}$$

where,

b = width of section in inches

d = depth of section in inches

The section modulus at center of the head as shown in Fig. 1 is

$$S = \frac{5 \times 23^2}{6} = 441$$

The fiber stress in the head, if made of steel, should be limited to about 10,000 pounds per square inch and if made of cast iron the fiber stress should be limited to about 1,500 pounds per square inch.

These maximum stresses are based on a tensile strength for steel of 70,000 pounds per square inch, and cast iron 15,000 pounds per square inch. The factors of safety for steel and cast iron, with a varying load from zero to maximum in one direction are 7 and 10 respectively.

Trade Publications

SYPHONS.—A booklet entitled "What Results" has been received from the Locomotive Firebox Company of Chicago, Ill. Testimonials of actual performance records are illustrated in the classified extracts from correspondence dealing with Nicholson thermic syphons.

MOTORS.—Bulletin No. 200-B of the Lincoln Electric Company, Cleveland, Ohio, has been received in which Linc-Weld motors are described. The simplicity of the motor and its welded construction as well as the fact that the motor will run under water are explained fully in this bulletin.

WELDING.—A booklet on the subject of good welding essentials has been written by Alexander Churchward and published by The Wilson Welder and Metals Company, Hoboken, N. J. This is known as Bulletin No. E and treats with the advantage and disadvantage of the short and long arc and the methods of determining a good weld. Finally the influence of length of arc on strength of weld is explained and other general information for welders is included in this work.

ACETELYNE.—The relative value of acetylene and city gas as fuels for cutting iron and steel in combination with oxygen is the subject of a booklet "The Superiority of Acetylene as a Fuel Gas for Cutting," distributed by the International Acetylene Association, New York. Laboratory research and practical shop tests are studied by J. K. Mabbs and J. L. Anderson in order to present the subject from both a theoretical and a practical standpoint.

Business Notices

FRANK G. COX has resigned as second vice-president of the Edge Moor Iron Company, Edge Moor, Del. and is now with the Otis Elevator Company, New York City.

JACOB F. SAVELA has been appointed welding service manager of the Lincoln Electric Company of Cleveland, Ohio. He will be under the direction of J. M. Robinson, sales manager of the Detroit district. Mr. Savela is a graduate of the University of Michigan and has had a wide practical experience.

P. P. BARRETT, has been appointed representative for the Reading Iron Company, Reading, Pa., in the Cincinnati territory. Mr. Barrett's headquarters are at Indianapolis, Ind.

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

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—C. D. Thomas, Salem, Oregon.

Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.

Vice-Chairman—William H. Furman, Albany, N. Y.

Statistician—L. C. Peal, Nashville, Tenn.

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.; Poseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Avenue, Columbus, Ohio.

Master Boiler Makers' Association

President—W. J. Murphy, divisional boiler foreman, Pennsylvania Railroad, Olean, N. Y.

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Second Vice-President—George B. Usherwood, supervisor of boilers, New York Central Railroad, Syracuse, N. Y.

Third Vice-President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington & Quincy Railroad, Lincoln, Neb.

Fourth Vice-President—Franklin T. Litz, general boiler foreman, Chicago, Milwaukee & St. Paul Railroad, Milwaukee, Wis.

Fifth Vice-President—Henry J. Raps, general boiler foreman, Illinois Central Railroad, Chicago, Ill.

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.

Boiler Makers' Supply Men's Association

President—A. W. Clokey, American Arch Company, Chicago, Ill.

Vice President—J. C. Kuhns, Burden Iron Company, Troy, N. Y.

Treasurer—George R. Boyce, A. M. Castle & Company, Chicago, Ill.

Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—Starr H. Barnum, the Bigelow Company, New Haven, Conn.

Vice President—M. F. Moore, Kewanee Boiler Company, Kewanee, Ill.

Secretary-Treasurer—A. C. Baker, 801 Rockefeller Buliding, Cleveland, Ohio.

Executive Committee—Joseph H. Broderick, the Broderick Company, Muncie, Ind.; George W. Bach, Union Iron Works, Erie, Pa.; A. C. Weigel, Walsh & Weidner Company, Chattanooga, Tenn.; H. E. Aldrich, Wickes Boiler Company, Saginaw, Mich; A. G. Pratt, Babcock & Wilcox Company, New York; Owsley Brown, Springfield Boiler Company, Springfield, Ill.; E. R. Fish, Heine Boiler Company, St. Louis, Mo.; J. F. Johnston, Johnston Bros., Ferrysburg, Mich.; J. R. Collette, Pacific Steel Boiler Corporation, Waukegan, Ill.

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,

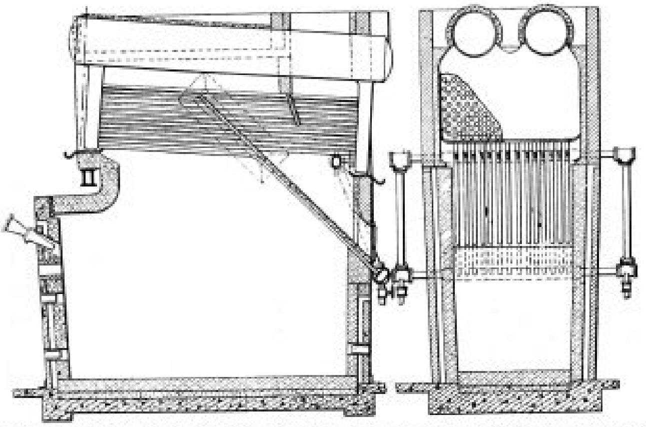
Washington Loan and Trust Building,

Washington, D. C.

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

1,634,139. EDWARD J. FRANKLIN, OF SALT LAKE CITY, UTAH. WATER-TUBE BRIDGE-WALL BAFFLE FOR STEAM BOILERS.

Claim—In a water tube boiler, in combination with a furnace having a combustion chamber, a bank of water tubes above said combustion chamber and connected for circulation of water therethrough, the lowermost row of said tubes having their rear end portions inclined downwardly



and rearwardly to a position adjacent the rear wall of the furnace and in such position as to be clear of the remaining tubes of said bank, means connecting the rear ends of said lowermost row of tubes to the water circulating system, inclined refractory baffle means supported upon said inclined portions of said tubes and cooperating with the rear wall of the furnace to form a pocket below said remaining tubes for collection of solid material, and normally closed opening means in the wall of the furnace for permitting access to said pocket. Four claims.

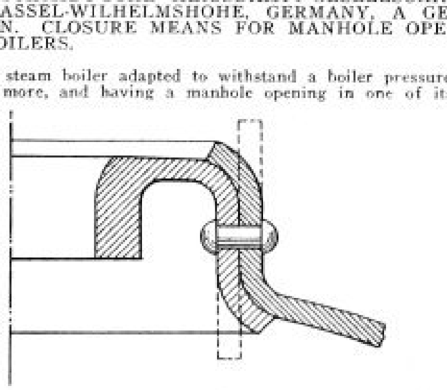
1,634,077. DANA H. MAYO, OF DETROIT, MICHIGAN. BAFFLE FOR WATER-TUBE BOILERS.

Claim.—A water tube boiler provided with an adjustable baffle composed of an upper immovable portion and a lower movable portion form-

ing a positively connected extension thereof, said movable portion being adapted to be raised and lowered towards and from the immovable portion to vary the gas circulation area. Twelve claims.

1,632,957. HERMANN FRANKE, OF HANOVER, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT M. B. H., OF CASSEL-WILHELMSHOHE, GERMANY, A GERMAN CORPORATION. CLOSURE MEANS FOR MANHOLE OPENINGS IN STEAM BOILERS.

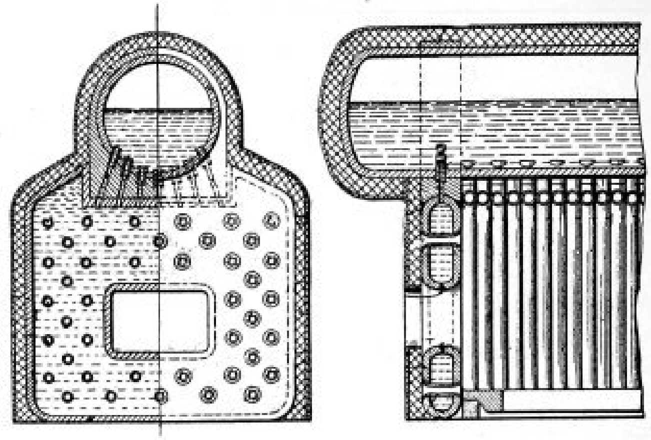
Claim.—In a steam boiler adapted to withstand a boiler pressure of 20 atmospheres or more, and having a manhole opening in one of its walls,



the edge of the material of said wall adjacent said opening being turned outwardly, a seat member against which a manhole cover is adapted to be pressed by the steam pressure within the boiler, said seat member having a peripheral flange bearing against the inner surface of said wall, the said outwardly turned edge having a flange overlying a portion of said seat member.

1,636,985. JACOB BUCHLI, OF WINTERTHUR, SWITZERLAND. HIGH-PRESSURE STEAM BOILER.

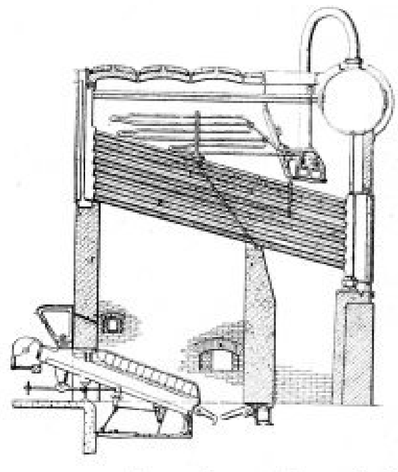
Claim—In a high pressure water tube boiler, in combination, an upper drum, and a rear wall for the firebox comprising a member embracing



said upper drum and shrunk to the latter and provided with bores in its lower part registering with bores in said upper drum, and a hollow body consisting of two connected halves fixed to said member and having flat walls stiffened by stay tubes, the bores in said member registering with bores in said hollow body. Three claims.

1,633,975. BENJAMIN BROIDO, OF NEW YORK, N. Y., ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y. SUPERHEATER BAFFLE.

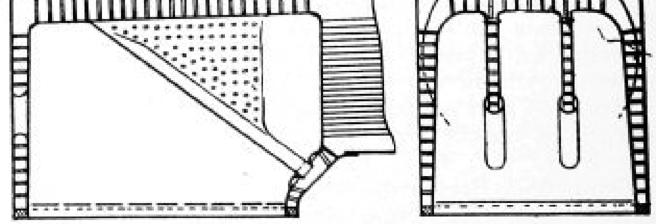
Claim—In a device of the class described the combination of a plurality of tubular superheater elements each comprising a plurality of parallel horizontal branches all in one plane, and a baffle made up of a plurality



of baffle units each comprising a plane portion, said baffle units each having a number of notches one to each branch of the associated superheater element extending inward from one of its edges, the other edge being plain through which notches the branches of the superheater elements extend, the notched edge of each unit lying against the plain edge of the adjacent unit. Three claims.

1,637,819. CHARLES GILBERT HAWLEY, OF CHICAGO, ILLINOIS, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE. LOCOMOTIVE-BOILER FIREBOX.

Claim—A locomotive firebox having a crown sheet and a spaced wrapper sheet in combination with a thermic siphon positioned in the



firebox, said thermic siphon being composed of spaced, vertically disposed and longitudinally arranged walls opening through the crown sheet, staybolts connecting said spaced siphon walls and a row of stays arranged in the median plane of the siphon and anchored at their top ends in the wrapper sheet and directly connected to the topmost staybolts connecting said spaced siphon walls. Two claims.

The Boiler Maker

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Request for change of address should reach us two weeks before the day of 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

Attend the Convention

THIS is the last notice before the convention to remind members of the Master Boiler Makers Association that the annual meeting this year is to be at the Hollenden Hotel, Cleveland, Ohio, May 22 to 25. No individual who has attended the conventions of this association during the past few years, but will acknowledge the great practical benefit obtained from the interchange of ideas developed during the discussions at these gatherings. No equally good opportunity is presented elsewhere for the examination of equipment peculiar to the boiler making industry. The Boiler Makers Supply Men's Association each year goes to a great deal of expense and effort to assemble exhibits that will best serve the interests of the members of the association and this year the display of equipment will be better than ever.

The daily program of the convention and the layout of the exhibition booths with the names of companies displaying equipment appear elsewhere in this issue for the benefit of those who will attend the convention.

It is understood from the secretary of the association that the committee reports this year are more extensive than have ever before been prepared for a convention of this body. The program certainly indicates that a broad range of subjects has been provided and the discussions are bound to bring out a wealth of valuable information for those in attendance.

A complete account of the convention with addresses, papers, discussions and exhibits will be published in the June issue of The Boiler Maker.

A Welding Code

AS time goes on, the art of fusion welding is being applied in wider and more diversified fields and with a constantly increasing degree of efficiency and safety. This is true to such an extent that definite action should undoubtedly be taken by the American Society of Mechanical Engineers Boiler Code committee to specify the permissible pressures under which welded pressure vessels may be used.

With the view of making such determinations, a joint research committee of the American Bureau of Welding and the American Society of Mechanical Engineers has been organized for the purpose of conducting an elaborate series of tests on welded vessels. The results of these tests will provide data from which the Boiler Code committee can prepare a code of allowable pressures and procedure for welding pressure vessels.

It may be said that although the art has now progressed to the point where this work can be undertaken with an assurance of success, it was only a short time ago that hearings on welding developed such a divergence of opinion on the matter of correct procedure, that the formulation of a definite code was almost impossible of accomplishment.

Since then, however, the two factors of procedure control and operator technique have advanced to a point where the element of doubt in the soundness of welds is no longer a limiting factor. Methods of field testing described in these pages from time to time, shop tests during fabrication of welded structures, equipment and materials employed and above all the development of competent operators and methods of checking their work have all reached a high state of development. It is still essential, however, that this progress be continued and every possible precaution taken to keep the welding torch out of the hands of the incompetent.

The code committee and the welding societies in their present investigation will be able to set definite limits satisfactory to all concerned and at the same time fix the procedure and methods of test and supervision that will make possible a still greater advance of the art in fields, where the use of welding has been delayed because of the element of doubt surrounding its use.

National Board Meeting

THIS year the annual meeting of the National Board of Boiler and Pressure Vessel Inspectors will be held at Erie, Pa., June 18 to 20. At the time of going to press the program of the daily sessions was not available, but from past performance of this group, an excellent one may be taken for granted.

In the comparatively short life of the board, the accomplishments of the inspectors have had a far-reaching effect in smoothing out the difficulties of uniformly administering the American Society of Mechanical Engineers' Boiler Code. This work has had a progressive effect and each year the range of work covered has been increasing, so that not only is the code itself safeguarded, but all manner of new equipment introduced into the field has been passed upon and if found to conform to the code requirements and otherwise have merit, the National Board has recognized its use in the field. A complete report of the proceedings of the National Board at its annual meeting will be published in the July issue of THE BOILER MAKER.

Boiler Manufacturers Meeting

THE president of the American Boiler Manufacturers Association with the aid of the several committees of arrangement and entertainment has assured a successful meeting of the association from the standpoint of interesting discussions, committee reports and the like. This meeting will be held at Buckwood Inn, Shawnee-on-Delaware, June 11, 12 and 13. It only remains for members to come to his support in making this annual gathering a complete success. Reservations at the hotel should be made at once to insure comfortable accommodations for the duration of the meeting.

Among other subjects to be dealt with in detail at the coming meeting is that of a uniform cost accounting system for the industry. Progress in the matter can only be made if all members of the association fill out and return the cost item questionnaire distributed at the winter meeting.

The subject of trade extension introduced at the 1927 meeting, at French Lick, will undoubtedly be considered again this year and action taken on several constructive proposals that have been made to the committee in charge of promoting the industry.

A full account of the work of the convention will appear in the June issue.

Communications

Welding for Boiler Repairs

TO THE EDITOR:

I find in the drums of some of our watertube boilers that grooving is becoming quite pronounced along the calking edge of the horizontal seams of drums. I have been wondering if there is any good reason why this grooving could not be built up by the electric welding process?

I have on several occasions rebuilt pittings and small corrosive areas on boiler shells with very good results but have not tried it on any seam groovings, neither do I know of anyone that has.

I would appreciate it very much if you could give me anything bearing on this particular point. I have no doubt some of your many readers have been up against this problem and may be able to answer these questions for me. How was it taken care of? Was it built up or was the whole sheet discarded? Does the A. S. M. E. Boiler Code have anything on this question?

Trinidad, Colo. INQUIRER.

Simple Kinks for the Layerout

TO THE EDITOR:

The job came into the shop of making a breeching for the uptakes of three boilers, one of the flue gas conduits being 20 by 20 inches and two 30 by 30 inches. It was required that the breeching be of ample size to handle the gases but that not a square foot more steel be used than was necessary.

When the layerout started upon this job, he said: "Figures won't lie but liars can figure and so can good straight lines and my good steel scale, which I'd rather use than a square yard of figures on a steel plate!" Accordingly he marked off 20 inches on the straight edge of a steel plate then squared up from one end of the line a distance of 30 inches. Then he laid down a diagonal or hypothenuse from top of 30-inch vertical line to the far end of the 20-inch horizontal line and scaled the length of the diagonal, which he found to measure 36 inches and a very small fraction. "There," he remarked—"the middle portion of the breeching must be 36 inches square. Now, let's see how big the large portion of the breeching must be."

From the intersection of the vertical and diagonal lines the workman laid down another line perpendicular to (square with) the diagonal line and made this line 30 inches long also, this line representing the size of the third uptake which was 30 inches. Another line was then drawn from the free end of the second 30-inch line to the end of the 20-inch line on the edge of the plate. This last diagonal line upon being measured proved to be about 47 inches in length, which the layout man accepted as the size of the breeching between the third boiler and the chimney.

This kink of the layout man depended for its accuracy upon the geometrical proposition that "the square of the hypothenuse of a right angle is equal to the sum of the squares of the other two sides" and the layout man went about his business without making a single figure save to write down 20, 36 and 47, the sides of the three breechings.

Pressure Tank Repairs

During repairs to a large pressure tank in position in a factory, it became necessary to enlarge with a diamond point tool a hole from 8 to 10 inches in diameter and the new hole had to be concentric with the old one. The diamond point tool was available, but on the job there were no dividers for laying out the new hole and, had dividers been at hand, there was nothing where upon to rest the central leg while striking a 10-inch circle around the 8-inch one. But the boiler maker was equal to the occasion and borrowed from the factory millwright a steel square and two sharp scratch awls or "scribers."

A vertical central line was drawn above and below the 8-inch hole and on this line two center punch marks were made 10 inches apart and equally above and below the hole. The boiler maker sharpened his soapstone marker to a slender point, gave the two sharp scribers to an assistant and instructed him to hold one in each center punch hole and to "hold them hard!" The steel square was then placed against and outside of the two scribers and, with the soapstone marker held in the corner of the square, that tool was moved up and down until the marker, in its corner, had traveled from one scriber to the other. Then the square was placed upon the other side of the scribers and the marking operation repeated. When the square and scribers were removed, a true and perfect circle was found to have been scribed through the two center punch holes.

Indianapolis, Ind. JAMES F. HOBART.

Question on Sector Angle

TO THE EDITOR:

In the February issue of THE BOILER MAKER there is quite a lengthy article describing the layout of a large cone contributed by D. W. Phillips. I can follow his instructions to a certain point, then am lost. I would appreciate it greatly if you would explain this point a little more fully.

The question is finding the number of degrees formed by two sides of the template, (bottom of column, page 47). The rule given is: "Divide the length of the arc by the circumference of the circle corresponding to the radius of the template and multiply the result by 360." Will you kindly substitute the wanted figures, assuming the template to be of the first course with a radius of 14 feet 3¾ inches. Has the number of pieces in the cone any bearing on the matter?

Buffalo, N. Y. PAUL SCHERER.

Determining the Sector Angle

Referring to the question as asked by Paul Scherer, concerning the method of developing a cone roof, as written by D. W. Phillips in our February issue, we submit the following reply: Open your February issue of THE BOILER MAKER to pages 46 and 47. Let us work out in detail the method by which Mr. Phillips derived the angle formed by the two sides of the template No. 1 on page 46.

The diameter of the cone at the line of rivets of the first and second course is given as 22 feet 0 inches, but to allow for the ⅜-inch plating, the diameter of the cone at the outside of the plate will be 22 feet 0 ⅜ inch or 264.375 inches. Then the circumference at this point will be

$$\pi D = 3.1416 \times 264.375 = 830.508 \text{ inches}$$
$$= 69.209 \text{ feet.}$$

Now in this circumference there are 14 plates so that the arc of the circumference for each plate will be 1/14th of the total circumference or

830.508 ÷ 14 = 59.322 inches, as is given by Mr. Phillips in his drawing of plate No. 1.

By using the formula $R = \dfrac{D}{(D-d)} \times S$, as given on page 47, the radius of the plate section, not the cone, but the plate from which the cone is made, may be obtained. Mr. Phillips has worked this out to be 14 feet 3¾ inches, the radius of the top course.

The circumference of a circle 14 feet 3¾ inches in radius is $2\pi R$ or

$$C = 2\pi \text{ (14 feet 3¾ inches)} = 2\pi \text{ (171.75 inches)}$$
$$= 2 \times 3.1416 \times 171.75$$
$$= 1{,}079.14 \text{ inches.}$$

The sector of which we are endeavoring to determine the angle between its sides contains but 59.322 inches of this circumference. Therefore the angle between the sides will be found in the ratio:

$$\frac{\text{The angle of the sector}}{\text{The total angle of a circle or 360 degrees}} = \frac{\text{Length of the arc of the sector}}{\text{Circumference of the circle}}$$

Then,

$$\frac{\text{Angle of sector}}{360} = \frac{59.322}{1{,}079.14}$$

or,

$$\text{Angle of sector} = \frac{59.322 \times 360}{1{,}079.14} = 19.77 \text{ degrees}$$

$$0.77 \text{ degrees} \times 60 = 46 \text{ minutes.}$$

Then the angle of the sector is found to be 19 degrees 46 minutes. This is the angle of each of the 14 sectors making up the first course of plating. The angles of the sectors of each of the remaining courses are found in a similar manner.

THE EDITORS.

Economy Railway Appliance Company, Ltd., has moved its offices to rooms 711-714 Railway Exchange Building, 321 Craig street, West, Montreal, Canada.

The Lincoln Electric Company, Cleveland, Ohio, has announced numerous changes in the sales and welder service divisions. H. A. Stamper has been placed in charge of consumer motor sales in the New York district. D. F. Titus has been placed in charge of welder service in the New York district. Both Mr. Stamper and Mr. Titus will be under the direction of G. N. Gull, New York district manager. A. H. Kirkpatrick has been made manager of welder service in the Cincinnati district under M. R. Simpson to succeed D. W. Carver who was recently transferred to the Cleveland district. Consumer motor sales in the Cincinnati district will be in charge of H. E. Nelson. P. A. Ludwig has assumed charge of welder service in Philadelphia and in vicinity while Forrest Kessler has been transferred from the welding time study department at the factory to the welder service division in the Cleveland district.

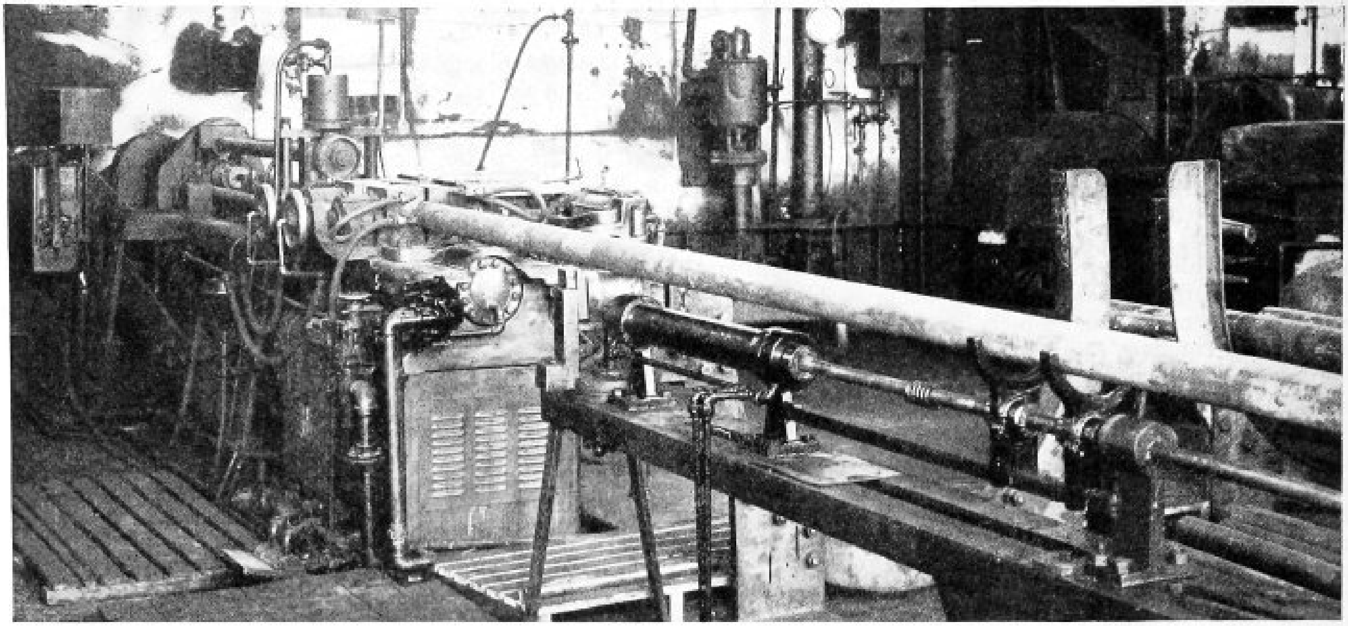


Fig. 1.—Complete layout of welding machinery

Electric Butt Welding Safe Ends

Method of reclaiming tubes and flues in the New York Central shops at West Albany

By Albert F. Stiglmeier*

WITH the present high stage of development of the electric flue welder, the old method of welding flues with the oil furnace has been to a great extent replaced. Formerly the three factors that governed the quality of the weld and the speed in which it could be made were the skill of the operator, the quality of oil and the bricking up of the furnace. A variation of any of these factors would be reflected in the results obtained.

Under the new method, heat generation is automatically regulated by the machine and the skill of the operator is practically negligible. Any intelligent man may be quickly taught the knack of flue welding with the proper equipment. The heating time varies from 15 to 30 seconds and is so small that the speed of output depends on the installation as a whole.

* General foreman boiler maker, New York Central Railroad; chairman of the executive board, Master Boiler Makers Association.

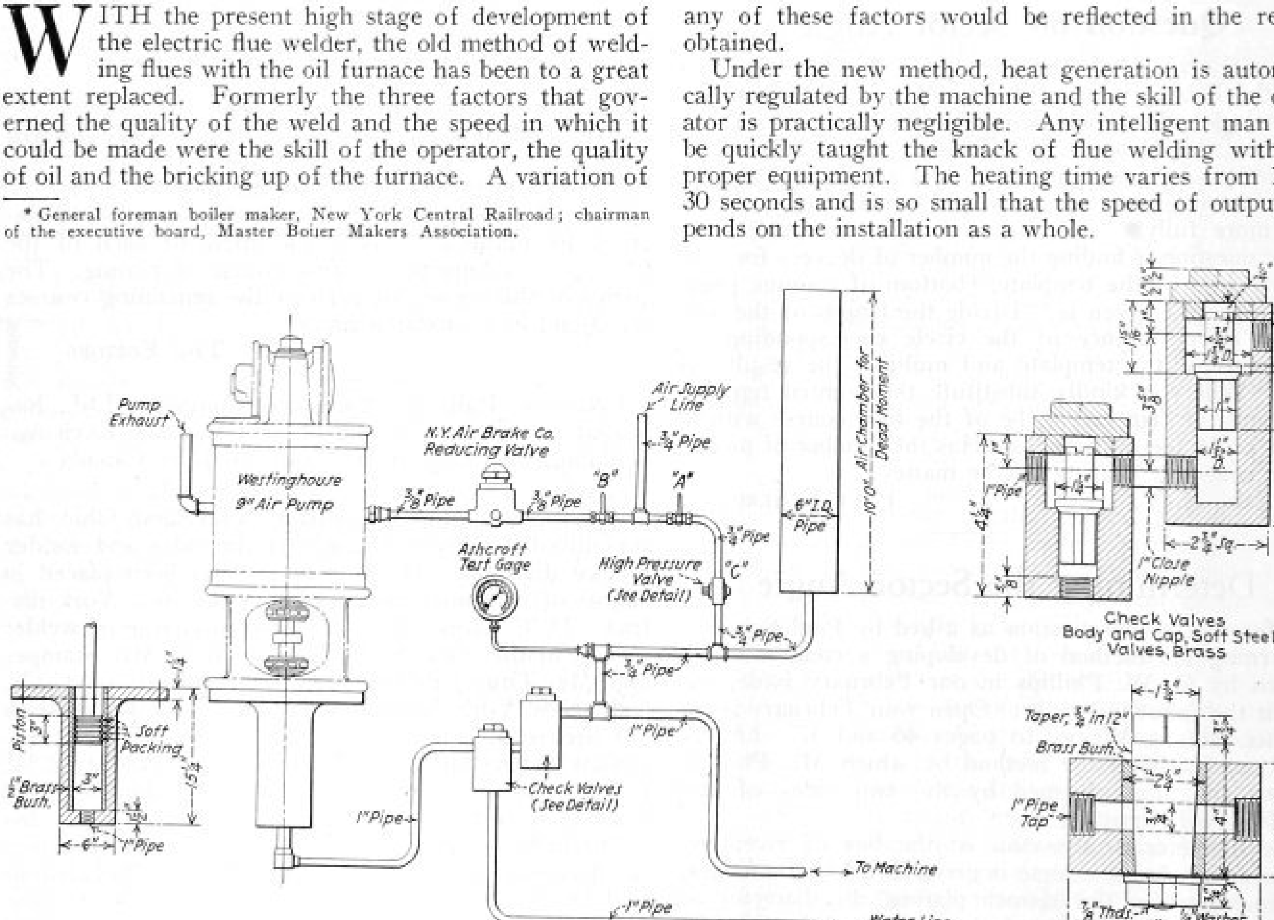


Fig. 2.—Arrangement and details of the pressure device

The amount of pressure applied to the flue during welding should be under perfect regulation and should be adjusted to the diameter of the flue to be welded. It should not be dependent on the manipulation of the operator. The importance of this can readily be seen. If the heating time is the same for any given diameter of flue, say 20 seconds and if a constant pressure suitable to that diameter of the flue is supplied for the same length of time, the results will be identical in each case. The flue will be upset at the weld just enough to permit it being smoothed down, making a smooth perfect weld without any great skill on the part of the operator.

In order to bring about these results, the New York Central Railroad has developed a pressure device that can be adjusted to any given pressure while welding the flue with the machine in operation. This is brought about by having a cushion of air in a storage tank with a pressure device operated as shown in Fig. 2.

Assuming the pressure device to be unused and completely empty, the complete operation of this device is explained as follows: The first operation is to charge the tank with compressed air. This is done by opening the valves *C* and *A* permitting the air to pass from the shop line through the valves *C* and *A* into the tank until the full shop pressure shows on the test gage *F*. Then the valves *C* and *A* are closed and the tank is charged.

The next operation is to open the valve on the water line allowing the water to pass through the first check valve from the pump to the chamber at the bottom of the pump. The pump is now started by opening the valve *B*. On the downward stroke of the pump forcing the water out, the first check valve is closed letting the water pass through into the bottom of the second check valve. This valve is lifted, permitting water to enter the tank. On the return stroke of the pump the operations are reversed and continued until the desired pressure is obtained. In order to produce the given pressure for the different diameters of flues, the reducing valve must be adjusted to suit the proper condition. When the flue welder is in operation, the pump will automatically start when the pressure is reduced in the tank. This is due to having the valve *B* open at all times when the welder is in operation. If welding is discontinued, valve *B* should be closed, and as the check valves close automatically the pressure should remain in the tank for some time. Once the tank is charged, welding may be resumed by opening valve *B*. If a different diameter flue is to be welded, the reducing valve will have to be adjusted to suit this new condition. The recommended pressures for the various sizes of flues is as follows:

2-inch to 3-inch diameter, 450 pounds
Over 3-inch to 4-inch diameter, 550 pounds
Over 4-inch to 5½-inch diameter, 700 pounds.

Smoothing the Weld

The machine for smoothing the weld may be either a roller or a hammer, but whatever the device employed it should be so located that the flue may be inserted and removed with a minimum of time and effort. In the

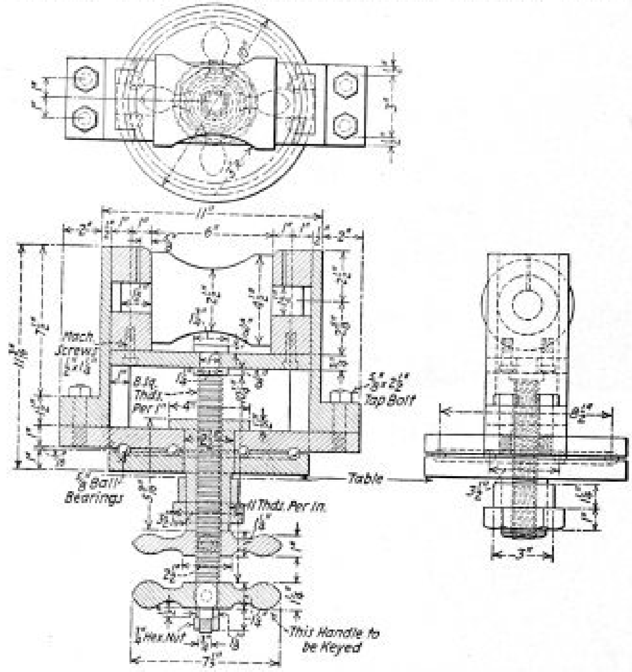


Fig. 4.—Detail of roller flue support

opinion of the writer the roller is preferable to the hammer. On a hammer the space between the mandrel and dies is constant. Flues vary in thickness and it often occurs that the new safe end is much thicker than the old flue. Under these conditions it is impossible to make a smooth weld with a hammer. With a roller, however, the flue can be smoothed down perfectly regardless of the condition of varying thickness. The roller should be

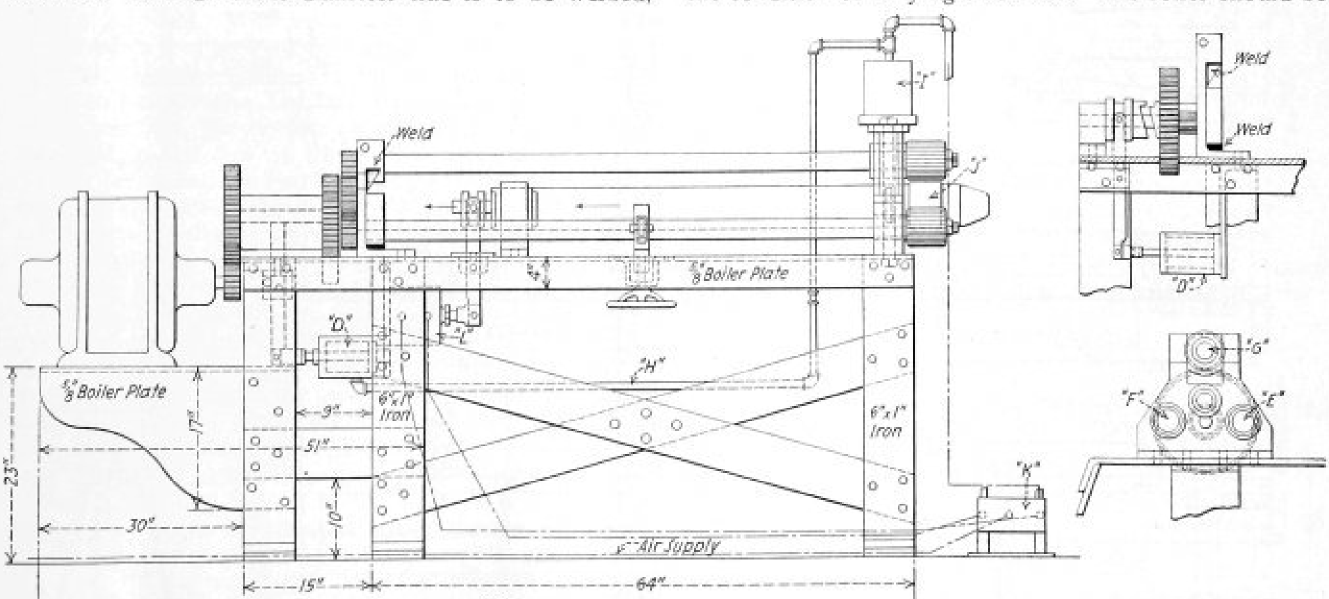


Fig. 3.—Arrangement and details of the roller

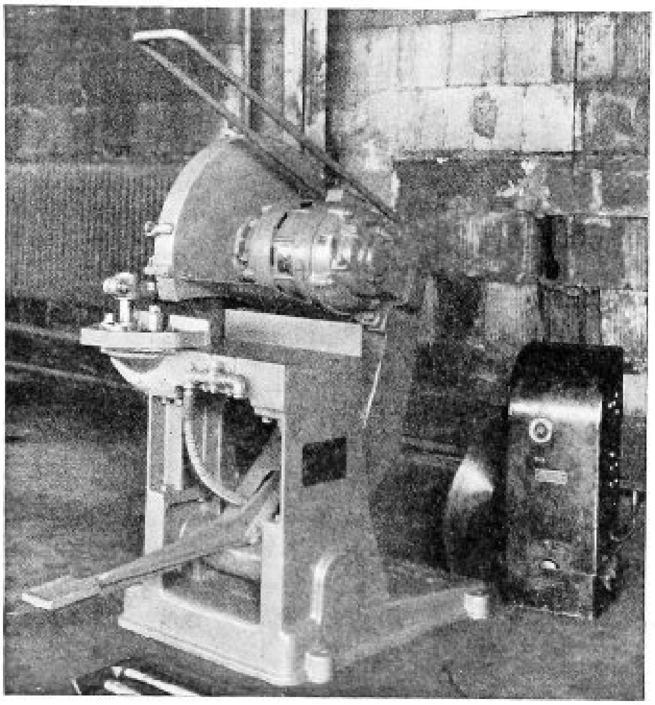


Fig. 5.—Machine used for cutting flues

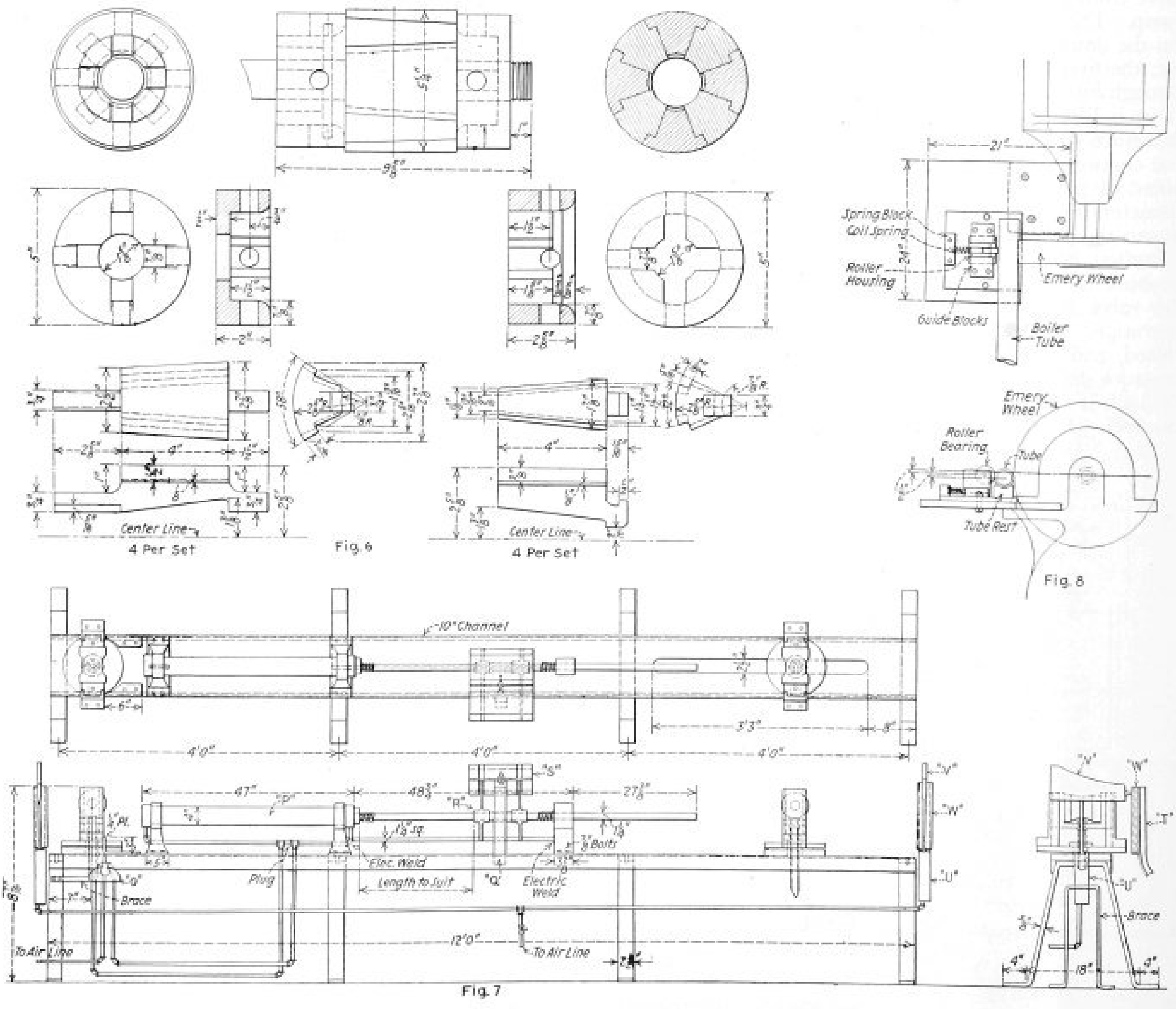
located directly back of the machine in line with the dies. With this arrangement a pilot extension on the mandrel can be used extending into the dies so that the flue end is actually entered on the mandrel and cannot drop out of line when the dies are opened.

Fig. 3 shows the roller that was developed at the West Albany shops which is operated as follows:

When the flue is forced over the mandrel *J*, the operator puts his foot on the foot-valve *K*. This admits air to the cylinders *L* and *D*. The air admitted to the cylinder *L* forces the mandrel *J* in the direction of the arrow thus expanding the mandrel. At the same time the piston of the cylinder *D* is moved to the left, engaging a clutch which causes the rollers *E*, *F* and *G* to revolve. When the piston of cylinder *D* has traveled to the clutch-engaging position, air passes through the pipe *H* to the cylinder *I* forcing the roller *G* down on the flue. When the operator removes his foot from the foot-valve *K* the operations are reversed, the mandrel collapses and the flue is easily removed from the mandrel. The support for the flue should be a double roller which will hold the flue in line with the dies and should be adjustable for height to take care of flues of different diameters.

Roller Supports

Fig. 4 is a detail sketch of one of two roller supports attached to a channel iron table about 8 feet long. This



Figs. 6, 7 and 8.—Details of mandrel, push up arrangement and flue surface grinder support is raised and lowered by turning the handle *M* to the left until it becomes loose, then by turning the handle *N* to the right to raise and to the left to lower. The handle *M* must be held rigid during this operation. After the roller stand is adjusted to the proper height, turn the handle to the right until it is tight, thus tightening the grip.

The heating time is so short that the output of welding depends on the speed with which the flues can be put in and out of machine. For this reason flues should be placed in racks located as close to the machine as possible, so that the men need take no steps to lift the flues from the rack to the welding machine.

It is important that the mandrel be kept as large in diameter as possible. For this reason the flues should be cut off square and have as little burr as possible. Where the flues are cut with a disk cutter there is more or less angle to the cut and a decided burr is formed. An electric butt weld is made by forcing the ends of the flue together under pressure. As the thin edge of the cut and the burr are always on the inside of the flue, these edges are forced inward when the flue ends are pressed together in the welder. This causes a decided flash on the inside of the flue, making it nearly impossible to force the flue on a mandrel as large as desired. The only machine that the writer knows of that will make a clean straight cut is a friction saw as shown in Fig. 5.

Welding Superheater Flues

When flues of large diameter, such as superheater flues, are to be welded, it is important that proper facilities be provided. It is difficult for a man to shove a flue on or off the welding mandrel, the weight of the flue being such that a maximum effort must be exerted to push the flue on and off. The result is that a man soon tires and the machine will not be worked to its full capacity.

An expanding mandrel should be provided which can be expanded after the flue is placed in position for rolling and which will collapse so that the flue can be easily removed from the mandrel after it is rolled. Fig. 6 shows the detail of the mandrel developed at our shops.

In order to relieve the man of laborious work, a push up cylinder should be provided that will force the flue on and off the mandrel. Air cylinders should also be provided that will lift the heavy flue off the rollers after the flue has been safe ended.

Fig. 7 shows a push-up arrangement and lift cylinder attached to the double roller support. It is operated as follows: Hinged clamp *S* is opened and the top section rests on bracket *Q*. The flue is placed on the roller supports and into the bottom section of the clamp *S* and fastened in the dies of the electric welder. While the flue is being heated, the helper closes the clamp S and tightens the bolt in the clamp. When the flue is heated, the operator releases the welding dies, pulls the handle forward on the valve *O*, thus letting air into the cylinder *P*. This pulls section *R* forward with the flue the full distance of the piston, which is the distance between the center of the electric welder and the center of the roller *E*, *F* and *G*, Fig. 3. After the flue is moved forward it is revolved as explained in the description of Fig. 3. Clamp *S* in Fig. 7 revolves in the brackets *R*. When the flue has been rolled, the operator pushes the handle in valve *O* to the right allowing air in the cylinder to push clamp *S* and the flue back into its first position. The helper then opens the clamp *S* letting the top section rest on the support *Q* and turns on the air by the valve shown. This allows the air to flow into the cylinders *U* raising the lifts at both ends to a position as shown by *V* and *W* letting the flue roll into rack *T*.

In concluding, I will mention the grinding of the surface of the flue and the safe end where held in the dies of the welder. While there are many different methods in use, we find that if a fine grade of emery wheel 3 inches wide is used with the roller, as shown in Fig. 8, attached to a bracket on the front of the emery wheel, very good results are obtained. With these facilities the machine can be operated to its full capacity and first class work may be done.

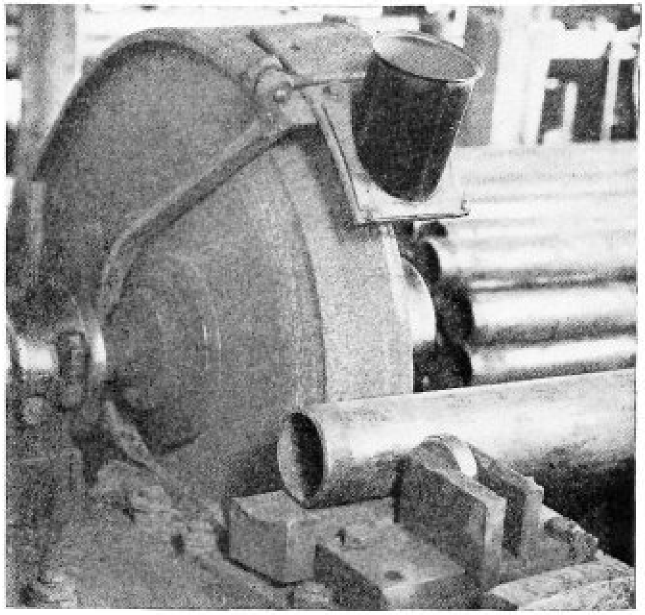


Fig. 9.—Method of grinding flues after welding

Fig. 1 shows complete layout with the exception of the clamp that fits in the forks on the push-up arrangement. The flue shown in the machine is of 3½-inch diameter and the push-up arrangement is not used. In the background, the pressure device is shown attached to the wall, out of the way. The mandrel in the roller machine is of the solid type as shown in Fig. 6 and is only used for superheater flues.

Program of Nineteenth Master Boiler Makers Convention

BELOW is published the official program of the nineteenth annual convention of the Master Boiler Makers Association which will be held at the Hotel Hollenden, Cleveland, Ohio, May 22 to 25.

First Day

Tuesday, May 22, 1928.

Registration of Members and Guests

8 A. M.

In order to participate in entertainments badges will be required. None will be issued unless dues are paid and members are properly registered. No deviations from this rule.

BUSINESS SESSION

Convention called to order .... 10.00 A.M.

Invocation:

Rev. Robert W. Mark, Pastor, Old Stone Church, Cleveland.

Addresses:

Hon. John D. Marshall, Mayor of Cleveland.

R. H. Flinn, S. M. P., Pennsylvania R. R., Buffalo.

Responses:

To the Mayor

W. J. Murphy, President

To Mr. Flinn

L. M. Stewart, First Vice President

Film Picture:

"The Age of Riveted Steel." Presented by A. F. Jensen, President, Hanna Engineering Co.

Annual Address:
W. J. Murphy, 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.
8.00 P. M. Reception to Officers and Members of the Association.

Second Day

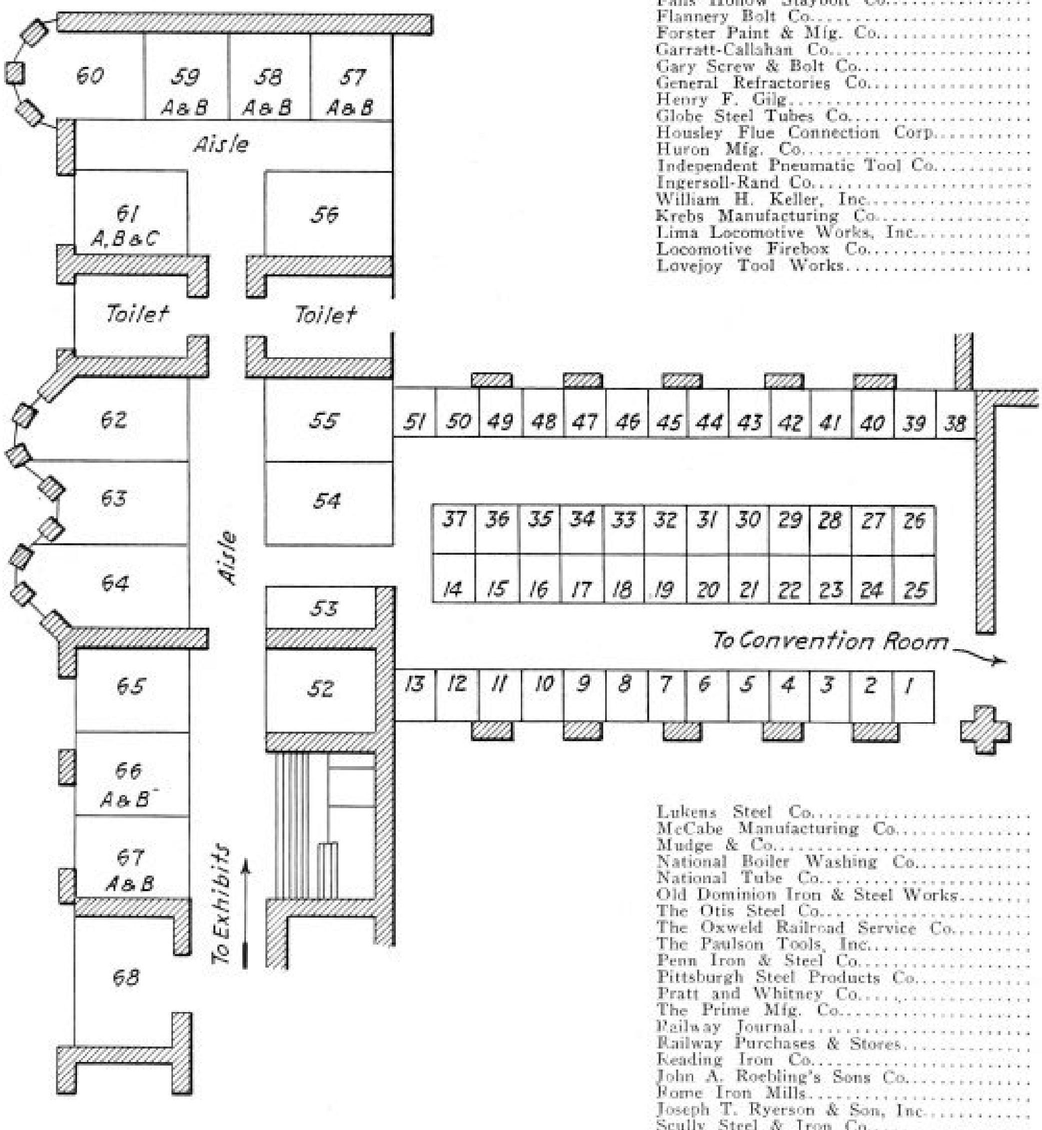
Wednesday, May 23, 1928

Convention called to order ....9.00 A. M.

A..dress:
W. R. Lye, District S. M. P., N. Y. C. R. R. Lines West, Collinwood, O.
Response:
Kearn E. Fogerty, Third Vice President
Unfinished Business:
Committee Reports on Topical Subjects:
No. 5. "Boiler Corrosion and Pitting."
Committee: T. P. Madden, Chair-Man; H. A. Bell, A. W. Novak.... 10.30 to 11.30 A. M.
Invitations to discuss this subject have been extended to the following representative Water Service Engineers:
Dr. C. H. Koyl, C. M. & St. P. R. R.
R. C. Bardwell, C. & O. R. R.

Exhibitors at Master Boiler Makers Convention

Name	Booth No.
Air Reduction Sales Co.	10, 11, 12 and 13
American Arch Co., Inc.	16
American Locomotive Co.	20 and 21
Arrow Tools, Inc.	9
Automatic Expander Co.	51
Charles H. Besly & Co.	61-A
Bethlehem Steel Co., Inc.	43
The Bird-Archer Co.	60
THE BOILER MAKER	14
The Bourne-Fuller Co.	57-A
W. L. Brubaker & Bros. Co.	34 and 35
The Burden Iron Co.	47
A. M. Castle & Co.	26
Central Alloy Steel Corp.	28 and 29
The Champion Rivet Co.	25
Chicago Eye Shield Co.	1
Chicago Pneumatic Tool Co.	8
The Cleveland Pneumatic Tool Co.	56
The Cleveland Steel Tool Co.	46
Dearborn Chemical Co.	63
Detroit Seamless Steel Tubes Co.	22 and 23
Dreis & Krump Mfg. Co.	75
Ewald Iron Co.	66-A
The J. Faessler Mfg. Co.	18
Falls Hollow Staybolt Co.	58-A & B
Flannery Bolt Co.	62
Forster Paint & Mfg. Co.	5
Garratt-Callahan Co.	38 and 39
Gary Screw & Bolt Co.	61-B
General Refractories Co.	74
Henry F. Gilg	70
Globe Steel Tubes Co.	2
Housley Flue Connection Corp.	19
Huron Mfg. Co.	41
Independent Pneumatic Tool Co.	30 and 31
Ingersoll-Rand Co.	65
William H. Keller, Inc.	36 and 37
Krebs Manufacturing Co.	4
Lima Locomotive Works, Inc.	72
Locomotive Firebox Co.	64
Lovejoy Tool Works	53
Lukens Steel Co.	24
McCabe Manufacturing Co.	52
Mudge & Co.	44 and 45
National Boiler Washing Co.	67-A
National Tube Co.	50
Old Dominion Iron & Steel Works	42
The Otis Steel Co.	73
The Oxweld Railroad Service Co.	55
The Paulson Tools, Inc.	66-B
Penn Iron & Steel Co.	7
Pittsburgh Steel Products Co.	33
Pratt and Whitney Co.	59-A & B
The Prime Mfg. Co.	15
Railway Journal	71
Railway Purchases & Stores	69
Reading Iron Co.	61-C
John A. Roebling's Sons Co.	54
Rome Iron Mills	17
Joseph T. Ryerson & Son, Inc.	6
Scully Steel & Iron Co.	32
The Superheater Co.	40
The Talmage Manufacturing Co.	48 and 49
Torchweld Equipment Co.	3
The W. S. Tyler Co.	57-B
The Tyler Tube & Pipe Co.	27
Ulster Iron Works, Inc.	67-B



R. E. Coughlan, C. & N. W. R. R.
Frank N. Speller, National Tube Company.

No. 8. To Report Topics for 1929 Convention. Committee: Franklin T. Litz, Chairman; Charles J. Longacre, Lewis E. Nicholas .... 11.30 to 12 M.

No. 9. Law: John F. Raps, Chairman; A. N. Lucas, Charles P. Patrick ....12 M. to 12:30 P. M.

Announcements.
Recess.

Third Day

Thursday, May 24, 1928.

Convention called to order .... 9.00 A. M.

Address: "Modern Locomotive Design and Its Influence Upon Railroad Operation."
With illustrations.
W. E. Woodward, Vice-President, Lima Locomotive Works.

Response:
Franklin T. Litz, Fourth Vice President

Committee Reports on Topical Subjects:

No. 1. "Standards and Recommended Practice." (Fusion Welding.) Committee: J. A. Doarnberger, Chairman; H. H. Service, Charles B. Raynor, L. M. Stewart, J. J. Mansfield .... 10.00 to 11.00 A. M.

No. 2. "What is the Most Efficient Method of Cleaning Scale That Accumulates Around the Root of Crown Bolts on the Water Side of Bolt and Crown Sheet of Locomotive Boilers?" Committee: K. E. Fogerty, Chairman; H. J. Raps, Frank Yochem 11.00 to 11.30 A. M.

No. 3. "Best and Most Economical Methods of Scaling the Inside of Locomotive Boilers When Flues and Tubes are Removed." Explain in detail tools, cost and man hours. Committee: I. J. Pool, Chairman; C. F. Petzinger, G. L. Young .... 11.30 A. M. to 12 M.

No. 7. "Three Types of Water Tube Boilers in Service. What Are the Advantages Over the Present Type of Stay Boilers?" Committee: Walter R. Hedeman, Chairman; M. A. Foss, John A. Clas .... 12 M. to 1 P. M.

Fourth Day

Friday, May 25, 1928.

Convention called to order .... 9.00 A. M.

Address:
Alonzo G. Pack, Chief Inspector of Locomotives, Interstate Commerce Commission.

Response:
W. H. Laughridge, Treasurer.

Committee Reports on Topical Subjects:

No. 6 "To What Extent Has the Life of Fireboxes, Staybolts and Flues Been Affected by the Present Practice of Operating Locomotives Over Several Divisions Instead of Former Practice of Only One Division?" Committee: O. H. Kurlfinke, Chairman; V. H. Dunford, Jr., M. V. Milton .... 10.00 to 11.00 A. M.

No. 4. "Is the Use of Self Feed Roller Expanders Injurious to the Flues, Tubes, Arch Tubes and Flue Sheets of Locomotive Boilers?" Committee: W. N. Moore, Chairman; E. J. Maneval, F. J. Jenkins .... 11.00 to 11.30 A. M.

Unfinished Business:
Report of Executive Committee .... 11.30 to 11.45 A. M.
Report of Committees on Resolutions 11.45 A. M. to 12 M.
On Memorials .... 12 M. to 12.10 P. M.
President's Address .... 12.10 to 12.20 P. M.
On Topics for 1929 Convention .... 12.20 to 12.30 P. M.

Election of Officers .... 12.30 to 1 P. M.

Adjournment.

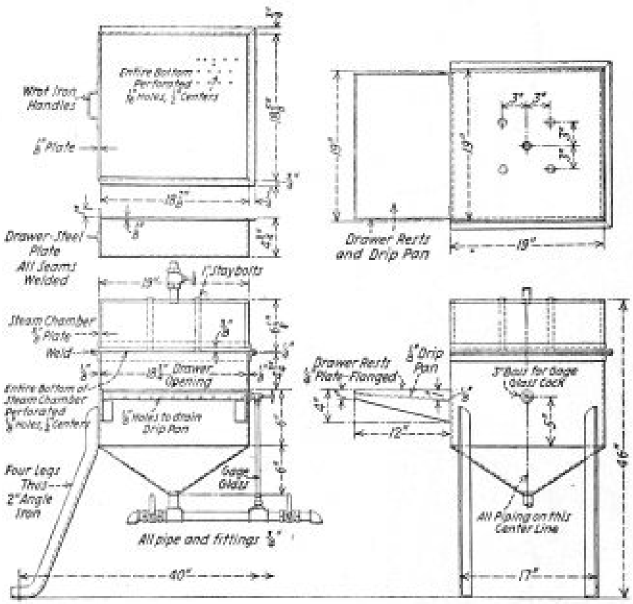
Reclaiming Threading Oil

By Albert F. Stiglmeier*

The process of threading 1,600 flexible staybolts with a diameter from 1 to 1⅛ inches and with threads 4 inches long, will produce about 7 gallons of chips, and about 7 quarts of oil will be lost. With the oil separator as shown it is possible to save or reclaim 6 quarts of oil from the 7 gallons of chips. On tests it has been shown that one can reclaim ¾ quart of oil per gallon of chips.

The oil separator, not being a patented device, can be made at a very small cost and is operated as follows:

Five gallons of chips are first loaded into the drawer. The two valves at the bottom right and left are closed and the valve at the top is opened letting live steam pass through a steam chamber, through the small holes in the bottom plate of the chamber and into the chips. This



Details of oil separator

steam heats the chips and allows the oil to pass through the small holes in the plate bottom of the drawer into another chamber at the bottom of the separator.

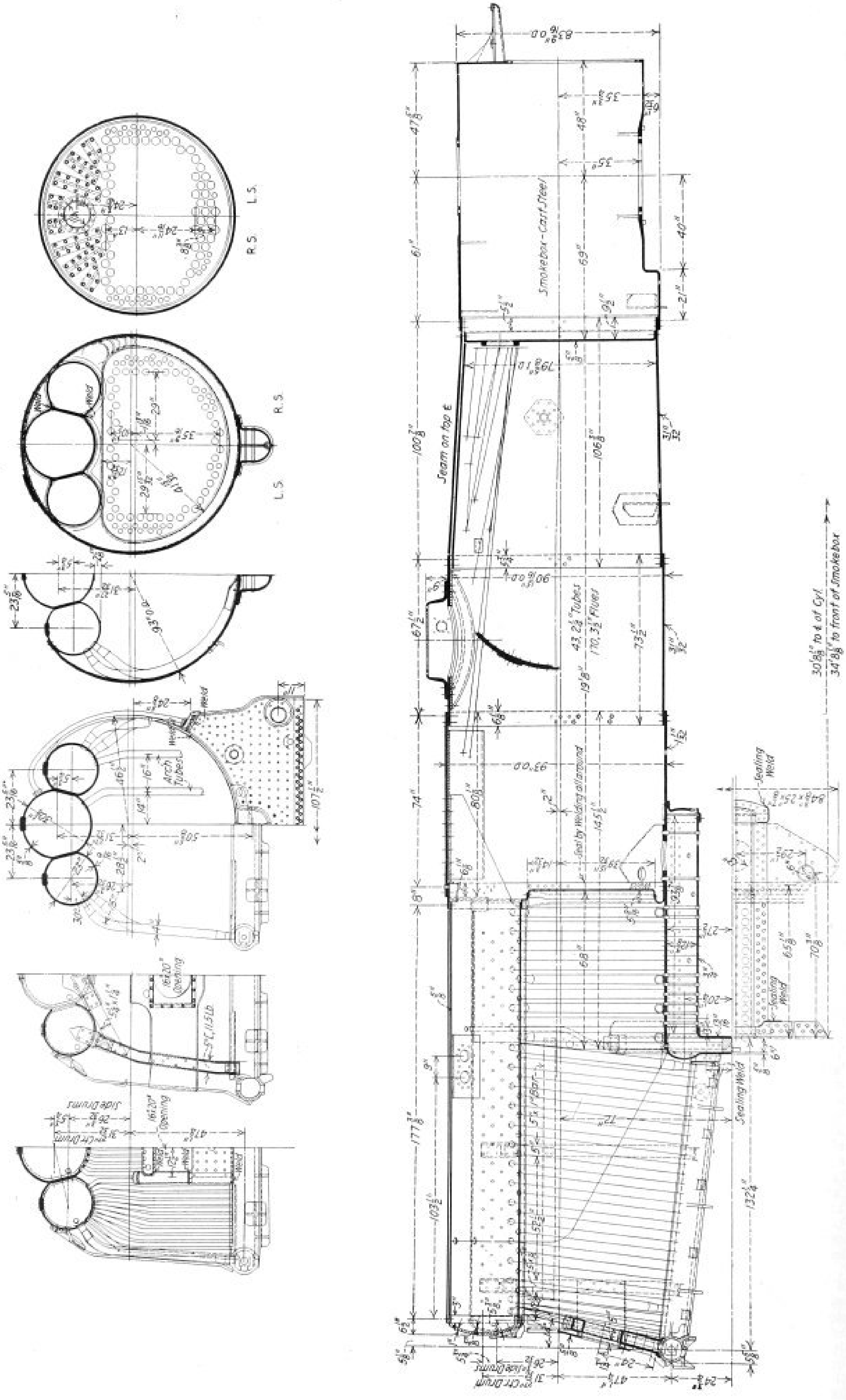
After steam has blown on the chips from 5 to 10 minutes, the steam is shut off by the valve at the top.

There will be oil and water in the bottom chamber, the water coming from the condensation of the steam, and the oil will float on the surface of the water. The water is separated from the oil by opening the valve at the bottom right allowing the water to drain until such a time that the oil starts to show. The valve at the right is closed and the valve at the bottom left opened allowing the oil to flow into a pail. The drawer is then removed and the chips are dumped out of the drawer. This completes the operation.

The gage glass shown on the left side of the separator is used to indicate the height of oil and water in the bottom chamber while the steam is turned on.

The Reading Iron Company, Reading, Pa., has moved its Chicago office to 1714 Engineering Building, 205 West Wacker Drive. This office is under the direction of Mr. R. A. Griffin, district sales representative.

* General Boiler Foreman, New York Central Railroad, West Albany shops, also chairman of the executive board of the Master Boiler Makers Association.



Elevation and cross section drawings of the boiler of the New Haven three-cylinder 4-8-2 type locomotives

McClellon Type Boilers Used on Three Cylinder New Haven Locomotives

Modifications in fireboxes and smoke boxes give additional efficiency and prevent air leakage

TEN three-cylinder, 4-8-2 type locomotives were recently received from the American Locomotive Company by the New York, New Haven & Hartford which were expressly designed for hauling heavy trains at high speeds. These locomotives are unusual in that they are equipped with the McClellon watertube firebox, the Bean one-piece smokebox and cast steel cylinders.

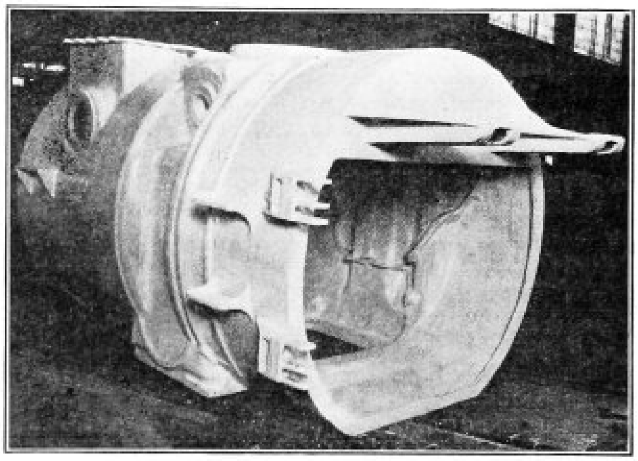
The diameter and stroke of the cylinder is 22 inches by 30 inches with a boiler pressure of 265 pounds, a driving wheel diameter of 69 inches and a weight on the drivers of 260,000 pounds, these locomotives will develop a tractive force of 85 percent cut-off, of 71,000 pounds. They carry the highest boiler pressure and develop the greatest tractive force of any locomotive on the New Haven.

Increasing demand for expeditious handling of traffic on the New Haven has made greater speed in the movement of its freight essential. The new locomotives were designed to meet these conditions. They will pull, at passenger train speed, 100 loaded cars weighing 5,000 tons. It is planned to use this power in fast freight service between Maybrook, N. Y.—The New Haven's western gateway—and Boston, Mass., the longest freight train run in New England, a distance of 275 miles. The new power will replace the locomotives which have handled these runs for several years.

Changes Made in the McClellon Boiler

The locomotives are equipped with McClellon boilers a general description of which was published on page 65 in the March, 1926, issue of THE BOILER MAKER. Modifications have, however, since been made in the work. The back tube sheet is made in two sections. The outer section consists of a ring flanged into the water side connecting to the third shell course, with an opening at the top flanged toward the fire side to receive the firebox drums. This construction is the same as on the previous engines of this type. However, instead of the tube section being integral as on the previous locomotives it is made in a separate piece, and joined to the outer ring by a riveted joint, its flange being turned toward the fire side. No braces are used in the back tube sheet. This form of construction will, it is believed, provide for the necessary flexibility between the tube section and the barrel of the boiler, and also greatly facilitate the renewal of the back tube sheet.

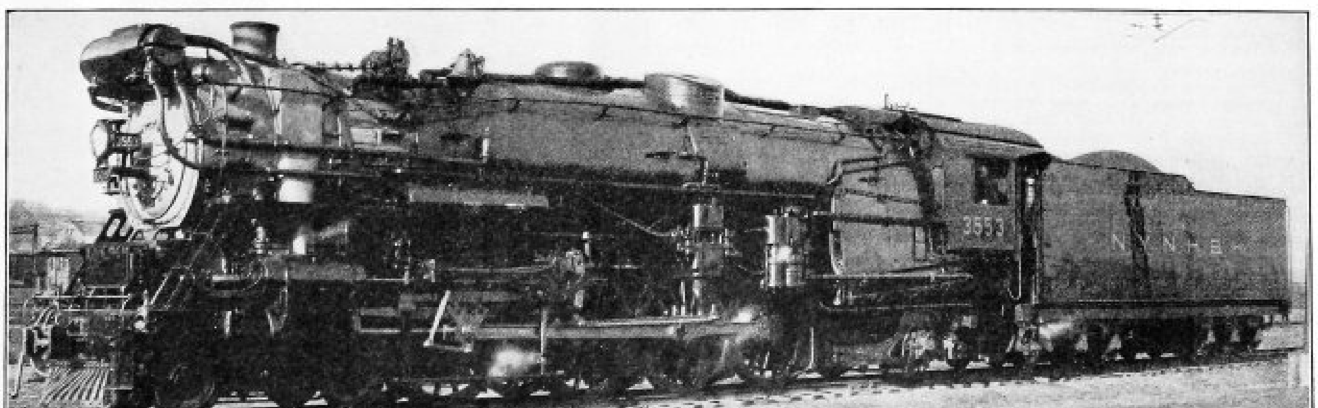
Additional circulation has been provided for between the hollow mud ring and the barrel, through two



The Bean smokebox, a one piece casting, is designed to eliminate air leaks

circulating pipes extending from each front end of the mud ring, and connecting to the barrel just ahead of the back tube sheet. These additional circulating pipes are to improve the circulation.

A change has been made in the method of lagging the firebox. Ascoloy steel sheets are applied next to the tubes from the drums to the mud ring, completely sealing the firebox. The lagging is applied outside of



One of the New Haven 4-8-2, three-cylinder locomotives which develop a tractive force of 71,000 pounds

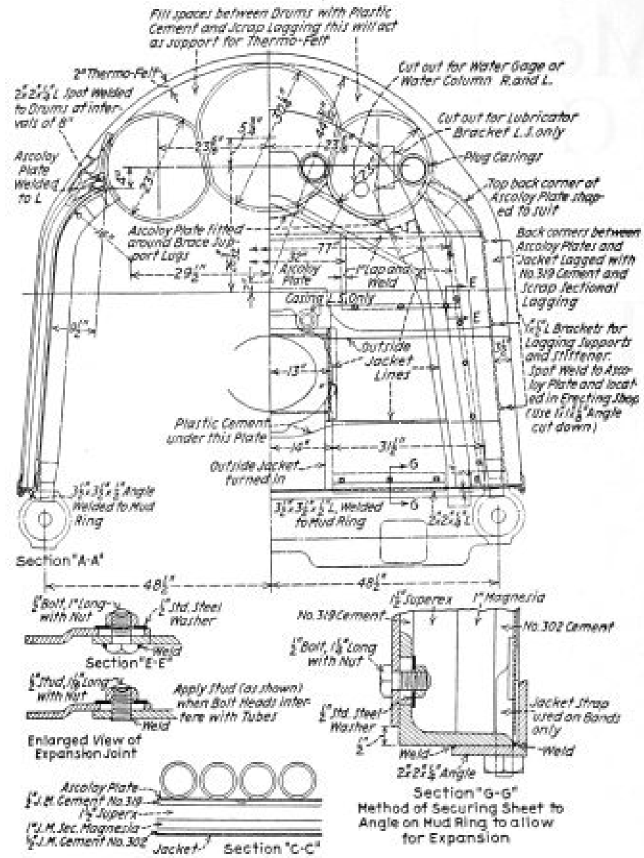
the Ascoloy sheets and a jacket outside of the lagging.

Other Changes in the Locomotives

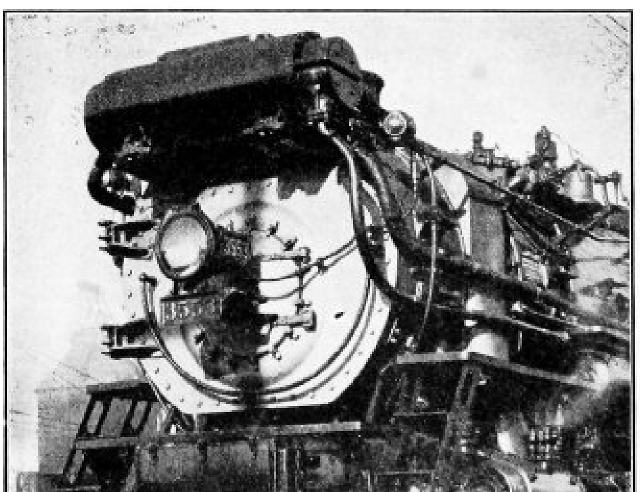
Outside of the boiler the principal modifications over the previous engines are in the use of cast steel cylinders and the Bean cast steel smokebox. The steel cylinders have effected a saving in weight of approximately 6,000 pounds. The Bean smokebox is designed to eliminate air leaks and to facilitate the application and removal of front end netting and deflector plates. Instead of being made of rolled steel plates, shapes, etc., it is cast in one piece, thereby giving simplicity and strength, also absence of air leaks so detrimental to fuel economy. The smokebox also includes lugs at the front and back which are tightly fitted to flanges on the cylinder which is, in turn, further locked to the smokebox by similar flanges and keys welded in place. This scheme insures positive and constant alinement of the frames and the maintenance of the correct position of

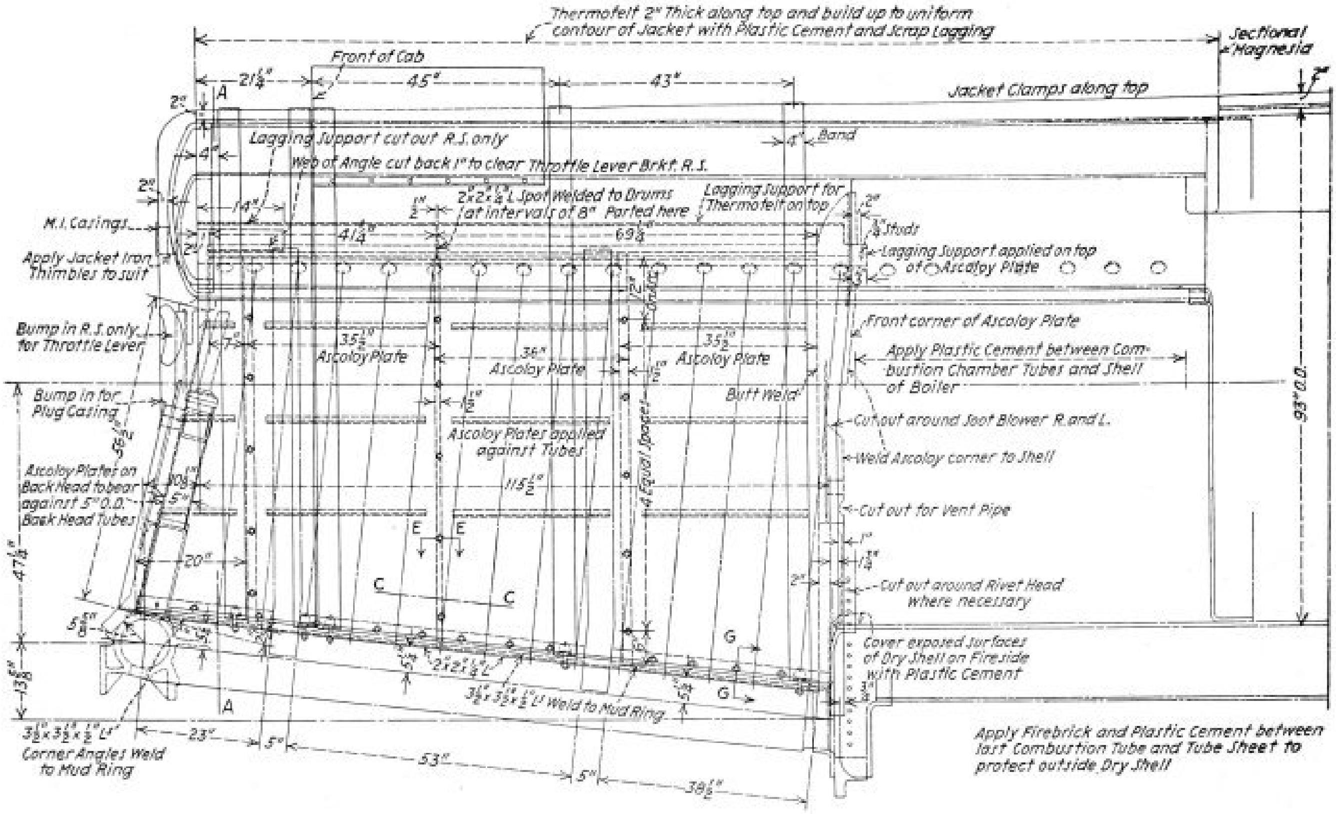
Table of dimensions, weights and proportions of the New Haven 4-8-2 type locomotives

Railroad	New York, New Haven & Hartford
Type of locomotive	4-8-2
Service	Fast freight
Cylinders, diameter and stroke	3 cyl., 22 in. by 30 in.
Valve gear, type	Walschaert
Valves, piston type, size	11 in.
Maximum travel	6 in.
Outside lap	1 1/16 in.
Exhaust clearance	3/16 in.
Lead in full gear	¼ in.
Cut-off in full gear, percent	85
Weights in working orders:	
On drivers	260,000 lb.
On front truck	58,500 lb.
On trailing truck	60,500 lb.
Total engine	379,000 lb.
Tender	288,500 lb.
Wheel bases:	
Driving	19 ft. 9 in.
Rigid	12 ft. 2 in.
Total engine	42 ft. 3 in.
Total engine and tender	85 ft. 4 in.
Wheels, diameter outside tires:	
Driving	69 in.
Front truck	33 in.
Trailing truck	44 in.
Journals, diameter and length:	
Driving, main	11½ in. by 14 in.
Driving, others	10½ in. by 14 in.
Front truck	6½ in. by 12 in.
Trailing truck	9 in. by 14 in.
Boiler:	
Type	McClellon
Steam pressure	265 lb.
Fuel, kind	Bituminous
Diameter, first ring, inside	79⅝ in.
Firebox, length and width	120 in. by 85 in.
Arch tubes, number and diameter	4—3 in.
Combustion chamber length	68 in.
Tubes, number and diameter	29—2¼", 14—3½"
Flues, number and diameter	170—3½ in.
Length over tube sheets	19 ft. 8 in.
Grate area	70.8 sq. ft.
Heating surfaces:	
Drums	96 sq. ft.
Combustion chamber tubes	95 sq. ft.
Firebox side tubes	145 sq. ft.
Firebox back tubes	35 sq. ft.
Firebox back section	2 sq. ft.
Arch tubes	27 sq. ft.
Firebox tube sheet and throat	51 sq. ft.
Total firebox	451 sq. ft.
Boiler tubes and flues	3,634 sq. ft.
Total evaporative	4,085 sq. ft.
Superheating	1,756 sq. ft.
Combined evaporative and superheating	5,841 sq. ft.
Tender:	
Style	Water bottom
Water capacity	16,000 gals.
Fuel capacity	18 tons
General data estimated:	
Rated tractive force, 85 percent	71,000 lb.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	68.5
Weight on drivers ÷ tractive force	3.65
Total weight engine ÷ comb. heat. surface	64.9
Boiler proportions:	
Tractive force ÷ comb. heat. surface	12.1
Tractive force × dia. drivers ÷ comb. heat. surface	841
Firebox heat. surface ÷ grate area	6.37
Firebox heat. surface, percent of evap. heat. surface	11.2
Superheat. surface, percent of evap. heat. surface	42.9



A cross section of the firebox and some of the details showing how the lagging is applied


The front end with its various brackets is cast in one piece



By using Ascoloy plates and four layers of lagging and cement, the firebox is completely sealed

wheels, axles, boxes, guides, valve motion, etc., thus tending to reduce maintenance costs.

Instead of the usual angles that are bolted to the inside of the smokebox, with the bolt holes causing air leaks, the small integral lips will receive the interlocking front end arrangement, which can be applied and removed in about one-third of the time needed for the removal of the older arrangement.

Care has been taken with the piping and back head arrangement to secure a pleasing appearance. All the piping possible, including sand traps and piping has been placed under the jacket. Where piping could not be placed under the jacket, care has been taken to run the piping along horizontal and vertical lines as far as possible. All steam pipes and valves, as far as possible, have been kept outside the cab under a turret housing over the top of the boiler in front of the cab. The steam valves in the turret are operated by extension handles which pass back through the cab where they are arranged in a neat line across the top of the firebox on a control board with each handle clearly labeled. With the exception of the air and back pressure gages, all of the gages are mounted in a straight line arrangement on an instrument board.

Among the special equipment included on these engines are feedwater heaters, automatic train control, force feed lubricators, air operated whistles, automatic bell stops, soot blowers, stokers and multiple throttles.

A folding door in the side of the tank provides access to the engine compartment for inspection and repairs.

The National Flue Cleaner Company, Inc., Groveville, N. J., manufacturer of soot blowers for return tubular and Scotch marine boilers, has announced the appointment of the following representatives: Walter G. Heacock Company, Cleveland, Ohio, and Detroit. Mich.; Jack Deerwester Company, St. Paul, Minn.; Charles Zinram, Erie, Pa.; Laib Company, Louisville.

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, 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 records of the interpretations of the committee in Cases Nos. 547 (reopened), 569, 578, 580-586, inclusive, as formulated at the meeting on February 24, 1928, all having been approved by the council. In accordance with established practice, names of inquirers have been omitted.

Case No. 547 (Reopened). *Inquiry:* *a* Is it permissible under the requirement of Par. P-186 of the code to form corner joints between the shells and heads of power boilers by the use of fusion welding, where the shell is extended beyond the head and carries an angle or other structural shape riveted thereto on the inner side, so as to withstand the thrust on the head due to steam pressure?

b Is it permissible under the requirement of Par. P-186 of the code to form the girth shell joints of firebox type boilers having furnaces and water legs extending the full length of the shell, by fusion welding, when such joints are disposed half-way between adjacent rows of staybolting and the head-to-head stresses on the shell are fully carried by through rods and tubes?

c Is it permissible under the requirement of Par. P-186 of the code, in firebox type boilers to weld the corner joints of furnaces that are subject to compressive stresses when both head and side sheets are supported by rows of staybolts close to the corners?

Reply: *a* If the shell is cylindrical or in the case of firebox construction is retained by staybolting, it is the opinion of the committee that the use of such a structural member so disposed as to oppose the thrust due to steam pressure and properly attached to the extended shell by riveting according to the rules for circumferential joints, will not conflict with the requirements of Par. P-186. The angle or other structural shape should, however, be of such size that the bearing surface against the edge of the head is not less than 2 inches in width.

b It is the opinion of the committee that while the through rods and tubes may perhaps be sufficient to withstand the calculated head-to-head stresses of such a firebox type boiler, neither the longitudinal staying effect of the through rods nor the transverse reinforcement of the staybolting in the water legs will be sufficient to insure freedom of the girth joint from transverse tension stresses due to weight components or variations in temperature, and thus the construction proposed will not meet the code requirement.

c It is the opinion of the committee that while the staybolting will perhaps amply support the head and side sheets, their attachment by fusion welding at the corners will not meet the requirements of the code, as the welds would not be free from bending and tension stresses due to both steam pressure and contraction and expansion.

CASE No. 569. *Inquiry:* Is it permissible under the rules of the code, in the case of multi-longitudinal drum boilers, to place tees between the safety valves and the drums, and to connect the side outlets of these tees together?

Reply: It is the opinion of the committee that Par. P-277 covers this arrangement completely and allows the use of such a connection as specified with certain restrictions.

CASE No. 578. *Inquiry:* Is it permissible to insert a cross water grate header into the upper part of the firebox of a locomotive type boiler, with attachment to the furnace crown sheet by means of fusion welding?

Reply: It is the opinion of the committee that the construction is such that the load is carried by other parts than the welding, and that in accordance with the provisions of Par. P-186, there is nothing in the code to prohibit the use of the construction as proposed.

CASE No. 580. *Inquiry:* Is it the intent of the code that where there is an extra allowance provided for the distance between the outermost staybolts of a flat stayed surface and the supporting flange or riveted joint at the outer edge of the sheet, as provided for in Par. P-205 of the code, the outer row of staybolts shall support the entire area between them and the outside supporting edge, or is the extent of the supporting power of the outer row of staybolts limited?

Reply: Under Par. P-220*b*, where special allowance is made for the spacing between the outer row of staybolts and the outer edge of the surface to be stayed, the area to be used in computing the load on the staybolts is a rectangular area with the outer edge coming half-way between the limit line of the area to be stayed and the center line of the outer row of staybolts.

CASE No. 581. *Inquiry:* Is it permissible, under the code, to attach 4-inch circulating tubes of a furnace water wall to cast-steel elbows by fusion welding, the tubes being inserted into the elbows without threading and the welding being depended upon entirely for strength?

Reply: Autogenous welding of superheater tubes to headers or fittings is not permissible under Par. P-186 of the code, where the strength of the welding is depended upon to resist the pressure tending to force the tube out of the header. Fusion welding is permitted in such construction only for tightness, where the stress due to steam pressure is fully carried by other construction.

CASE No. 582. *Inquiry:* Is it permissible under the code, where corrugated furnaces are required of greater length than can be made in a single piece, to join two corrugated furnace sections by circumferential hammer welding at the middle, the hammer welding process resulting in a flat portion about 6 inches wide?

Reply: It is the opinion of the committee that such a method as described for joining two sections of corrugated circular furnaces is permissible under Par. P-243 of the code, provided the plain portion at the circumferential weld does not exceed the limit of 9 inches and the maximum allowable working pressure is as specified therein for plain portions.

CASE No. 583. *Inquiry:* Is it the intent of the Code for Low Pressure Heating Boilers to require firebox steel plate to be used exclusively in any part of a low pressure heating boiler?

Reply: It is not the intent of the Code for Low Pressure Heating Boilers to require the use of firebox steel plate in any part of a heating boiler.

CASE No. 584. *Inquiry:* Do the requirements of the Boiler Code regarding blow-off valves apply to economizers and water walls?

Reply: It is the opinion of the committee that where water walls or economizers are integral with the boiler proper without intervening stop and check valves, they should be considered as part of the boiler, and all blow-off or drain valves which would empty the boiler should be installed as per Pars. P-308 to P-311, inclusive.

CASE No. 585. *Inquiry:* Request is made for revision of the requirement in Par. U-20 of the code which limits the maximum allowable unit working stress in seamless shells to 9,000 pounds per square inch. It is pointed out that for the drawing of seamless steel vessels, 55,000 pound per square inch material is commonly and very successfully used, so that an allowable unit working stress of 11,000 pounds per square inch is allowed.

Reply: This value of 9,000 pounds for the maximum allowable unit working stress came from the table in the Power Boiler Code for piping and is conservative in view of the fact that the piping is provided for use up to a maximum temperature of 750 deg. F. It is the opinion of the committee that for temperatures up to 600 degrees, one-fifth of the ultimate strength can be safely used. This matter is under consideration for revision.

CASE No. 586. *Inquiry:* Will it not be acceptable under Par. U-112*b* of the code to use steel plate for forge welding purposes with greater content of silicon than the specified limit of 0.05 percent? Attention is called to the fact that difficulties with steel plate conforming exactly to the Specifications for Plate of Flange Quality for Forge Welding, extending over a number of years, have been overcome by increasing the silicon content of this material up to 0.15 per cent.

Reply: Par. U-112*b* is mandatory in its requirement that the quantity of silicon present in steel plate of this specification shall not exceed 0.05 percent. However it is proposed to revise this feature of the requirement of Par. U-112*b*, and pending this revision it is recommended that this limitation on silicon content be waived.

Firebox Plate Failures

Theory advanced that use of air hammers on plates sets up metal strains that permit corrosion

By Fred H. Williams

RECENTLY, a firebox plate failure occurred, the examination of which resulted in a new theory as to possible cause of the fracture. When the failure was discovered, a specimen, containing the fracture, was cut from the side sheet of the firebox about 12 inches from the mud ring; it included three staybolt holes and one combustion tube hole with about 3 inches of the sheet on either side of the fracture.

The section of the plate, as shown in Fig. 1, shows the location of the fracture in relation to the staybolt holes and the combustion tube hole. It will be noted tnat the crack extends from the staybolt hole at the bottom of the photograph through the intervening plate to the combustion tube hole, up to the next staybolt hole, where it stops. The crack runs vertically with reference to the firebox chamber and longitudinally with reference to the final rolling of the plate.

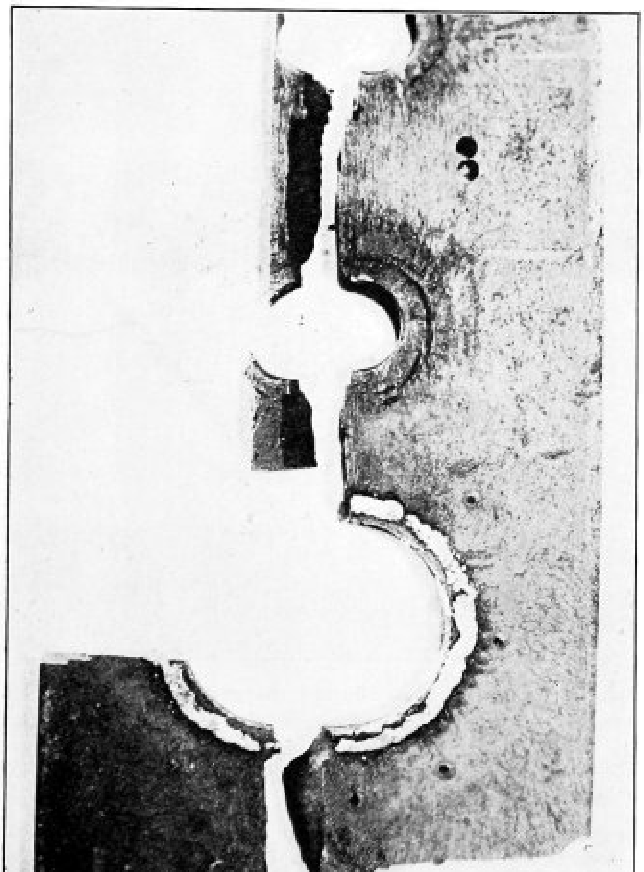


Fig. 1.—A piece of the side sheet plate showing the fracture —The view shows the firebox surface

The crack started, in this case in the weld, where the combustion tube was welded to the inside side sheet and worked both upwards and downwards from the upper and lower edges of the hole to the two staybolt holes on the top and the one on the bottom of the section of the plate shown.

The crack, starting at the deposited metal, worked both up and down as a rapidly progressing creeping crack following almost a straight line, not perpendicularly through the plate, but in a diagonal direction to the right in the upper half and to the left in the lower half.

An examination of the fracture of the plate at the combustion tube hole edges indicates plainly that it started from the weld working upward and downward.

The Firebox Side Surface of the Fractured Plate

The surface of the plate, shown in Fig. 1, is the firebox side and is most interesting in that it shows more extensive corrosion than on the water side of the sheet, and corrosion of a different nature. Looking at the plate between the upper two staybolt holes, a series of vertical lines can be seen with gradually widening spaces between them at the center, and while not shown as plainly in the picture between the other staybolts and the combustion tube hole, they are there nevertheless and on both sides of the crack. These lines are comparatively narrow but deep grooves caused by corrosion. The pattern of the grooves collectively, indicates that the metal is in a strained condition over these areas. Moisture for the corrosive action probably came from leaky staybolts or from condensation of steam and moisture of the air entering through the combustion tube. The grooves are really narrow pits following the strain

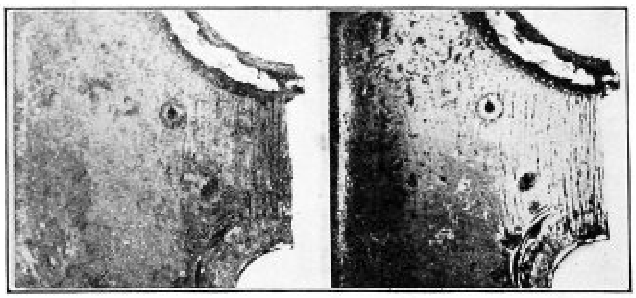


Fig. 2, Left—This view shows the strain lines and pitting of the plate between the staybolt hole and the arch tube hole; Fig. 3, Right—The same as Fig. 2, but polished to intensify the lines

lines and are made by the eating away of the metal through electrolytic action. The energy for this action is obtained through differences of potential of the strained and unstrained crystals of the steel. The electrolyte is made up of the moisture previously mentioned and gases from the fire. The fracture follows the strain lines of the shortest length. Thus, the fracture occurs between the staybolt holes and the combustion tube hole. The fracture starts from the coarse grained metal of the weld at the combustion tube hole and works down from the lower edge and up from the upper edge of the same hole. The slope of the fracture is probably due to the slant that the welder gave to the electrode in depositing the metal, and its freezing into long slanting grains, thus affording a weaker path than straight through the plate. The fracture follows the grooves on the firebox side caused by the corrosion, and along the short vertical strain lines between the staybolt holes, and between them and the combustion tube hole. As the pits are deep and continuous on the firebox side, the crack follows for the most part the original direction as set by the starting crack from the deposited metal of the weld.

In order to make a closer study of the pitting, two photographs are shown of the piece of the plate located in the lower left hand corner of Fig. 1. The first is shown in Fig. 2, which gives more definition to the lines in the untouched plate. The pits can be seen faintly as rust streaks; they appear as lines of rust and they are. Looking at this piece of plate when it is cleaned and the surface slightly ground, these lines of rust are brought out more clearly as is shown in Fig. 3. We now have a real picture which shows the strains that

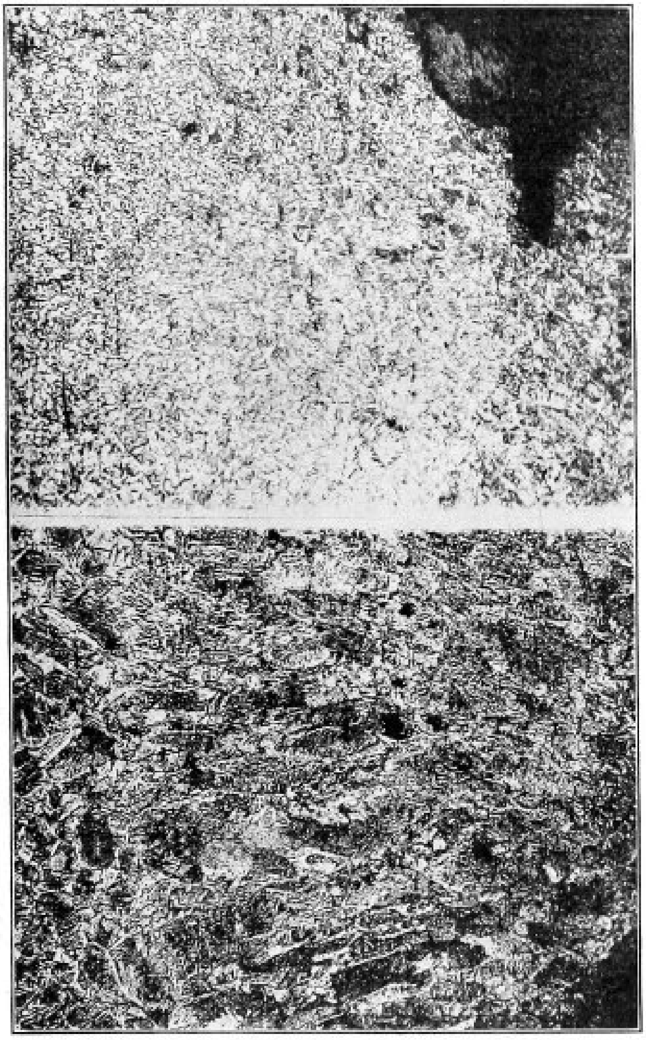


Fig. 4, Top—The structure of the steel at and near where the arch tube was welded to the plate—The parent metal to the left and the deposited metal to the extreme right; Fig. 5, Bottom—The structure of the weld and the parent metal at the outer edge of the bead shown at the lower right corner

were in the plate, as the rust followed the strain lines and developed comparatively deep narrow grooves along them.

The reverse side of this plate does not show quite the same picture. The rust pits are partly of a different nature and are not so numerous nor are they in the same formation. The formation is more complicated and less clearly interpreted.

The Welded-in Combustion Tube

It is probably hardly fair to place the blame entirely on the welded-in combustion tube. Similar cracks and failures take place in sheets without any welds in sheets near the location of the crack. In fact, it is quite within reason to believe that the corrosion pits would have

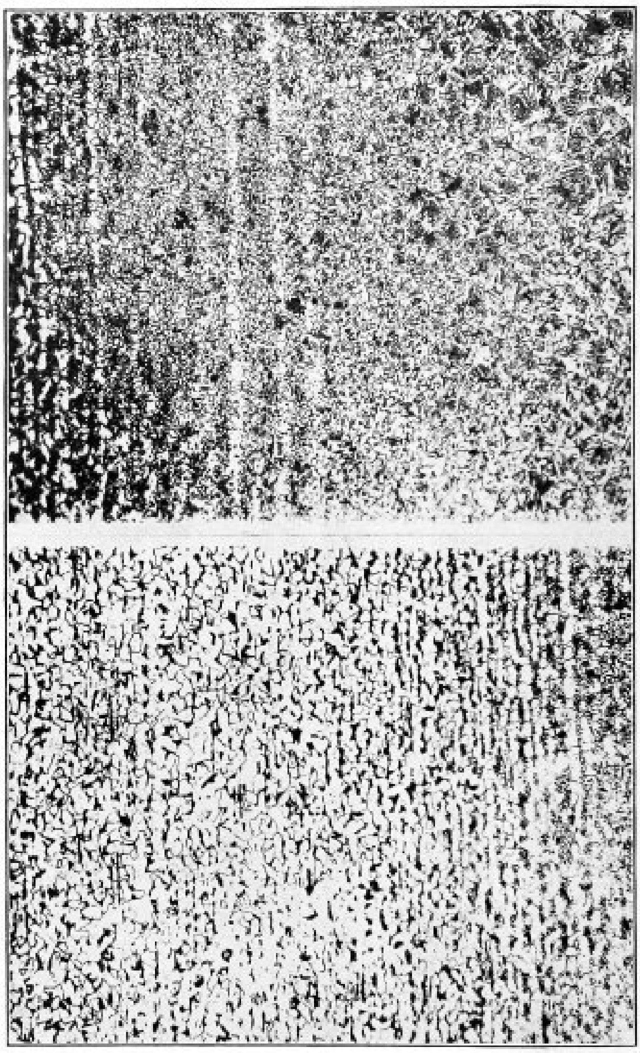


Fig. 6, Top—The heat affected the metal structure to the right and the parent metal to the left is nearly the original structure; Fig. 7, Bottom—This shows a continuation of Fig. 6

caused the crack in time, even though not assisted as it was at the start, by the welded-in combustion tube.

A study of the weld will show wherein it is weak, and also the line of failure. The part of the deposited metal adjacent to the combustion tube may be seen in Fig. 4. It is very good.

The coarse grain of the deposited metal and the overheated parent metal is shown in Fig. 5. In this view, the lower right hand corner shows the edge of the bead of deposited metal, which shows good penetration. The very long narrow crystals or structure is shown at the right and at the left is the finer structure of the parent metal that was near the overhead plate near and at the edge of the crater of the arc.

Fig. 6 shows the structure of the metal further away from the crater and the commencement of the original structure of the plate. The plate is of the best open hearth acid firebox steel, ⅜ inch thick.

Next along the path from the weld inward, we come to the junction of the structure shown in Fig. 6, and the original material. This is shown in Fig. 7, where the center and left half of the photomicrograph show no effects from the weld. It is interesting to note that the metal is very clean and nearly free from ghost lines which are more numerous in the central portion of the plate; likewise included slag or non-metallics are very few and of short lengths, narrow and of practically no consequence. The weld was on the face of the plate and the heat affected portion extended barely into the less fine inner zone of the plate.

Corrosion Pits

The next two photomicrographs show the pits on the firebox side of the plate and the structure of the

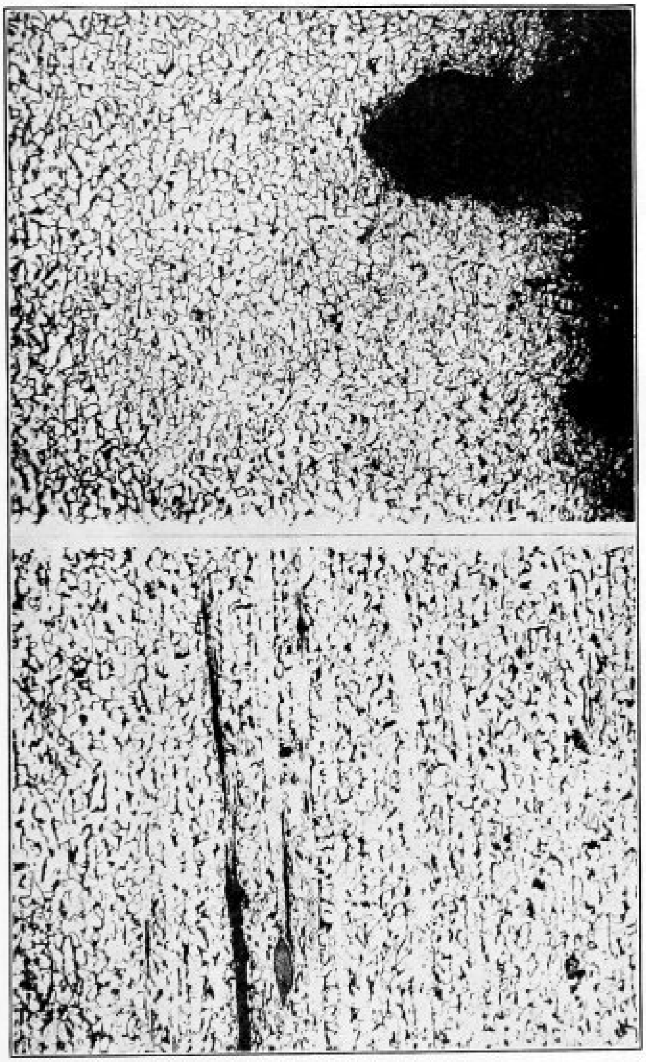


Fig. 8, Top—The black represents one of the pits or grooves eaten out by corrosion on the firebox side of the sheet; Fig. 9, Bottom—The structure of the central portion of the plate

steel in the surface zone of the plate and the central zone.

In Fig. 8, we see some of the pits; one is very deep, comparatively speaking, and one or two just starting. The deepest pit is just .0175 inch deep and .01 inch wide —deep enough to mark the line of the fracture. Just an ideal nick in the plate to start a failure. Note the uniformity of the structure of the steel and the fineness of the grain, also the absence of any crack at the bottom of the pit. The pit is, plainly, rust eating into the metal and not a crack. The corrosive action is hastened by the difference of potential of the crystals causing current to flow from one crystal to the other, breaking up the metal and causing the deep pits.

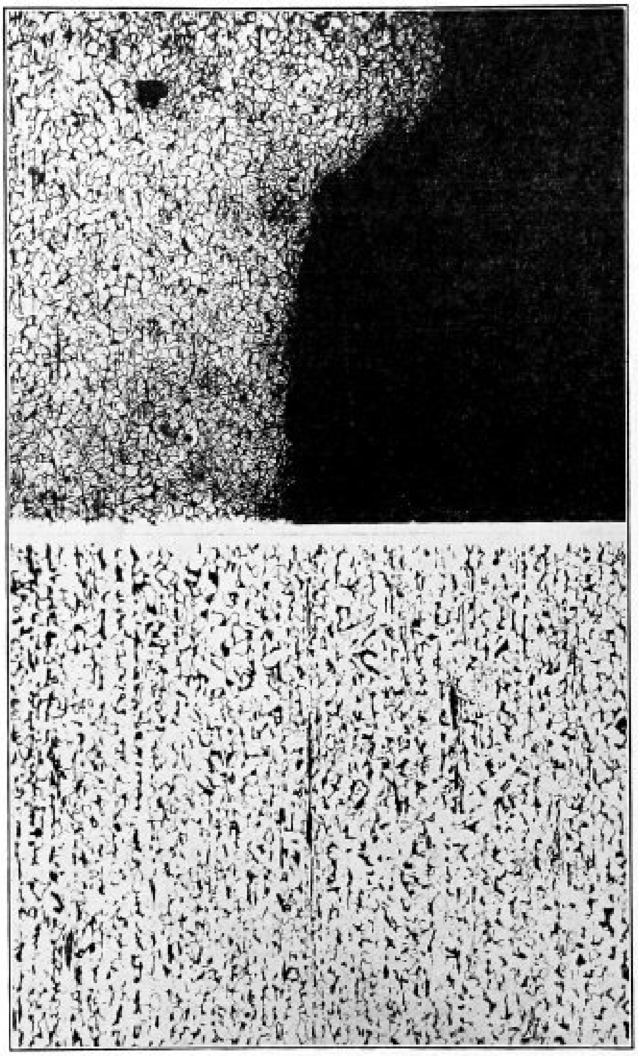


Fig. 10, Top—This shows one of the pits in the plate on the water side of the sheet; Fig. 11, Bottom—The cross section of the plate near the center

In Fig. 9, the small impurities are seen. The dark band is almost too small to note—a little overetched—it is in reality similar to the light gray spot to the left. It is very thin, not more than .01 inch in length. Note the few ghost lines including these impurities and also some that are very free from such impurities as appear elsewhere. The grain structure shows careful rolling and finishing at a proper temperature.

The corrosion on the inner or water side of the firebox side sheet is shown in Fig. 10. Most of these pits are not so deep, but they are much wider and of more rounded areas than those on the firebox side. Then follows a section of the central portion of the plate which is longitudinal to the direction of the rolling of the plate which is the direction when the billet is first put on the rolls. A few passes are made and the lines developed along in one direction. These are then widened somewhat when the plate is rolled at right angles to the first few passes. The structure is of a fine, uniform grain size and with very few non-metallic areas.

A Test Piece

A test piece, ½ inch in width, was cut off the top portion of the plate, which included the pitting along the surface between the staybolt holes. An examination of the fractured test piece shows a series of cracks that do not run very deep. The cracks are more on the firebox side of the side sheet. The fracture underneath the surface and out of the influence of these cracks is of a fine uniform structure.

Physical characteristics of test cut off top portion of fractured plates

Tensile strength, lb. per sq. in.	72,250 lb.
Yield point, lb. per sq. in.	64,400 lb.
Elongation in two inches	17.5 percent
Reduction of area	31.3 percent

A longitudinal test piece, 1 inch wide was also cut vertically. Figs. 11 and 12 show these two test pieces.

Conclusion

The writer has endeavored to show the inside nature of the failure in combination with the outside features and has pointed out that, while the weld helped at the start of the fracture, the real cause for the final fracture was the corrosive action of impure water on the strained metal between the staybolt holes. These deeply penetrating corrosion pits that collectively united into grooves along the strained metal marked and facilitated the path of the fracture. The effect is the same as nicking any piece of steel and then subjecting it to a sudden strain which would result in a failure. Similar pits and grooves extended down the tapped staybolt holes and were deeper to some extent due to the erosive action of the leaking water. These small leaks of the staybolt pits providing proper conditions, as in this instance, resulted in a dangerous crack and the removal from service of a locomotive.

Writer's Theory of the Failure

It will be seen, by examining Fig. 3, that the grooves

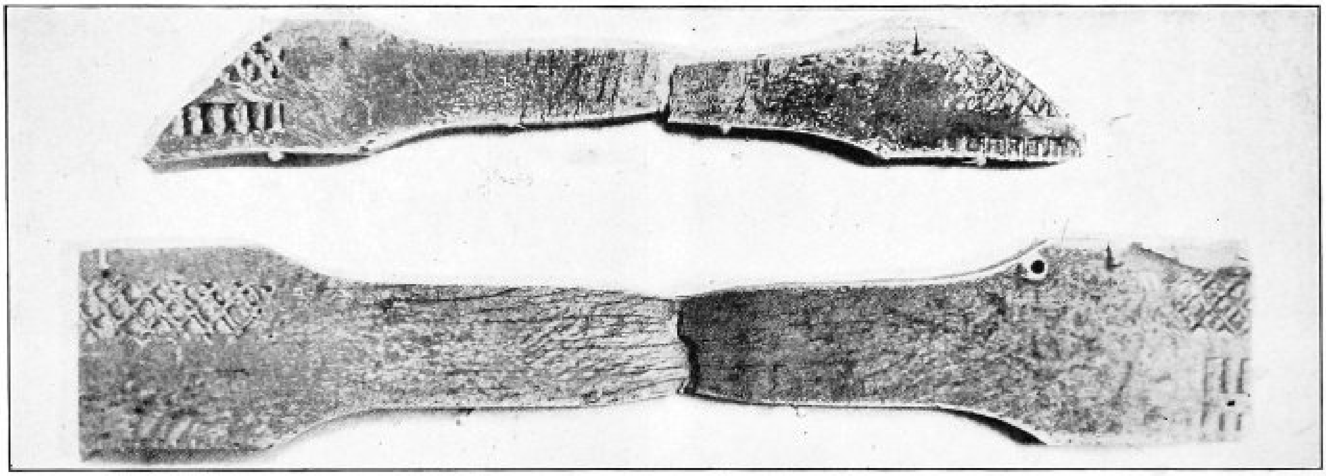


Fig. 12, Top—The test piece, after fracture, showing the water side; Fig. 13, Bottom—The test piece after fracture showing the firebox side of the sheet

from the plate shown in Fig. 1, to the left of the photograph. This test piece, upon fracture, shows only the cross section of the pits. The cracks show up faintly longitudinal to the test piece. The continuous pitting apparently runs vertically even between the vertical lines of the staybolt holes.

The following are the physical properties of the longitudinal test piece:

Tensile strength, lb. per sq. in.	67,665 lb.
Yield point, lb. per sq. in.	54,750 lb.
Elongation in five inches	17.5 percent
Reduction of area	55.0 percent

These figures differ considerably from those from the same plate when rolled. The following are the physical properties of the plate as rolled:

Tensile strength, lb. per sq. in.	57,700 lb.
Elongation in eight inches	32 percent

Chemical analysis of the plate when new: Carbon, 15 percent; phosphate, .035 percent; manganese, .44 percent; sulphur .028 percent.

The analysis of the plate when failure took place is practically the same. The carbon content of the plate is one point less.

The grooves caused by electrolysis causing a corrosive action on the plate, run vertically and not horizontally to the side sheet and thus weaken the sheet made by the corrosion follow a pattern wherein the staybolt holes are the nodes of a series of wave lines which reach their maximum amplitude between the staybolt hole and the combustion tube hole.

It appears to the writer that the air hammers, used in the fabrication of the firebox, are the cause of these strains in the metal and the subsequent corrosion pitting. The use of the hammer on the outside and a dolly on the inside, will undoubtedly set up these strains. The practice of using the hammer on the inside will undoubtedly increase these strains. With an air hammer on each end of the staybolt and operating at the same time, the blows will seldom synchronize and thus double the strains.

The plate metal is not burned nor overheated except at and near the weld, where the crystals are somewhat coarsened owing to the overheating of the metal adjacent to the line of the weld.

Attention is called to the change in the physical properties of the plate before fabrication and after service at the time of the failure. The service has increased the tensile strength and reduced the elongation considerably. There is no apparent change in the structure of the steel in the plate that would lead one to say that the metal was overheated; neither is the grain of the steel anything but very fine and uniform.

About .01 inch from the surface of the firebox side of the plate, the writer noticed a slight decarbonization of the steel and between this narrow band and the surface the steel was of a higher carbon content. This band was about .002 inch in width. This slight change does not appear to the writer to be of any special consequence except that it indicates that the metal has been but slightly changed and that only by a moderate temperature for some length of time rather than at an intensive heat.

Recommendations

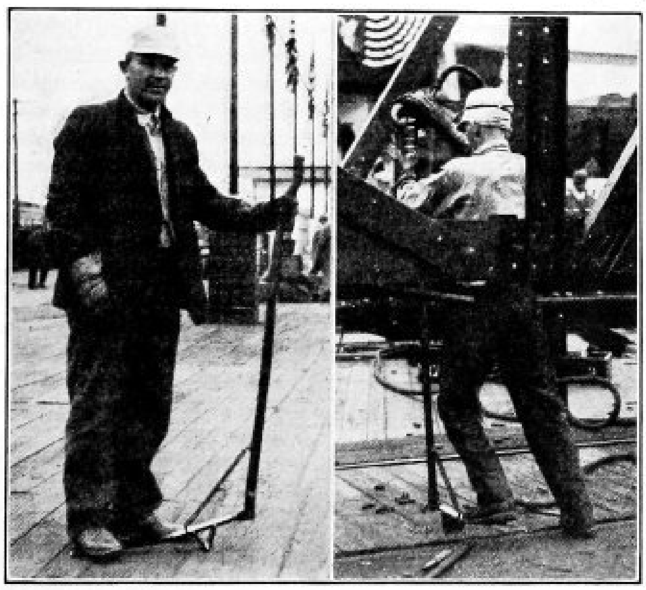
Experimental tests should be made to ascertain whether the spinning of the staybolts in the fabrication of the firebox would benefit or remove entirely the failure similar to the one just described.

When further failures take place, a section of the crack enclosing two or three staybolt holes should be ground slightly and examined to corroborate the lines in the failure. The patterns made by the rust following the strain lines should be studied and thus ascertain the cause of these strain lines and the remedy. A study should be made to ascertain why a change of physical properties takes place through service and without excessive overheating of the plate.

Probably these recommendations are already being carried out by some of the readers and perhaps they would be glad to enlighten those not so fortunate.

A One-man Bucker-Up for Vertical Riveting

ONE of the devices developed for the last contest held by the car department of the Delaware & Hudson was a bucker-up so constructed that one man could both drive and buck up any



With this device one man can drive and buck-up his own rivets

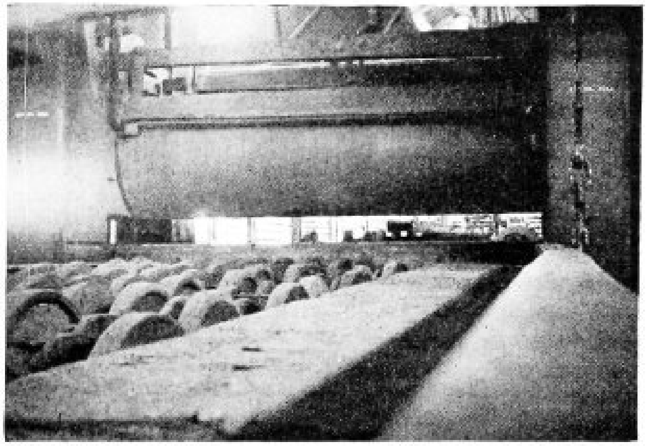
of the vertical rivets used in the underframe of a tank or car. The construction of the bucker-up is shown at the left in the illustration and the method of using it is shown at the right.

It consists essentially of a bar secured with a pivot hinge and a brace to a pedal lever to which is welded a vee-shaped lug which serves as a fulcrum. The upper end of the bar is shaped to suit the head of the rivet and is hardened to reduce wear. The rivet is placed in the hole from the underside, the bucker-up is placed in position and the riveter holds the rivet in place by pressing down on the pedal lever as shown.

Rolling Boiler Plate *

By E. N. Treat

THIS narrative is intended to describe the general manner by which a plate is rolled directly from the ingot. Methods may differ in individual mills throughout the country as to the working down of an ingot to the plate size. The idea here is to picture the

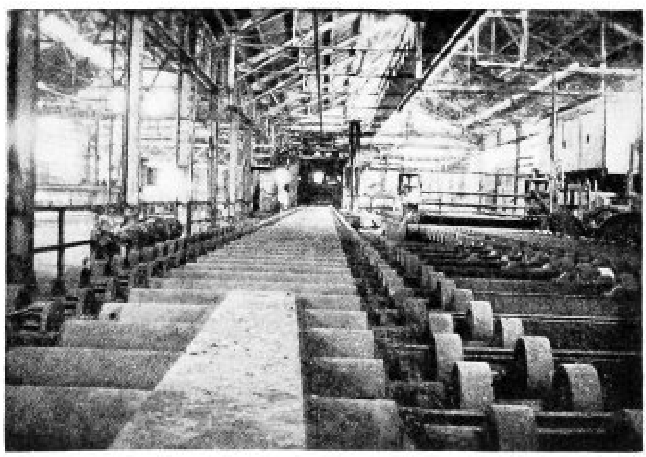


The rolling mill showing table rolls upon which the plate travels

essential stages in the reduction of an ingot to the commercial size desired.

The thickness of the ingot must be reduced with an elongation and increase of superficial area. To facilitate this procedure the ingot is heated to rolling temperature in the reheating furnace and when such heat is attained the ingot is deposited on the table before the rolls of the rolling mill by means of the electric crane. The rolls are adjusted for the first pass and the ingot is

* One of a series of short articles describing the various processes in manufacturing boiler plate at the steel mills.



View of the straightening rolls

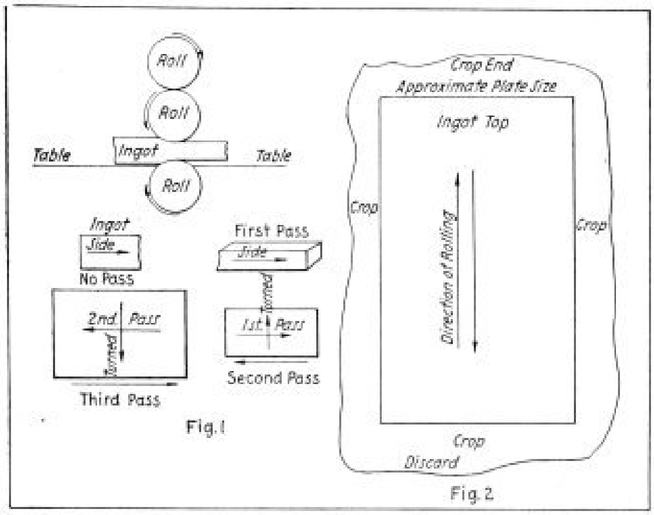
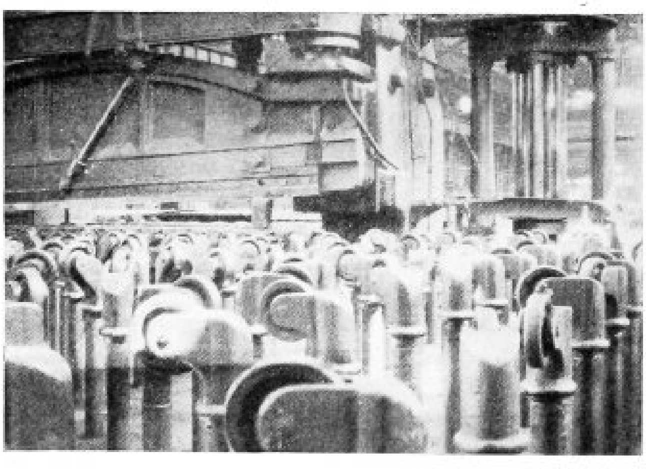


Plate rolling operations

forced through the rolls as in Fig. 1. Here the end of the ingot is caught between the rolls and drawn to the other side. The ingot is now turned and forced between the upper rolls where it is drawn to the starting side of the first pass.

In an instant the ingot has been drawn through the rolls and is noticeably thinner than originally. Turning, the ingot continues until it has become too large to enter the rolls sidewise and thereafter rolling is done back and forth as may be seen by the arrows in Fig. 2.

Nearing the desired thickness the plate is gaged while passing through the rolls. This is done by means of a special gage held in the hand of a mill man familiar with that work. Accuracy in gaging is important, as the



Casters upon which plates are moved

plate will not be accepted by the inspector or purchaser if it is not within the specified limits of maximum or minimum thickness. Customers do not wish to purchase heavier material than required, nor to pay transportation charges on excessive weights.

After successive rolling, the plate being near the desired size and thickness it may be observed that some scale sifts back and forth over the top surface of the plate. This mill scale may cause indentations and render the material useless for the purpose intended. The removal of much of the loose scale is accomplished by means of several jets of steam from pipes directly over the rolls which blow the scale off the plate as it is drawn through the rolls. Adhering scale is loosened by salt thrown over the surface of the plate. The salt combined with moisture upon the hot plate causes an explosion which loosens much scale that would otherwise adhere to the surface.

At the final pass of the plate through the rolls, the plate has lost much of its heat. The ends of the plate may turn upward several feet and the general surface is decidedly uneven at this stage. It is then carried along the moving run where it enters the straightening mill for its final rolling before going to the laying out beds.

Straightening rolls are much smaller than the initial breaking down rolls. Their chief function is to straighten the plate before it becomes too cool, as after the temperature has fallen below the point of pliability little work in the way of making a practically flat surface may be accomplished. After passing the final rolls, the plate is transported by means of moving rollers to the laying out bed where the pattern is laid out.

Rolling mills are costly to construct. Continuous operation is most desirable. Material spoiled during rolling must generally be remade with a consequent loss to the mill worker and manufacturer. The operators must be men of unusual ability and long experience or the result of breakage of the mill or rejected material will not be successful financially.

Wrought Iron Boiler Resists Corrosion for Century

LOSSES from corrosion have been increased in recent years because of the increasing tendency to use mild steel at every opportunity, simply because of cheapness, instead of wrought iron. Obviously, one of the main remedies is to return to a considerable extent to the use of non-corroding iron of this character, especially when the weight of the metal is not so great.

As to why good class wrought iron should be non-corrosive is something of a mystery, but a striking indication of that property is being exhibited in England by a Bradford concern, which has had a cross section of genuine best Yorkshire bar iron taken out of a "wagon" boiler after having been in use for over 100 years. This appears to be all the more extraordinary because the water was of very bad quality, being 26 degrees total hardness and not softened or treated in any way whatever. The bar is still today 85 percent of its original cross sectional area and an ordinary steel bar under the same conditions would have been more or less completely dissolved probably 50 or 60 years ago.

Successful Drilling of Manganese Steel

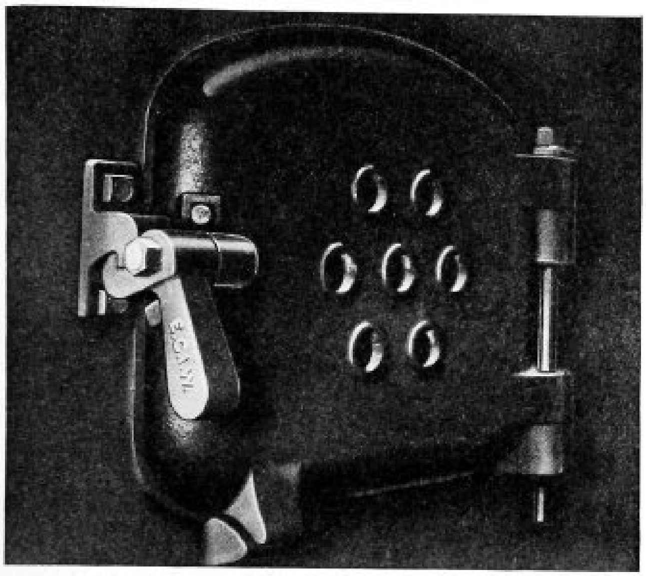
THE Morse Twist Drill & Machine Company, New Bedford, Mass., has recently developed a drill capable of machining high manganese steel. This has hitherto been considered more or less impractical.

With the advent of a new cobalt steel the company was able to successfully drill railroad frogs with a chemical content of 1.08 carbon, 10.04 manganese and with a Brinell hardness of 207-217. This was accomplished with a drill of special structure to withstand extreme torque and point pressure. On one grind it was possible to drill nine holes 1½ inches deep through this railroad frog.

Fire Door Safety Latch

THE Erie City Iron Works, of Erie, Pa., has recently developed an improved safety latch which will conform to the requirements of any state inspection department.

The Ohio Board of Boiler Rules has adopted regulations governing latching devices on fire doors which require that "All steam boilers carrying pressures in



Fire door safety latch

excess of 15 pounds per square inch shall have firing doors of inward opening type, unless such doors are provided with substantial and effective latching or fastening devices or otherwise so constructed as to prevent them when closed from being blown open by pressure on the furnace side. These latches or fastenings shall be of the automatic positive locking type, having a latch or bolt in a fixed bracket on the door frame or furnace front. The latch or bolt must be dependent upon gravity or counterweighted. Friction contacts, latches or bolts actuated by springs shall not be used. The material and construction of the device shall be durable and substantial." Such are the requirements for which this new latch has been designed.

Drilling Jig for the Boiler Shop

IN order to save time and labor, the combination revolving jig as shown in the accompanying illustrations has been adopted at the Colonie Shops of the Delaware & Hudson Railroad. This kink, designed by Harry A. Lacerda, is used for drilling boiler fronts and smokebox rings.

The boiler fronts are placed on this jig and tightened down by means of a keyway and tapered key forcing down a sliding strap which firmly holds the boiler front

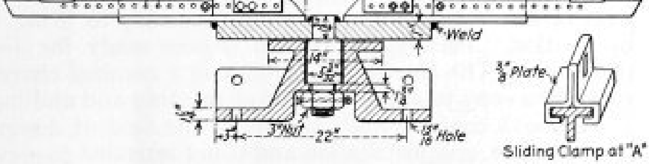


Fig. 1.—Cross section of combination drilling jig

in place. Fig. 2 shows a boiler front ready for drilling.

Smokebox rings are fastened to the jig by means of a keyway and tapered key and sliding strap as shown

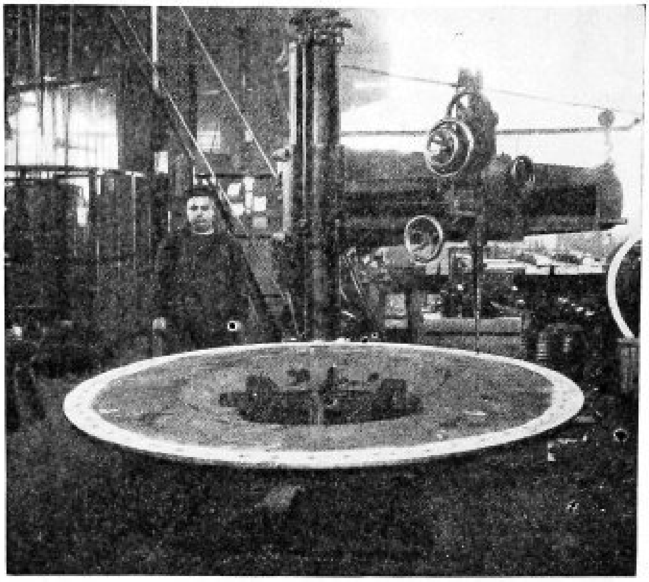


Fig. 2.—Drilling jig set up for boiler fronts

in detail *A* in Fig. 1. Fig. 3 shows a smokebox ring in place.

This jig is adjustable and will accommodate boiler fronts and smokebox rings of various diameters. The absence of bolts and the use of wedges simplify the operation of this machine and facilitate the movements necessary to place the boiler front in position.

The use of cranes has been dispensed with during the actual operations of drilling and blocking is not found necessary. The revolving feature permits faster drilling in moving the machine from one hole to the

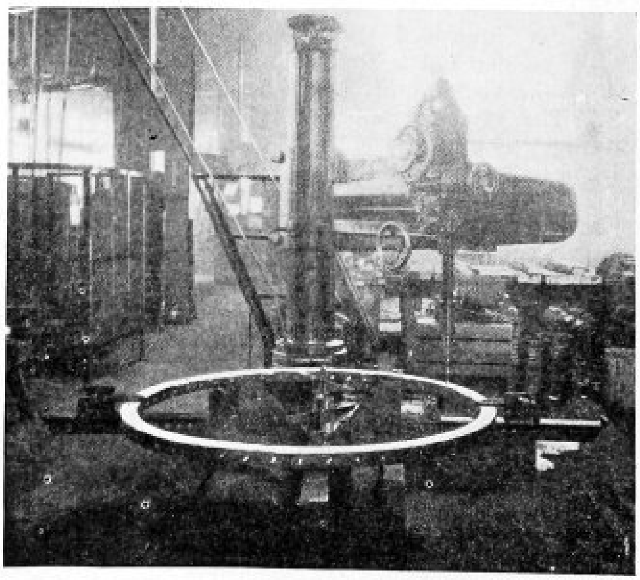
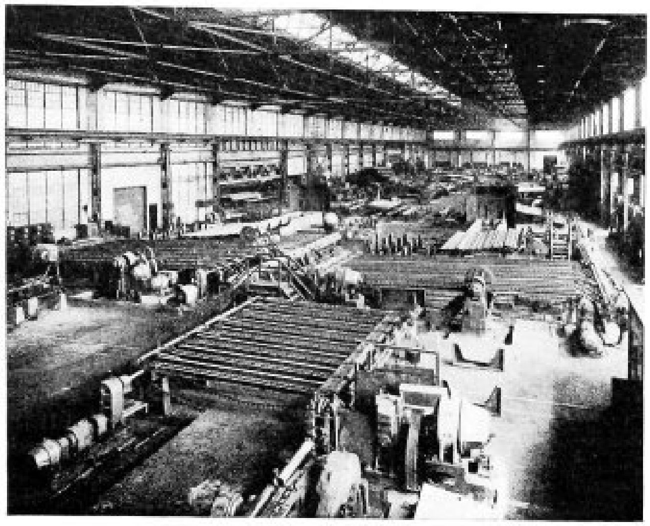


Fig. 3.—Combination jig showing smoke box ring in place

other. One man may operate the drill and move the work at the same time thereby rendering a further reduction in labor. It is also estimated that a 60 percent increase in drilling speed may be obtained by the use of the combination jig.

New Bethlehem Pipe Mills in Full Operation

ACCORDING to a recent announcement, the new pipe mills of the Bethlehem Steel Company, at the Maryland plant, Sparrows Point, Md., are now in full operation. The pipe unit comprises 2 butt



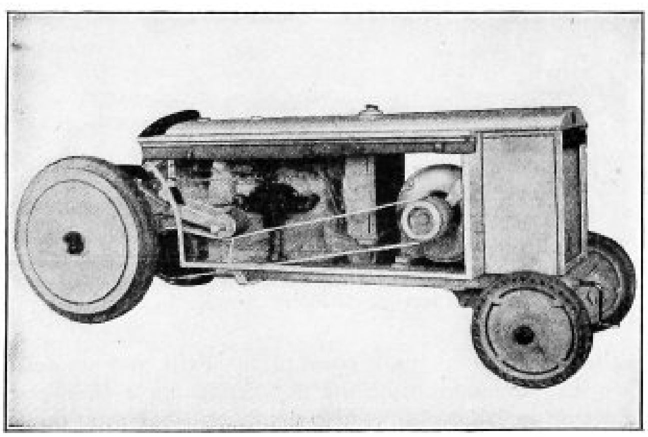
Interior view of Bethlehem Pipe Mills

mills designed for the manufacture of butt welded pipe, from 1/8 inch to 3 inches in diameter; 2 lap mills equipped to manufacture all sizes of lap welded pipe, from 2 inches to 16 inches in diameter; a galvanizing department and all auxiliary equipment.

New Welder Tractor Combination

AN improved combination of an electric arc welder and a Fordson tractor is now offered by the General Electric Company, Schenectady, N. Y. The principal improvements consist of the substitution of a new type welding equipment and the addition of head and tail lights and a protective cover.

The principal equipment consists of a standard Fordson tractor, belt-connected to a type WD-300-A, 25-volt, 300-ampere one-hour rated 1,750 -revolutions per minute, ball-bearing generator. This unit is mounted



Side view of welder showing belt connected to generator

directly on the tractor and is protected by a metal canopy and canvas side curtains. Other equipment includes a governor, power take-off, muffler, waterproof pulleys on engine and generator, belt and belt tightener, industrial (disk type) rubber tired wheels front and rear, extension frame, off-set crank, control panel and reactor, head and tail lights, and battery and charging control. As optional equipment the following are available: light industrial (spoke type) wheels front and rear; standard Fordson farm wheels front and rear, and any other desired accessories.

The overall length of the complete unit is 12 feet; the height is 4 feet 8 inches; the width is 5 feet 2 inches, and the net weight is approximately 4,900 pounds.

Among other applications, this equipment is particularly useful to welding contractors, boiler shops, marine repair shops, structural field contractors, oil well drilling companies, oil refineries, pipe line owners and tank builders. The outfit has been particularly designed to provide such activities with a complete, portable welding machine suitable for hard, continuous use. The utility of the tractor as a hauling device has not been impaired. For field use, the unit will haul equipment and tools to the job and then supply welding current for the work. For welding pipe lines and for use along railroad rights of way, extra long welding leads are not necessary because the equipment is so easily moved at a moment's notice.

Folder Describes New Staybolt

THE Flannery Bolt Company, Pittsburgh, Pa., is now distributing a folder entirely devoted to an analysis of the physical improvements effected in the Tate staybolt which has resulted in the Nu-Tate bolt, which is especially adapted to use in modern high pressure locomotive boilers. This new type staybolt, in order to obtain the results desired, is put through a case-hardening process which is designed to harden the surface of the bolt head, thus minimizing wear and friction when the bolt is drawn tightly against its seat in the sleeve. The tensile strength of the head and the neck of the bolt has also been increased, it is claimed, to such an extent as to make it practically impossible to break off the head of the bolt. Finally a special heat treating process is given to the bolt after forging, in order to insure uniformity in the grain structure. These three points of development are aptly illustrated by micro-photographs.

New Edition of "The Boiler Book"

"THE Boiler Book" was first published by The Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., about six years ago for the purpose of presenting, in convenient form, some of the data most frequently required for the design, manufacture, and installation of boilers and other pressure vessels. The fact that the first edition was so soon exhausted seemed to indicate that the book was playing a useful role and led to the decision to publish a second edition with certain changes and addenda necessary to bring it up to date. This second edition is now ready for distribution by The Hartford Company at a nominal charge of $1.00 a copy to cover the cost of printing and mailing.

The book confines itself strictly to the field of design, manufacture, and installation and is not intended to serve as a handbook for boiler operators.

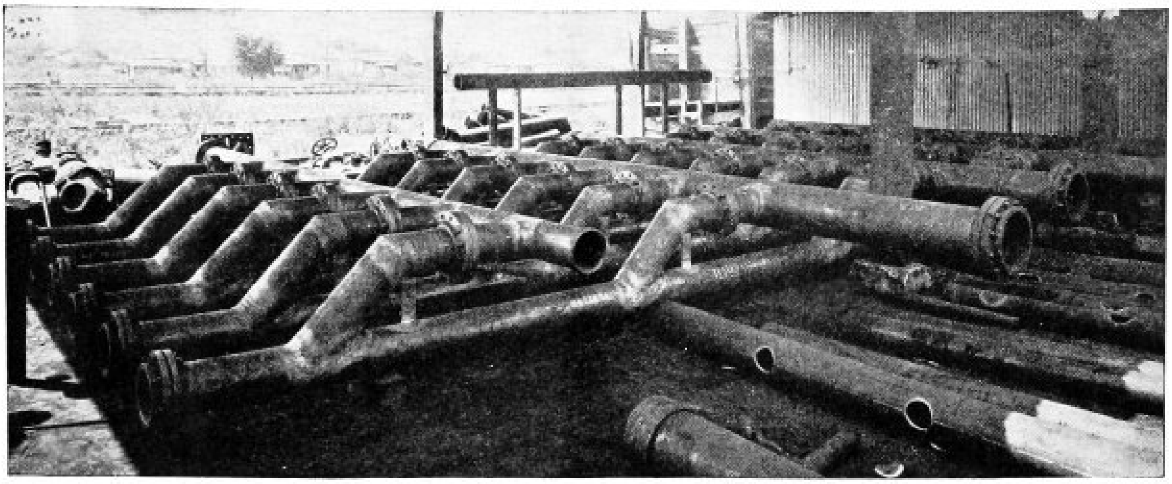


Fig. 1.—Welded pipe manifold

Templates for Pipe Fittings*

By following these suggestions, patterns for bends, tees and branches can be quickly made

ONE of the important reasons for oxwelding pipe work is that any fittings can be made as desired; elbows, tees, branches or any fitting, no matter how complicated, or how close coupled.

The simplest pipe fitting is of course the elbow or bend. A 90-degree bend, for example, can be made very quickly by simply cutting through a piece of pipe on a plane intersecting it at an angle of 45 degrees, and then welding the two pieces together so they form a right angle.

On very small pipe it is of course possible to make such a 45-degree cut without guide lines extending around the pipe, but for the larger sizes of pipe it is necessary to have some means for marking the correct location of the cut on the pipe.

* Published through the courtesy of *Oxy-Acetylene Tips.*

This brings up the question of pipe patterns or templates. Many welders seem to consider this subject extremely complicated, but if they will follow the suggestions outlined here they will soon have a thorough working knowledge of template construction and will be agreeably surprised to find that it is not at all a difficult matter.

No elaborate drafting equipment is required; simply the following material:

- Straight edge ruler
- Square
- Dividers
- Angle protractor
- A sizeable piece of heavv paper.

Elements of Template Construction

If a piece of thin sheet metal were wrapped tightly around a piece of pipe and a cut then made with a big hack saw working in a plane of 45 degree to the axis of the pipe through both pipe and sheet, the two pieces of sheet metal would each form a template for a 45-degree cut on that size pipe. If the template were then spread flat it would be found that the cut edge was not a straight line but a wave like curve. The question to be solved is "How reverse this process? How can the required curve be made on a template without going through the procedure just outlined?"

Development of a Pipe Surface

Let *A* in Fig. 2, represent a cylinder of thin material, the diameter of which is equal to the outside diameter of the pipe at hand. Consider this cylinder divided lengthwise into a number of equal sections; 16 is most convenient. Viewed directly from the end, the cylinder would appear as a circle, *B*. If the cylinder were cut along any element and then rolled out flat, it would become a rectangle divided into sixteen equal sections. From these three drawings *B, C* and *D*, reproduced full size for the size of pipe being used, any simple template can be quickly made.

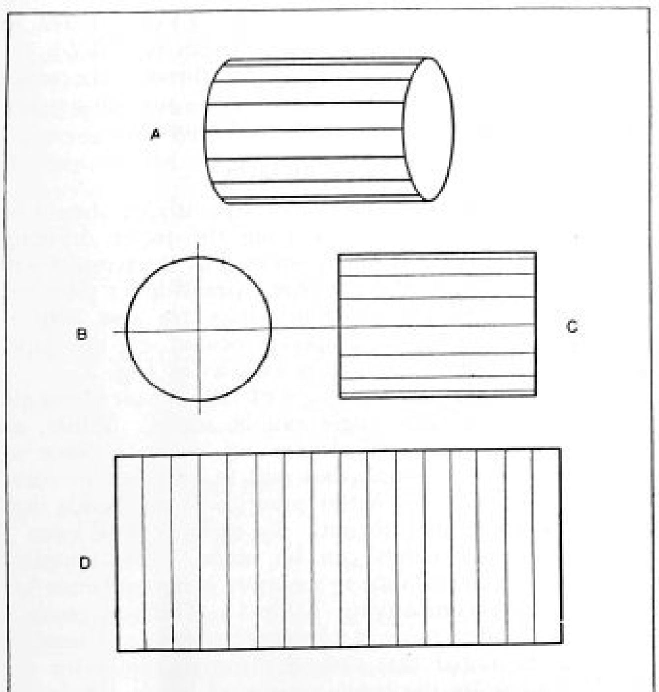


Fig. 2.—Elements of a template

To reproduce these full size, the only measurements necessary are outside diameter of the pipe and the outside circumference. The latter may be measured with a tape or by simply wrapping a strip of paper tightly around the pipe and marking the point of overlap.

In the upper left hand section of a sheet of heavy paper somewhat wider than the pipe circumference draw a circle with diameter equal to the measured outside diameter of the pipe. See *B*, Fig. 3. Divide this circle into 16 equal parts as follows: Draw the vertical diameter *a-i*. With the protractor at the center of the circle, *o*, measure an angle of 22½ degrees from *o-a*. The line forming this angle will cut the circumference at *b* and *a-b* will be 1/16 of the circumference. Set the points of the dividers on *a* and *b*, and use this length to divide the circumference into 16 parts. On the diagram Fig. 3 all these points have been lettered, and it is advisable to letter the first few templates to correspond. Once the principle has been grasped, it will be unnecessary to continue the lettering.

Now draw long horizontal lines from *a* and *i* perpendicular to the diameter *a-i*. Also draw long lines through *b* and *b'*, *c* and *c'*, etc., forming a series of parallel lines. At any convenient point on this series, measure off a rectangle, as at *C*, Fig. 3. The length *l*, of this rectangle should be somewhat greater than the pipe diameter, say about 1½ times the outside diameter of the pipe.

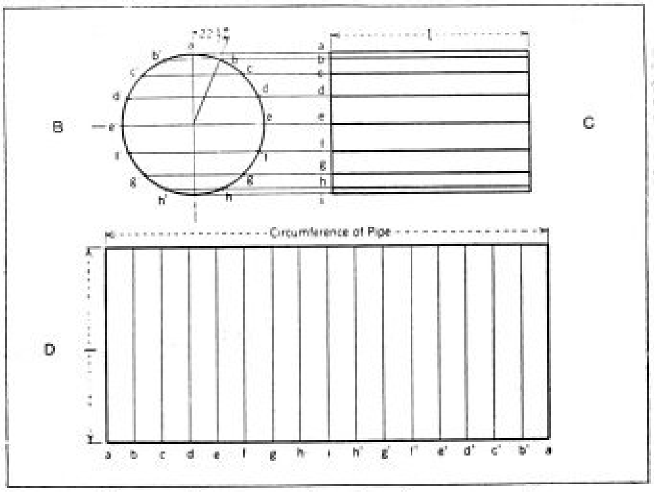


Fig. 3.—First steps in drawing a template

Below these draw the rectangle *D* with width equal to the circumference of the pipe and height equal to *l*, the length of rectangle *C*. Divide *D* into 16 equal parts as shown. If, as is often found, the circumference is an odd figure not easily divisible by 16, try dividing the rectangle first into 4 parts and then using the dividers to divide each of these into 4 again. A little manipulation of the dividers will quickly give the length that is exactly ¼ of each quarter section or 1/16 of the whole. Even simpler is to take a strip of paper of same length as rectangle *D*, fold it in half, then in half again until divided into 16 parts. Then unfold and mark off the divisions on rectangle *D*.

Template for 45-Degree Intersection

Assuming that a 45-degree template is wanted, draw a line through the lower right hand corner of rectangle *C*, making an angle of 45 degrees with the right hand side of the rectangle. Line 1-9 at *C* in Fig. 4 has been drawn thus.

Remembering that rectangle *C* represents a cylinder; if the portion to the right of line 1-9 were removed and the remainder flattened out, we would have the desired 45-degrees template. Since rectangle *D* represents the entire cylinder flattened out; how can we show what the cut portion would look like?

Very simply. As long as the cylinder is square cut at each end, the horizontal lines in rectangle *C* and the vertical lines in rectangle *D* are all of equal length *l*. But when we consider the cylinder cut at an angle at one end, as in *C*, Fig. 4, the horizontal lines are no longer equal. The length of the line from *a* is now *a-l* instead of *L*; that from *b*, *b-2*, etc.

Accordingly, we must change the lengths of the verticals in rectangle *D* to correspond. Measure *a*-1 on rectangle *C* with the dividers and lay this length off at either end of rectangle *D*, since the cylinder was split along the line through *a*. Now set the dividers to length *b*-2 on rectangle *C* and lay off *b-2* and *b'*-2 on rectangle *D* as indicated. A moment's study of the drawing will show why *b'-2* is equal to *b-2*. With the dividers set at *c-3*, on rectangle *C*, *c-3* and *c'-3* are next marked on *D*. Continue in this way until all the verticals in rectangle *D* have been corrected. (Vertical *i*-9 of course remains unchanged as its length is still *l*.)

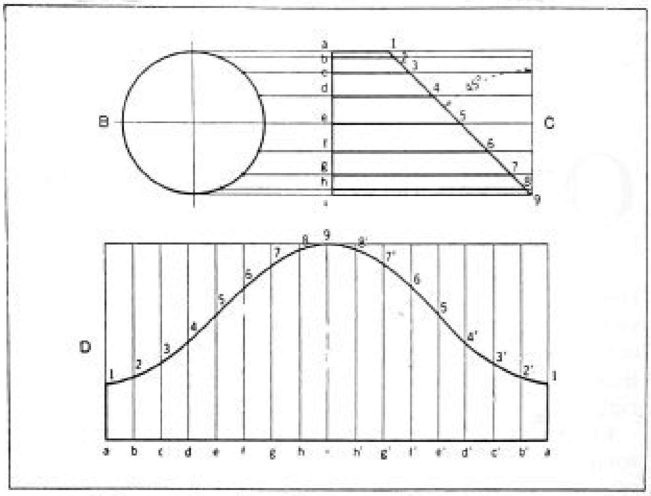


Fig. 4.—Drawing for a 45-degree template

Finally, draw a curved free-hand, through the series of points on the verticals, making it as smooth as possible. This curve forms the desired templet.

Metal Templates

If the template is to be used frequently, it should be cut out in thin sheet brass, using the paper drawing merely as a pattern. A tab at one end of the templet will aid in holding it around the pipe. Small holes punched along the half and quarter divisions are also helpful in getting the templet properly located on the pipe. The finished templet will then look as in Fig. 5.

Simply by changing the angle of line 1-9 on rectangle *C*, a template of any angle can be made. While, as noted above, a single 45 degree cut across a piece of pipe will give two pieces that will fit together to form a 90-degree bend, it is better practice to use bends that are not so sharp and abrupt. By using 3, 4 or even 5 pieces, smoother bends can bo made. The template angles necessary for making the more common bends are given in the accompanying Table 1. Thus, to make a 90-degree bend, 4-piece, a 15-degree template is needed.

It will be noted that only 8 different templates are required to make the large variety of bends tabulated; indeed, neglecting 10 and 20-degrees (which appear only once each) the six remaining templates form a most useful set.

As shown in Fig. 6, a master template for the whole set can be easily made on a single drawing. The individual templates are made by placing the master template on a piece of sheet brass and marking the corners

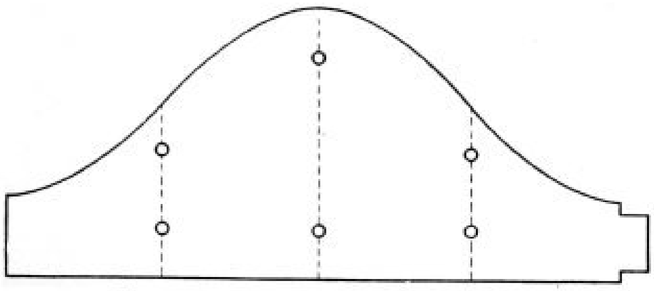


Fig. 5.—Completed 45-degree template

and points along each curve with a center punch. Any other series can be made in the same way. Each size

Table I—Angles for Multi-Piece Bends

Total Angle of Bend, Deg.	Template Angle for 2-Piece (1 Weld)	3-Piece (2 Welds)	4-Piece (3 Welds)	5-Piece (4 Welds)
15	7½	—	—	—
22½	11¼	—	—	—
30	15	7½	—	—
45	22½	11¼	7½	—
60	30	15	10	7½
90	45 (a)	22½	15	11¼
120	—	30	20	15
180	—	45 (a)	30	22½

(a) These should be avoided wherever possible in pipe carrying fluids at considerable velocity, as the angle is too sharp. Use instead a bend having a larger number of pieces.

of pipe will, of course, require a separate set of templates, but the time spent in making templates is quickly repaid by the ease with which neat, accurate fittings can be made.

Using the Templates

To use a template simply wrap it tightly around the pipe at the point where the cut is to be made and center punch a line on the pipe along the curved edge. In following this line with the cutting blowpipe, hold the blowpipe so the pipe walls are cut through at the same angle as the intersecting plane. This will require a little practice, as the angle at which the blowpipe is held changes continually. The correct result is a miter cut; the same as though the cut had been made in a miter box.

When cut in this way, the edges of the two pieces of pipe will fit snugly together to form the bend. As this close contact corresponds to an unbeveled end in straight lengths, each piece should be beveled before welding. When the beveled pieces are fitted togther forming the bend, there will then be a good vee all around the line of weld. The pieces are cleaned, tacked and welded.

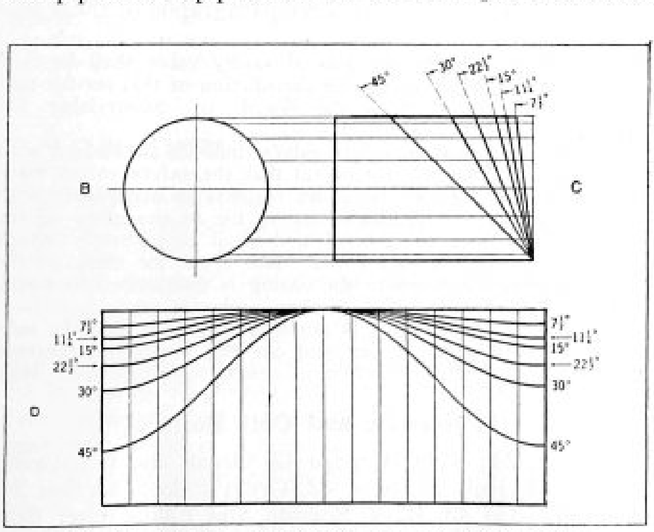


Fig. 6.—Master drawing for a set of templates

Templates for Tees and Branches

Even where one pipe intersects another, as in tees and branches, it is not at all difficult to draw a template. Sometimes two templates are used for a tee or branch, the first to cut off the end of one pipe (called the branch), and the second to form a companion hole in the other pipe (called the header). For all except the most exacting work, the second template may be dispensed with entirely. The branch as cut with the first template can be used as template for marking the hole in the header.

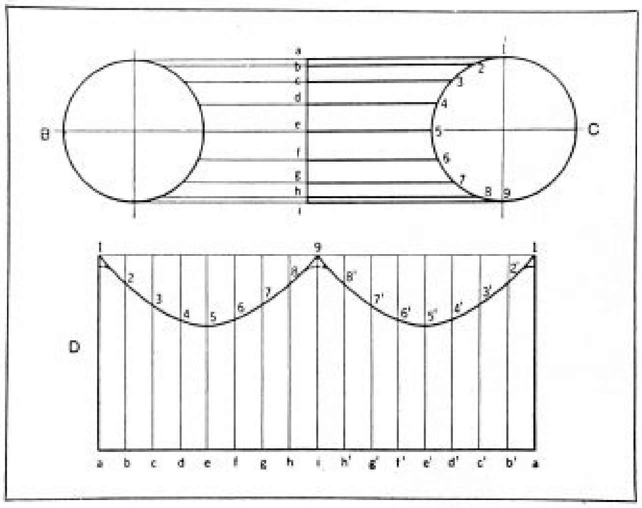


Fig. 7.—Template for branch—Branch and header same size

Fig. 7 shows how extremely simple the development is for a tee where branch and header are of the same diameter. Instead of cutting the end of cylinder *C* at a sloping line, it butts into a circle, representing the side of a piece of pipe. The lengths of each element are scaled from *C* and laid off on *D* exactly as described above. The sharp points at 1 and 9 on *D* should be rounded off in the finished template as shown by the dotted lines.

Application of Template

Use this template for the end of the branch, making the cut square instead of mitred.

Then set the branch in position on the header (it should fit closely), and trace a chalk line around it. Cut out the hole, making the edges square.

Then bevel the hole all around. It is not necessary to bevel the branch, but it should be fitted into the header before welding and any parts that may project inside the header should be cut off. Then tack the branch in position and weld.

Where the branch and header differ in diameter the development is quite similar, shown in Fig. 8.

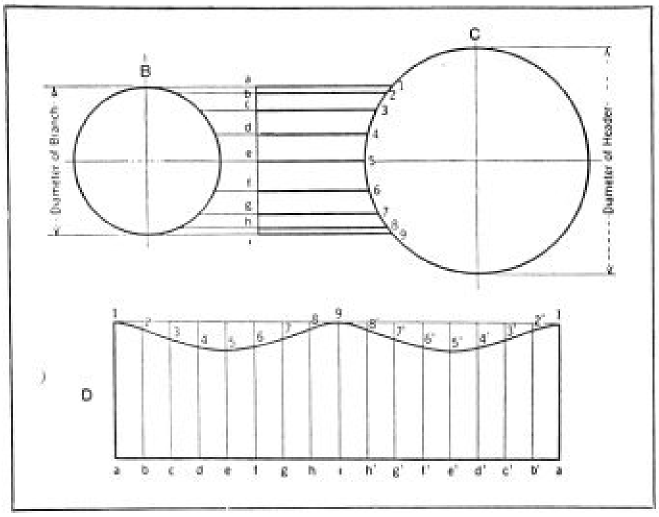


Fig. 8.—Template for branch—Branch and header not same size

Making an Angle Branch—Template Not Required for This Case

When the branch is not at right angles to the header, or does not intersect it on the center line, the following method can be used. It has the advantage of not requiring a template.

Block the branch at the desired angle and position to the header. The end of the branch can be held firmly in position on the header by means of a small tack weld. Along the upper side of the branch lay a straight edge with the end *A* (Fig. 10) just touching the header. Mark the straight edge at a point *B* near the end of the branch, and mark the branch at *B* also.

Move the straight edge around the branch, keeping it parallel to the center line of the branch and having point *A* touch the header at all times. Mark on the branch the various positions of *B* as the straight edge is moved around the pipe. Draw a smooth curve through these points.

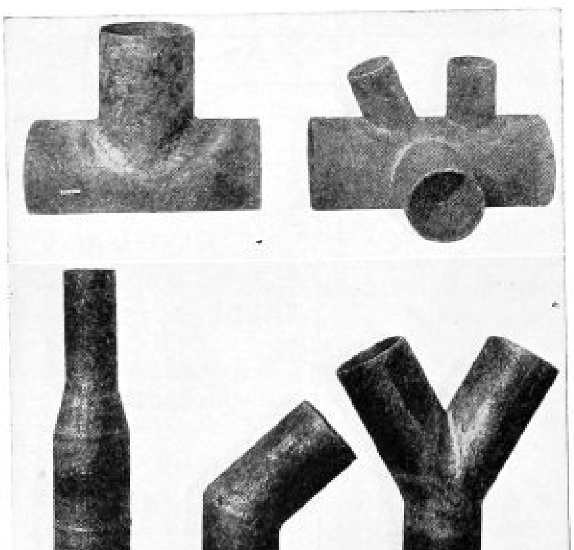


Fig. 9.—Typical gas welded fittings

Then cut the branch along the curve and see if it will fit snugly against the header at the correct angle. If not, trim the edge until it does. Then place it in position on the header and mark off the curve of intersection. Cut the hole out square.

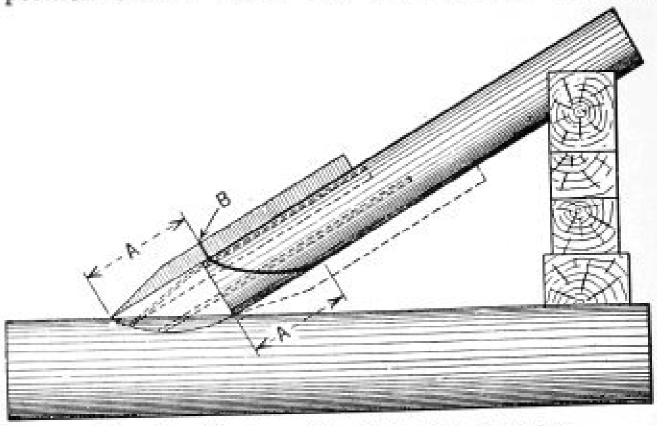


Fig. 10.—Simple method for angle branches

Bevel the edges of both header and branch. When fitted together there should be a good vee all around.

Changes in Boiler Rules

UNDER the provisions of section 4405, Revised Statutes of the United States, the Board of Supervising Inspectors, Steamboat Inspection Service, at a regular annual meeting held in Washington, D. C., from January 18 to 31, 1928, inclusive, adopted the following amendments of the General Rules and Regulations prescribed by the Board of Supervising Inspectors. These amendments of the rules, having received the approval of the Secretary of Commerce, have now the force of law and must be observed accordingly.

Unless otherwise indicated, the changes in the rules will be shown by the use of line type to indicate parts struck out and by printing in *italic* the additions to the rules. Only such rules as apply to boilers appear below:

Boilers and Attachments—Safety Valves

Section 23, Rule II, page 38, Ocean and Coastwise; section 23, Rule II, page 37, Great Lakes; Bays, Sounds, and Lakes other than the Great Lakes; and Rivers, General Rules and Regulations, were amended by making the following the first three paragraphs of these sections:

After June 30, 1928, no type of safety valve shall be used on any vessel coming under the jurisdiction of this service that has not been approved by the Board of Supervising Inspectors.

The manufacturers of safety valves shall file an affidavit with the Supervising Inspector General that the safety valves manufactured by them will be in all respects in accordance with the blue prints and specifications on file in the office of the Supervising Inspector General and shall permanently attach a name plate to the valves that shall show the name of the manufacturer, the pressure the casing is guaranteed to stand, diameter, seat area, serial number, and capacity.

Before any safety valve is put into service it shall be subjected to a pressure of one and one-half times the pressure it is to be subjected to when in actual service. (Sec. 4418, R. S.)

Watertube and Coil Boilers

Section 24; Rule II, page 43, Ocean and Coastwise; section 24, Rule II, page 42, Great Lakes; section 24, Rule II, page 42, Bays, Sounds, and Lakes other than the Great Lakes; and section 24, Rule II, page 42, Rivers, General Rules and Regulations, were amended as follows:

Duplicate blue prints or drawings of watertube and coil boilers, with their specifications, shall be submitted for approval to the Board of Supervising Inspectors (under sec. 4429, R. S.), and the design approved by said board, before the boilers will be allowed to be used on any vessel coming under the jurisdiction of the Board of Supervising Inspectors. After the approval of the design by the said board, one certified set of the approved blue prints or drawings shall be filed with the records of the Board of Supervising Inspectors, and (one certified set with the records of the supervising inspector of each district, and one set of blue prints shall be furnished the office of the local inspectors of the district in which the boiler is manufactured.) *60 certified sets of the blue prints or drawings shall be furnished the Supervising Inspector General for the use of supervising and local inspectors. (Sec. 4405, R. S.)* The blue prints or drawings necessary to comply with the foregoing provisions shall be supplied by the manufacturers. Manufacturers shall furnish local inspectors of districts where boilers are to be installed an affidavit certifying that the boilers are constructed in accordance with the (design and) specifications approved by the Board of Supervising Inspectors.

Hydrostatic Pressure

The first paragraph under the caption "Hydrostatic Pressure," page 44, Rule II, all classes of the General Rules and Regulations, was amended as follows:

All coil and pipe boilers hereafter made, when such boiler is completed and ready for inspection, shall be subjected at the first inspection to a hydrostatic pressure (double that of the steam pressure allowed in the certificate of inspection) *at a ratio of 150 pounds to steam pressure of 100 pounds.*

Pipe Boilers Approved

Under the provisions of section 4429, Revised Statutes, the board took the following action on boilers not constructed of riveted iron or steel plates:

O'Brien longitudinal drum watertube boiler, presented by the John O'Brien Boiler Works Company, St. Louis, Mo. Approved.

Vincent steam generator, presented by the Steam Automotive Corporation, Oakland, Calif. Approved.

Hawley boiler, presented by Hawley Inventions (Inc.), Minneapolis, Minn. Approved.

Marine boilers manufactured by the Babcock & Wilcox Company, New York, N. Y. (Changes in design in the drum construction of the boilers to improve the conditions for complete inside calking.) Approved.

Nelis steam generator, presented by Joseph J. Nelis, vice-president, Foster Marine Boiler Corporation, New York, N. Y. (Changes: Elimination of lower row of tubes, the same being replaced with a longer tube to make a water-cooled arch. These longer tubes terminate in a 10-inch lap-welded steel header and from the top of this header complete the circulation by six tubes back to the main drum, as shown by blue print No. N. Y. M. B. 261-22. Also change with reference to placing additional pipe on boiler, removing brickwork from the furnace and making a steam generator by pipes placed in lieu thereof, as shown on blue print No. N. Y. M. B. 281-1.) Approved.

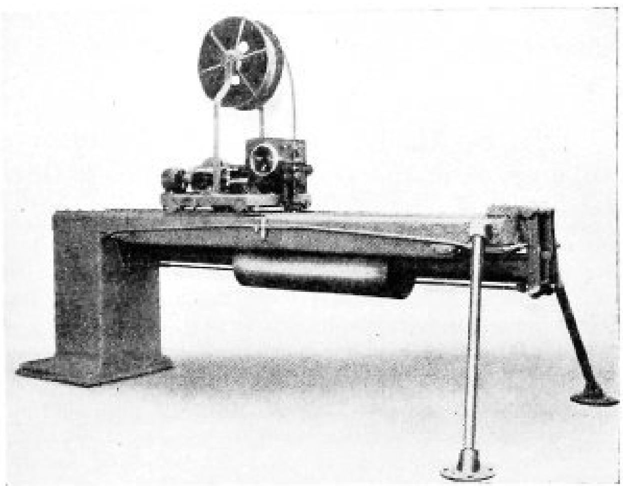
Automatic Arc Seam Welder

THE new automatic welder for longitudinal seams, developed by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., was specially designed for the manufacture of pipe and tanks made from steel sheet and plate with thicknesses of 1/16 inch to 3/8 inch. The standard machine will handle pipe and tank barrels varying in diameter from 10 inches to 40 inches, and of maximum length of 8 feet. Greater diameters may be accommodated for by providing a pit in the floor.

The machine consists of two parts; a clamping mechanism for holding the material to be welded and an automatic arc, traveling welder for making the weld.

The clamping mechanism is attached to a horizontal bridge, supported at one end by a heavy base and at the other by a pipe support. This bridge consists of two parallel beams about 4 inches apart. Below the space between these beams, and parallel to them, projects a standard, railroad rail as a cantilever from the heavy base. The tank to be welded is slipped over the free end of this rail and clamped tight by compressed air clamps with the seam to be welded extending along a copper backing strip on top of the rail. The seam to be welded is thus tightly clamped in a horizontal position. On top of the two parallel beams is machined a track for the traveling welder.

The traveling welder consists of a carriage containing a driving motor, an automatic arc welder, and a reel of welding wire. The carriage is driven in either direction along the cast iron bridge through a reduction gear which may be adjusted to speeds from 5 inches to 50 inches per minute. The welder automatically feeds the welding wire to the arc, maintaining a uniform arc voltage and producing a uniform welded seam. The welding current may be varied from 175 amperes to 300 amperes. The carriage runs on roller bearings and is equipped with a clutch by which it may be released from gear and rolled freely along its track. Thus no time is lost in cases where it is desired to build up each weld in the same direction.



Traveling welder for tank work

This machine can be furnished in modified form to handle work with diameters as small as 6 inches and of maximum length of 20 feet. However, in cases requiring special material clamping equipment, the traveling welder is furnished as a separate unit.

The Wagner Electric Corporation, with home offices at St. Louis, Mo., has announced the removal of the New York city branch sales office from 50 Church street to 30 Church street. The New York city service station still remains at 321 West 54th street.

J. H. Williams & Company, Buffalo, N. Y., and the Husky Wrench Company, Milwaukee, Wis., have formed a selling combination for the purpose of marketing the Williams "Super-renches" and "Husky" socket wrenches.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by C. J. Zusy

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.*

A. S. M. E. Code Calculations

Q.—I hope you can favor me in an early issue of *The Boiler Maker* with an illustration of the method of calculating in the Power Boiler Section of the A. S. M. E. Code paragraphs 180-260 and 261, using dimensions of any power boiler carrying 180 pounds or more pressure, as I am studying for deputy state inspector. C. M. C.

A.—For the benefit of those who do not have a copy of the A. S. M. E. Boiler Construction Code at hand I will quote the paragraphs questioned.

P-180. The maximum allowable working pressure on the shell of a boiler or drum shall be determined by the strength of the weakest course, computed from the thickness of the plate, the tensile strength stamped thereon, as provided for in the Specifications for Steel Boiler Plate, the efficiency of the longitudinal joint, or of the ligament between the tube holes in the shell or drum (whichever is the least), the inside diameter of the course, and the factor of safety.

$$\frac{TS \times t \times E}{R \times FS} = \text{maximum allowable working pressure pounds per square inch}$$

where,

TS = ultimate tensile strength stamped on shell plates, as provided for in the Specifications for Steel Boiler Plate, pounds per square inch.

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

E = efficiency of longitudinal joint or of ligaments between tube holes (whichever is the least).

R = inside radius of the weakest course of the shell or drum, inches, provided the thickness of the shell does not exceed 10 percent of the radius. If the thickness is over 10 percent of the radius, the outer radius shall be used for R.

FS = factor of safety, or the ratio of the ultimate strength of the material to the allowable stress. For new constructions FS in the above formulae = 5.

The factor of safety used in determining the maximum allowable working pressure calculated on the conditions actually obtained in service shall not be less than 5.

To illustrate the above formula we will consider a boiler shell of the following proportions:

Inside diameter, 88 inches.

Thickness of shell, 13/16 inch.

Efficiency of longitudinal joint, 92 percent. This efficiency is for a butt and double strap joint, quadruple riveted.

Tensile strength stamped on shell plate, 55,000 pounds per square inch.

The thickness of the shell being less than 10 percent of the inside radius of the shell, the value of R in the formula should be 44.

Then,

$$\frac{55{,}000 \times 0.8125 \times 0.92}{44 \times 5} = 187 \text{ pounds, maximum allowable working pressure}$$

P-260. Manhole frames on shells or drums shall have the proper curvature, and on boilers over 48

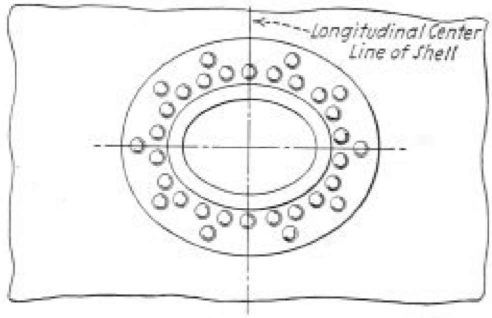


Fig. P-16.—Method of riveting manhole frames to shells or drums with two rows of rivets

inches in diameter shall be riveted to the shell or drum with two rows of rivets, which may be pitched as shown in Fig. P-16. The strength of manhole frames and reinforcing rings shall be at least equal to the tensile strength (required by paragraph P-180) of the maximum amount of shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell through the manhole, or other opening.

When a flanged manhole frame is used the

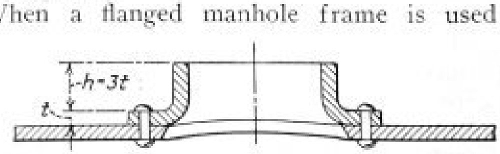


Fig. P-17.—Cross section of flanged manhole frame

flanged portion of the frame may be considered as reinforcement up to a height *(h)* of three times the flange thickness (see Fig. P-17).

To illustrate paragraph P-260 I have shown in Fig. 1 the manhole ring and liner that is used on the same boiler, the shell dimensions of which were used to illustrate paragraph P-180.

My interpretation of this paragraph is that the strength of the material added must be at least 100 percent of the strength of the material removed.

The ultimate strength of the material removed from the shell on account of manhole and rivet holes on a line parallel to the longitudinal axis of the shell is the 15½-inch diameter manhole plus two 1 1/16-inch rivet holes on each side of the ring or a total of 19¾ inches of boiler steel. The ultimate strength equals 19.75 x 0.8125 x 55,000=882,578 pounds. The 55,000 figure is the tensile strength stamped on the boiler shell.

The material added is, of course, the ring and the liner, both of which are made of boiler steel. The tensile strength of the plate from which the liner was cut was stamped with a tensile strength of 56,500 pounds per square inch and the ring, 57,300 pounds per square inch. Then the ultimate strength of the material added for the liner, is:

$[31.5 - (15.5 + 4 \times 1.0625)] \times 0.75 \times 56{,}500 = 497{,}906$ pounds for the ring.

$[31.5 - (15 + 4 \times 1.0625 + 2 \times 0.875)] \times 1{,}625 \times 57{,}300 = 977{,}681$ pounds.

Total ultimate strength of the material added= $497{,}906+997{,}681=1{,}475{,}587$ pounds. The strength of the material added is far in excess of the strength of the material removed and therefore meets the requirements of paragraph P-260.

P-261. The strength of the rivets in shear on each side of a frame or ring reinforcing manholes or other openings such as those cut for steel nozzles and boiler flanges over 3-inch pipe size, shall be at

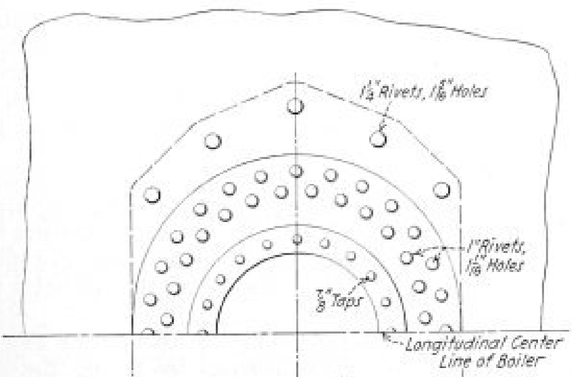


Fig. 1

least equal to the tensile strength (required by Par. P-180) of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell, through the manhole, or other opening.

This paragraph governs the number and size of the rivets in the ring and liner.

We will consider, for example, the manhole ring and liner as shown in Fig. 1. The ultimate strength of the material removed from the shell on account of manhole and rivet holes is shown in preceding paragraphs to be 882,578 pounds. To meet the requirements of this paragraph it is necessary that the total rivet shear of all of the rivets on one side of the longitudinal center line of the manhole be at least equal to 882,578 pounds.

By referring to Fig. 1 it will be noted that there are 27 rivets in double shear in the ring and 5 rivets in single shear in the liner. The rivets are steel with an ultimate shearing strength in single shear of 44,000 pounds per square inch of cross sectional area and for rivets in double shear 88,000 pounds per square inch of cross sectional area. In computing the cross sectional area of rivets, the area of the rivet after driving, or, in other words, the area of the rivet holes, should be taken.

The ultimate shearing strength of all the rivets on one side of the longitudinal center line of the manhole as shown in Fig. 1 is:

$27 \times 0.8866 \times 88{,}000 + 5 \times 1.353 \times 44{,}000 = 2{,}404{,}221$ pounds.

The ultimate shearing strength is far in excess of the strength of the material removed from the shell and therefore meets the requirements of paragraph P-261.

Broken Condenser Tubes

Q.—I am asking for a little information in regard to broken tubes in vertical condensers that are used to remove caustic soda. There are four of these condensers in a row; the first three are all right. In No. 4, I renewed all of the tubes, say 280 charcoal iron tubes 2 inches by 5 feet. The trouble is that they break off about 2 inches above the lower head and I am at a loss to know what is the cause of this and what to do to prevent this trouble. The tubes have been expanded with a self feeding expander, but are not beaded. This condenser is operated at about 7 pounds pressure and the caustic is boiled to about 200 degrees and then is drawn off. There are also seven 4-inch tubes in this condenser and they act the same way. Some would fracture in different places on the length of the tube but would not leak, but would almost be broken and with a tap of a hammer they would show up plainly. I have drawn a rough sketch which will give you some idea of the condenser. Any information pertaining to this letter will be greatly appreciated. I am a local boiler maker and this broken tube trouble has got me guessing.

D. T. S.

A.—In view of the fact that there are four so-called condensers for removing caustic soda, as shown in Fig. 1, identical in design, operating under the same tempera-

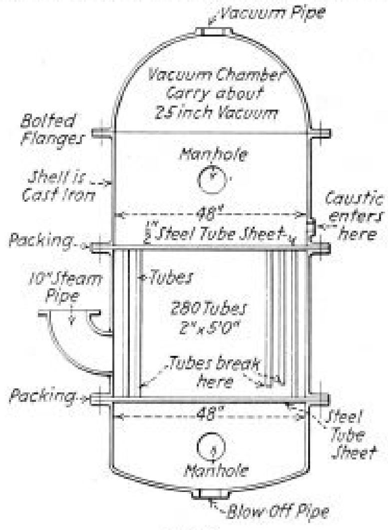


Fig. 1

tures and pressures, it would appear that the design or operating conditions are not responsible for the trouble you are experiencing with the tubes breaking in one of these condensers.

Eliminating the design and operating conditions from the question there are but two other things to be considered and they are material and workmanship. I believe we can safely disregard the possibility that defective material may be a contributing factor for the reason that if the trouble were defective material the tubes would not fail continually in exactly the same location.

This process of elimination leaves but workmanship to be considered. The only theory that can advance in the line of poor workmanship is that the tube holes in the lower tube sheet are oversize. If the tube holes are oversize, it can readily be seen that excessive expanding will have to be resorted to in order to make a tight job. This excessive expanding results in the rollers cutting into the tubes at about the location you state the tubes are breaking, and the tubes become weakened at this point and failure is very likely to occur. If the tube holes are oversize they should be shimmed so that excessive expanding is not required.

I would be pleased if you will advise if you found the tube holes oversize and if you resorted to the use of shims when applying the last set of tubes.

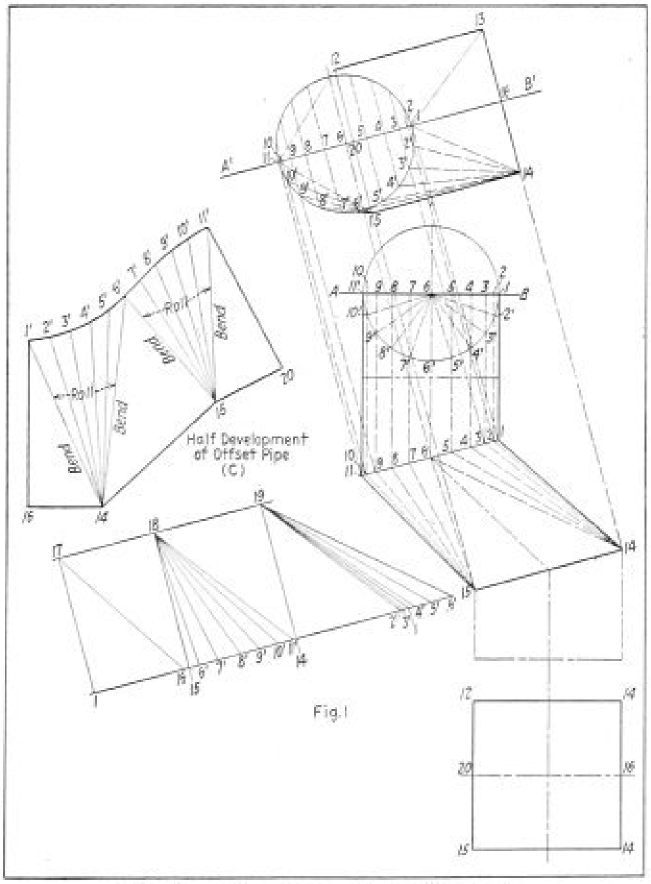
If any of our readers can advance any other theory as to the probable cause of these tube failures, I would be pleased to pass the information along to D. T. S.

Laying Out an Offset Pipe

Q.—I would like to know how to lay out an offset pipe or stack. The middle section is the part I am particularly interested in. The round end is 19 inches in diameter and the other end is 21 inches square.—E. G.

A. To develop the offset pipe as shown in Fig. 1, it is necessary to draw a plan and elevation.

It is necessary to draw the plan view in the same plane as the lines *1—11* and *14—15* in the elevation, which are the top and bottom planes and are parallel.



Details of development of offset pipe

Draw the horizontal center line *A'—B'* through the plan, thus dividing the object into symmetrical halves. It will now be seen that if a development is made of the lower portion, as seen in the plan, a duplication of the resultant figure will be the complete development.

The object consists of a square base which is offset and changes into a circle. The plan view then becomes a rectangle tapering into an ellipse.

To develop the ellipse, divide the half circle *A—B* into a number of equal spaces as *1'—11'*. Draw perpendiculars to the line *A—B* at points *1' to 11'* to cut line *1—11* of the elevation.

Erect perpendiculars to the line *1—11* at the points *1 to 11* in the elevation, same to cut line *A'—B'*. Where the line 2 intersects the line *A'—B'* step off the distance *2—2'*, taken from the half circle *A—B*, each side of the center line *A'—B'*. Follow the same procedure with line 3, 4, 5 etc. Connect these points forming an ellipse in the plan view.

The periphery of the ellipse in the plan view is divided into equal parts as *1—2', 2'—3', 3'—4'* etc. Draw the lines *1—14, 2'—14, 3'—14* etc.

Connect, in the elevation, the points *1—14, 2—14 3—14* etc. The surface of the object is thus divided into a number of triangles. The cord distances may be taken from the plan as they are there shown in their true lengths. A construction of right angled triangles is necessary, in order to find the true lengths of the lines *1—16, 1—14, 2—14,* etc.

The heights of all the angles which it is necessary to construct, are the same, due to both upper and lower bases being parallel. Draw perpendiculars *1—17, 15—18, 14—19,* take the distance *1—16* as shown in the plan and set it off with the dividers on the base line; in like manner *1—14, 2'—14, 3'—14* etc. as shown in the plan and proceed to copy all the distances there shown.

The true lengths of all the lines now having been determined triangles may be constructed as shown at (C).

Draw the lines *1'—16* equal in length to *17—16*; next describe an arc from the point *1'* as a center with a radius equal in length to the hypothenuse of the right angle triangle *19—14—1*, then describe an arc from point *16* as a center with a radius equal in length to the line *14—16* on the plan view. This completes the triangle *1'—16—14*.

Then taking the chord distances, *1—2', 2'—3', 3'—4'* etc. from the plan and the hypothenuse of the right angled triangle *19—14—2', 19—14—3'* etc., construct the angles in the development following the same procedure as for the triangle *1'—16—14* until all the triangles are completed.

The development is now complete to the line *14—6'*. The triangle *14—6'—15* is formed by taking the distance *14—15* the same length as *14—15* in the plan view as it is there shown in its true length and proceeding with the development of the angles, completing the development.

At a recent meeting of the board of directors of the Detroit Seamless Steel Tubes Company, Detroit, Mich., all of the retiring directors and officers of the company were re-elected for the coming year.

It is announced that the Ingersoll-Rand Drill Company with offices at 314 N. Broadway, St. Louis, Mo., was succeeded by Ingersoll-Rand Inc., on May 1. A new branch operating under the St. Louis office has just been opened at 226 West A St., Picher, Oklahoma. It is felt that by establishing this new office the company will be in a better position to serve its customers in northern Oklahoma, southern Missouri and Arkansas.

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

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—C. D. Thomas, Salem, Oregon.
Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.
Vice-Chairman—William H. Furman, Albany, N. Y.
Statistician—L. C. Peal, Nashville, Tenn.

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.; Poseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Avenue, Columbus, Ohio.

Master Boiler Makers' Association

President—W. J. Murphy, divisional boiler foreman, Pennsylvania Railroad, Olean, N. Y.
First-Vice-President—L. M. Stewart, general boiler inspector, Atlantic Coast Line, Waycross, Ga.
Second Vice-President—George B. Usherwood, supervisor of boilers, New York Central Railroad, Syracuse, N. Y.
Third Vice-President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington & Quincy Railroad, Lincoln, Neb.
Fourth Vice-President—Franklin T. Litz, general boiler foreman, Chicago, Milwaukee & St. Paul Railroad, Milwaukee, Wis.
Fifth Vice-President—Henry J. Raps, general boiler foreman, Illinois Central Railroad, Chicago, Ill.
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.

Boiler Makers' Supply Men's Association

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Vice President—J. C. Kunns, Burden Iron Company, Troy, N. Y.
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President—Starr H. Barnum, the Bigelow Company, New Haven, Conn.
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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,

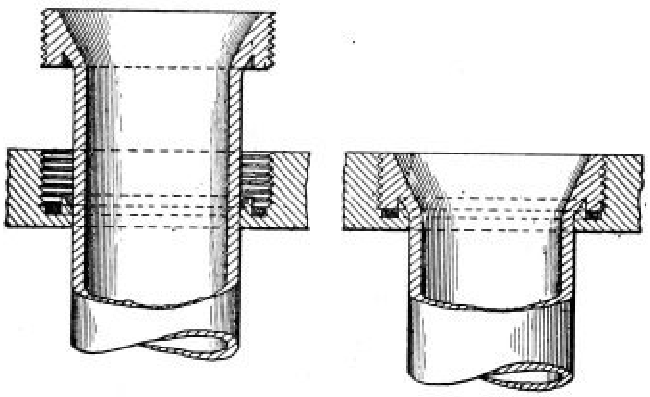
Washington Loan and Trust Building,

Washington, D. C.

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

1,658,525. ROBERT B. HOUSLEY, OF INDIANAPOLIS, INDIANA, ASSIGNOR OF ONE-HALF TO EVELYN C. HOUSLEY. FLUE JOINT.

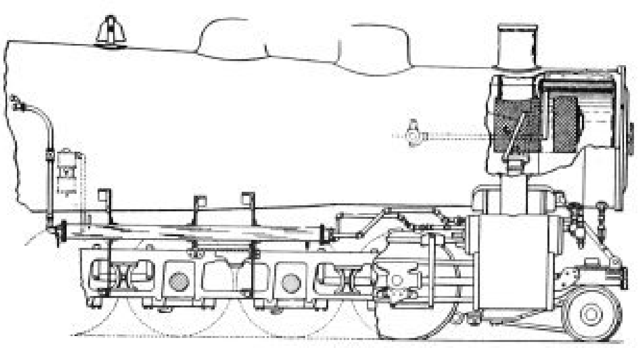
Claims.—1. The combination of a flue sheet having a perforation therethrough with an annular groove around the same the outer wall of which is threaded, an annular rib formed around the opening in the flue sheet between the perforation and the groove said annular rib having an inclined end, a flue having a flared end fitting snugly within the perforation in the flue sheet having external threads for cooperation with the threads in the annular groove and having a rearwardly extending annular portion with an underlying inclining surface for cooperation with the inclined end of the annular rib whereby the parts will cooperate to form a tight joint, substantially as set forth.



2. The combination of a flue sheet having a perforation therethrough with an annular groove around the same the outer wall of which is threaded, an annualar rib formed around the opening in the flue sheet between the perforation and the groove said annular rib having an inclined end, a flue having a flared end fitting snugly within the perforation in the flue sheet having external threads for cooperation with the threads in the annular groove and having a rearwardly extending annular portion with an underlying inclining surface for cooperation with the inclined end of the annular rib whereby the parts will cooperate to form a tight joint, the inclination of the end of the annular rib being greater than the inclination of the cooperating surface of the tube whereby the rib will be deformed when the parts are connected, substantially as set forth.

1,647,476. BURR R. SKINNER, OF ABERDEEN, SOUTH DAKOTA. MEANS FOR HEATING BOILER FEED WATER.

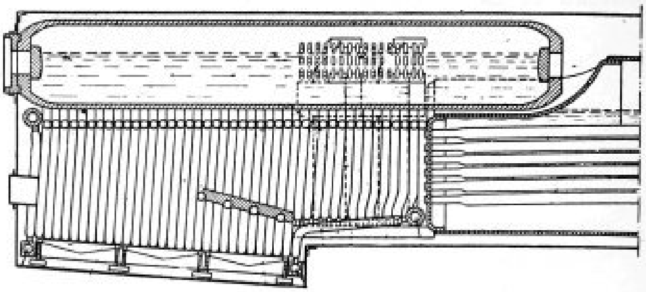
Claim.—1. Means for heating boiler feed water including a primary heater chamber having a packing box on one end and a distributing chamber on the opposite end thereof, two steam-supply pipes connected to the heater chamber at a point adjacent to the distributing chamber and at a point distant therefrom respectively, a combining chamber movably arranged in the heater chamber in proximity to the packing box and having an



extension feed pipe fixed thereto and extending movably through the packing box, a plurality of water conducting tubes fixedly connected with the distributing chamber and the combining chamber, and a water feed pipe connected with the distributing chamber. Six claims.

1,648,396. OTTO H. HARTMANN, OF CASSEL WILHELMSHOHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF GESELLSCHAFT M. B. H., OF CASSEL-WILHELMSHOHE, GERMANY, A CORPORATION OF GERMANY. LOCOMOTIVE BOILER.

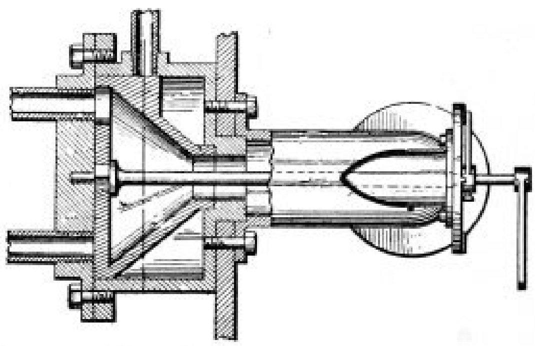
Claim.—In a locomotive, a water tube firebox formed of vertical tubes and having a grate of normal maximum length for hand stoking, a drum communicating with the upper ends of the tubes of said firebox to form



therewith a high pressure steam boiler, a fire tube boiler in which low pressure steam is generated by the combustion gases from said firebox, said fire tube boiler being independent of said high-pressure boiler, and watertubes forming a constricted combustion channel located between said firebox and said fire tube boiler, the upper ends of the tubes of said combustion channel being connected to said drum to transfer heat from the combustion channel to said drum.

1,648,028. GEORGE PURVIS, OF DETROIT, MICHIGAN. BOILER BLOW-OFF AND CIRCULATING DEVICE.

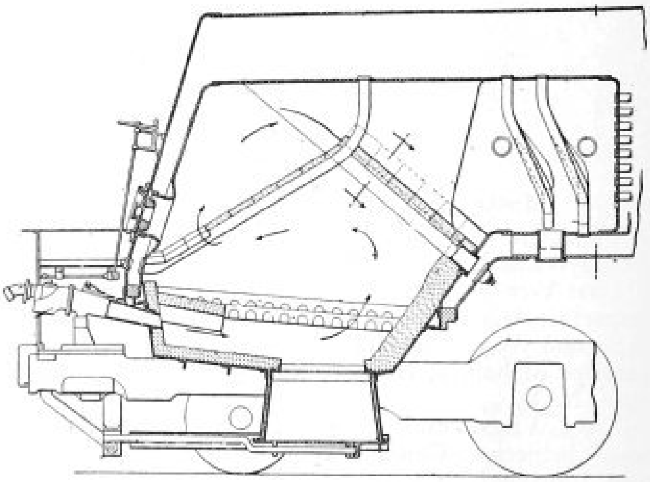
Claim.—1. The combination with a boiler, of valve means mounted thereon and having a chamber therein, a blow off pipe and a discharge pipe communicating with each other through the valve means and leading



therefrom respectively to the bottom of the boiler and to a point exterior of the boiler, means for establishing circulation within the boiler and comprising conduits leading from said chamber substantially to the bottom and to the normal water level line of the boiler respectively, said valve means comprising a movable element having portions adapted respectively to close said blow off pipe and to interrupt circulation through said conduits. Two claims.

1,650,691. GEORGE W. CLENDON, of PIERMONT, NEW YORK, ASSIGNOR TO INTERNATIONAL COMBUSTION ENGINEERING CORPORATION, A CORPORATION OF DELAWARE. PULVERIZED FUEL BURNING LOCOMOTIVE.

Claim.—1. In a pulverized coal burning locomotive, a fire box, means for delivering fuel into said box in a forward direction adjacent the bottom thereof, an inverted V-shaped arch in said box the rear leg of which ter-



minates short of the rear wall of said box, an outlet above and forward of said arch, together with longitudinal channels largely defined by evaporative surfaces above said arch to substantially cool the fuel and flame stream before it reaches said outyet. Five claims

The Boiler Maker

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Contents

Master Boiler Makers' Convention

THE nineteenth annual convention of the Master Boiler Makers' Association held at the Hotel Hollenden, Cleveland, Ohio, from May 22 to 25, is now a matter of history. The meeting this year was notable in that it marked the twenty-first anniversary of the founding of the association. In this period the body has grown from a small handful of members to an influential and important unit of the mechanical divisions of the railroads of the United States and Canada.

For this development the association is to be congratulated, but there is still a wide field for future growth. General conditions on the railroads this year may have been responsible for the marked decline in the attendance, but it is to be hoped that all members who were not present will make certain that their dues are paid and thus insure themselves of good standing in the future. Apparently too, there are mechanical officials not sufficiently convinced of the value of meetings of this kind for developing the boiler department supervisory staff and who did not authorize the attendance of their men.

It may be said in this connection that the contacts made at meetings of the Master Boiler Makers' Association and the broad view on a great variety of specific problems of maintenance obtained by those taking part in the convention, have repaid the individual railroads of the country many times over in actual savings of time and labor. As time goes on and new types of power of higher pressures come into every day use requiring radically different methods of maintenance, it will be increasingly essential that the master boiler makers and inspectors keep themselves informed of the best practice. Superintendents of motive power should bear this thought in mind, and when the 1929 convention to be held at Atlanta, Ga. assembles, the attendance will again reach the standard that has prevailed for a number of years past.

All present members of the association to whom the privilege was extended this year of taking part in the convention at Cleveland should submit careful reports of the proceedings to their mechanical officers in order to insure their attendance at future conventions.

The outline of the proceedings which appears elsewhere in this issue indicates the scope of the subjects covered as well as the excellent exhibit of new boiler department equipment and materials provided by the Master Boiler Makers Supply Men's Association. This feature is one of the most important of the entire convention and serves to keep the membership of the association informed on the best mechanical practice in building or repairing boilers.

Several outstanding accomplishments of this convention are worthy of special mention. With the exception of a single individual, all members appointed on the special topic committees served faithfully and well. The reports prepared for the proceedings were submitted in complete form promptly so that they all appeared in the program. Further than this, at no convention of this association have subjects been so completely or exhaustively covered as at the present one. Since the value of the business sessions of the association lies in these reports and their attendant discussion, the 1928 meeting was a remarkable success. Topic committees appointed in the future now have a record which they should strive to equal, but in order to do so, their investigations of the problems to be covered must begin promptly when they are appointed and continue until all individual reports are submitted to the chairman and a composite report prepared.

Due to lack of space it was not possible to publish all topical reports discussed at the present convention in this issue, but these will appear later with the complete discussion which took place after their reading.

Meeting of the A. B. M. A.

THE program of the annual meeting of the American Boiler Manufacturers' Association, which is reported elsewhere in this issue, assumed a slightly different form than has been the past custom of this group. The technical problems of the industry are well recognized and are being met in accordance with the best modern practice. The economic side of the business, however, requires careful study to keep abreast of the constantly changing conditions now prevailing. This phase of the industry assumed an important place in the transactions of the association at this meeting and committee work that has been in progress for two or three years became crystallized in action that will govern future activities of the members as a group.

A general outline of the problems facing the industry are contained in the president's opening address and their solution will bring a higher degree of prosperity to the industry than has ever prevailed in the past. There are still a number of large manufacturers of boilers and allied products who are not members of the association. For the better organization of the entire industry and for their own future welfare, these concerns should become active in the affairs of this body.

Without doubt, more actual benefit was derived by the members of the American Boiler Manufacturers' Association at this meeting than at any past convention in the forty years of its existence.

High Pressure Locomotive Boilers

IN the section devoted to communications from our readers in this issue appears a letter on the subject of "Riveting in High Pressure Locomotive Boilers," which calls attention to a phase of boiler construction and maintenance on which until recently little was known. Today, however, the railroads of the country as well as the stationary power industry are turning more and more towards higher pressures as the solution of their motive power problems.

An entirely new set of factors in both the construction and repair branches of the boiler industry are being introduced and letters on the subject from our readers who are meeting these new conditions in the shop, brought about through servicing modern type locomotives, will as time goes on serve an extremely useful purpose in helping those who will gradually be called upon to do similar work.

Communications

Riveting in High Pressure Locomotive Boilers

To the Editor:

A thought occurs to me, which may be worthy of consideration; that is, if from time to time you could get a letter from some of the leading master boiler makers stressing the advancement being made in locomotive boiler construction; the high pressures now demanded, the exactness of the work including tolerances in the holes, and mechanically well made rivets that should be driven into the holes; the pressures required under bull riveters, and all in all, a treatise on just what good boiler work should be, and how much is expected of it.

We are encountering these problems in the commercial line every day, in fact, we are now working on rivets for high pressure work that are made from alloy steel, and these rivets are made to fit holes that are reamed within 1/64 inch of size. If letters along these lines could be published in The Boiler Maker under the name of the author, I think it would open the eyes of people to the workmanship expected on high pressure boilers. As a boy when I first started to learn the machinist's trade, locomotive boilers were not expected to carry over 120 pounds steam; today, the latest type boilers are carrying 450 pounds, and it does not require a mechanic to understand that the class of work expected of a boiler maker today is quite different to the work in vogue forty years ago.

Cleveland, O. D. J. Champion

Building Up Corroded Boiler Parts by Welding

To the Editor:

"Inquirer's" question in the May issue of The Boiler Maker, as to the advisability of building up or reinforcing the grooving along calking edge of horizontal riveted seams on watertube boiler drums, is one that, in my opinion, calls for careful and practical judgment, where we have no prescribed rules governing this class of repairs. The A. S. M. E. Boiler Code, also the Ohio Boiler Code are silent on this item.

Where a stayed surface is grooved or corroded away it may be built up, provided the original thickness is not reduced more than 40 percent. Therefore, where we have a self-sustained vessel, such as a mud drum, we should hesitate to repair or build it up if it were reduced more than 25 percent.

The A. S. M. E. Code states that where plates of shells and other parts of internally fired boilers subject to tensile strain are reduced in thickness by corrosion not exceeding 25 percent of the original thickness, they may be reinforced, such reinforcing not to exceed an area of 200 square inches. In this case, we are dealing with grooving, which is considered more serious than corrosion, therefore "Inquirer" should "play safe"; the possibilities are so apparent and the results would be so disastrous, that no economy should be considered.

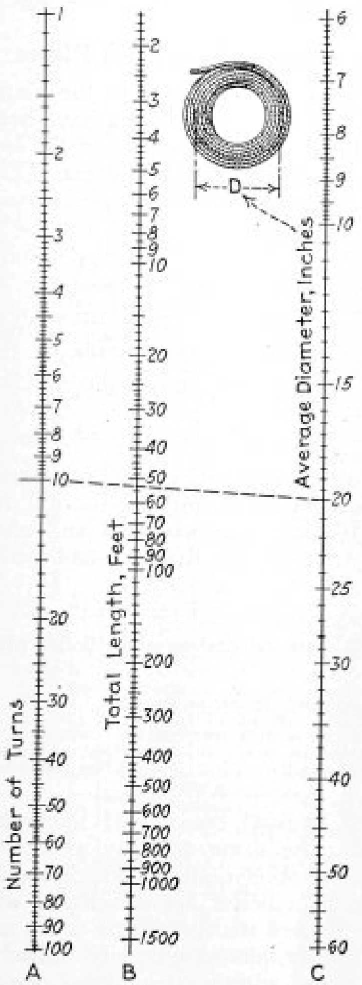
It has always been the practice where shell plates of either stationary or locomotive boilers show corrosion or grooving, to cut away, in the case of horizontal externally fired boilers, the affected part of the shell and apply a patch, or renew the sheet to just above the fire line. On locomotive boilers, the patch can be applied without removal of the material, other than the necessary scarfing down of the seam lap.

Lorain, Ohio. JOSEPH SMITH

Finding the Length of Coiled Material

TO THE EDITOR:

The man who handles wire cable, rope, hose, etc., will find the accompanying chart useful for finding the length in feet of anything of the sort that is rolled up, such as rolled-up cable cord, lead pipe, tubing, etc. All that is necessary is to count the number of turns and measure the average diameter as shown on the chart, and then lay a straight edge across the chart as indicated by the dotted line drawn in the sketch. The answer is immediately found in Column *B*.



For example: To find how many feet in a rolled-up cable whose average diameter is 20 inches, and in which there are 10 turns, connect the 10 in Column *A* with the 20 in Column *C* as the dotted line shows and the intersection with the middle column will give the answer, which is 53 feet.

The range of the chart, it will be noted, is large enough to care for most of the conditions to be found in ordinary practice.

The chart can be used "backward" as well. For instance, if it is desired to take along about 300 feet of a coiled up article and the workman wants to know how many turns to take, a straight edge laid across 300 on the middle scale will tell how large the coil should be made and the number of turns required in order to contain the desired length. Paste this scale on a card and hang it up in a convenient place.

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

David Thomas has been appointed manager of bar iron sales of the Reading Iron Company, Reading, Pa., manufacturers of wrought iron tubular and bar iron stock.

The Linde Air Products Company has recently opened a new district sales office at 48 West McLemore avenue in Memphis, Tenn. H. N. Smith will be manager in charge of the district which includes western Tennessee, northern Mississippi and eastern Arkansas.

Spiral Pipe Development

TO THE EDITOR:

In looking through some of the back numbers of THE BOILER MAKER I came across the May, 1927, number with a problem for a special pipe, so I thought I would work it out as I had never seen one of the kind and I

Two views of spiral pipe model developed by George House from a layout appearing in The Boiler Maker

found it came out all right. I am sending this to you but the measurements are not the same. It was the rule that I wanted. It is a very nice rule and I think it will work out all right for any special pipe. I made last week the pattern shown in the accompanying sketch. On May 13, I was 73 years old. Hope I shall be spared to contribute something else later on.

Pinole, Cal. GEORGE HOUSE.

Three Times the Plate Thickness

"WHY do you add three times the plate thickness to the length of a sheet, when you lay out a plate for a section of a steam boiler?" asked a green hand of his shop foreman.

"Because the diameter of a shell must be calculated from middle to middle of shell, not from the inside or the outside. Adding a half-thickness of plate on each side of the shell, increases the diameter one thickness of plate, whatever it may be, therefore the length of the sheet should be increased 3.14 times that amount, or approximately 3 times the plate thickness."

Nickel Steel for Locomotive Boilers*

Possesses high strength and ductility—Physical properties at high temperatures and after ageing superior to carbon steel

By Charles McKnight

Metallurgist, Development and Research department, International Nickel Company

TWO years ago the Canadian Pacific railway in designing some new locomotives desired to increase the capacity and efficiency of their motive power without materially increasing the total weight. This could be done by increasing the boiler pressure 25 per cent but to do that without increasing the thickness of the boiler plate appeared on the face of it to be an impossibility. But the Canadian Pacific successfully accomplished the apparently impossible by taking a step that they had been investigating and considering for some time. This was the use of three per cent nickel steel boiler plate of 70,000 lb. per sq. in. minimum tensile strength. Approximately 30 per cent stronger than carbon steel, its use permitted an increase in boiler pressure from 200 to 250 lb. per sq. in. without any change in thickness of the boiler plate. A total of 44 locomotives were thus constructed for this company in 1926; 24 Pacific type and 20 Mikado type. They have fully justified the expectations of improved performance and efficiency.

Table I—Average of 523 tests on three per cent nickel steel boiler plate

	Per cent Average	Per cent Specified		Average	Specified
Carbon	0.163	0.20 max.	Ult. tens. str., lb. per sq. in.	77,880	70,000 Min.
Manganese	0.557	0.40-0.80	Yield point, lb. per sq. in.	47,550	50 per cent U.t.s.
Phosphorus	0.021	0.045 max.	Elongation in 8 in., per cent	26.33	1,600,000/U.t.s., Min. 20
Sulphur	0.029	0.045 max.			
Silicon	0.203	Not spec.	Red. of area, per cent	54.15	50
Nickel	2.960	2.75-3.25	Impact value, Izod, ft. lb.	63.4	

Such an unprecedented step on as large a scale as this immediately aroused countrywide interest, not only among railroad officials but among builders and users of other types of boilers. Several railroads have translated this interest into actuality in the shape of one or more locomotives; for example, the new high-pressure locomotives of the Delaware & Hudson have nickel steel boilers. Others are still seriously considering it and experimenting. The same is true of manufacturers of large stationary boilers.

Unquestionably the Canadian Pacific railway independently pioneered in this development. It detracts in no way from this road to say that inquiry has since developed that this action was anticipated more than a quarter of a century ago when the Baldwin Locomotive Works built a locomotive with boiler shell, firebox and other important parts of nickel steel. A few years earlier nickel steel plate had been employed for the tubes and boilers of the U. S. cruiser "Chicago." The first stationary boiler of nickel steel was also built about the same time. That these were not followed by more was probably because the demands were not as great then as now and also a better plate was not necessary.

Ascertaining definitely that these boilers had been built so long ago settled quite as definitely the question of what life could be expected of nickel steel. The boilers of the "Chicago" are still in service after 30 years use, although the demands are now light. The same is true of the locomotive, which still operates after more than 25 years of service.

Comparison of Nickel and Carbon Steel Plates

During the past two years, beginning with the plates rolled for the Canadian Pacific railway, data have been collected showing the physical characteristics of the low carbon three per cent nickel steel boiler plates. The averages of results of tests on all but a few nickel steel plates which have been utilized during this period for boiler construction are shown in the Table I and compared with a number of tests on carbon steel boiler plate in Table II.

Table II—Average of 385 tests on carbon steel boiler plate

	Average per cent		Average
Carbon	0.193	Ult. tens. str., lb. per sq. in.	59,200
Manganese	0.401	Yield point, lb. per sq. in.	36,200
Phosphorus	0.022	Elongation in 8 in., per cent	28.64
Sulphur	0.033	Reduction of area	(Not determined)
		Impact, Izod	(Not determined)

Primarily nickel steel is used because of its higher strength with practically the same ductility as carbon steel. But, in addition, the other qualities which are desirable, even necessary, in a boiler are developed with nickel steel to a higher degree than with any other material, so that it is peculiarly, almost uniquely, suited to boiler requirements. These additional qualities are its physical characteristics at high temperatures, its excellent impact values, its resistance to embrittlement in boiler service and its uniformity.

High Temperature Characteristics of Nickel Steel

Physical testing of boiler materials at room temperatures and under usual conditions can at best be only an approximate guide to the suitability of the material for boiler service. At best the working temperature of a boiler is some 200 deg. F. higher, in a temperature range where changes occur in the nature of the steel. But even worse, with the temperatures and pressures now being used, the steel enters the "blue-brittle" range, where an ordinarily soft and ductile metal unaccountably loses its toughness and becomes very brittle, although the strength is greater than when cold. A piece of boiler steel which can be bent double when cold will break off short at this temperature and the fracture will have the

* Paper presented before the semi-annual meeting of the American Society for Steel Treating at Montreal, Quebec, February 16-17, 1928.

characteristic blue color which alike indicates the temperature and the derivation of the term "blue-brittleness."[1]

A great deal of research into this matter of high temperature characteristics of steel has been done recently. The data most applicable here seem to be those incorpo-
perature characteristics of steel has been done recently. The data most applicable here seem to be those incorpo-
ent. In Fig. 1 at 480 deg. F. (corresponding to a saturated steam pressure of about 500 lb. per sq. in. gage) the properties of nickel steel are relatively low. Nevertheless there is a superiority over the special carbon boiler steel of 123 per cent in yield point, 7 per cent in tensile strength, 28 per cent in elongation and 8.5 per cent in impact resistance. The data embodied in this

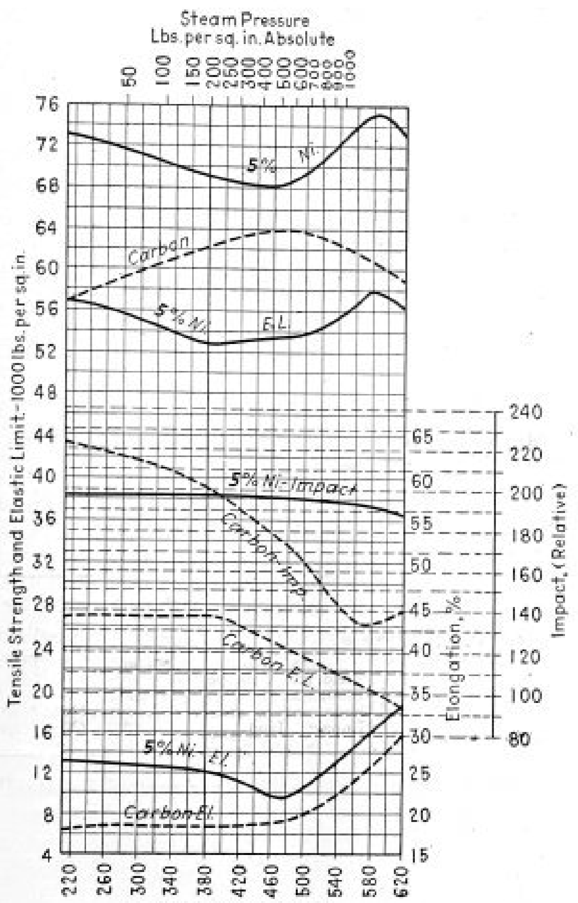


Fig. 1—Characteristics of 5 per cent nickel and straight carbon boiler sheets at elevated temperatures

curve are taken directly from the authority quoted and the figures for carbon steel refer to a "special boiler steel" of German manufacture.

Embrittlement in Service

The high temperature characteristics of the metal are buttressed by another and unique feature. The boiler designer has always been faced by the specter of embrittlement in service. It has long been known that ordinary tensile tests are of little value as indices of performance in a boiler. Impact tests, resorted to as a means of detecting britttleness prior to service, have failed in their purpose. How misleading such tests can be is shown by the report of Goerens previously re-

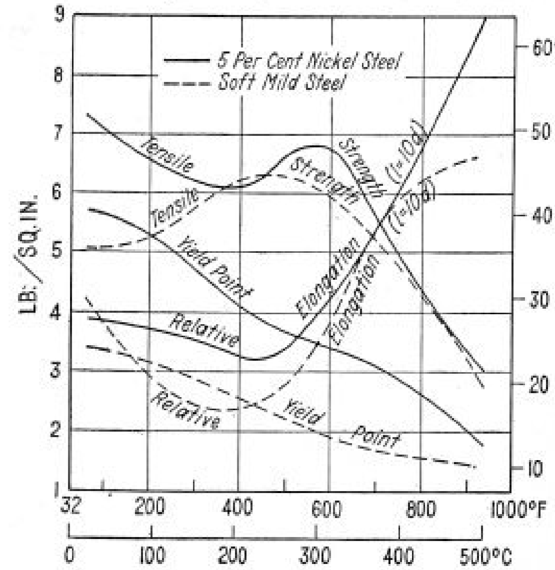


Fig. 2—Tensile characteristics of 5 per cent nickel and straight carbon boiler steels at elevated temperatures

ferred to. He discusses the phenomena of "ageing" and "recrystallization" of boiler plate in service and then gives interesting data on some full-size long-time tests. The data are too comprehensive and detailed to be included here, but in Fig. 3 are shown graphically the essential results. Briefly, he first annealed a carbon steel boiler plate (0.8 in. by 5.25 ft. by 22.5 ft.) and then

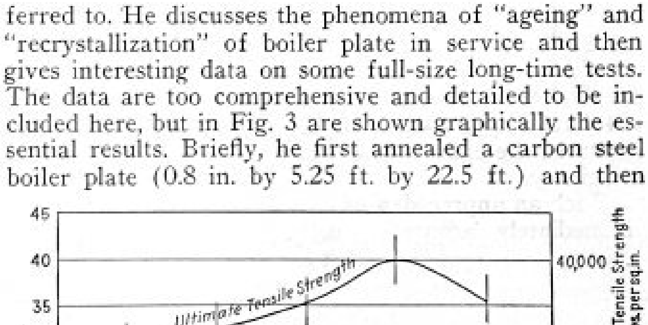


Fig. 3—Graphic of data obtained on full size long time tests of boiler plate

formed it by bending as it would be formed in a boiler. Tested before bending and at intervals of one day, one year, 2½ years without actual service, and 2½ years with 17½ months in actual boiler service, it was found that the strength and elastic limit increased a little progressively while the elongation decreased after bending and then remained practically constant. But most strik-

[1] See "Tensile Properties of Boiler Plate at Elevated Temperatures"—H. J. French—*Transactions*, American Institute of Mining and Metallurgical Engineers, 1922, and discussion thereof.

[2] Data from "Die Kesselbaustoffe," by von P. Goerens, *Zeitschrift des Vereines Deutscher Ingenieures*, Jan. 19, 1924, Vol. 68, No. 3.

[3] The physical data presented in this paper should be considered comparable only in each given set of figures. This is particularly true of elongations and impact values, which vary widely according to the test specimen used.

In examining the results of several thousand tensile determinations, the author encountered discouraging discrepancies, due principally to varying conditions of test. The main factor causing discrepancies seemed to be the finishing temperature of the steel as rolled, which caused surprising variations of results. If this factor is disregarded, it is possible to obtain excellent tensile characteristics from a plate entirely unsuited for fabrication or subsequent service in a boiler.

In the work on nickel steel in our own and associated laboratories, the tensile test specimen was invariably the American Society for Testing Materials standard 8-inch plate specimen and the metal had been given the thermal treatment customary for this type of boiler steel; i.e., a retarded cooling after rolling.

ing is the serious dropping off in impact resistance, from 24.0 to 3.3, a decrease of 86.25 per cent. Small wonder that frequent inexplicable boiler failures occur through embrittlement and cracking.

In a way similar to ageing, recrystallization affects boiler plate but not to so marked a degree. Fortunately, also, the effect of recrystallization is not markedly apparent until temperatures in excess of 900 deg. F. are encountered. Practically, in a boiler the effects of either ageing or recrystallization or both may occur because the plates are stressed during forming and bending in the manufacture of the boiler or they may occur after the boiler is in commission as a result of stresses which are induced by differences in the temperature at various parts of the boiler. The injurious effects will become more noticeable as the boiler pressure and consequent thickness of the plates increase because of the greater difficulties of forming, bending and riveting heavier plate as well as because of the fact that increased heating surface and higher rates of evaporation offer more

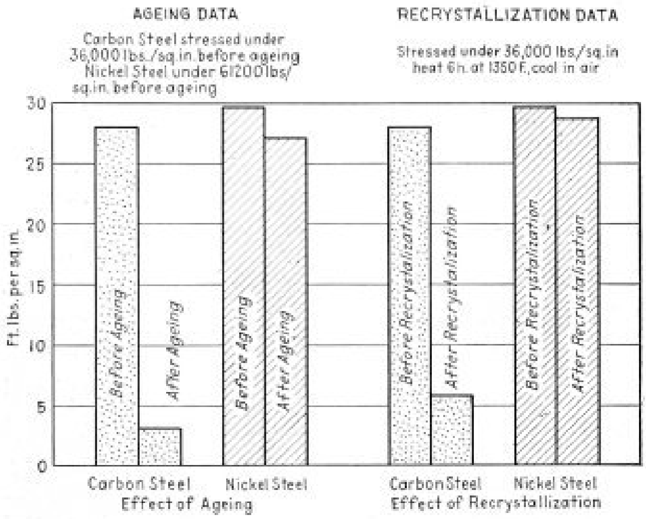


Fig. 4—Comparative ageing and recrystallization tests on 5 per cent nickel steel and special boiler steel (0.11 per cent carbon)

favorable conditions from temperature differences and additional stresses in the boiler.

Nickel steel resists these two destructive agencies to a marked degree, probably better than any other steel. The results of comparative ageing and recrystallization tests on five per cent nickel steel and "special boiler steel" (carbon 0.11 per cent; manganese 0.53 per cent; phosphorus 0.026 per cent; sulphur 0.031 per cent); are embodied in Fig. 4 which shows conclusively the vast superiority of the nickel steel.

Uniformity of Nickel Steel

It is well known that there is marked variation both in the chemical composition and tensile results of test pieces taken at various parts of a carbon steel boiler plate[4] and that when specifications are met with tests from one place the plate may diverge dangerously from the requirements at other places. Experience has shown and it has often been commented on that one can confidently expect a much smaller variation with nickel steel. The Tables III and IV show the satisfactory results of several top and bottom tests, as well as the uniformity of analysis.

The valuable bend test has been satisfactorily met. The specifications usually call for a top transverse bend test and, as a general rule, nickel steel not only meets the full requirements of a 180-deg. bend about a pin whose diameter equals the plate thickness, but can be closed down flat on itself without cracking. There is little difference between the bends on carbon steel and nickel steel. As a matter of fact, one user stated that

Table III—Uniformity of tests of nickel steel

Test	Yield point, lb. per sq. in.	Tensile strength, lb. per sq. in.	Elongation, per cent	Area, per cent
Bottom Long.	40,600	77,800	25	56.1
Top Trans.	43,600	76,700	20	36.0
Bottom Long.	41,100	77,900	28	57.0
Top Trans.	42,200	77,700	25	48.9
Bottom Long.	43,500	78,400	25	58.2
Top Trans.	43,100	78,600	25	49.1
Bottom Long.	42,100	77,400	26	59.7
Top Trans.	41,900	78,000	22.5	51.4
Av. Variation, per cent	2.86	2.70	2.37	11.4
Av. Variation, per cent Carbon steel, picked at random, same number	...	6.02	....	...

Analysis: Carbon	Manganese	Phosphorus	Sulphur	Nickel
Per Cent 0.19	0.55	0.012	0.035	2.95

the bend tests on nickel steel were the best he had ever seen.

Manufacture

In the industrial application of nickel steels, consideration had to be given to the proportion of nickel to be used in the steel. It was eventually decided to use a 2.75 to 3.25 per cent nickel steel. The desirable char-

Table IV—Uniformity of analysis of nickel steel

	Top, per cent		Bottom, per cent	
Carbon	0.29	0.22	0.21	0.15
Manganese	0.72	0.69	0.73	0.76
Phosphorus	0.018	0.018	0.016	0.016
Sulphur	0.021	0.024	0.027	0.023
Silicon	0.25	0.25	0.23	0.22
Nickel	2.62	2.68	2.66	2.66

acteristics of nickel steels are obtained with this steel, although to a slightly less degree than with five per cent nickel. The cost is less and there is the added advantage that such a steel is a standard of which many thousands of tons of plate have been made, the total eclipsing the aggregate amount of all other alloy steel plate ever rolled. Table V gives in abbreviated form the physical characteristics which have been obtained in tests of this steel and which are concordant with the results with five per cent nickel steel.

Table V—Properties of three per cent nickel steel

	Tensile tests			Ageing tests		
	68 deg. F.	486 deg. F.	660 deg. F.	Sample	After ageing	After recrystallization
Ult. tens. str., lb. per sq. in.	62,200	64,000	54,100	62,300	66,900	60,000
Elastic limit, lb. per sq. in.	42,700	28,500	25,600	42,700	59,700	38,000
Elongation, per cent	27.5	21.9	33.1	36.0	36.0	33.0
Red. of area, per cent	71.0	63.0	73.1	71.0	67.0	70.0
Impact, ft. lb.	30.6	29.8	28.4	30.1	27.7	29.0

The decision having been made to employ a three per cent nickel steel, there remained only to fit the steel to the boiler design. At that time a steel of 70,000 lb. per sq. in. minimum ultimate tensile strength was not only adequate, but generously so. A steel having between 0.15 and 0.20 per cent carbon was, therefore, decided upon and it has not been necessary thus far to depart from that standard.

When the first plates were being rolled, it was mutually agreed by the consumer and the manufacturer that in order to take the most advantage of the contained alloy, the nickel steel should be "killed,[5]" although most boiler plate is not so treated. (See reference page 155.)

With a killed steel, the yield is less than with the ordinary steel, on account of the piped portion of the ingot

[4] See "Experiments on the Segregation of Steel Ingots in Its Relation to Plate Specifications"—C. L. Huston—*Proceedings*, American Society for Testing Materials, Vol. VI

which must be discarded. A fair figure is 60 per cent or more usable product from the ingot. Also a killed steel is prone to have surface defects, such as "snakes" and "pits."

These variations in practice with killed steels do not detract from their desirability but are, as a matter of fact, guarantees of superior quality. Killed steels for boiler plate have gained a great deal of favor recently and by some it is thought that for high pressure work they will eventually supplant entirely the present type. They have one great advantage in that their defects are usually on the surface and apparent on inspection.

Nickel steel for plate is always killed in modern practice and therefore presents the same problems of yield and surface to the manufacturer. It is essential that the steel be well made, that approved ingot molds and hot-tops be used, that the heating of ingots prior to rolling be given careful attention and that the rolling itself be conducted so as to ensure the best possible surface. With these precautions, experience has shown that there is little difference between nickel steel plate and other killed steels, either in yield or in rejections on account of surface defects.

One of the problems which was encountered and which had to be overcome by the manufacturer was that of unintentional heat treating of the nickel steel. Ordinary boiler plate is finished at the mill in a wide range of temperatures, depending largely on the thickness of the plate, and is straightened immediately after rolling. The continued passing of the plate back and forth between the leveling rolls has almost the same effect as a quench. This does not mean a great deal of difference on the low carbon steels but when nickel steel was so treated, the quick cooling hardened the plates considerably. It was found necessary to roll the plates at a temperature sufficient to ensure their finishing at a good red heat, after which the plates were rolled off the hotbed and piled one on top of the other and later covered with sand. Using this method, it took the plates about eight hours to cool down to a black heat and this anneal, if it can so be termed, resulted in a better product and improved bend tests.

No difficulties in fabricating nickel steel plate have developed and no variation from standard practice has been necessary. Either carbon steel or nickel steel rivets can be used, as dictated by design, and welding with the arc or gas process is perfectly feasible. Nickel steel welding rod should be used.

Possibility of Higher Strengths with Nickel Steels

The plates in the boilers of the "Chicago" of 3.5 per cent nickel steel, had an ultimate tensile strength of 80,000 to 90,000 lb. per sq. in., a yield of 50,000 to 63,000 lb. per sq. in. with an elongation in 8 in. of over 20 per cent and they also met with full bend test.[6]

The analysis of nickel steel now being extensively used for boilers was selected not because it was the ultimum obtainable, but because it meets the present requirements of strength adequately with excellent subsidiary characteristics. It now seems possible that the extension of some work already undertaken may make available another nickel steel as much superior to the present nickel steel as it is superior to carbon steel.

Corrosion and Firebox Cracks

While only a small consideration in the adoption of nickel steel for boilers, a feature not to be overlooked is that of the increased resistance to corrosion. It is, of course, well known that above 20 per cent nickel confers practical immunity from the types of corrosion met with in boilers and this immunity is proportional to the nickel content below that figure. With three per cent nickel, tests show a higher resistance to corrosion than the usual boiler materials.

There always has been trouble with firebox sheets of locomotive boilers cracking between the staybolt holes and this trouble is apparently increasing with the increase in the size of boilers and the pressures employed. It is usually considered that this cracking is fundamentally due to corrosion, but we feel that corrosion is of secondary importance. It is recognized that when a steel has been overstressed and then subjected to corrosive agents, the corrosion will take place more rapidly

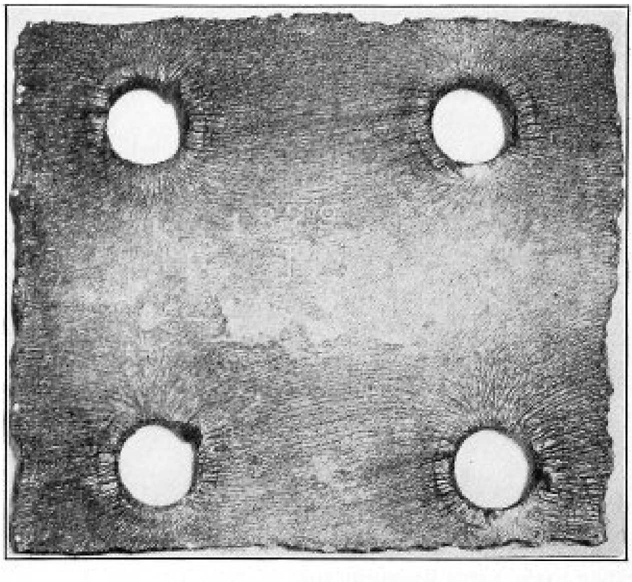


Fig. 5—Carbon steel firebox plate showing corrosion along stress lines

where the stress has occurred.[7] That this condition exists in firebox sheets which crack, seems to be demonstrated by the fact that even a superficial examination will show that the cracks running from one staybolt hole to another take on the appearance of magnetic lines of force (see Fig. 5); i.e. they follow the stress lines. We believe it unusual, if it occurs at all, for these cracks to run longitudinally or parallel with the direction of least strain in a firebox sheet. If these conclusions are justified, then it is not so much a question of corrosion as one of strength and resistance to embrittlement and the obvious remedy is to apply a stronger sheet.

Nickel steel is of double advantage here as its higher strength and resistance to embrittlement enable it to resist the primary cause, while it is also naturally more resistant to corrosion. The first to make practical use of nickel steel for firebox sheets was the Canadian National railroad about three years ago and since then a number of others have made experimental installations. There has been no failure of nickel steel plate from this cause and, on the other hand, in the cases where it has

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[5] Briefly, a "killed" steel differs from an "open" or "rimming-in" steel in that sufficient silicon, manganese, aluminum or other element is added to render the steel substantially gas-free after solidification. A secondary effect is that, blowholes being no longer present in sufficient volume to counteract it, the steel exhibits piping along the center-line of the ingot. To lessen this, it is essential to use hot-tops and properly designed molds. Silicon is rarely in excess of 0.30 per cent in such steels.

[6] Private Communication, U. S. Navy. Also "Nickeled Steel"—A. L. Colby, *Proceedings*, American Society for Testing Materials, Vol. III, 1903.

[7] See "Risshildungen und Anfressungen an Dampfkesselelementen," Körber and Pomp, *Korrosion und Metallschutz*, May, 1927

been applied as a cure, it is reported as being effective.

Boiler Tubes and Staybolts

For boiler tubes the situation regarding corrosion is exactly the reverse of that for shell plate, as corrosion-resistance is here the primary consideration and the increased strength has little to do with it. Boiler tubes running from 0.10 to 0.20 per cent carbon and containing about 2.0 per cent nickel have shown in actual service a life of from seven to fifteen times that of carbon steel tubes in districts where the water is bad. This, of course, has been sufficiently encouraging to warrant the extended use of nickel steel boiler tubes in bad

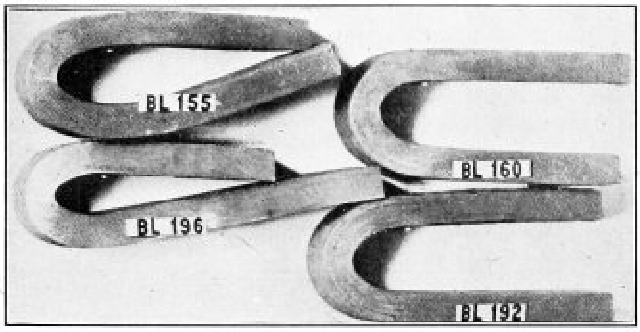


Fig. 6—Bend test on high tensile (100,000-lb.) nickel steel plate

water districts and in addition there are a large number of railroads who either have nickel steel boiler tubes under test or are using them as a regular material on some portions of their line. Their use is not entirely new, as tubes with a higher percentage of nickel were used by several of the navies, among them our own, as long ago as 1900, and ones with a lower percentage only a few years later. The unexplained peculiarity of these tubes has been the fact that boiler scale collects to a much less degree on them than on the ordinary tubes.[8] It has been reported in at least one case where a boiler was tubed partly with carbon steel and partly with nickel steel, the nickel steel tubes outlived three sets of carbon steel and when they were removed they were found to be in practically the same condition as when they came from the mill; that is, with the mill scale perfectly apparent.

The primary load on a staybolt is that which it is designed to carry—a pure tensile stress which is not excessive in relation to the strength of the materials used and which is numerically equal to the load due to steam pressure on a square of area equal to the product of the

Table VI—Corrosion tests

(a) Exposure Corrosion Tests

	Loss in weight, lb. per sq. ft. per year, Sea water	Fresh water
Wrought iron	0.1409	0.1275
Soft steel	0.1612	0.1204
Three per cent nickel steel	0.1173	0.1021

(b) Twelve Months' Exposure—Sea Water

	Loss in weight, per cent
Wrought iron	1.89
0.25 per cent carbon steel	1.72
Three per cent nickel steel	1.36

(c) Exposure to Steam and Salt Water

	Loss in weight, per cent: Steam two months	Boiling three months 10 per cent NaCl solution
Bessemer steel	0.58	1.81
Open-hearth steel	0.33	1.98
Three per cent nickel steel	0.27	1.00

Results taken from Nickel Steel—Synopsis of Experiment and Opinion—D. B. Browne, *Transactions*, American Institute of Mining and Metallurgical Engineers.

staybolt spacing distances. But a far more important load is that occasioned by expansion of the firebox and weaving of the boiler. In firing a cold boiler the firebox begins to expand longitudinally before the shell plates are hot, which results in a bending of the staybolts. Eventually, the shell is also heated and expands, so that the bending is to some degree recovered, but this recovery is never entirely complete, since there is always a

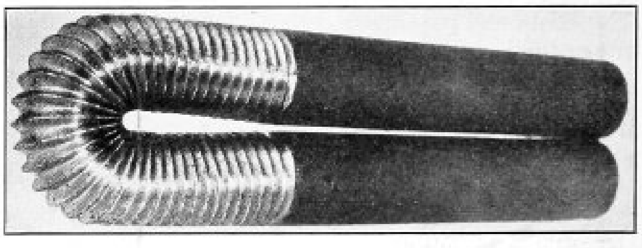


Fig. 7—Nickel steel staybolt threaded bend test

marked temperature difference between the firebox sheet and the outside shell.

Furthermore, the inside of a boiler where it is in contact with hot gases is very sensitive to temperature changes. For example, the opening of the firebox door will almost instantly cause a contraction of the arch tubes, and to a lesser extent, the boiler tubes. With the closing of the door, expansion re-occurs. This movement is quite marked and has been measured. Any change in position of the inside firebox is relative to

Table VII—Comparison of staybolt materials

Material	Carbon	Manganese	Silicon	Nickel	Treatment	Yield point, lb. per sq. in.	Tensile strength, lb. per sq. in.	Elongation	Reduction of area	Brinell hardness No.	Impact	Endurance limit	Stress to cause failure at 15,000
Wrought iron	0.02	0.04	0.13	...	As received	33,000	49,400	34.0	46.4	103	45	.....	.....
					1650 F. C.	30,300	46,500	36.5	49.3	95	32	.....	43,000
Wrought iron	0.06	0.04	0.09	...	As received	34,000	48,600	34.8	51.2	102	46	31,000	48,000
					1650 F. C.	29,400	45,500	37.3	54.4	92	38	28,000	46,000
Staybolt steel	0.06	0.02	0.01	...	As received	29,900	46,300	41.3	73.3	86	62	28,000	45,000
					1650 F. C.	19,300	49,700	41.0	69.3	88	17	27,000	44,000
Staybolt steel	0.15	0.36	0.03	...	As received	32,250	58,800	39.5	65.2	110	69	30,000	49,000
					1650 F. C.	33,000	53,000	38.3	62.1	101	12	30,000	46,000
Staybolt steel	0.18	0.47	0.07	...	As received	43,500	70,100	32.8	53.7	123	27	.....	.....
					1650 F. C.	34,100	63,800	32.0	51.1	112	9	31,000	49,000
Nickel staybolt steel	0.10	0.07	0.02	2.07	As received	39,600	53,000	41.8	72.7	104	87	.....	.....
					1650 F. C.	41,500	53,700	43.5	79.0	102	87	.....	53,000
Nickel staybolt steel	0.08	0.04	0.02	1.98	As received	40,700	54,900	40.0	76.9	107	82	35,000	.....
					1650 F. C.	42,700	55,100	43.8	77.0	103	83	32,000	51,000

[8] "Non-Corrosive Nickel Steel Boiler Tubes"—A. L. Colby—*Proceedings*, Society of Naval Architects and Marine Engineers, Vol. 11, p. 135. Discussion elicited the fact that in a comparative test of two boilers, one tubed with ordinary tubes and the other with three per cent nickel steel tubes, after five months' service the nickel steel tubes were smooth, glossy and free from attached scale, while the ordinary tubes were rough and pitted, with scale covering the pitted surface. An 18 months' trial showed a seven per cent fuel economy in favor of the boiler with nickel steel tubes.

the outer shell of the boiler and naturally, therefore, causes bending of the staybolts. In addition, the entire locomotive has a certain amount of vibration.

The result of all these factors is that staybolts are subject to vibration and continual, even if slight, bending motion while under tensile stress, and ideal fatigue conditions are established, which may lead to a failure.

Corrosion is also one of the important factors affecting staybolts. Located in the worst places in a boiler from a viewpoint of corrosion and subjected to stresses and to a temperature difference between the ends, both of which induce chemical corrosion, the staybolt has always been peculiarly subject to rusting and pitting and one of the main considerations influencing the choice of material has been the ability to resist corrosion.

Steel has been replacing other materials used for staybolts quite rapidly and of the various compositions of steel used it is noteworthy that almost all contain nickel in amounts varying from 0.50 to 3.50 per cent. The analysis most often used is a very low carbon 2 per cent nickel steel. For staybolt service such a steel is superior to any other material as it is strong enough for the duty, yet remarkably ductile, has good resistance to fatigue and remarkable impact values. On tests this type of steel has consistently shown impact values of such high order that no other steel is in the same class.

A comparison between staybolt material of wrought iron, steel and nickel steel is shown in Table VII.

Program of National Board Meeting

The sixth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors will be held at the Hotel Lawrence, Erie, Pa., June 18 to 21. The program prepared for this meeting is an interesting one and all members are urged by the officers of the Board to make every effort to be present. A complete report of the proceedings of the meeting will appear in a later issue of The Boiler Maker. The details of program are given below:

Monday, June 18, 9:00 A. M.

Welcoming Address—Hon. Joseph C. Williams, Mayor of Erie, Pa.

Address—Harry W. Sims, president, Chamber of Commerce.

Address—E. E. Knobloch, president of Manufacturers' Association of Erie, Pa.

Address—William G. Hass, Director of Public Safety.

Address—C. D. Thomas, chairman, chief boiler inspector, State of Oregon.

Report—C. O. Myers, secretary-treasurer, chief boiler inspector, State of Ohio.

Report—L. C. Peal, statistician, city boiler inspector of Nashville, Tenn.

Report—F. A. Page, chief boiler inspector, State of California: "The Unfired Pressure Vessel Code in California."

General Discussion and appointment of committees.

Afternoon

Noonday Luncheon at plant of Erie City Iron Works.

Address—On powdered coal, followed by a demonstration of burning powdered coal and visiting plant of Erie City Iron Works.

Visiting Plant of the Sims Company, manufacturers of welded low pressure heating boilers.

Visiting Plant of The Union Iron Works. "Demonstration of Flanging."

Tuesday, June 19

Address—Dr. D. S. Jacobus, chief engineer, The Babcock & Wilcox Co., "Dished Heads."

Address—H. Leroy Whitney, The M. W. Kellogg Co., "Reinforcement of Openings."

Joint Paper—Messrs. J. V. Romer and W. W. Eaton, of the Babcock & Wilcox Co., "Alloy Materials for Boiler Shells and Tubes."

Address—George W. Bach, vice president and general manager, Union Iron Works, "The Relationship of the Boiler Manufacturer to The National Board of Boiler and Pressure Vessel Inspectors."

Afternoon

Boat Trip to Canada. Noonday luncheon served on boat.

Dinner on Canadian shore.

Wednesday, June 20

Executive Session and committee reports.

Thursday, June 21

Visiting Plant at Orville, Ohio, where the largest welded pressure vessel in the world will be seen in operation.

Visiting Plant of Reeves Brothers at Alliance, Ohio. Demonstration of welding under the procedure control of longitudinal and girth joints of large unfired pressure vessels.

Noonday Luncheon at Akron, Ohio, and Evening Dinner at Alliance, Ohio.

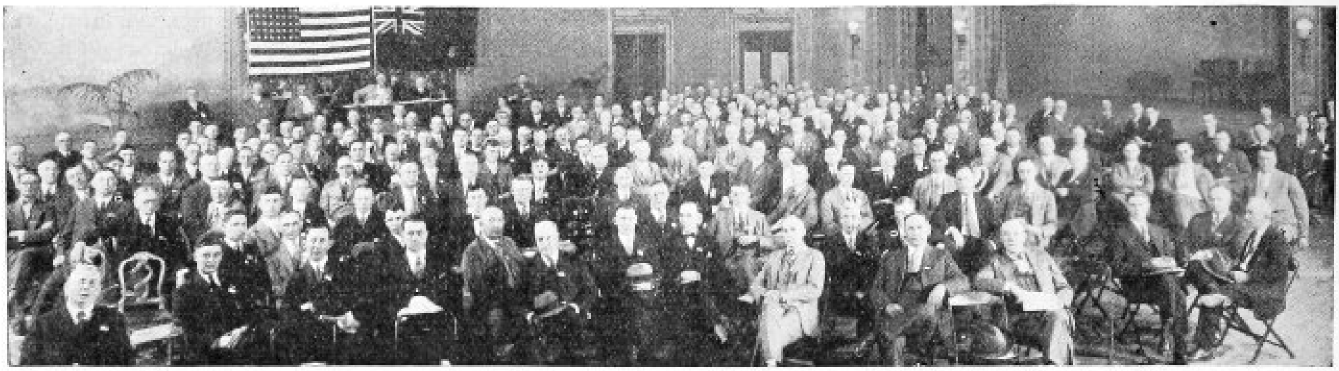
Formal Adjournment of Convention.

High Pressure Watertube Boiler Explosion

By G. P. Blackall

The British Board of Trade has issued a report on the explosion of a high pressure watertube boiler, the first of its kind installed for marine use, which occurred in the turbine steamer King George V on September 29 last. The accident is attributed to scale deposited on the inside of a tube, which resulted in overheating and subsequent rupture. The engineer-surveyor-in-chief, in a note appended to the report, emphasizes the danger of scale deposit in the tubes of watertube boilers if the feed water is impure, and says it is clear that in high pressure watertube boilers distilled water should alone be used.

The Hartford Steam Boiler Inspection & Insurance Company, Hartford, Conn., has recently established the Detroit department of that concern with headquarters at 2401-7 First National Bank Building, Detroit, Mich. L. L. Coates, for many years resident agent of the Detroit branch of the Chicago department has been appointed manager and Thomas P. Hetu, former assistant chief inspector of the Philadelphia department has been appointed chief inspector of the new Detroit department.



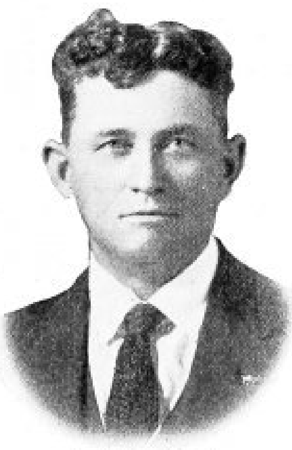
Master boiler makers assembled at opening session of convention

Master Boiler Makers' Association Meets at Cleveland

Nineteenth annual convention of association marks twenty-first year of organization's history

ALTHOUGH not the largest in point of the number of members in attendance, the nineteenth annual convention of the Master Boiler Makers' Association, held at the Hotel Hollenden, Cleveland, Ohio, May 21 to 25, was one of the most successful in its accomplishments of any ever held by the association. There were registered about 600 members of the association, their guests, ladies and members of the Boiler Makers Supply Men's Association. Of this number 260 were members and 25 new members elected to the body.

W. J. Murphy
Retiring President



L. M. Stewart
President Elect

G. B. Usherwood
First Vice President

The sessions throughout the four days of the convention were presided over by W. J. Murphy, division boiler foreman, Pennsylvania Railroad, who was president of the association for the year 1927 and 1928.

After the invocation by the Rev. Robert W. Mark of Cleveland, a representative of Mayor John D. Marshall of the city, welcomed the association to Cleveland.

R. H. Flinn, superintendent of motive power, Pennsylvania Railroad at Buffalo, was next introduced and addressed the association on the development of the railroads in the past ten years. During this period of readjustment the boiler makers of the railroads have done their part in promoting the physical condition of the motive power of the country. In 1923, the railroads were faced with the necessity of reducing car shortages and cutting the percentage of bad order cars and locomotives. In the five years following this the mileage of cars and locomotives between shoppings has been increased, greater car loadings have been realized, and neither locomotive nor car shortages have occurred at any time during the past year. The future development of the industry of the country depends on the ability of the transportation facilities to keep pace just as in the past progress has depended on transportation. The results accomplished have come about by definite planning and by the purchase of modern equipment, including rolling stock, locomotives and shop machinery.

Next in the order of the program was an excellent paper by A. F. Jensen, president of the Hanna Engineering Works, Chicago, Ill., on the subject "The Age of Riveted Steel." The reading was accompanied by the showing of a moving picture film outlining the manufacture and application of rivets in a wide range of fields, including ship work, bridge construction, fabricated steel buildings and in locomotive and car construction.

The Age of Riveted Steel

By A. F. Jensen

YOU are charged with the solemn duty of protecting the traveling public, train crews and a tremendous property investment. Riveting is one of your important processes and you will no doubt agree that it has proven dependable and contributed much to the safety and progress of humanity.

There are no intangibles when considering riveting; riveting methods and machinery have eliminated the necessity for skilled workmen; the strength of a riveted joint can be mathematically predetermined; its efficiency does not depend on the man doing the riveting and a riveted joint may be inspected and reasonable assurance of its soundness obtained.

The explosion of a riveted boiler built to code requirements due to an inherent defect of either material or workmanship is practically unknown.

It is a recognized fact that serious boiler explosions cannot occur unless the rupture in the boiler is sufficient to suddenly reduce the pressure. Locomotive boiler explosions are never of sufficient severity to throw the boiler off its frame unless the sheets tear and suddenly release the pressure. Where crown sheets tear the fatalities are approximately eight times as great as where they do not tear.

Crown sheet failures are largely the result of overheating due to low water and nothing will prevent the crown sheet coming down when it has been overheated. However, if a particular method of joining metals will minimize the fatalities and property damage it should be used. That riveting accomplishes precisely that, is evidenced by the records of the Bureau of Locomotive Inspection.

Modern laboratory instruments for research in applied mechanics were not available when tests were made which determined the design rules followed today in riveted joint structures. The unquestioned reliability of millions of riveted joints made to those rules demonstrates that if the tests were crude to present day standards, the inaccuracies resulted in errors on the safe side. But how much on the safe side? A recent investigation by Commander E. L. Gayhart (C. C.) U. S. N., of the behavior and of the ultimate strength of riveted joints under load disclosed an efficiency of 80 to 85 percent on cross section for all joints instead of the theoretical value of 76 percent.

Rivet Driving Pressures

The pressure applied when driving rivets and the length of time the pressure is maintained upon the rivet are two important factors which materially affect the efficiency of the riveted seams of boilers. To those engineers who are inclined to the opinion that the riveting process has some influence on the so-called caustic embrittlement of metals we suggest a consideration of these factors. Such an investigation will undoubtedly disclose a wide difference in the practice of various boiler shops.

If plates fit well, only a moderate pressure is required to obtain a tight joint provided the pressure is maintained or held on for a sufficient period of time. Prior to 1924, 10 of the most important boiler shops in Germany used pressures between 65 and 95 tons per square inch of rivet area. Since that time they have reduced the pressure to less than 52 tons. Assuming a ⅞-inch diameter rivet, they would drive it with 32 tons whereas we would probably use 70 tons, more than twice as much pressure per square inch of rivet area.

Rivets were originally driven by hand hammer. The boiler maker of generations ago was skillful in wielding a hammer in each hand. A swage was used for finishing the heads. The first yoke type riveters were steam actuated, the piston working direct on the die. Some steam riveters amplified the available pressure by inertia of heavy moving parts, and were similar in action to a steam hammer. The hydraulic riveter soon followed. The first portable riveters (1873) were hydraulic. The first riveting gun of which we have knowledge was patented in 1875 and was operated like a steam engine, with fluid actuated *D* valve. The hydro-pneumatic riveter was invented in 1895. In 1877 the plain toggle mechanism, or Allen type riveter, air operated, was introduced. The first toggle lever, or Hanna type riveter, was built in 1903—today there are 700 styles and sizes.

New Type Riveters

Portable pneumatic riveters which weigh as much as 30 tons and capable of driving 1-⅝-inch rivets of boiler quality through 5-inch grip are in use for heavy steel plate joining, such as hydro-electric penstocks and spiral shells. One portable riveter for gas holders of 10,000,000 cubic feet capacity drives 2¼-inch rivets cold.

Riveting stands firmly upon its record, an accredited success as a fabricating process. It has played an important part in the development of our most important industries and will only be supplanted by methods more economical, less dependent on skilled labor and assuring equal safety.

Abstract of President Murphy's Address

It was in May, 1907, in this city of Cleveland, Ohio, and in the same hotel we are now assembled that the Master Boiler Makers' Association began a career that today stands second to none in the mechanical world.

Much credit is due to the broadminded men who made the birth of this great association possible and we are fortunate in having a number of these men present today.

As a boy passing from his boyhood days into manhood on the event of his twenty-first birthday, so will this organization pass into a new light after 21 years of accomplishment. Twenty-one years have made the Master Boiler Makers' Association an essential factor for progressiveness among railroad organizations.

The present day operation and maintenance of boilers requires greater skill and ability than ever before. We are living in an era when our employers, the railroads, as public servants are subject to great criticism. We as supervisors, are a part of the railroad and must assume our share of the responsibility and assist in maintaining a service pleasing to the public. This can be accomplished by making proper repairs when locomotives are in the back shop undergoing classified alterations and avoid holding engines out of service in the enginehouse.

The railroads are in need of genuine old time skilled mechanics. Our schools are doing wonderful work in fitting young men to take the place of us older mechanics who in the natural course of events must soon drop out and leave the young men to carry the heat and burden of the day. They teach the essential principles of technical work and train the mind by discipline until it becomes a practical working machine. They instruct thoroughly on the technical end of business. They can start the boys in the right direction but they cannot make them complete managers.

It is our duty as master boiler makers to take these boys in hand and teach them the fundamentals of our profession. Here I wish to impress upon the minds of every master boiler maker that it has been universally conceded that there is an unlimited amount of dignity attached to the boiler maker profession. Inasmuch as this is widely circulated, I will ask you one and all, as my colleagues, to use your utmost in preserving this dignity.

As this was the twenty-first meeting of the association, the first president, George Wagstaff, now of the American Arch Company, New York, congratulated the body on reaching its majority. Twenty-one members of the association were present at this meeting who had also been present at the first convention of the association, which was held in Cleveland in 1907.

K. E. Fogerty
Second Vice President

F. T. Litz
Third Vice President

O. H. Kurlfinke
Fourth Vice President

The reports of the secretary, Harry D. Vought, and of the treasurer, W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio, were next approved by the association. Routine business then completed the first session.

Wednesday Session

The second session was opened at 9:15 A. M., Wednesday, at which time W. R. Lye, district superintendent of motive power, New York Central Railroad at Collinwood, Ohio, was introduced to address the convention. An abstract of Mr. Lye's remarks follows:

Abstract of Mr. Lye's Address

It has been my privilege to attend a considerable number of conventions in the past five years, master boiler makers and others. Previous to that time my job with the railroad was of a nature that kept me almost confined to the shop or engine house. My idea, therefore, of what actually transpired at a convention, what benefits were to be obtained, were of a rather hazy nature and my remarks, therefore, must be considered from the slant of a fellow on the firing line after the opportunity to analyze the convention idea during the past few years.

The intermingling of supervisors from all our railroads, as an occasion of this kind permits, is undoubtedly invaluable. The ideas transmitted from one to another, not necessarily on the floor of the convention, are bound to create new thoughts and new ideas in the minds of each person participating in such discussions.

I am wondering, however, if we all appreciate the duty we owe to our individual railroads, to our officers and our associates insofar as transmitting such knowledge to them is concerned. It is my thought that too many of us permitted or instructed to attend conventions year after year become after a while rather indifferent, or I might say careless, as to our responsibilities in the premises. The knowledge is absorbed, but in too many cases is not transmitted where it can do actual good in the sphere to which we are assigned. Too often a very casual report is liable to be considered all that is necessary to repay the time and effort spent by the officers of the association and to repay for the time of the people in attendance.

The future of an association depends entirely upon the benefits derived from it, and it is my thought that the future of this, or any association may be enhanced by a sincere and earnest effort on the part of all in attendance to faithfully take home the ideas absorbed and agreed upon as beneficial and include them in their instructions as supervisors to those who are actually on the firing line and who, therefore, cannot receive such information at first hand.

The first of the committee reports was next read and discussed by the members. The subject "Boiler Corrosion and Pitting" was prepared by a committee composed of T. P. Madden, chairman, H. A. Bell and A. W. Novak. This paper and its attending discussion will be published in full in a later issue of the magazine. The discussion following the reading was entered into by a number of water service engineers including Dr. C. H. Koyl, C. M., St. P. & P. R .R.; R. C. Bardwell, C. & O. R. R.; R. E. Coughlan, C. & N. W. R. R. In addition, a number of others interested in the subject were present as guests of the association. In general, the discussion dealt mainly with various water treatments that have been developed to prevent pitting and corrosion, including open and closed feed water heaters, soda ash treatment, various electrolytic methods among which was mentioned the metallic arsenic treatment for the interior of boilers developed on the Chicago and Alton Railroad. The subject of caustic embrittlement of boiler sheets was also briefly discussed, but as too little has as yet been determined on the causes and prevention of this latest boiler disease, the subject is to be discussed at a later convention when studies have been made of the extent of the trouble in locomotive boilers. C. A. Seley, consulting engineer of the Locomotive Firebox Company, Chicago, Ill., pointed out the value of proper circulation of water in the boiler as an aid in cutting down the extent of pitting and corrosion and explained methods adopted in foreign locomotive practice especially those of the German State Railways to avoid the difficulty.

In the course of the routine business following this discussion, the following members of the association, who have retired from active duty, were elected to honorary membership: T. W. Lowe, formerly general boiler inspector, Canadian Pacific Railroad; H. J. Raps, formerly general boiler foreman, Illinois Central Railroad; A. S. Greene, formerly general foreman boiler maker, Big Four Railroad; W. H. Lucas, formerly chief boiler inspector, Michigan Central Railroad; J. B. Holloway, civil engineer, Los Angeles, Calif., and M. J. Courtney, formerly boiler inspector, Great Northern Railroad.

I. J. Pool
Fifth Vice President

A. F. Stiglmeier
Chairman of Board

W. H. Laughridge
Treasurer

H. D. Vought
Secretary

Thursday Session

The Thursday session of the meeting was called to order at 9:15 A. M. by the president, who introduced W. E. Woodward, vice president, Lima Locomotive Works, Lima, O. The subject of Mr. Woodward's address was "Modern Locomotive Design and its Influence upon Railroad Operation." The talk was accompanied by the showing of an extensive moving picture dealing with the development of the locomotive in size, efficiency and economy from the early days. The Lima A-1 locomotive typifying the great advance in modern design was used as a basis of comparison with other types. As this locomotive and its operating characteristics have been previously described in these pages the details will not be repeated in this report.

It is sufficient to state that by means of increased grate area and limited cut-off, this engine and others of the type now in service have been able to demonstrate the possibilities to be realized from the application of modern super power design to the steam locomotive.

John Doarnberger, master boiler maker, Norfolk & Western Railroad, chairman of the committee on "Fusion Welding," read the report of this committee, which described in detail the wide range of application of the various welding processes since the last meeting of the association. The report also included specific examples of locomotive firebox welding, the application of boiler patches by means of the process and an outline of the standard welding practice of the Norfolk & Western Railroad. The members of the committee were H. H. Service, Charles B. Raynor, L. M. Stewart and J. J. Mansfield. This paper and the discussions which followed its reading will appear in full in a later issue.

Method of Cleaning Scale Around Crown Bolts

THIS committee has gone into the subject of cleaning scale that accumulates around crown bolts on the water side of locomotive boilers very thoroughly and where conditions of this kind exist, a great many of the railroads use the method of leaving the water from the boiler for at least 48 hours so that the scale will not have any moisture. They then use an air hammer and bobbing tool on the exterior side of crown sheet. It was also found that some use a No. 80 or No. 90 air hammer, which this committee believes is a mistake, as this hammer is too large and is liable to cause leaky crown stays. The small air hammer is recommended where this method is to be used.

Again others use the sand blasting device by working same above the flues and through the washout plug hole. Again on some railroads by removal of the dome cap at quarterly inspection periods, inspectors enter the boilers and learn the exact condition of the crown sheet regarding the amount of scale accumulated. Where this is found, the sheet is bombarded and a washout hose is taken down through the dome and the crown sheet is washed out thoroughly.

On some of the railroads they have wayside treating plants. This treatment consists of soda ash and lime, and has been found a very effective treatment in the removal of scale from the crown sheet.

Again it has been found that a chemical treatment is used on this scale formation that the boilers build up so rapidly. A fact not quite so generally known, however, is that scale formation on the firebox is usually of quite different character than that on the flues and tubes, even though these scale formations come from the same waters. This is due to the fact that various solid impurities in the water are precipitated at different temperatures; since these solids form different kinds of scale, the physical characteristics of this scale vary in accordance with the changing temperature of the feed water as it passes from the front end of the boiler to the rear.

There are cases where bobbing of crown and side sheets is justified. Where the treatment of the water has been neglected and heavy cemented scale exists, it will be necessary to overtreat the water to reduce this old scale in service. In such cases it may be deemed proper to hasten the action by bobbing. These cases should be considered as exceptions and bobbing should not ordinarily be resorted to on account of the danger of causing leaks and deteriorating the sheets.

This report was prepared by a committee composed of Kearn E. Fogerty, chairman, Henry J. Raps, and Frank Yochem.

Scaling Inside of Locomotive Boilers with Flues Removed

THE removing of scale and thorough cleaning of locomotive boilers after full sets of flues have been removed for the purpose of examinations and inspections has been required by law on locomotives operating in Interstate Service in the United States for the last seventeen years During this period ending with the first six months of the 1928 fiscal year, only six boiler shell explosions occurred in the United States, in which persons were killed or seriously injured. Your committee does not have comparative figures on accidents which occurred prior to this period; however, taking into consideration the large number of locomotives operated, this record is commendable. It was in part, no doubt, made possible by efficient inspection.

We know of only two practical methods of scaling boilers that will in all cases meet the requirements of the law. They are the air hammer method and the sand blasting method. It is probable that in a few territories where water conditions make it possible, boilers can be thoroughly cleaned by only scraping and washing. If you are fortunate enough to enjoy the latter conditions, the first two methods mentioned should not be practiced as they undoubtedly have a tendency to injure the metal. However, generally speaking, the practice of only scraping and washing does not thoroughly clean the boiler so no time studies have been made by your committee.

When air hammers and scaling tools are used to scale boilers the plate and braces are subject to serious damage by cutting or nicking which probably in many cases will invite cracks and broken braces. To keep this condition to a minimum the use of sharp scaling tools and big air hammers should be avoided as much as possible. Tools shaped similar to a fuller calking tool so as to prevent cutting are recommended when this method is employed.

Some of our members report that they have tried scaling boilers with the sand blast method but due to labor and other conditions had no success with it whatever. Other members advise that the sand blast method for scaling boilers is the best method both from the standpoint of damage done to the boilers and economical view.

The following figures are the results of a time study made at a large shop of scaling Mikado boilers after all flues had been removed by both the sand blast and air hammer methods.

Sand blasting boiler shell, front flue sheet, braces and firebox of Mikado locomotive.

	Hours	Rate	
1—Boiler maker	3½	.75	$2.63
1—Boiler maker helper	3½	.52	1.82
			$4.45
1710 lbs. sand at $5.60 per ton			4.28
			$8.73
Unloading sand—1 laborer—1 hour			.40
			$9.13

Details of Sand Blast—Relative Cost of Hand Method

No. 2 sand blast sand used. Paugborn sand blast machine used. Air tool method—shell front flue sheet and braces scaled—Mikado locomotive.

3—Boiler makers—8 hours at $.75........ $18.00

The above figures clearly indicate that from the economical standpoint there is a decided advantage in favor of the sand blast method of scaling boilers.

An important feature in connection with sand blasting boilers is to thoroughly soak the scale with water to both soften it and keep the dust down to a minimum. This can be accomplished by washing the bulk of scale out of boiler before the sand-blasting operation is started. Some railroads mix the water and sand and perform the operation with the wet sand. The above time studies, however, were based on the dry sand operation after scale had been soaked with water.

It has been claimed that the coating of mill scale which is found on new boiler plate steel has a tendency to protect the metal to some extent from impurities in water and that the methods required to scale boilers, remove the mill scale thereby permitting the shells to pit and deteriorate more readily. There is some merit to this claim. However, the life of mill scale on boiler plate rarely lasts as long as the first set of flues so that the advantage gained would be but short lived.

This report was prepared by a committee composed of I. J. Pool, chairman, C. F. Petzinger and G. L. Young.

Election of Officers

Contrary to usual custom, the election of officers was held at this point in the program instead of on Friday as it had been scheduled. The officers elected for the coming year are as follows:

President—L. M. Stewart, general boiler inspector, Atlantic Coast Line, Waycross, Ga.

First Vice President—George B. Usherwood, supervisor of boilers, New York Central Railroad, Syracuse, N. Y.

Second Vice President—Kearn E. Fogerty, general boiler inspector, Chicago, Burlington & Quincy Railroad, Aurora, Ill.

Third Vice President—Franklin T. Litz, general boiler foreman, Chicago, Milwaukee, St. Paul & Pacific Railroad, Milwaukee, Wis.

Fourth Vice President—O. H. Kurlfinke, boiler engineer, Southern Pacific Company, San Francisco, Cal.

Fifth Vice President—Ira J. Pool, District boiler inspector, Baltimore & Ohio Railroad, Baltimore, Md.

Secretary—Harry D. Vought, 26 Cortlandt street, New York.

Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio.

Executive Board—A. F. Stiglmeier, New York Central Railroad, Albany, N. Y., chairman.

Executive board (one year), M. A. Foss, supervisor boiler inspection and maintenance, New York, New Haven & Hartford Railroad, New Haven, Conn.; John Harthill, general foreman boiler maker, New York Central Railroad, Cleveland, O.; George G. Fisher, foreman boiler maker, Belt Railroad, Chicago, Ill. (Two years), Albert F. Stiglmeier, general foreman boiler maker, New York Central Railroad, Albany, N. Y.; C. H. Browning, general foreman boiler maker, Grand Trunk Railroad, Battle Creek, Mich.; George L. Young, foreman boiler maker, Reading Company, Reading, Pa. (Three years), R. A. Pearson, boiler inspector, Canadian Pacific Railway, Calgary, Alberta, Canada; Charles J. Longacre, foreman boiler maker, Pennsylvania Railroad, Elizabeth, N. J.; W. N. Moore, general boiler foreman, Pere Marquette Railroad, Grand Rapids, Mich.

At a meeting of the executive board, following the session, Charles J. Longacre was appointed secretary of the executive board.

Following the election of officers, the final paper for the session, "Three Types of Combined Watertube and Firetube Boilers in Service. What are the Advantages Over the Present Type of Stay Boilers?" was read by Walter R. Hedeman, master boiler maker, B. & O. Railroad, chairman of the committee composed of M. A. Foss and John A. Clas. This paper will be published in full in a later issue.

Friday Session

The Friday session opened at 9:15 A. M., with an address by A. G. Pack, chief inspector, Bureau of Locomotive Inspection of the Interstate Commerce Commission.

Repair and Maintenance of Locomotive Boilers

By A. G. Pack

THE boiler is the most vital part—the heart—of the locomotive, therefore, proper design, construction and maintenance should never be sacrificed to expediency. The best and safest work is none too good for what is required today of the modern locomotive boiler with its ever increasing size and pressure. Nothing has added more to the development and expansion of civilization than has the steam boiler. The railroads have been the medium through which the once vast, trackless waste areas of our country have been developed and made habitable.

Our strides in the past have been remarkable; however, the opportunities before us command all the experience, knowledge, breadth of vision and foresight that it is possible for us to acquire. We have only scratched the surface of improvements in design, processes, methods of maintenance, economies, and efficiences that civilization has a right to expect from us, but in our desire to progress, we must be diligent in our efforts to avoid the pitfalls that ever surround us. There are those who, perhaps without realizing it, are prone to sacrifice safety in an effort to satisfy their ambition to create something new or to use an old device or process in a new way. This, of course, may be expected, especially so in times of rapid development such as the present, because the success of really meritorious devices or the success of processes under limited conditions, brings forth a flood of inferior imitations, or a tendency to misuse the processes in the hope of obtaining recognition or a share in the market. With the knowledge that the other fellow is the one who has to take the chance, safety is too often given minor consideration. We should not allow ourselves to become enthused by promises of greater economy to the extent that we become blinded to the full requirements of safety to persons and property, which in the long run becomes extravagant and wasteful in both human life and limb, and of funds.

The proper design and construction of boilers is of great importance. It is likewise important that they be maintained in good condition. Those of you who are charged with the responsibility for inspection and maintenance have perhaps a more solemn duty to perform than those who are engaged exclusively in design and construction. If you are to obtain recognition in your profession, you must be men of experience, men of certainty, men who are resolute and who will not hesitate in issuing an order to discontinue the use of a defective boiler nor in requiring that repairs shall be substantial and adequate. The factor of safety of the boiler must not only be maintained, but a large factor of reliability must be provided if we are to insure continuity of service because interruptions in service frequently lead to dangerous situations in other directions than from the boiler itself, and contribute largely to uneconomical and unsatisfactory operation.

Modern Locomotive Performance

When we compare locomotive performance of today with that of only a few years ago, we can not help but marvel at the progress that has been made in economy, efficiency and safety. The foundation of this progress, is the improved condition of motive power, to which a number of agencies have contributed, among which are the requirements of the locomotive inspection law and the activities of this association and its membership as a whole.

Since I am primarily interested in safety of operation, I will quote from statistics from the records of the Bureau of Locomotive Inspection to show the relation between the condition of motive power and accidents.

Fiscal year ended June 30	Percentage of locomotives inspected found defective	Number of Accidents
1923	65	1348
1924	53	1005
1925	46	690
1926	40	574
1927	31	488
1928 (First 9 months)	25	322

It will be noted that the percentage of locomotives inspected and found defective decreased from 65 percent in 1923 to 31 percent in 1927 and to 25 percent in the first nine months of this fiscal year, and that the number of accidents decreased from 1348 in 1923 to 488 in 1927 and to 322 in the first nine months of this fiscal year.

Boiler Explosions

While these results, obtained through more thorough inspection and timely and proper repairs, have been truly remarkable, there is one class of accidents which gives me especial concern. I refer to boiler explosions caused by crown sheet failures, the severity of which may be expected to increase in proportion to the increasing size of boilers and higher steam pressures. It is said that the frailties of human nature are responsible for many accidents of this character, with which I agree. Nevertheless, we should not look upon such occurrences as inevitable because much can yet be done to alleviate the situation.

The use of the safest practicable firebox construction, especially within the area which may be exposed to overheating due to low water; the application of modern appliances such as thermic syphons, the application and working of which is now well established; the use of reliable feed water appliances which may be conveniently operated and the working of which may be determined without the necessity of engine men endangering their safety by leaning far out of the cab window; the construction, application and maintenance of water glasses, water columns and gage cocks that will accurately register the water level in the boiler under all conditions of service, so located and maintained that the engineer and fireman may obtain quick and accurate readings from their usual and proper positions in the cab without materially detracting their attention from other important duties, will do much to prevent and relieve the distressing results from crown sheet failures caused by low water.

We all wish to direct our energies and activities toward economical progress—conservation of humanity, materials, and time. I have placed humanity first and I feel certain that you will agree with me that the conservation of humanity is one of the most important problems confronting the American people today. We see this illustrated every day on every side. We have our great health departments, dieticians and educational institutions whose endeavor is to promote health and longevity. In our great manufacturing institutions and on the railroads where the hazard of operation exists to any material extent, we are confronted with signs reading "Safety First." This indicates to me very conclusively that not only the American people are interested in the conservation of humanity but that the great employers are equally as much interested and do not desire their employees to take the desperate chance nor to keep in their employ the chance-taker.

Accuracy in Reports Essential

While this association does not assume responsibility for remarks made at its meetings, the publication of such remarks in your official proceedings savors of quasi-approval and therefore those who have occasion to read the proceedings usually place great weight on any matter appearing therein. For this reason I am of the opinion that members should be careful that what they say is founded on facts, otherwise the information which is broadcast in the published proceedings may be misleading.

Any influence that may be exerted in our chosen line of endeavor is limited by the character of the work that we do, therefore, we should exercise great care in seeing that our conclusions are based on comprehensive experience and accurate data covering a sufficient period of time to demonstrate their worth, otherwise the information which we give out may be misleading and do great harm by causing others to put into effect unsafe and uneconomical practices. If you are discriminating in your judgment, and I have every reason to believe that the majority of you will be, you may be sure that the results of your deliberation will be creditable marks in the history of progress and in the art of boiler construction and repair.

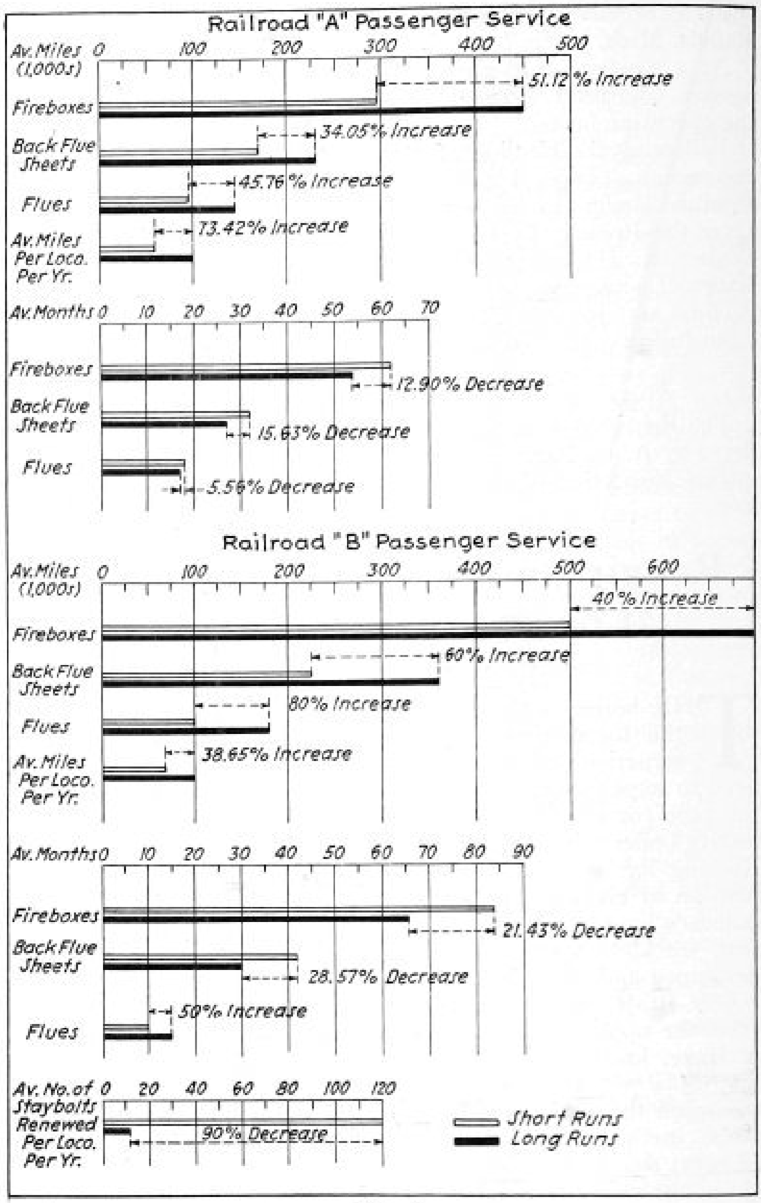


Fig. 1.

Effect on Fireboxes of Operating Locomotives over Several Divisions

IN general, it is the practice to consider the mileage made by a locomotive in determining the time when an engine is due for shopping and the extent of repairs that should be made. Since locomotives average a certain number of miles a month, in the course of several years the mileage would be burdensome to remember, so it is common to hear that a certain engine has a firebox seven or eight years old and the question of mileage is not mentioned.

Operating locomotives over several divisions is a common practice on many railroads and there is no question but that many more locomotive miles per month are obtained from this operation. Time however, has still been considered by many in determining the life of the firebox and flues, and in some cases it has been noticed that the repairs to such parts are made more often than was the case when engines operated over one division or in the so called short run.

It is our opinion that to measure the life of firebox and flues by elapsed time altogether is not reasonable. The mileage made by a locomotive is the most direct measuring stick in determining the merit of any changes in operation that may be contemplated.

With this thought in mind, this committee to prove to what extent the life of fireboxes, flues and staybolts is being affected by operating locomotives in long runs, first must determine to what extent the mileage is affected, and second to what extent the life of these parts is affected.

It is generally supposed that a firebox is good for a certain mileage whether or not the locomotive operates over a short run or over a long run. In other words, if

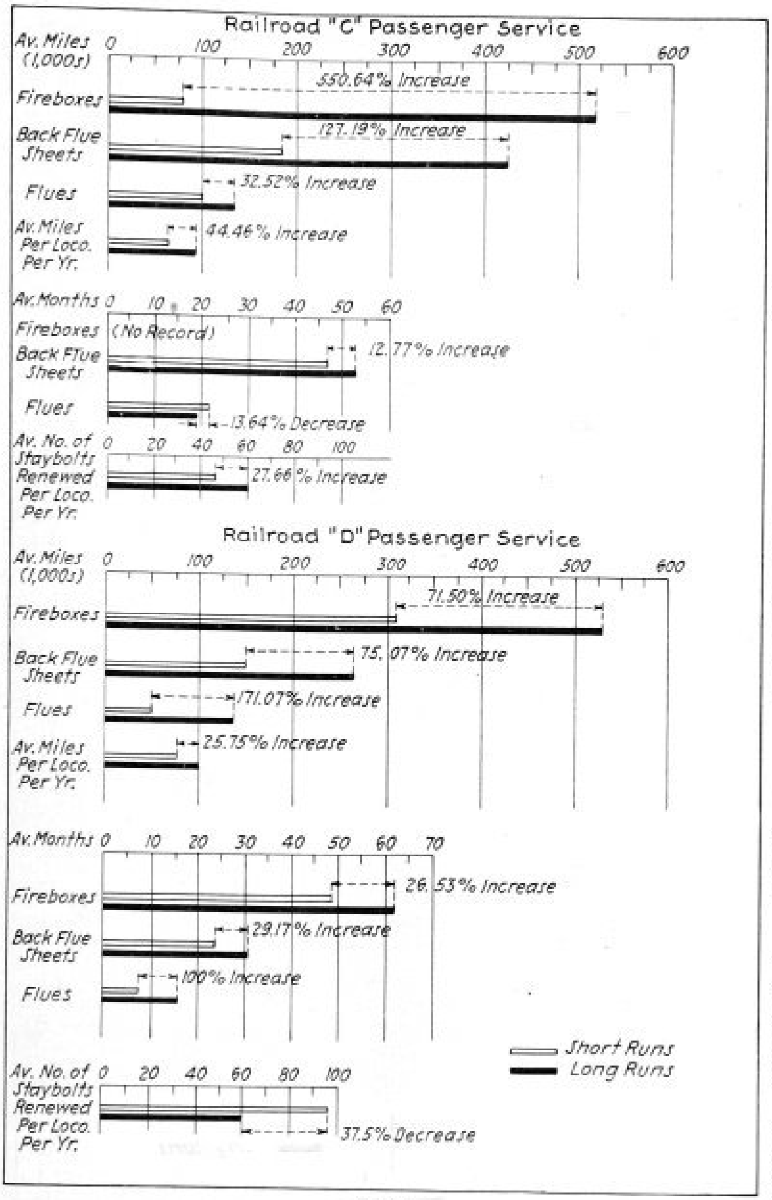


Fig. 2

We believe this is the answer to the question contained in the heading of this topic which we as a committee are requested to answer. It is evident that long runs have a beneficial effect on fireboxes and flues. Chart F covering the averages shows this graphically. The average percent increase in the life of the various parts is less than the average percent increase in the mileage, for while the increase in mileage is universal on all roads reporting, some roads showed a slight decrease in life.

It is important for us to present information covering the method employed in arriving at this conclusion as on a subject such as this considerable search of record and calculation is involved. Railroad A operates 4-6-2 type locomotives on long runs of 536 miles. The record of 15 locomotives covering a period of seven years when these operated in short runs was taken as a basis and compared with a similar record of 15 4-6-2 type locomotives operated in the same territory but on the extended run comprising two of the former short runs. The record of these engines is shown graphically on the accompanying charts.

	Before long runs were inaugurated	After long runs were inaugurated
Length of engine run	248-288 miles	536 miles
Average miles covered by engines per month	5,192	8,371
Average firebox mileage	298,056	450,428
Average life of firebox	5 yrs. 2 mos.	4 yrs. 6 mos.
Average flue mileage	97,218	141,705
Average time between flue removal	1 yr. 6 mos.	1 yr. 5 mos.
Average back tube sheet mileage	171,249	229,556
Average time between back tube sheet renewals	2 yrs. 8 mos.	2 yrs. 3 mos.

These charts show a comparison of the result of operating locomotives in long runs. The increase in mileage and decrease and increase in elapsed time for renewals is expressed in percent.

In order to determine whether or not the economies obtained on Railroad A were representative of what was generally being obtained on other roads, a questionnaire was prepared and forwarded to the chief mechanical

it takes six years for a firebox to make this mileage and considering the mileage per month is doubled due to long runs, then the life of the firebox would only be three years. In this case the long runs would have no effect on the firebox, flues, or the parts under consideration. On the other hand, were the firebox to last only two years, while the mileage has been doubled, the life would have been decreased more than half and the effect of the long runs would prove detrimental.

From an investigation made by the committee, the results obtained indicate that in addition to the increased firebox and flue mileage there also is obtained an increase in the life of these parts. The following figures are the average results of operating locomotives in long runs on the railroads supplying adequate information:

* Firebox mileage	81.77 per cent increase
Flue mileage	74.83 per cent increase
Back Tube Sheet mileage	102.99 per cent increase
Staybolt renewals	47.62 per cent reduction
Life of Fireboxes	12.54 per cent increase
Life of Flues	15.52 per cent increase
Life of Back Tube Sheets	10.70 per cent increase

* Mileage of Fireboxes shown by Railroad C is not included.

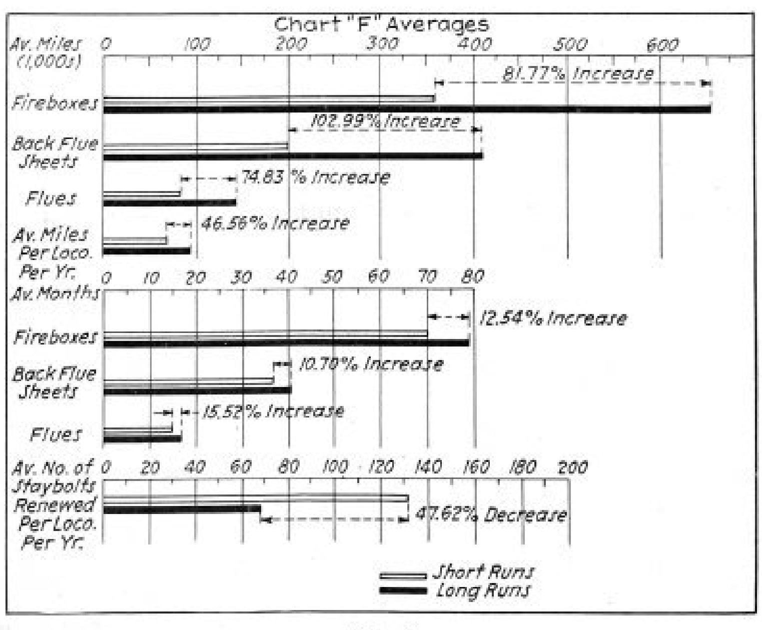


Fig. 3

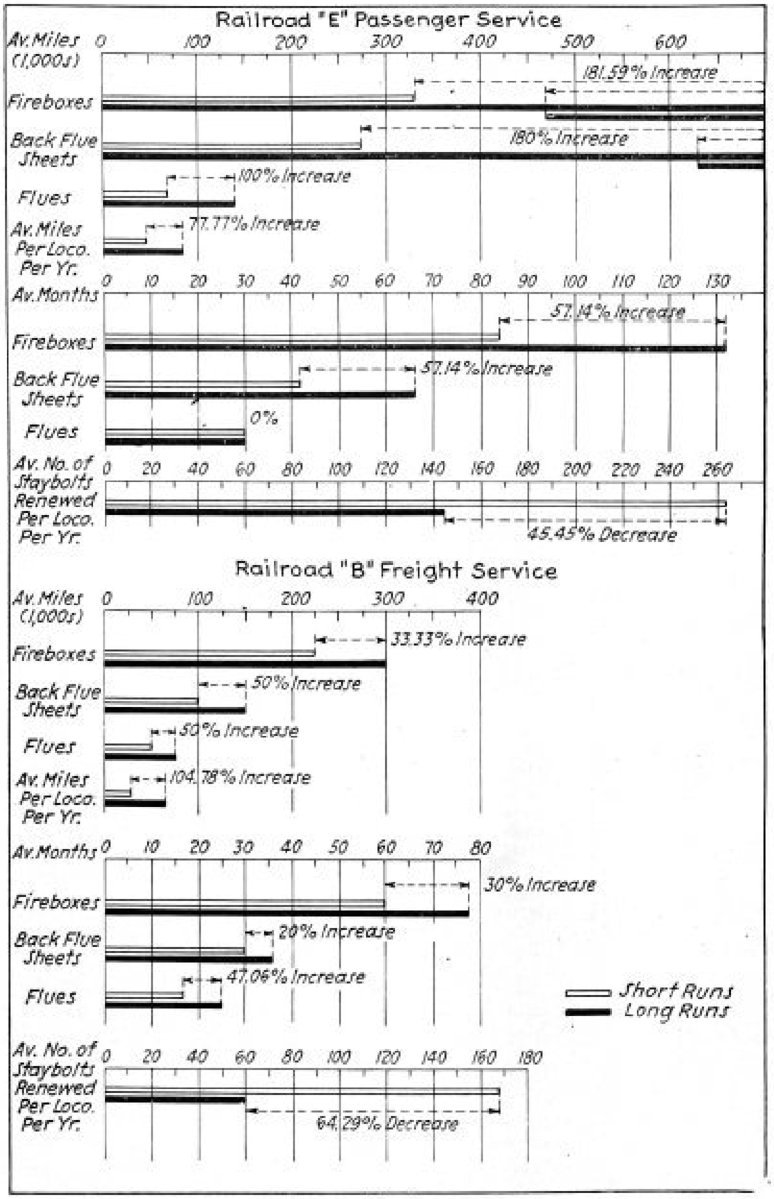


Fig. 4

officers of 32 railroads selected for their possibility of operating long engine runs. We received acknowledgment from 20. Some stated they were unable to comply with our request as they do not operate long engine runs while others, though operating long runs, had not sufficient data from which to make a satisfactory reply to our questionnaire. We were fortunate, however, in having several questionnaires returned that contained the information desired.

Results of Analysis

Upon checking the data over closely the analysis showed that some answers were estimates while others were without doubt actual locomotive records. These latter were plotted graphically and for the benefit of comparison we have included the data on the accompanying charts, designating the railroads used as examples as A, C, and E.

It will be noted that many of these roads made a better showing than Railroad A but this may be attributed to the typography of country through which the roads run, water condition, etc. At any rate, a consistent improvement is indicated on account of operating locomotives in long runs.

Attention is directed to the reduction in the number of staybolt renewals which may be attributed to long runs. It seems that this is accounted for through keeping engines in service for a greater period of time and reducing the number of times a locomotive is cooled down. Where no reference is made to staybolt renewal, no records were available from which to make the statement and it is consequently eliminated.

Other important features analogous to the subject are the average number of times locomotives are cooled down or fired up per month and the man hours required per month in the upkeep or maintenance of firebox sheets, flues and staybolts on locomotives operated in long runs compared to those in short runs. Our questionnaire covered this but all answers received did not contain the data on account of accurate records not being kept. To give an idea of improvement due to the inauguration of long runs, the following is given which represents the average of all roads reporting:

Average number of times locomotive is cooled down or fired up per month..........24.3 per cent reduction
Man hours required per month in the upkeep or maintenance of:
Firebox sheets ....55.6 per cent reduction
Flues ....44.4 per cent reduction
Staybolts ....56.6 per cent reduction

This reduction is attributed to the fact that long run engines are kept on the road for longer periods and when thus operating they reduce the number of times severe strains are set up due to expansion and contraction when fired up and cooled down.

This report was prepared by a committee composed of O. H. Kurlfinke, chairman, M. V. Milton and V H. Dunford, Jr.

Discussion

The discussion which followed the reading of this paper consisted mainly in outlining individual experiences in maintaining the boilers of locomotives being utilized on long runs.

The Effect of Self Feed Roller Expanders on Locomotive Boiler Flues

IN our endeavor to collect and compile data on this very important and much discussed subject, your committee outlined a plan whereby a list of questions was standardized and mailed to 105 master boiler makers, inspectors, and men of life long experience in the application of flues and tubes, in order to get what we consider the best methods which prevail all over the United States and Canada. Of the 105 questionnaires sent out we received 60 replies from 46 railway systems which helped us very much in our preparation of data which seems important in order to intelligently arrive at a solution of the question involved. The 60 men who helped us so splendidly, your committee wishes to thank. as their answers are really the essence of our report.

We have submitted no drawings in support of this topic as we feel that all are so familiar with the tools and appliances used that it would be a waste of time and space.

Questionnaire submitted to members as follows:

1. How many superheat tubes do you apply per year?
2. How many small, 2-inch and 2¼-inch flues do you apply per year?
3. How many arch tubes do you apply per year?
4. Do you roll all small flues in front end with self feed roller expander?
5. What size motor do you use in front end on small flues, No. 3 or No. 4?
6. Do you roll superheat flues in front end with self feed roller expander?
7. Do you use the self feed belling roller expander on superheat flues in front end?
8. Do you roll small flues in firebox on application, if so do you use the self feed roller expander?
9. Do you roll superheat flues in firebox on application, if so do you use self feed roller expander?
10. Do you use the self feed belling roller expander on superheat flues in firebox on application?
11. Do you roll superheat flues in firebox, in the roundhouse, if so do you use the self feed roller expander?
12. Do you roll small flues in firebox in roundhouse, if so do you use the self feed roller expander?
13. In your opinion, is the use of the self feed roller expander injurious to the flues, tubes and flue sheets of locomotive boilers?

On first thought some of the questions asked may seem irrelevant, but by close observation it seems to your committee the correct procedure in order to establish a record as to number of flues, superheat, and arch tubes applied per annum and methods of application, which constitutes standard practice.

In summing up results of canvass by questionnaire we find that of 60 boiler supervisors on 46 railroads who reported the application per annum of 298,115 superheat flues, 50 use the self feed roller in front end, and the remainder the hand feed. Same men reported the application of 2,809,210 2-inch and 2¼-inch flues. Of these 57 use self feed roller in front end, 1 rolls by hand, and 2 did not answer, 55 reporting application of 34,415 arch tubes per annum.

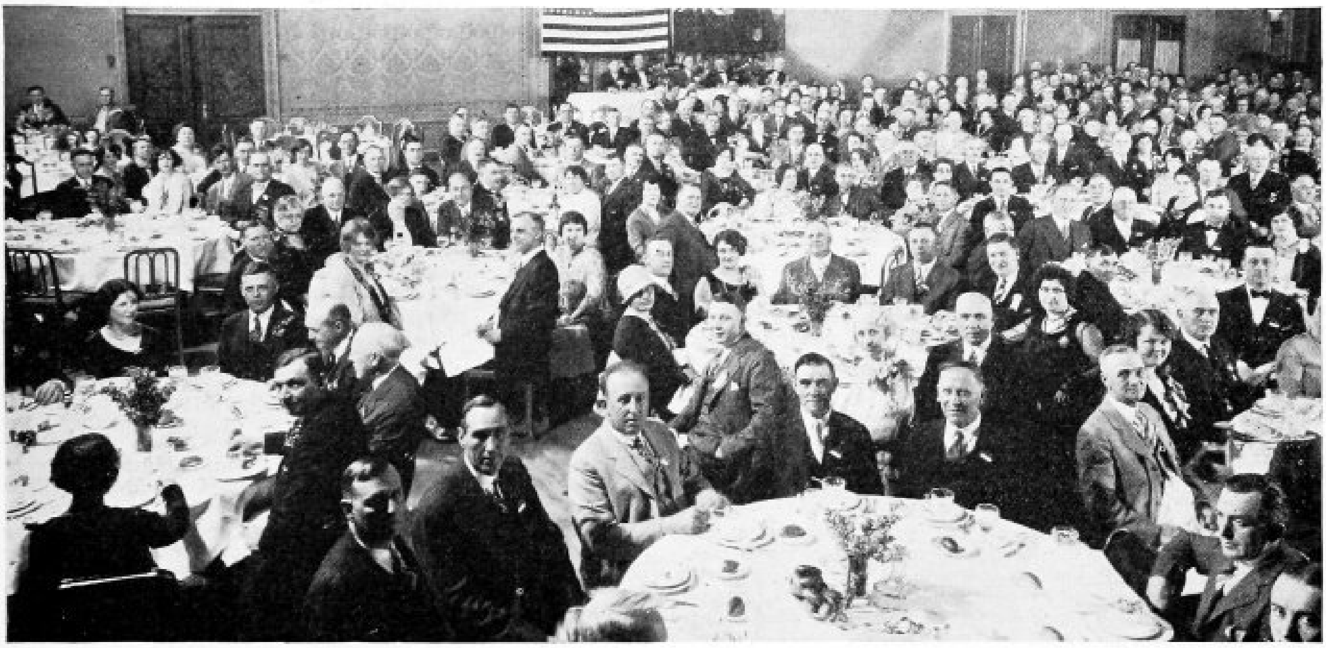
Size of motor drive socket being of importance in the opinion of your committee, the question was submitted relative to drive shank. We find that the No. 3 Morse shank prevailed, approximately 75 percent of supervisors using this size motor, 13 percent No. 4 or 2-inch and 2¼-inch flues in front end, and 12 percent are using various sizes, some few using compound geared rigging with smaller motors.

No. 7 was submitted relative to the belling roller expanders, which is a new tool on the market. Information on this was considered valuable. We find that only four shops use this tool.

No. 8. Answers to this item show that 35 supervisors roll firebox end of small flues on application, 2 use the hand roller, 33 the self feed roller, 21 do not roll at all, and 5 did not answer.

No. 9 refers to rolling of superheat flues in firebox on application. Six use the self feed, 6 do not roll at all, and the remainder use the hand feed roller.

No. 10. Three supervisors report use of self feed belling roller in firebox on application of superheat flues, the remainder have the same practice as No. 9.



Annual banquet of master boiler makers and supply men

No. 11. Forty-seven reported against rolling of superheater flues in firebox in roundhouse, 13 reported rolling superheats in roundhouse on running repairs. This in our opinion is wrong practice, except in extreme cases, where it is necessary to hold engine and chip off and re-weld.

No. 12. Forty-six do not roll small flues in roundhouse, 9 do roll, 5 gave no answer. Only in extreme cases should roller expanders of any kind be used on firebox end of flue in roundhouse.

No. 13. The real deciding factor in the opinion of the committee shows that 43 supervisors favor the use of self feed roller expanders and 17 do not.

The final recapitulation is this: 43 supervisors who applied 222,335 superheat flues, 2,006,795 tubes and 27,968 arch tubes, favor the use of the self feed roller expanders; 17 supervisors who applied 75,780 superheat flues, 802,415 tubes and 6,447 arch tubes, do not favor the use of the self feed roller expanders. However, several who seem to be against the use of the self feed roller expanders are using them. This is of course explained by the fact that boiler supervisors are subject to the ruling of superiors.

Your committee after careful study and several months of research has concluded that the use of the self feed roller expanders is not injurious to flues, tubes, arch tubes, and flue sheets of locomotive boilers if used by competent mechanics. However, this will be decided on convention floor, as it is only a conclusion, or recommendation of a minority of the membership of the association.

This report was prepared by a committee composed of Wm. N. Moore, chairman, E. J. Maneval, and F. J. Jenkins.

During the routine business which concluded the meeting, A. F. Stiglmeier, who is serving on the joint pressure vessel and welding committee of the American Society of Mechanical Engineers, rendered a report on the status of the work being done to evolve a code of welding for pressure vessels.

Stiglmeier Report

In this report Mr. Stiglmeier mentioned the numerous meetings of this committee during the past year at which the plans for conducting tests on pressure vessels were formulated. He also read an outline of the work as submitted to him by W. Spraragen, secretary of the joint committee. This outline also included the program of tests, specifications of the tanks to be tested and tables showing the series of tests to be undertaken. Details of Mr. Spraragen's statement and tables of tests are given below:

Letter to the Association from Secretary of the Joint Committee

"In connection with our previous correspondence I sincerely trust that you will call to the attention of the members of your organization the present status of the work of the Joint Pressure Vessel Committee of the American Society of Mechanical Engineers and the American Bureau of Welding.

"For the benefit of those members of your organization who are not familiar with this work, I may state that this committee was organized for the purpose of securing authentic test data in regard to the strength of welded joints in pressure vessels which could be used by the A. S. M. E. Boiler Code Committee in drawing up suitable rules and regulations governing the use of welding in such construction without placing unjust restrictions on same. In particular, this program is aimed to secure data of all types of joints commonly used in tank construction and also on all other processes. For the benefit of the few members of the Boiler Code Committee who are still skeptical as to what might happen to tanks subjected to alternating pressures in service, a series of breathing tests will be made on a number of the tanks. The program as laid out at present includes some very interesting investigations as to fatigue properties of welded joints, impact test and special strain gage work.

"We are asking tank manufacturers to submit four tanks of any given size or method which they most commonly use in their work. We are also asking them to contribute a portion of the funds.

"Aside from the fact that the test data will enable the Boiler Code Committe to draw up a proper code, the test data shoud also be of great value to individual tank and boiler manufacturers to know how their product stands up under destructive test.

"Through the cooperative method, the cost of such testing will be much less than otherwise. Half of the cash funds needed will be contributed by manufacturers of gas and electric welding apparatus and supplies.

"The Bureau of Standards has agreed to do the testing work providing the necessary test assistance is furnished. The National Research Council has agreed to act as treasurer for the funds.

"We sincerely trust that some of the members of your organization will see fit to cooperate with the committee by furnishing information for test purposes.

"A subcommittee has been appointed to prepare exact instructions covering the procedure to be followed in making up the tanks and test specimens called for in the program.

"The American Welding Society has been asked to prepare general rules of procedure in regard to welding, which may be incorporated in the code. The most cordial relation exists between the Boiler Code Committee and the Joint Pressure Vessel Committee."

Outline of Joint Committee Letter To Tank Manufacturers

"The American Bureau of Welding and The American Society of Mechanical Engineers have organized a joint research committee on welded pressure vessels to investigate in a comprehensive manner the strength of vessels of different types, with the expectation that the data obtained will assist the A. S. M. E. Boiler Code Committee when it revises its rules and regulations governing the construction of pressure vessels, and will furnish also useful data to designing engineers and tank manufacturers.

"About four years ago a preliminary series of tests on pressure vessels was made at the Bureau of Standards the results of which were helpful to the boiler code committee. Unfortunately, due to lack of cooperation in the industry these tests were not as comprehensive as desired since they did not include many forms of joints and processes. The present investigation is to be comprehensive and it has been suggested, accordingly, that studies of breathing tests of tanks and the effect of welding on the parent metal be included. Therefore, in order that this study be as complete as possible it is essential that the cooperation of the entire pressure vessel industry be secured.

"To facilitate the tests on completed tanks it is highly desirable that the tanks supplied should have the sizes listed in the program. Tank manufacturers are requested, therefore, to make to these dimensions all the tanks which they supply for test. If tanks are to be included, which do not conform to the construction outlined in this program as to (a) method of fabrication of the longitudinal, (b) the head joint or (c) the shape of the head or method of inserting it in the shell, they should be confined to those types which the manufacturers of others believe will be used in the future. It would be very unfortunate if the boiler code committee or any regulatory body should, in revisions of the pressure vessel codes, place undue restrictions on methods of fabrication which the experience of tank manufacturers had shown to be good engineering. The only way to prevent action of this kind is to obtain test data on all good methods of fabrication so that these bodies can have the benefit of the latest authentic information. It should be pointed out that four tanks of each size and style are desired. The sub-committee on procedure control will prepare detailed instructions covering the preparation of the tanks and test plates.

"The cooperation of the Bureau of Standards has been pledged and it has agreed to supply the necessary facilities and personnel to conduct the tests. The National Research Council will act as treasurer of the funds and the joint research committee will supervise the work. Copies of the progress and final reports will be sent to every firm and individual who contributes toward the success of this investigation."

Program for Testing Tanks

1. This investigation is undertaken to determine the strength and other properties of joints for pressure tanks fabricated by processes which may be used commercially. Tanks fabricated by the following and other processes will be included in the program: fusion welding, brazing, riveting, combined riveting and fusion welding.

2. Among the other processes which may be considered are atomic arc, and flash butt welding.

Tentative List of Tanks Fabricated by Fusion Welding

SERIES	Form of Longitudinal Joint	Welding Requirements	GAS WELDING		ARC WELDING			
					METAL		CARBON	
			Manual	Automatic	Manual	Automatic	Manual	Automatic
			NUMBER OF TANKS					
1	Single-Vee Butt	Weld reinforced on open side of Vee	4	4	4	4	4	4
2	Single-Vee Butt	Weld reinforced on both sides of Vee	4	4	4	4	4	4
3	Double-Vee Butt	Weld reinforced on both sides	4	4	4	4	4	4
4	Lap	One full fillet weld	4	4	4	4	4	4
5	Lap	Two full fillet welds	4	4	4	4	4	4
6	Strapped Single-Vee Butt	Two full fillet welds and Vee reinforced on open side	4	4	4	4	4	4
		TOTAL	24	24	24	24	24	24

Tentative List of Tanks Fabricated by Brazing, Riveting and Combined Riveting and Fusion Welding

SERIES	Process	Form of Longitudinal Joint	Welding and Riveting Requirements	Manual	Automatic
7	Brazing			4	
8	Riveting	Lap	Single riveted	4	
9	Riveting	Lap	Double riveted	4	
10	Riveting	Double-strapped Butt	Treble riveted	4	
11	Riveting and fusion welding	Lap	Single riveted and one full fillet weld	4	
12	Riveting and fusion welding	Lap	Double riveted and one full fillet weld	4	
			TOTAL	24	

It was moved by J. F. Raps, that the work of the association in connection with boiler welding be brought to the attention of the Mechanical Division of the American Railway Association which is preparing a code of welding practice for railroad work.

Supply Men Elect Officers

At the annual business meeting of the Master Boiler Makers Supply Men's Association held at the Hotel Hollenden, Cleveland, Ohio, May 24, the following officers were elected for the coming year:

President, John C. Kuhns, Burden Iron Company, Chicago, Ill.; vice president, Harry Loeb, Lukens Steel Company, Coatesville, Pa.; secretary, W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.; treasurer, George R. Boyce, A. M. Castle & Company, Chicago, Ill.

Executive Committee (three years)—M. K. Tate, Lima Locomotive Works, Lima, Ohio; B. H. Tripp, Cleveland Pneumatic Tool Company, Cleveland, Ohio; W. A. Clokey, General Refractories Company, New York.

List of Exhibitors and Supply Men at Boiler Makers Convention

Air Reduction Sales Company, New York.—Represented by B. N. Law, R. T. Peabody, F. E. Rogers and G. Van Alstyne. The exhibit included Airco oxygen and acetylene, Airco National carbide and Airco-Davis-Bournonville welding and cutting apparatus and supplies.

American Arch Company, New York.—Represented by J. P. Neff, J. D. Brandon, T. Mahar, W. E. Salisbury, A. M. Sucese, M. R. Smith, W. W. Neale, T. F. Kilcoyne and Geo. Wagstaff. The exhibit included pictures of arches and literature.

American Locomotive Company, Chicago, Ill.—Represented by G. P. Robinson and W. J. Leisering. The exhibit included staybolts, rigid and flexible.

Arrow Tools, Inc., Chicago, Ill.—Represented by N. W. Benedict and C. E. Murphy. The exhibit included flue beading tools, chisels, rivet sets, back-out punches and various small forged tools.

Automatic Expander Company, Milwaukee, Wis.—Represented by P. F. Saager, Carl Slesazeck and P. W. Justman. The exhibit included automatic tube expanders.

Charles H. Besly & Company, Chicago, Ill.—Represented by R. E. Beimer. The exhibit included Stanard taps for boiler work.

Bethlehem Steel Company, Inc., Bethlehem, Pa.—Represented by George H. Raab. The exhibit included charcoal iron boiler tubes; etched sections of charcoal iron boiler and superheater tubes; engine bolt and staybolt iron; staybolt steel.

The Bird-Archer Company, New York.—Represented by Major L. F. Wilson, C. A. Bird, J. J. Clifford, John L. Callahan, J. C. Hulton and H. P. Mauer. The exhibit included model of sludge remover showing operation; blow-off cocks and power operation equipment; water treatment boiler chemical samples.

THE BOILER MAKER, New York.—Represented by George Slate, H. E. McCandless and L. S. Blodgett.

Bourne-Fuller Company, Cleveland, Ohio.—Represented by Collin H. Aiken and A. U. Klingman. The exhibit included Climax alloy staybolt steel display board, Upson rivets and special bolts and nuts.

W. L. Brubaker & Bros. Company, New York.—Represented by W. Searls Rose and C. W. Borneman. The exhibit included staybolt taps, boiler taps, hand and nut taps, pipe taps, bolt and pipe dies, bridge reamers, crown bolt taps, inserted blade reamer and screw plate set.

The Burden Iron Company, Chicago, Ill.—Represented by John C. Kuhns and William Downs. The exhibit included samples of drilled hollow and solid staybolt iron and Burden iron rivets.

A. M. Castle & Company, Chicago, Ill.—Represented by George R. Boyce and L. J. Quetsch.

Central Alloy Steel Corporation, Massillon, Ohio.—Represented by Irving H. Jones and Geo. T. Ramsey. The exhibit included Toncan boiler tubes, Toncan staybolt iron, Toncan firebox sheets and Agathon engine bolt steel.

The Champion Rivet Company, Cleveland, Ohio.—Represented by D. J. Champion, Pierre Champion and T. J. Lawless. The exhibit included rivets, coupler pins and stainless rivets.

Chicago Eye Shield Company, Chicago, Ill.—Represented by Robert Malcom and John Liautaud. The exhibit included welding goggles, welding helmets and welding glass.

Chicago Pneumatic Tool Company, Chicago, Ill.—Represented by J. L. Rowe, E. K. Lynch, H. R. Deubel, D. E. Cooke, S. A. Congdon, Jr., L. F. Duffy, F. O. Duffy and R. M. Porter. The exhibit included miscellaneous pneumatic tools.

The Cleveland Pneumatic Tool Company, Cleveland, Ohio.—Represented by H. S. Covey, J. DeMooy, A. Scott, J. T. Graves, C. D. Garner and R. E. Ahern. The exhibit included riveting, chipping, calking and beading hammers; holder-on air drills; plain and compound geared corner drills; sand rammers, floor, bench and core; portable grinders, valve grinders for rings and superheater flues; Bowes air hose couplings, Cleco pressure-seated air valves, etc.

The Cleveland Steel Tool Company, Cleveland, Ohio.—Represented by R. J. Venning, F. B. Evarts, F. F. Frey, J. E. Stenger and H. W. Leighton. The exhibit included punches, dies, chisel blanks and rivet sets.

Dearborn Chemical Company, Chicago, Ill.—Represented by Charles M. Hoffman, R. Q. Milnes and L. P. Bowen. The exhibit included Dearborn scientific water treating preparations, Dearborn wayside treaters, NO-OX-ID rust preventive.

Detroit Seamless Steel Tubes Company, Detroit, Mich.—Represented by C. H. Hobbs, S. H. Worrell, C. C. Rosser and H. E. Ross. The exhibit included photographs showing manufacture of Detroit seamless steel tubes and tube samples.

Dreis & Krump Manufacturing Company, Chicago, Ill.—Represented by D. D. Dorsey. The exhibit will include no tools but samples and photographs of work done.

Ewald Iron Company, Chicago, Ill.—Represented by J. P. Bourke and W. R. Walsh. The exhibit included Tennessee charcoal bloom staybolt iron and Laurel engine bolt iron.

J. Faessler Manufacturing Company, Moberly, Mo.—Represented by G. R. Maupin and P. C. Cady. The exhibit included flue expanders, flue rollers, flue cutters, etc.

Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio.—Represented by C. M. Walsh, E. J. Raub and J. T. Doyle. The exhibit included plain, hollow and solid staybolt iron; hollow and solid staybolts.

Flannery Bolt Company, Pittsburgh, Pa.—Represented by J. Rogers Flannery, E. S. Fitzsimmons, E. G. Flannery, L. Finegan, W. M. Wilson, John H. Murrian, E. J. Reusswig, G. R. Greenslade and Blake C. Howard. The exhibit included Tate and F B C flexible staybolts, tools for installation; Flannery hollow flexible staybolts and means for electrically testing same; Flannery crown and buttonhead rigid staybolts.

Forster Paint & Manufacturing Company, Winona, Pa.—Represented by O. T. Caswell. The exhibit included printed matter.

Garratt-Callahan Company, Chicago, Ill.—Represented by J. G. Barclay, W. F. Caspers, H. M. Gray and A. H. Hawkinson. The exhibit included "Magic" boiler preservative.

Gary Screw & Bolt Company, Chicago, Ill.—Represented by G. J. Garvey. Exhibit included boiler rivets, bolts and nuts.

Henry F. Gilg, Pittsburgh, Pa.—Represented by Henry F. Gilg. The exhibit included samples of boiler crown stays from rolled hollow steel staybolt bars.

Globe Steel Tubes Company, Milwaukee, Wis.—Represented by T. F. Clifford and J. S. Bradshaw. The exhibit included samples of boiler tubes and safe ends of various sizes.

Housley Flue Connection Corporation, Indianapolis, Ind.—Represented by R. B. Housley and O. B. Capps. The exhibit included Housley safety washout and arch tube plugs.

Huron Manufacturing Company, Detroit, Mich. — Represented by H. N. Reynolds, E. H. Willard, E. C. Roddie and P. C. Cady. The exhibit included washout plugs and arch tube plugs.

Independent Pneumatic Tool Company, Chicago, Ill.—Represented by R. S. Cooper, A. Anderson, W. A. Nugent, I. T. Cruice, H. F. White, C. W. Leonard, T. J. Clancy and P. L. Stetler. The exhibit included a complete line of pneumatic drills, riveting hammers, chipping hammers, scalers, the Thor safety rivet buster and hammer type holder-ons, as well as electric drills. A feature of the Thor exhibit will be the new rotary grinders and sanders.

Ingersoll-Rand Company, Cleveland, O.—Represented by W. A. Johnson, J. W. Green and J. W. Nichols. The exhibit will include one 6A Ingersoll-Rand riveter; one 6AS Ingersoll-Rand riveter complete with outside trigger handle; one No. 90 close quarter drill complete; one "B" round Ingersoll-Rand chipping hammer complete; one 3R hex. Ingersoll-Rand chipping hammer complete; samples of various sizes of rivet sets used in the standard riveting hammers.

William H. Keller, Inc., Grand Haven, Mich.—Represented by Guy S. Warren, W. E. Hall and L. J. Wakefield. The exhibit included pneumatic tools and accessories.

Krebs Manufacturing Company, Chicago, Ill.—Represented by C. E. Krebs, W. J. Selbie, R. E. Bronson and F. S. Harper. The exhibit included a multiple expansion motor for locomotive arch tubes, including cutter heads of all designs and sizes.

Lima Locomotive Works, Lima, Ohio.—Represented by M. K. Tate, W. E. Woodard and J. E. Long.

Locomotive Firebox Company, Chicago, Ill.—Represented by A. A. Taylor, L. R. Pyle, C. A. Seley, C. M. Rogers, J. Baker, E. E. Graves, E. J. Reardon and E. F. Smith. The exhibit included Nicholson thermic syphon.

Lovejoy Tool Works, Chicago, Ill.—Represented by W. H. Dangel. The exhibit included roller and spring tube expanders, drill sleeves, flue cutter, flue hole cutter, staybolt header, recupping tool, clips, belling tools, Lacerda dolly-bar and sockets.

Lukens Steel Company, Coatesville, Pa.—Represented by Harry Loeb and G. A. Carowell. The exhibit included sample test pieces and literature.

McCabe Manufacturing Company, Lawrence, Mass.—Represented by Fred H. McCabe. The exhibit included moving pictures taken at the previous convention at Chicago; flanged parts.

Mudge & Company, Chicago, Ill.—Represented by Clyde P. Benning. The exhibit included Mudge "security unit" locomotive spark arrester.

National Boiler Washing Co. of Ill., Chicago, Ill.—Represented by Fred W. Gale and Guy L. Lloyd. The exhibit included National hot water blow-off washout and filling up system for locomotive boilers.

National Tube Company, Pittsburgh, Pa.—Represented by P. J. Conrath and J. W. Kelly. The exhibit included samples of superheater and boiler tubes as well as setting of same into back tube sheet.

Old Dominion Iron & Steel Works, Richmond, Va.—Represented by Thos. S. Wheelwright and Major Geo. Brooks-West. The exhibit included samples of solid and hollow rolled iron and electric steel bars.

Otis Steel Company, Cleveland, Ohio.—Represented by J. G. Carrothers, George E. Sevey and Harry C. Young.

Oxweld Railroad Service Company, Chicago, Ill.—Represented by W. A. Hogan, G. M. Crownover, A. N. Lucas, E. B. Daly, Wm. Jones and F. C. Hasse. The exhibit included oxy-acetylene welding and cutting apparatus.

The Paulson Tools, Inc., Chicago, Ill.—Represented by Charles Lonck, Harry L. Burrhus and Andrew S. Green. The exhibit included blading tools, hand and pneumatic chisels, pneumatic blank rivet sets, staybolt drivers, rivet buster, chisels and drift pins.

Penn Iron & Steel Company, Creighton, Pa.—Represented by C. J. Nieman. The exhibit included samples of Lewis special staybolt iron, engine bolt iron and hollow staybolts.

Pittsburgh Steel Products Company, Pittsburgh, Pa.—Represented by C. V. Lally, C. H. Van Allen, E. L. Morris and W. H. Rowe, Jr. The exhibit included display board showing stages of manufacture of seamless steel tubes, samples of seamless steel boiler, superheater tubes and test pieces.

Pratt & Whitney Company, Hartford, Conn.—Represented by Elmer E. Cullison and J. J. Hebor. The exhibit included taps, dies, reamers, etc.

The Prime Manufacturing Company, Milwaukee, Wis.—Represented by T. F. Going and D. A. Lucas. The exhibit included washout plugs, arch tube plugs, gage cocks, water glass cocks and water columns.

Reading Iron Company, Reading, Pa.—Represented by G. H. Woodroffe. The exhibit included samples of boiler tubes.

John A. Roebling's Sons Company, Trenton, N. J.—Represented by E. T. Weart, G. W. Swan and R. R. Newell. The exhibit included welding wire and advertising literature.

Rome Iron Mills, Inc., New York.—Represented by C. C. Osterhout. The exhibit included samples of Rome Superior staybolt iron and Rome Perfection engine bolt iron.

Jos. T. Ryerson & Son, Chicago, Ill.—Represented by W. S. Campbell and A. W. Willcuts. The exhibit included Lewis special staybolt iron and Lewis special hollow drilled staybolts.

Scully Steel & Iron Company, Chicago, Ill.—Represented by Ellis Westerberg and E. E. Stockum. The exhibit included boiler tube expanders, tube cutters, boiler shop tools.

The Superheater Company, New York.—Represented by Bard Browne, K. E. Stilwell and E. R. Stanford. The exhibit included literature only.

The Talmage Manufacturing Company, Cleveland, Ohio.—Represented by Frank M. Roby and Alfred F. Letherer. The exhibit included Talmage ash pan, Talmage blow-off valve and Cleveland float low water alarm.

Torchweld Equipment Company, Chicago, Ill.—Represented by W. A. Slack and H. G. Larisch. The exhibit included gas welding and cutting equipment, accessories and supplies.

The W. S. Tyler Company, Cleveland, Ohio.—The exhibit included Draftac spark arrester, netting, woven wire screens.

The Tyler Tube & Pipe Company, Washington, Pa.—Represented by John H. Wallace, W. H. S. Bateman and Harry Abbott. The exhibit included boiler tube samples.

Ulster Iron Works, Inc., Dover, N. J.—Represented by N. S. Thulin, J. C. Campbell, L. E. Hassman, C. F. Barton, J. H. Craigie and E. W. Kavanagh. The exhibit included Ulster special wrought staybolt iron, Ulster wrought engine bolt iron and Ulster wrought drilled hollow staybolts.

Registration of Members at Convention

Aiken, C. H., Dept. Boiler Equip., Bourne-Fuller Co., Shaker Heights, 3628 E. 163rd St., Cleveland, Ohio.
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.

Batchman, F. A., F. B. M., N. Y. Central R. R., 1421 Kran St., Elkhart, Ind.
Beland, Arthur J., G. F. B. M., Chicago Junction R. R., 7346 Kenwood Ave., Chicago, Ill.
Bell, H. A., G. B. I., C. B. & Q., 316 S. 11th St., Havelock, Nebr.
Bennett, G. W., Dist. Insp., I. C. C., 15 Kent St., Albany, N. Y.
Buffington, C. W., Gen. M. B. M., C. & O. R. R., Richmond, Va.
Burkholtz, G. E., Trav. G. B. I., Frisco, 1019 State St., Springfield, Mo.

Callahan, J. L., G. B. I., The Bird-Archer Co., 122 S. Michigan Ave., Chicago, Ill.
Clark, R. W., G. F. B. M., N. C. & St. L. R. R., 1806 Division St., Nashville, Tenn.
Conrath, P. J., Boiler Tube Expert, National Tube Co., 4712 Drexel Blvd., Chicago, Ill.
Cook, James T., Jr., G. F. B. M., Boston & Albany R. R., 96 Southwest St., West Springfield, Mass.
Cooke, J. E., M. B. M., B. & L. E., 360 So. Main St., Greenville, Pa.
Corns, 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.
Crimmens, R. P., Dist. B. F., Big 4, 1005 Wabash St., Mattoon, Ill.

Deen, W. H., F. B. M., C. & O. of I. R. R., 466 W. Main St., Peru, Ind.
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.
Donahue, Thomas P., Asst. F. B. M., N. Y., N. H. & H. R. R., 4 Day St., Norwood, Mass.
Duffy, C. G., G. F. B. M., Kansas City Term. R. R., 4730 Fairmont Ave., Kansas City, Mo.

Elkins, C. E., G. F. B. M., M. P. R. R., 2508 W. 13th St., Little Rock, Ark.
Ellwanger, M. A., G. B. F., C. & N. W. R. R., 727 Melrose Court, Clinton, Ia.
Evans, W. H., F. B. M., Georgia R. R., 528 Walker St., Augusta, Ga.

Fairchild, E. P., F. B. M., Atlantic Coast Line, 513 Folks St., Waycross, Ga.
Feisner, Adolph, B. M. F., I. C. R. R., 623 Sumner St., Waterloo, Ia.
Finucane, John T., 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.
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.

Gillespie, Wm. J., Gen. Loco. & B. I., P. & L. E. R. R., 1127 Charles St., McKees Rocks, Pa.
Good, William B., B. F., I. C. R. R., Centralia, Ill.
Grosnick, Wm., B. F., C. & N. W., 1204 4th Ave., Antigo, Wis.

Hagan, George N., B. F., Erie R. R., R. F. D. 7, Marion, Ohio.
Hancken, W. C., F. B. M., Atlanta B. & A. R. R., 115 S. Johnson St., Fitzgerald, Ga.
Harper, Carl A., G. B. Insp., Big Four, 3006 N. Delaware St., Indianapolis, Ind.

Harrison, William P., G. F. B. M., A. T. & S. F. R. R., 114 E. 7th St., La Junta, Colo.
Hart, L. E., B. F., Atlantic Coast R. R., 621 Hammond St., Rocky Mount, N. C.
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., 350 Ry. Exchange, Chicago, Ill.
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Heiner, C. W., F. I. C. R. R., 212 S. 15th St., Mattoon, Ill.
Holt, John W., B. F., C. & N. W. R. R., 7078 S. 13th St., Escanaba, Mich.
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Houser, J. N., G. B. F., 426 S. 19th St., Paducah, Ky.
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Hursh, P. S., Supv. Boilers, B. R. & P. R. R., 17 Linden Ave., DuBois, Pa.

Jenkins, F. J., Gen. Loco. Insp., T. & P. R. R., Dallas, Texas.
Jones, J. T., G. B. F., N. K. P., 421 Madison St., Conneaut, Ohio.

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Kilcoyne, Thos. F., Travel. Eng., American Arch Co., 2273 Washington Ave., Norwood, Cincinnati, O.
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Kirkwood, C. R., B. F., Big Four, 8220 Springfield Pike, Cincinnati, Ohio.
Knight, M. H., F. B. M., N. Y. C., 802 Thomas St., Elkhart, Ind.
Koenig, Joseph, B. F., T. P. M. P. R. R., 317 Bermuda St., New Orleans, La.
Kolbernik, O. H., G. B. F., Nickel Plate, 315 Sandusky St., Conneaut, Ohio.
Kreider, Charles N., G. B. Insp., Reading Company, Reading, Pa.
Krum, Jno., B. M. F., N. Y. C. R. R., 735 Division St., Toledo, O.
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Lenz, A. C., B. F., Ann Arbor R. R., 319 North Oak St., Owosso, Mich.
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Loveland, D. A., G. B. F., L. V. R. R., 717 S. 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.
Ludlow, William H. Interstate Commerce Commission, 7712 S. Shore Drive, Chicago, Ill.
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.

Maneval, E. J., F. B. M., N. Y. C. R. R., 1211 Walnut St., Jersey Shore, Pa.
Mansfield, J. J., G. B. I., C. 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.
Martin, N. W., G. B. F., M. & St. L. R. R., 52 Ash St., Minneapolis, Minn.
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Mallam, T. L., F., P. R. R., Juniata, Pa.
Miller, Charles, G. F. B. M., Virginian Ry., 904 Ninth St., Princeton, W. Va.
Milton, M. V., Ch. B. I., C. Nat'l, 1548 Duffern St., Toronto, Ont.
Moore, Wm. N., G. B. F., Pere Marquette R. R., 625 College Ave., S. E., Grand Rapids, Mich.
Moses, L. O., Gen. B. I., N. Y. C., 348 King Ave., Columbus, Ohio.

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Nicholson, E. J., F. B. M., C. & N. W. R. R., 409 Crooks Ave., Kaukauna, Wis.

Oliver, Jos. V., B. M. F., L. V. R. R., 213 Seymour St., Auburn, N. Y.

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.
Patrick, C. P., F. B. M., Central Vermont R. R., 99 N. Main St., St. Albans, Vt.
Peabody, Reuben T., R. R. Sales Asst., Air Reduction Sales Company, 342 Madison Ave., New York.
Pease, William, B. F., M. C. R. R., 805 Casgrain Ave., Detroit, Mich.
Peters, H. J., F. B. M., Penn. System, 717 Berkeley Rd., Columbus, O.
Petzinger, C. F., G. F. B. M., Cen. G. R. R., 742 Courtland Ave., Macon, Ga.
Porter, Louis R., F. B. M., Soo Line, 2723 Ulysses St., Minneapolis, Minn.
Powers, John P., F. B. M., C. & N. W., 216 Lynn St., Boone, Iowa.
Powers, Thos. F., Asst. Supt. of M. P., C. & N. W. R. R., 132 S. Grove Ave., Oak Park, Ill.

Reardon, Edward J., Service Engineer, Locomotive Fire Box Company, 310 S. Michigan Ave., Chicago, Ill.
Redmond, A. J., B. M. F., L. I. R. R., 22418 Orange St., Queens Village, L. I., N. Y.
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Robertson, G. S., G. F. B. M., F. W. & D. City R. R., Box 192, Childress, Texas.
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.

Seley, C. A., Cons. Eng. & Dist. S., Locomotive Fire Box Company, 310 S. Michigan Ave., Chicago, Ill.
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.
Smith, J. D., B. F., Wabash R. R., 324 S. 6th St., Moberly, Mo.
Stallangs, W. G., G. B. M. F., I. C. R. R., 12 S. Evergreen Pl., Memphis, Tenn.
Steinbuck, M. L., B. M. F., C. & N. W. R. R., Box 1081, Milwaukee, Wis.
Stephenson, E. C., B. Insp., C. & O. R. R., 824 8th St., Huntington, W. Va.
Stevens, Gay E., B. M., Boston & Maine, 322 Highland Ave., Somerville, Mass.
Stevens, Henry V., Asst. G. B. Inspt., A. T. & S. F. R. R., 116 North Elmwood Ave., Topeka, Kans.
Stewart, L. M., G. B. I., Atlantic Coast Line, Box 660, Waycross, Ga.
Stokes, John E., F. B. M., I. C. R. R., 300 South East St., Clinton, Ill.

Tate, M. K., Mgr. of Service, Lima Locomotive Works, Lima, Ohio.
Totterer, Carl F., Gen. F., C. & A. R. R., 1406 N. Western Ave., Bloomington, Ill.

Umlauf, E. C., G. F. B. M., Erie R. R., 209 Erie Ave., Susquehanna, Pa.
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.

Vogelsinger, J. R., F. B. M., Erie R. R., 19 Collier St., Hornell, N. Y.

Wagoner, Geo. A., B. M. F., C. & N. W., 913 Elmore St., Green Bay, Wis.
Wagstaff, Geo., American Arch Co., 17 E. 42nd St., New York, N. Y.
Warner, Victor, F. B. M., Nickel Plate R. R., 9226 Clyde Ave., Chicago, Ill.
Weis, August, B. F., I. C. R. R., 711 N. 9th St., Ft. Dodge, Ia.
Welk, John T., G. B. Insp., Wabash R. R., 944 E. Eldorado St., Decatur, Ill.
Wilson, Walter, Asst. B. Insp., Canadian Pacific R. R., 5215 Waverly St., Montreal, Can.

Young, C. F., B. I., L. S. & M. S. R. R., 920 Willard St., Elkhart, Ind.
Young, E. W., Mech. Asst., C. M. & St. P. R. R., 787 Caledonia Pl., Dubuque, Ia.
Young, George L., F. B. M., Reading Company, Reading, Pa.

Ziegenbein, Emil F., G. B. F., M. C. R. R., 121 Gilbert St., Jackson, Mich.

Note: An additional list of members registered will be found on page 180.

Guests Registered at Convention

Annester, A., Loco. Insp., I. C. C., Toledo, Ohio.
Bardwell, R. C., Supt. Water Supply, C. & O. R. R., Richmond, Va.
Black, W. G., Mech'l. Asst. to Pres., Erie R. R., Cleveland, Ohio.
Campbell, Homer, Cleveland, Ohio.
Clarkley, C. R., Motive Power Insp., B. & O. R. R., 2032 Gerard St., Covington, Ky.
Chidley, Joe, S. M. P., N. Y. C. R. R., Cleveland, Ohio.
Coe, T. W., S. M. P., N. Y. C. & St. L. R. R., Cleveland, Ohio.
Coleman, G. H., Loco. Insp., I. C. C., 46 Post Office Bldg., Columbus, Ohio.
Cooney, E. M., B. M., C. & E. I. Ry., Danville, Ill.
Coughlan, R. E., Engineer, C. & N. W. R. R., Chicago, Ill.
Courtney, H., Shop Supt., P. & L. E. R. R., McKees Rock, Pa.
Cross, C., Supv. of Apprentices, N. Y. C. R. R., New York, N. Y.
Dickson, G. A., Thamesville, Ont., Canada.
Dwyer, Jack, F. B. M., Mechanicsville, N. Y.
Fee, Claude, B. F., N. Y. C. R. R., Ashtabula, Ohio.
Flinn, R. H., S. M. P., Penn. R. R., Buffalo, N. Y.
Galloway, A. K., S. M. P., B. & O. R. R., St. Louis, Mo.
Garrett, E. R., Supv., Piece Work, Big Four R. R., Beech Grove, Ind.
Hass, H. P., Asst. to Mech'l Supt., N. Y., N. H. & H. R. R., New Haven, Conn.
Hazzard, W. L., Supv., Piece Work Schedules, N. Y. C. R. R., Buffalo, N. Y.
Houser, Fred., Executive Secretary, Atlanta Convention & Tourist Bureau, Atlanta, Ga.
Hunke, H. J., Secretary to S. M. P., N. Y. C. & St. L. R. R.
Johnston, S. C., Chemist, C. & O. R. R., Huntington, W. Va.
Jones, V. L., Asst. Mech'l Eng., N. Y., N. H. & H. R. R., New Haven, Conn.
Kaiser, G. J., Boiler Foreman, Collingwood Shop, Detroit Road, Dover, Ohio.
Kehoe, Charles, Boiler Foreman, D., L. & W. R. R., Hoboken, N. J.
Kuhn, B. F., Asst. Supt. M. P., N. Y. C. R. R., Cleveland, Ohio.
Lannert, Earl, Deputy Smoke Commissioner, Cleveland, Ohio.
Larrick, W. A., M. M., N. Y. C. R. R., Cleveland, Ohio.
Ludgate, B. A., Asst. Eng., P. & L. E. R. R., Pittsburgh, Pa.
Ludlow, William H., Loco. Insp., I. C. C., Chicago, Ill.
Lye, W. R., Dist. S. M. P., N. Y. C. R. R., Cleveland, Ohio.
McAllister, J., Supv. Shops & Tools, N. Y. C. R. R., Albany, N. Y.
McCune, W. C., Loco. Insp., I. C. C., Toledo, Ohio.
Maginn, J. J., M. M., N. Y. C. & St. L. R. R., Conneaut, Ohio.
Meyer, C. G., Chief Clerk, S. M. P., N. Y. C. & St. L. R. R., 4135 East 119th St., Cleveland, Ohio.
Miller, K. T., Asst. Mech'l Eng., Erie R. R., 2112 Chesterland Ave., Cleveland, Ohio.
Nelson, J. J., Boiler Insp., Erie R. R., 306 N. Mantua St., Kent, Ohio.
Parsons, J. G., Supt. of Shops, N. Y. C. R. R., Albany, N. Y.

Pierce, A. B., Engineer, Water Supply, Southern R. R., Washington, D. C.
Ramage, J. C., Engineer of Tests, Southern R. R., Alexandria, Va.
Roy, Joe, Chagrin Falls, Ohio.
Royer, William C., Vice-Pres. and Assoc. Mgr., Hotel Biltmore, Atlanta, Ga.
Shasberger, W. J., Supt. of Shops, N. Y. C. R. R., Cleveland, Ohio.
Sheehan, J. D., Gen. Foreman, N. Y. C. R. R., Cleveland, Ohio.
Simon, E. P., Engineer, Ohio Machine & Boiler Co., Cleveland, Ohio.
Stephenson, E. C., Boiler Inspector, C. & O. R. R., 824 8th St., Huntington, W. Va.
Stimmel, R. M., Chemist, Hocking Valley R. R., Columbus, Ohio.
Sweeny, P. J., Gang Foreman, Penn. R. R., Pittsburgh, Pa.
Taylor, H. L., Supv. Machine Shop and Tools, B. & O. R. R., 5008 Hardford-Road, Baltimore, Md.
Thompson, Art, Loco. Insp., Wabash R. R., Decatur, Ill.
Thomson, C. L., General Insp., Big Four R. R., 41 N. Kealing Ave., Indianapolis, Ind.
Woodard, W. E., Vice-Pres., Lima Loco. Works, New York, N. Y.
Wray, R. W., S. M. P., Penn. R. R., Pittsburgh, Pa.
Zink, Carl, Cleveland, Ohio.

J. W. Owens Awarded First Prize of $10,000

JAMES W. OWENS, director of welding of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has been awarded first prize of $10,000 in the Lincoln Arc Welding competition, for a paper entitled, "Arc Welding: Its Fundamentals and Economies," a treatise on arc welded design and shop practice and an analysis of its industrial applications and world wide possibilities. Mr. Owens became prominent in the field of welding in April, 1918, when he was appointed a member of the welding Committee of the Emergency Fleet Corporation. In September of the same year he was assigned as welding aide at the Norfolk Navy Yard where he was associated until 1926 when he was appointed director of welding at Newport News Shipbuilding & Dry Dock Company. Mr. Owens is the author of the book, "Fundamentals of Welding—Gas, Arc and Thermit." He is member-at-large of the American Bureau of Welding and was vice-president of the American Welding Society from 1920 to 1922.

James W. Owens

Henri Dustin, professor of applied science at the University of Brussels, Belgium, was awarded the second prize of $5,000 on a paper which bore no title.

The third prize of $2,500 was awarded to Commander H. E. Rossell of Annapolis, Md., on a paper entitled "Electric Welding of Ships' Bulkheads and Similar Structures."

Fred B. Walker of Winthrop, Mass., and B. K. Smith of Houston, Texas, received honorable mention on their papers, entitled respectively, "Theory of the Application of the Base Plate to an Arc Welded Rail Joint" and "Stable Arc Welding on Long Distance Pipe Lines."

The Lincoln Arc Welding prizes, given by the Lincoln Electric Company of Cleveland, Ohio, and placed in the custody of the American Society of Mechanical Engineers, were awarded at the spring meeting of the American Society of Mechanical Engineers at Pittsburgh, Pa., on May 14 by Alex Dow, president of the society.

The purpose of this competition was to encourage improvement in the art of arc welding, the pointing out of new and wider applications of the process, or the indicating of the advantages and economies to be gained by its use.

The judges of the Lincoln Arc Welding prizes were as follows:

Chairman—L. P. Alford, editor of Ronald Press.

S. W. Miller, Union Carbide & Carbon Corporation, Research Laboratories and American Welding Society.

Prof. Comfort A. Adams, Harvard Engineering School.

Henry Goldmark, American Society of Civil Engineers.

Dr. George Burgess, Director of Bureau of Standards, Department of Commerce.

Prof. Robert Fernald, Department of Mechanical Engineering, University of Pennsylvania.

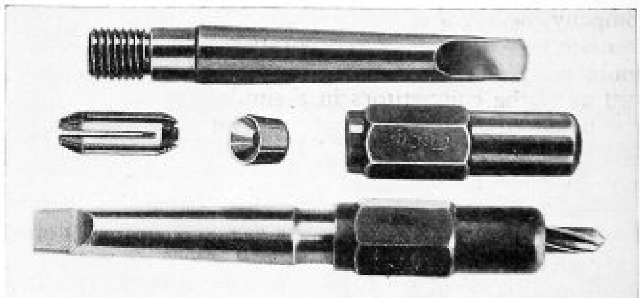
Dr. W. F. Durand of Stanford University, past president, American Society of Mechanical Engineers.

Chuck Designed to Prevent Breakage of Drills

THE Specialty Trading Corporation, 551 Fifth Avenue, New York city, is manufacturing and marketing a new type of drill chuck, under the trade name STICK-TO.

This chuck is designed to prevent the breakage of drills, and to use up any kind of broken drills. This chuck grips the twist of the drill without marring or dulling its cutting edge, as well as the round shank.

The design is clearly shown in the accompanying illustration. The chuck consists of two principal parts, the arbor, which is hollow, and the outer sleeve which when screwed together holds the twist drill firmly with the aid of internal taper surfaces, and a jamb sleeve slitted and beveled at both ends. When the chuck is screwed together one of these beveled ends is jambed against the tapered surface in the outer sleeve, while the other end of the jamb sleeve is pressed together by a loose interior collar, which is tapered and beveled on the inside at one end. The twist drill in the chuck is held at two points a certain distance apart providing eight contact points, preventing slippage of drills and giving an excellent alignment.



The assembled chuck and its four parts

This drill chuck may be used for rough as well as precision work. It is highly recommended for use with the quick change collet system, multiple spindle work both drilling and tapping as the diameter of the chuck is so small that it will work in very close centers. The drills may be set to any depth in the chuck eliminating the use of stops.

American Boiler Manufacturers Hold Fortieth Annual Meeting

Sessions devoted largely to economic aspects of the boiler manufacturing industry and future possibility of development

THIS year the annual meeting of the American Boiler Manufacturers' Association, which was the fortieth of the organization, was held at Buckwood Inn, Shawnee-on-the-Delaware, Pa., June 11 to 13. About 60 members, associates and guests were in attendance. The keynote struck in the opening address of the president of the association, Starr H. Barnum of the Bigelow Company, New Haven, Conn., was that through closer cooperation with each other and with the Department of Commerce and a definite program of trade extension, conditions in the industry could be greatly improved. He also outlined the trend in the design and construction of power boilers made to meet present day requirements. An abstract of President Barnum's address, in which he pointed out these developments, follows:

The general program of the various sessions of this 1928 meeting is on a slightly different basis than has been our practice in the past. It is realized that there are many matters that are of common interest to all; further, however, that there are many matters that are of interest only to certain groups of our industry. Bearing this fact in mind, the program has been laid out accordingly.

I hope that this will further stimulate the activity of the various committees and result in furthering the service that the association can be to the industry as a whole.

In the past year, there have been two prominent company members of our association that have affiliated themselves with large corporations. This will undoubtedly result in a benefit to the buyer and seller, as well as to the competitors in a similar line of endeavor, due to the increased amount of time and money to be devoted to the development of the art, and further the general tendency towards stabilizing prices.

As shown by the reports made of sales to the Department of Commerce, the general tendency as to volume of business has been on the decline, and this results in many firms setting their prices at even a lower basis than previously. Our industry today in many ways really cannot be said to be in as satisfactory a position as it deserves. As I see it this is due to a number of reasons.

First, the productive capacity somewhat in excess of even a normal demand.

Second, so many companies now making boilers of practically no individual design. A few years ago, there were but 2 or 3 vertical curved tube boilers on the market. Now, there are many times this. On the horizontal watertube, there were but 1 or 2 sectional header type; now, there are 5 or 6. On the horizontal watertube box header type of boiler, at one time there were but a few different designs on the market. Now there are many makes, some of which are almost identical except for a few minor details.

Third, on fire tube boilers, particularly of the horizontal return tubular type, the normal demand for this type of boiler is less than it would have been, for the obvious reason that the central station is supplying power more widely, and the popularity of the welded low pressure steel heating boiler, the latter now being often used instead of the horizontal return tubular boiler.

Fourth, there are more companies going into the manufacture of boilers; that is, take for example heating boilers. Instead of merely the makers of fire tube boilers of the design of several years ago switching to the heating type, new companies have also been started.

Fifth, on the small upright boiler, the demand has been decreased, due a great deal to the popularity of the gas engine.

Sixth, in addition to all this, boilers are run at higher ratings and higher efficiencies, which means that a less amount of so called rated capacity is installed. This of course affects the whole industry in nearly all the types of boilers that are manufactured.

All the above and other reasons lead to establishing the selling price, as a rule, at a somewhat lower basis than it should be. The lack of foresight of many of our members in not realizing the folly of making ridiculously low prices, and further, not only the willingness to cut but the apparent eagerness of some for the opportunity of cutting prices tend to the same end. This, combined with the unscrupulous buyer—who does exist—makes it hard for many of us to operate our business upon the basis that it should be.

Do you realize that from the years 1921 to 1925 inclusive, an average of over 42 percent of the manufacturing corporations, each year reported no net income?

The year 1925 was not considered a poor year, but let me give you some figures:

Of the 88,674 manufacturers reporting in 1925, only 95, or virtually 1/10 of 1 percent earned a total of 1,650 million of dollars, and the next 446 earned 900 million, or together, these 541 concerns—that is, less than 1 percent, earned more than two thirds of the 3,701 million of dollars total net profits reported; and two out of every five concerns showed losses.

Now, a condition such as that given above is not a healthy one, and what little we can do to help find the answer is going to bring, not only our industry but the industry of the country to a higher level.

The treasurer's report by A. C. Baker, secretary-treasurer of the Association was next submitted to the association for action. In connection with the matter of finances, A. G. Pratt, of the Babcock and Wilcox Company, New York, and chairman of a special committee on the advisability of establishing association dues on a sliding scale depending upon the amount of business conducted by the individual member companies, delivered a report which was accepted. The findings of this committee will be submitted with suitable recommendations at a later meeting of the association, when action will be taken.

Further reports of special committees were submitted. One of these dealt with establishing the relative financial conditions of members of the boiler manufacturing industry through reports analyzed by the firm of Ernst and Ernst, accountants, New York. It is the opinion of the leaders of the association that such work would be of extreme value in overcoming handicaps that now stand in the way of the industry in getting a fair return for its products, and also help promote uniformity in the administration of the business.

The question of affiliation of the American Boiler Manufacturer's Association with the National Industrial Conference Board came up for consideration. It was felt that conditions are not right at present to accept the invitation of the board, but that the association should render practical support to the body, until such time as membership might be deemed advisable.

Membership Report

In reporting for the membership committee of which he is chairman, George W. Bach of the Union Iron Works, Erie, Pa., stated that the association now had a waiting list for associate membership, that would be accepted after proper classification had been determined. At present there are 67 companies holding full membership, and 38 associates. There have been no resignations during the past year.

Report of Boiler Code Committee Work

An important problem of the American Society of Mechanical Engineers Boiler Code Committee at the present time according to E. R. Fish of the Heine Boiler Company, and one in which the manufacturers are vitally interested is to determine the best procedure for incorporating revisions to the boiler code in the code itself and through the National Board to make such revisions mandatory without working a hardship on those building boilers. The time element in the case of revisions is an important one. At present the code committee makes certain revisions as required due to the progress of the art, at each regular meeting and after the lapse of a certain interval for their consideration, they are passed by the council of the society and immediately issued and put into effect by the code states and cities.

The present consideration is to determine when revisions should be issued and when the National Board of Boiler and Pressure Vessel Inspectors should enforce them.

After considerable discussion by the members, a resolution was passed by the association that the American Society of Mechanical Engineers Boiler Code Committee be advised that if the committee made tentative revisions through the year and then once a year had the council approve them for incorporation in the code, then the National Board could make the changed requirements mandatory once a year, probably on January 1. This would provide that no revisions be made compulsory in less than a year's time and would work no hardship on the manufacturer who might otherwise have to make changes several times a year in his production processes. At the same time the builder could adopt such revisions to his construction at any time before they become mandatory through enforcement by the National Board.

Brief reports were made by the Ethics committee, headed by Charles E. Tudor of the Tudor Boiler Manufacturing Company, Cincinnati, O.; the Stoker committee by A. G. Pratt; the Commercial committee by E. R. Fish.

Design of Dished Heads

Perry Cassidy, chairman of the committee of the association acting with the boiler code committee on "Rules for the Design of Dished Heads" submitted the following report:

The A. S. M. E. Boiler Code Committee has about completed the revisions of the paragraphs dealing with the design of dished heads and contemplates publishing these proposed revisions shortly.

The important changes in the rules are as follows:—

1. The formula for blank heads will be the same as the Massachusetts code formula.
2. The formula for manheads will be the same as the Massachusetts code formula with the exception that the additive factor will be 15 percent of the thickness required for a blank head with a minimum of 1/8 inch which is more conservative than the Massachusetts formula.
3. A semi-elliptical blank head, in which the minor axis is at least 1/2 the diameter of the shell, will have a required thickness of at least that of a seamless shell of the same diameter.
4. A semi-elliptical manhead will comply with the rules for other forms of manheads.
5. Paragraph P-196 will be revised to provide for stayed dished heads with through stay tubes attached by outside and inside nuts. Where such heads have a minimum thickness of 7/8 inch; and are at least 2/3 as thick as called for by the rules for unstayed dished heads, advantage may be taken of the strength of the dished head and the stay tubes.
6. The knuckle radius of a dished head, measured on the concave side, will not be less than 3 times the thickness of the head and not less than 6 percent. of the diameter of the shell.
7. The depth of the flange in a manhead, measured from the outside at the major axis, will not be less than 3 times the required thickness of the head for thicknesses up to 1 1/2 inches. For head thicknesses greater than 1 1/2 inches, the depth of the flange will be the thickness of the plate plus 3 inches.

The boiler code committee has devoted a great deal of time and thought to the revision of these rules and has consulted with the manufacturers, users and many others interested in the design, construction and use of boilers. The rules will be subject to criticism and suggestions after being published and anyone who does not agree with the proposed revisions will have the right and opportunity to place his objections before the boiler code committee.

Uniform Boiler Law Society

In discussing the work of the American Uniform Boiler Law Society, E. R. Fish, chairman of the association committee, outlined the necessity of not only promulgating the boiler code in new states but more important still guarding against any change in the requirements of the code in states and cities where it is already adopted. Both Mr. Fish and Mr. Pratt were emphatic in crediting the society with preventing departures by the states from the letter of the code and in thus doing, work real hardship on the manufacturers. It is felt by all members who have followed the work of the Uniform Boiler Law Society that additional support be provided so that the body can carry on its work without handicaps from lack of funds.

Charles E. Gorton, chairman of the administrative council of the society cited numerous examples where adverse legislation has been avoided in code states through the activity of the council. Now that the code is so widely adopted it is his feeling that it is of the utmost importance to keep these states and cities in line. In the past two years, seven additional states have had the question of adopting the A. S. M. E. Boiler Code on their legislative calendars which but for press of business of a more immediate nature would have been passed. These states will rapidly be brought to a realization of the importance of this legislation and take the necessary steps to pass the bills in question. In the meantime the society will continue to maintain uniformity in the industry, by working on individual cases and with the National Board.

Following Mr. Gorton's remarks, A. G. Pratt made a motion that the council of the Uniform Boiler Law Society be commended for its work and the association take further steps to support it.

C. O. Meyers, secretary-treasurer of the National Board of Boiler and Pressure Vessel Inspectors was next invited to address the association on the work of this body. Mr. Meyers remarks follow in part:

National Board Work

By C. O. Meyers

The question of procedure on manufacturer's data reports of boilers that are not completely assembled in the shop was discussed at our last annual meeting, with the result that it was referred to the executive committee. After thoroughly discussing this question from all angles the executive committee adopted the following ruling:

For boilers that are not completely assembled in the shop, or are not assembled in the field by the maker of the drums, headers or other major parts, the responsibility for the stamping on the drums shall rest upon the manufacturer of those parts and the qualified inspector who witnessed the construction. A manufacturer's data report covering the drums, headers, etc., shall be prepared and filed, and shall be signed by that manufacturer and the inspector.

On the complete assembly and final inspection and hydrostatic test of the boiler in the field, a complete report shall be filed on the boiler when ready for use by a commissioned inspector making final inspection.

Each drum of multiple drum boilers, shall be stamped with the same standard number and shop number.

The question of proper stamping for repair drums was presented to the executive committee at one of our meetings in New York. This question required considerable thought and analysis, and the committee decided that it was best to subdivide the ruling for stamping of repair drums into three classes as it was found that there are three different conditions under which repair drums are furnished and the stamping of them should conform with the conditions of the boiler upon which they are to be placed, so the following ruling was adopted:

1. When the original boiler was not constructed in accordance with the A.S.M.E. Code, the repair drum shall be constructed in accordance with the A.S.M.E. Code and inspected during construction by a qualified inspector, and stamped with the A. S. M. E. symbol, the manufacturer's serial or A. S. M. E. number.
2. When the repair drum is to be furnished for a boiler that has been constructed in accordance with the A. S. M. E. Code and original boiler is stamped with the A. S. M. E. symbol, manufacturer's serial or A. S. M. E. number, and not stamped in addition to this with a state standard or National Board stamping, the repair drums shall be stamped with the A. S. M. E. symbol and manufacturer's serial or A. S. M. E. number that the original boiler was stamped with.
3. When the repair drum is furnished for a boiler that is stamped National Board, the repair drum shall be stamped National Board and carry the same National Board number that the original boiler was stamped with.
4. Repair drums shall be stamped immediately above the State, National Board or A. S. M. E. stamping with the words "Repair Drum." When repair drums are furnished for boilers in Code states a manufacturer's data report shall be filed with the secretary-treasurer of the National Board, in duplicate. One copy of this data will be filed with the proper State Department.

The boiler code committee referred the following questions to the members of the National Board for recommendations.

Should tubes two gages thicker than required for the maximum allowable working pressure which are rolled in the head and beaded be considered the equivalent of stays on miniature boilers with eads welded to the shell by the fusion process?

This question was referred to the entire membership of the National Board and the results of their action was to the effect that tubes two gages heavier than that required for a maximum allowable working pressure shall not be considered as stays. The Code Committee was so advised.

The boiler code committee's attention was called to the lack of uniformity between certain state laws and the A. S. M. E. code in which the state laws require the date the boiler was built to be stamped on the boiler upon completion, and the code provides that the date the boiler was put in service. This matter was referred to the executive committee.

The executive committee unanimously agreed and so advised the code committee that boilers should be stamped upon completion with the year built.

The A. S. M. E. Boiler Code Committee has received several inquiries relative to the use of the power boiler symbol in the stamping of unfired pressure vessels. The code committee requested the National Board of Boiler and Pressure Vessels Inspectors to work out a suitable symbol for use in stamping of unfired pressure vessels built in accordance with the A. S. M. E. Pressure Vessel Code. This question was submitted to the executive committee and it was unanimously agreed that the symbol now used on power boilers be used upon all pressure vessels constructed in accordance with the various codes of the American Society of Mechanical Engineers with a suitable abbreviated identification to indicate to which code the vessels were constructed. When discussing this question further before the code committee it was suggested and agreed to by all present that the outline of the "cloverleaf" be standardized and used for all codes, and instead of the letter "S" in the center of the cloverleaf place the initial of the code to which the vessel conforms. For instance, miniature boilers the symbol would be the outline of the cloverleaf with the letter "M" in the center.

At a recent meeting of the boiler code committee it was suggested that the manufacturer's registration number be eliminated from the stamping of power boilers. It was pointed out that this was a duplication for identification as the stamping provides for the abbreviated name of the manufacturer which is sufficient for the purpose intended.

A few years ago the A. S. M. E. Boiler Code Committee changed their policy of revising the Code from the four year revision period to revisions, whenever corrected, the revisions being taken care of as they come up at the regular monthly meetings. Recently some questions have arisen regarding the date such revisions become effective, which brings up a new question and one upon which if it is not settled might cause considerable confusion in the future, and I will recommend to the meeting of the National Board June 18 to 21, that the following procedure be suggested to the boiler code committee:

That revisions be made as they are at this time and assembled at the end of a fiscal year, July 1st, and promulgated at this time with the advice that they are to become effective the following January 1st.

The annual meetings of the National Board are usually held in the spring and this would give the members of the Board an opportunity to express their views upon all the revisions that were made within the past year prior to the final announcement July 1, and it would give those who are interested at least six months advance notice.

For the past several years we have been making an effort to secure the cooperation with the National Board of the State of Michigan and we are pleased to advise that the Michigan Board of Boiler Rules recently adopted a resolution accepting boilers stamped National Board and inspected by inspectors holding National Board commissions. We are also pleased to report that we have received advice from the officials of Washington D. C., that boilers stamped National Board and inspected during construction by National Board Inspectors will be accepted for operation, and they also advised that an effort is being made to have a Boiler Inspection Law passed to cover the District of Columbia. We are in touch with this situation and will use our efforts to secure the cooperation of the District of Columbia should a law be put into effect.

Monday Evening Session

The feature of the evening session on Monday was an address by W. L. Churchill, industrial economist, New York City, on the development of the business side of the industry. All progress, as he stated, is controlled largely by the profits earned by industry, for without these profits, no money can be spent for improvements. A solution for the economic problems of the boiler manufacturer can be found as in the case of other similar types of business. To this end Mr. Churchill made a number of constructive suggestions which will be published in a later issue.

Tuesday Morning Session

The early part of the Tuesday session was devoted to the reports of special committees and consideration of general business.

Feed Water Study

In the absence of J. B. Romer, chairman of the committee on feed water study, the secretary read a letter from Mr. Romer, asking that the American Boiler Manufacturers' Association members come to the further support of the joint committee undertaking the present investigations on the subject. No organization interested in the matter will derive more actual benefit from the solution of the problem than this association and every means should be taken to cooperate with the committee.

Several members cited examples of contact with the troublesome problem of feed water and advised that great expense is often incurred by the manufacturers where their boilers are involved in feed water difficulties.

Boiler Insurance

S. F. Jeter vice president of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., acting for the Insurance Board, requested that the association appoint a committee to cooperate with the board in determining a fair revision on insurance rates for watertube boilers above 750 horsepower. It is felt by the board that the two factors which should be used as a basis for establishing rates are size and pressure.

It is thought that coverage on boilers will be broadened by the new rates to be established so that any damage done to boilers from explosions will be provided for as well as property damage.

Consideration will also be given to the new hazards introduced by the use of water walls and provision for this factor will be made in the new scale of insurance rates.

Mr. Jeter concluded by reading a resolution passed at a recent meeting of the Insurance Board in New York City, delegating him to bring this matter to the attention of the association.

Smoke Prevention Committee Report

George W. Bach in reporting for the committee delegated to act with the Smoke Prevention Association, took occasion to review the excellent progress made with the problem, especially the action which several years ago resulted in the adoption of standard setting heights for boilers.

A further problem which has been developing during the last few years is to be brought to a head at the meeting of the Smoke Prevention Association in Rochester, New York, in August. Mr. Bach will be at this meeting to discuss the matter of standardizing the distance from the dump grate to the nearest heating surface in internally fired boilers where mechanical stokers are being adapted.

The requirements of various smoke inspection authorities vary to a marked extent; in some cases a length of flame travel of 14 feet is required and in others half this amount is sufficient. It is hopeu that the matter can be cleared up in the near future and a proper length determined for efficient combustion and fixed by both associations.

Boiler Performance Guarantees

In presenting the report of the committee on boiler performance guarantees E. R. Fish, chairman, called attention to the need for the settling the question by some action of the association.

The 39th annual convention of the association, held at French Lick Springs in 1927, instructed the Committee on Boiler Performance Guarantees to prepare and present a standard form of predicted performance or guarantees for use of the association when and if such predicted performances or guarantees are required to be made in connection with boiler proposals or boiler contracts.

There was then given a detailed statement of the necessity of a uniform procedure and the various items on which prediction of performance must be based, such as kind and heat value of the fuel, CO_2 content, character of operation, capacity of fuel burning apparatus, etc. Certain tolerances that should be allowed were also specifically defined.

This report was prepared by a committee composed of E. R. Fish, chairman; A. G. Pratt, William Jacobi, and A. C. Weigel.

Following the presentation of the report and a short discussion of minor details, a motion was carried that the report be arranged by the committee in suitable form to become the standard practice of the association and that in this form be made available to members for their use.

The remainder of this session was devoted to special committee reports which were not available for publication.

Wednesday Morning Session

Special and routine business was continued into the Wednesday morning session, which was completed with the election of officers.

Election of Officers for 1928-1929

Following the reports of the trade extension committee, the nominating committee recommended the following members as officers during the year 1928-1929:

President—H. E. Aldrich, Wickes Boiler Company, Saginaw, Mich.

Vice President—Charles E. Tudor, Tudor Boiler Company, Cincinnati, O.

Executive Committee—Starr H. Barnum, the Bigelow Company, New Haven, Conn.; George W. Bach, Union Iron Works, Erie, Pa.; C. W. Edgerton, Coatesville Boiler Works, Coatesville, Pa.; Owsley Brown, Springfield Boiler Company, Springfield, Ill., J. R. Collette, Pacific Steel Boiler Corporation, Waukegan, Ill.; E. R. Fish, Heine Boiler Company, St. Louis, Mo.; Sidney G. Bradford, Edge Moor Iron Company, Edge Moor, Del.; A. G. Pratt, Babcock and Wilcox Company, New York City; A. C. Weigel, Walsh and Weidner Company, Chattanooga, Tenn.

Registration at A. B. M. A. Meeting

The following members and associates were registered at the fortieth annual meeting of the American Boiler Manufacturers' Association:

Aldrich, H. E., Wickes Boiler Company, Saginaw, Mich.
Bach, George W., Union Iron Works, Erie, Pa.
Barnum, Starr H., The Bigelow Company, New Haven, Conn.
Bateman, W. H. S., Champion Rivet Company, Philadelphia, Pa.
Blake, A. D., *Power*, New York City.
Blodgett, L. S., THE BOILER MAKER, New York City.
Boyd, Marcus, Boiler Tube Company of America, Pittsburgh, Pa.
Bradford, S. G., Edge Moor Iron Company, Edge Moor, Del.
Bradford, William, Edge Moor Iron Company, Edge Moor, Del.
Bradshaw, Grant, Andrews-Bradshaw Division, Blaw-Knox Company, Pittsburgh, Pa.
Broderick, M. H., The Broderick Company, Muncie, Ind.
Brown, J. Roland, Reliance Gauge Column Company, Cleveland, O.
Brown, Owsley, Springfield Boiler Company, Springfield, Ill.
Butt, Howard, Air Preheater Company, New York City.
Cardwell, George A., Lukens Steel Company, Coatesville, Pa.
Cassidy, Perry, Babcock and Wilcox Company, New York City.
Champion, D. J., The Champion Rivet Company, Cleveland, O.
Champion, F. Pierre, The Champion Rivet Company, Cleveland, O.
Chipman, F. W., International Engineering Works, So. Framingham, Mass.
Churchill, W. L., New York City.
Collette, J. R., Pacific Steel Boiler Corporation, Waukegan, Ill.
Connelly, W. C., D. Connelly Boiler Works, Cleveland, O.
Crane, J. B., Ladd Water Tube Boiler Company, New York City.
Davis, E. Tyler, Tyler Tube and Pipe Company, Washington, Pa.
Dickson, R. B., Kewanee Boiler Corporation, Kewanee, Ill.
Donovan, Hugh, Donovan Boiler Works, Parkersburg, W. Va.
Edgerton, C. W., Coatesville Boiler Works, Coatesville, Pa.
Felker, George F., Crosby Steam Gauge Company, New York City.
Fellner, Irving, *Power*, New York City.
Fish, E. R., Heine Boiler Company, St. Louis, Mo.
Figsby, F. H., Ernst and Ernst, New York City.
Gates, R. M., Superheater Company, New York City.
Gilbert, E. F., Dampney Company of America, Boston, Mass.
Goldie, A. G., Babcock-Wilcox-Goldie-McCulloch Company, Galt, Ont., Can.
Goldie, A. R., Babcock-Wilcox-Goldie-McCulloch Company, Galt, Ont., Can.
Gorton, Charles, E., American Uniform Boiler Law Society, New York City.
Huyette, P. B., Paul B. Huyette Company, Philadelphia, Pa.
Jeter, S. F., Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.
Keenan, W. F. Jr., Foster-Wheeler Corporation, New York City.
Kramer, A. W., Power Plant Engineering Company, Chicago, Ill.
Laterman, Edward, Champion Rivet Company, Cleveland, O.
Lazear, J. M., Boiler Tube Company of America, Pittsburgh, Pa.
Low, F. R., *Power*, New York City.
Loeb, Harry, Lukens Steel Company, Coatesville, Pa.
Mensonides, S., Farrar and Trefts, Buffalo, New York.
Meyers, C. O., Chief Boiler Inspector, State of Ohio, Columbus O.
Middleton, C. W., Babcock and Wilcox Company, New York City.
Nevin, W. A., Heggie, Simplex Company, Joliet, Ill.
Obert, C. W., Union Carbide and Chemical Corporation, New York City.
Pratt, A. G., Babcock and Wilcox Company, New York City.
Seabold, H. E., Brownell Company, Dayton, O.
Shively, J. H., Edge Moor Iron Company, Edge Moor, Del.
Snow, N. L., Diamond Power Specialty Company, New York City.
Straub, F. G., University of Illinois, Urbana, Ill.
Tudor, Charles E., Tudor Boiler Company, Cincinnati, O.
Tudor, M. J., Tudor Boiler Company, Cincinnati, O.
Turn, C. R., International Boiler Works, Stroudsburg, Pa.
Wallace, John H., Tyler Tube and Pipe Company, Washington, Pa.
Waring, B. G., Yarnall Company, Philadelphia, Pa.
Weigel, A. C., Walsh and Weidner Company, Chattanooga, Tenn.
Wickes, E. B., Wickes Boiler Company, Saginaw, Mich.
Yarnall, D. R., Yarnall Company, Philadelphia, Pa.

Forestalling Potential Boiler Explosions*

THE idea uppermost in the mind of a boiler inspector is to pass by no seam, joint, tube, plate, or brace until he is satisfied it contains no defect that might result in an explosion. His concern is as much for the interests of the boiler owner as for those of the insurance company which employs him. In spite of this it happens now and then that a factory manager protests against what may appear to him to be an overzealous investigation of parts which, to a layman, would seem to be in good condition. A case of this kind was encountered recently by an inspector.

Sent out to inspect externally two horizontal tubular boilers, this inspector found that a third boiler had been installed and connected to the two boilers already insured. The additional unit was of the same type, having been used in one of the company's other plants. A heavy coating of insulation covered the top of this third boiler and the only external evidence of anything suspicious was a wisp of steam seeping out between the insulation and the dome.

Faulty Welding on Dome Flange

The inspector advised the plant manager to remove some of the covering for a thorough investigation of the leak. At first the manager demurred on the ground that the covering had been applied but a short while before. The leak was undoubtedly a minor one, he explained, for when the boiler was relocated, repairs had been made to the dome riveting. Another inspector had pronounced the job O. K.

By employing tact the inspector eventually secured consent for the removal of the lagging. He discovered that welding had been done around the dome flange where it was riveted to the shell. On one side of the dome a weld extended for a distance of 16 inches; on the other side were four similar welds, ranging in length from 4 to 8 inches.

The inspector concluded that the welding had been done in an effort to repair cracks and he insisted that the dome be removed. Again the manager hesitated and again the inspector carried his point. A fully developed crack was found along the inner edge of the inner row of dome flange rivet holes. This fissure extended through six consecutive holes, from two of which were other cracks extending radially inward. A condition somewhat similar was found on the other side of the dome. Welding was only skin-deep and while it checked most of the leakage it added little to the strength of the defective part.

In his report the inspector said: "There is no question but that cracks would have increased in length until a failure occurred which no doubt would have resulted in a disastrous explosion." Needless to say, the assured were very thankful the dangerous condition was found.

At another plant an equally serious defect was uncovered by an inspector's perseverance and alertness. Refusing to be satisfied with an internal inspection that disclosed no apparent serious condition, this inspector made it a point to be present when the boiler was next fired up and on this second trip he located a crack that almost certainly would have caused a violent explosion.

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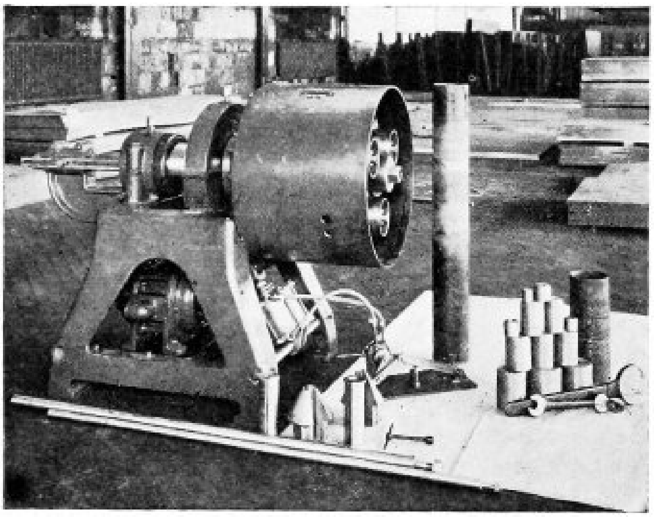
* Reprint from "The Locomotive" of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

The first investigation satisfied the inspector that although there was some slight pitting, beading had broken away from several tube ends, and there was exterior corrosion due to water seeping down through the brick work on top; these things in themselves were not serious defects. However, he suspected that the tube ends were not strong enough for service and, inasmuch as no other boiler or pump was available for a hydrostatic test he arranged to be present when the boiler was next put under steam pressure.

New Flue Roller Accommodates Flues of any Size

IN order to produce a machine that would make safe ends and do reclaiming work on any length boiler tubes, a new design in flue welders has been worked out by Joseph J. Ryerson and Son, Inc., Chicago, Ill. It is claimed that this machine not only embodies these features but furthermore allows for lighter weight construction.



Ryerson flue roller

In the new Ryerson flue roller the rolls rotate about the flue in the same way as the best rollers, but the rolling down action is done by means of an air cylinder actuated by a foot-controlled air valve. This method is easier for the operator and the labor is reduced.

The machine can be used on any size flue or tube from the smallest to the largest by changing only the mandrel. This operation is simple. It is but necessary to remove one nut, slip off the mandrel, put on the size required and tighten the nut. The adjustment of the rolls for different sizes is the same as has been used in the past and involves a simple operation of turning an adjustment screw with a socket wrench.

The roller operates with a 3-horsepower motor on standard flues and by a 5-horsepower motor on 6-inch superheater tubes..

A Tube Explosion

AN explosion that started when eight tubes in the lowest row of a watertube boiler were pulled from the front header, damaged not only the boiler but destroyed its setting, tore loose all pipe connections, parted the breeching, and blew a hole in a brick wall of the boiler room of the Consolidated Ice Company, Inc., at Monroe, La., September 6, 1927. Fortunately, no one was near the boiler when it let go.

The explosion was cumulative in effect, in that when the bottom row of tubes pulled loose, the energy released by escaping steam and water raised the boiler from its setting and allowed it to crash downward four feet in such a way as to throw its full weight onto tubes which fell across a brick baffle wall about midway the furnace. Needless to say, this added considerably to the damage.

Both chief engineer and watch engineer had left the boiler room a few seconds before the explosion. They succeeded in closing the stop valve to prevent another boiler on the line from discharging steam through the damaged header.

While the boiler was twenty years old it was apparently in good condition before the accident. Within the past two years it had been completely retubed and neither headers nor drums showed defects when inspected. However, the lowest row of tubes had been the last to be replaced and, when installed, their ends had not been flared. This is believed to have allowed them to blow out under pressure.

The plant uses natural gas as fuel. Inasmuch as there were no actual eye-witnesses to the explosion, the investigators took cognizance of the possibility that instead of being caused by steam pressure the damage might have been the result of a gas explosion within the fire chamber and breeching.

In plants using gas as fuel, care must be taken to guard against combustion chamber detonations by so regulating the relative amounts of fuel and air as to assure complete combustion. In lighting such a furnace great care should be exercised, a piece of burning waste or paper being thrown into the chamber before the gas is turned on. Attempts to light the gas after it has had a chance to accumulate in the chamber may result disastrously. Even when tossing lighted waste into a supposedly empty furnace the fireman should not stand directly in front of the fire door. Leakage may have allowed enough gas to accumulate to form, with air, an explosive mixture.—*The Locomotive.*

Safety Latches for Fire Doors

SINCE the publication of the description of the fire door safety latch as made by the Erie City Iron Works, Erie, Pa., which appeared on page 137 of the May issue of THE BOILER MAKER, it has been learned that latches similar in type have been used by the Detroit Stoker Company, Detroit, Mich., for the past 15 years and by the Union City Iron Works, Erie, Pa., for at least 10 years. Undoubtedly other concerns are also using this type latch so that in the interests of veracity, the statement in the May issue, that the latch had been "developed" by the Erie City Iron Works, should be changed to read "adopted" by this company.

When the File "Hollers"

A YOUNG WORKMAN was industriously pushing a flat file against the corner of a strip of boiler plate and the file emitted discordant squawks at every stroke.

"Here, you," said an old workman: "Don't push the file at an angle against the piece of steel. Don't you know that a file can't do good work when it hollers? Lower your hand until the file purrs like an old cat, then it will be cutting *with* the spring of the plate, instead of *against* it and the file will cut faster and the teeth last a whole lot longer than when the file *squawks* at each stroke."

Flanging Attachment Developed for Standard Punch

THE Huber Company, Los Angeles, Cal., boiler makers and tank builders, have developed a method of using a standard punch for flanging heads and bending angles. This work is accomplished by dies which are quickly attached to the punch and

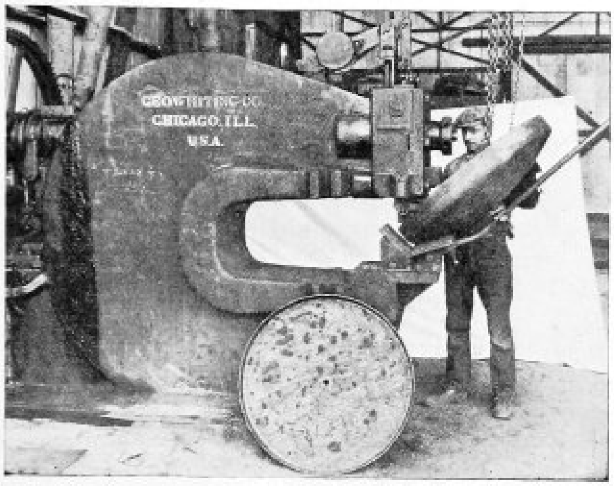


Fig. 1.—Attachment for flanging heads

easily operated. Separate dies are used for flanging and angle bending. These dies are made of cast steel and are rugged in design. There are only 5 moving parts and the devices should last indefinitely.

Fig. 1 shows a flanging attachment. Heads from 18 inches to 8 feet in diameter and ranging in thickness from 3/16 inch up to 3/4 inch can be flanged cold on the device shown. The flange is actually rolled on gradually by revolving the head which is turned at each stroke. With a little practice flanges can be made to within 1/16 inch in diameter. As the rolling operation is gradual no wrinkles, nor marks are made on the face of the flange. A 5/8 inch by 36 inch head can be flanged in about 25 minutes, one man operating the machine.

Fig. 2 shows an attachment for bending angles cold.

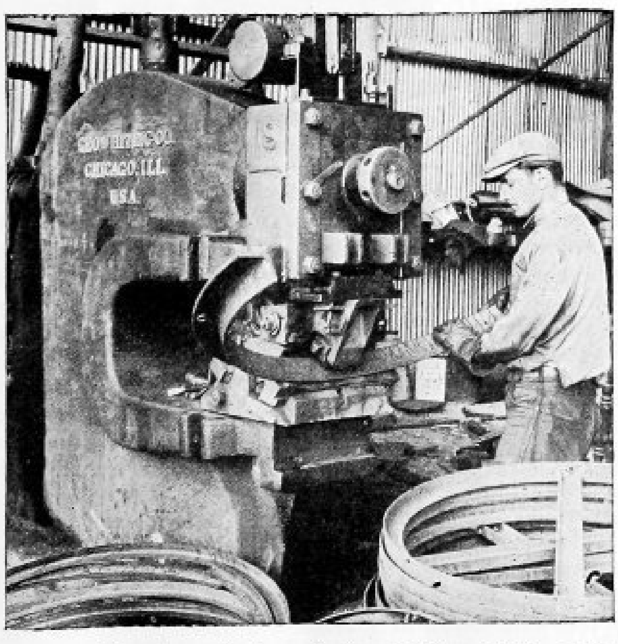


Fig. 2.—Flanging attachments for flanging angles cold

Inside and outside angles from 20 inches to 15 feet can be bent cold. The finished angle is true to form and without twist. The bending capacity is proportional to the power capacity of the punch. A punch having a capacity of 1 inch hole in 1 inch plate will bend a 3½ inch by 3½ inch by ½ inch angle to about 4 feet diameter. One operator can bend light angles of small diameters. Heavy angle rings will require assistance in handling. However, the bending operation is very rapid and a 3 inch by 3 inch by 3/8 inch angle about 48 inches in diameter can be finished within 15 minutes.

Fig. 3. shows the regular attachment for flanging cones. In this case a flange line is marked on a cone the same as for hot flanging, and then the cone is attached to the flanging die so it can be rotated, bringing the flange line under the flanging block. An even flange true to the diameter is obtained. The flanging time of a cone 5 feet in diameter is about 45 minutes. The advantage claimed for this type of flanging die is that should the operator make the cone, or heads, slightly larger than desired they can be sized to the required diameter without much loss of time.

Shops that do their flanging and angle bending hot because of lack of heavy equipment may now obtain

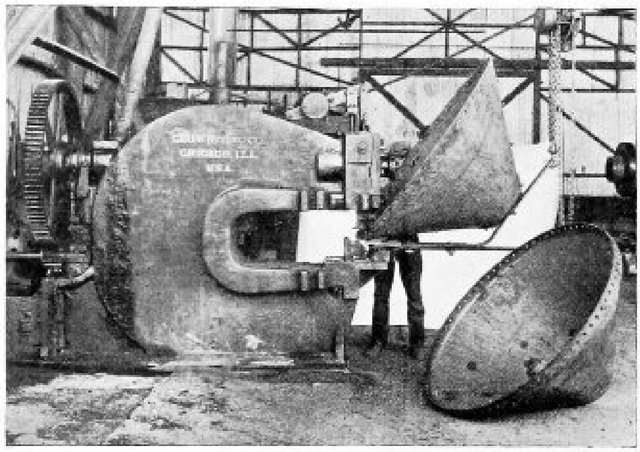


Fig. 3.—Regular attachment for flanging cones

dies for cold flanging and bending which will fit a standard punch. These dies make it possible for shops not equipped with heavy flanging and angle bending machinery to turn out work economically.

Additional Registration at Boiler Makers' Convention

(See main list page 170)

Allison, L. D., Loco. Insp., Bureau Loco. Insp., I. C. C., 46 P. O. Bldg., Columbus, Ohio.
Badger, R. L., Supv. Boilers, Erie R. R., Meadville, Pa.
Becker, W. C., G. B. F., I. C. R. R., 8051 Ellis Ave., Chicago, Ill.
Bell, W. G., G. B. I., Florida East Coast Ry., St. Augustine, Fla.
Bergstrom, C. H., B. F., St. Louis & San Francisco Ry., 741 South Ave., Springfield, Mo.
Berrey, Frank E., F. B. M., Erie R. R., Route 3, Box 42, Berea, Ohio.
Boyer, Charles, B. F., Indianapolis Union Ry., 3312 W. 16th St., Indianapolis, Ind.
Brennan, Edward John, G. B. F., Boston & Maine R. R., 56 Monument St., West Medford, Mass.
Bressette, R. B., B. F., C. & N. W. Ry., 736 7th Ave., So. Clinton, Ia.
Brinsley, Harry A., Service Engineer, Paige & Jones Chemical Co., 602 E. Lewis St., Ft. Wayne, Ind.
Brooks, W. A., Div. B. M. F., Penn. R. R., 10206 Dickens Ave., Cleveland, Ohio.
Browning, Charles H., G. F. B. M., G. T. R. R., 56 Manchester St., Battle Creek, Mich.
Burke, Lawrence A., B. F., C. & N. W. R. R., 5523 S. California Ave., Chicago, Ill.
Burkholtz, G. E., Trav. G. B. I., St. L., S. F. R. R., Frisco R. R., 1019 State St., Springfield, Mo.
Burnside, G. M., B. F., Monongahela Ry., 242 Bank St., Brownsville, Pa.

Campbell, John C., Ulster Iron Wks., 719 Peoples Gas Bldg., Chicago, Ill.
Cannon, W. R., G. B. M. F., I. H. B. R. R. Co., Hammond, Ind.
Carbis, N. J. Service Engineer, 1903 E. 70th st., Cleveland, Ohio.
Carroll, S. M., G. M. B. M., C. & O. R. R., 2961 Staunton Rd., Huntington, W. Va.
Cavedo, A. L., B. F., C. & O. Ry., 2213 W. Grace St., Richmond, Va.
Chapman, A. B., Supv. of Welding, C. & O., 1821 9th Ave., Huntington, W. Va.
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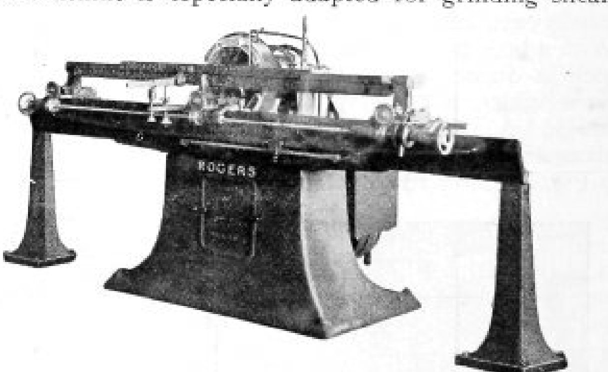
Zink, Fred J., F. B. M., C. & N. W. R. R., 707 Utah Ave., Huron, S. D.

Sectional Wheel Grinder

Samuel C. Rogers and Company, Buffalo, N. Y. has produced an addition to its line of automatic knife grinders and saw sharpeners known as the type "K" sectional wheel knife grinder. This machine is especially adapted for grinding shear blades and all straight knives. A new feature introduced in this machine is a 14-inch sectional grinding wheel mounted in a strong steel chuck with a simple adjustment for securely holding the segments.



Rogers type "K" sectional wheel grinder

The sectional wheel construction permits faster grinding than the solid wheel type of machine because the spaces between the grinding sections form channels for carrying away the abrasive particles and the stock ground off the knife. This type of construction also allows free entrance of the cooling medium to the actual grinding contact, which carries away the heat generated and aids in washing away the refuse.

The new type "K" machine is made in eight different sizes varying from 76 to 144 inches. All sizes are equipped with a water attachment, ball bearings, direct motor drive with built in standard 5 horsepower 60 cycle motor, with starter, extended shaft and brackets.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by C. J. Zusy

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.*

Determining the Working Pressure of a Boiler

Q.—Please publish as soon as possible an illustration of that part of P-212 which is found in section I on power boilers, (page 29 to 30). A. S. M. E. Code.—C. M. C.

A.—To illustrate this paragraph I will use a locomotive boiler so that all of the different rules in paragraph P-212 appearing on pages 29 and 30 of the American Society of Mechanical Engineers Boiler Code can be applied to the same boiler.

P-212a. The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:

First, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays or riveted longitudinal joint or other construction. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in paragraph P-199, using 70 for the value of C.

Second, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays or riveted longitudinal joint or other construction. To this pressure there shall be added the pressure corresponding to the strength of the stays or braces for the stresses given in table P-7, each stay or brace being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay or brace.

Applying the first rule to the boiler as shown in Fig. 1, it is necessary first to calculate the efficiency of the ligament, longitudinally, between the stay holes in the wrapper sheet.

Let

p = pitch of stays, inches
d = diameter of stay holes, inches
E = Efficiency of ligament.

Then

$$E = \frac{p-d}{p}$$

The maximum allowable working pressure without allowing holding power of the stays, due allowances being made for the weakening effect of the holes for the stays is computed as follows:

$$P = \frac{11{,}000\ t \times E}{R}$$

Where

P = maximum allowable working pressure, pounds per square inch.
t = thickness of wrapper sheet, inches
E = efficiency of ligament or longitudinal joint
R = inside radius of wrapper sheet, inches.

The maximum working pressure allowed by the second part of the first rule and which should be added to the maximum allowable working pressure as found above to obtain the total maximum allowable working pressure allowed by the first rule in P-212a is found as follows:

Let

P = maximum allowable working pressure, pounds per square inch
T = thickness of plate in sixteenths of an inch
p = maximum pitch measured between straight lines passing through the centers of staybolts in the different rows, which lines may be horizontal, vertical or inclined, inches.
C = 70 as specified in paragraph P-212a.

Then

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

The second rule of paragraph P-212a is applied as follows:

The maximum allowable working pressure without allowing for the holding power of the stays is the same as found by employing the first part of the first rule and is illustrated above.

The maximum working pressure allowed by the second part of the second rule and which should be added to the maximum allowable working pressure as found by the first part of this rule to obtain the total maximum allowable working pressure, allowed by the second rule in P-212a is found as follows:

Let

p = longitudinal pitch of staybolts, inches, as shown in Fig. 1 (c)
p' = transverse pitch of staybolts, inches, as shown in Fig. 1 (b)
a = least cross sectional area of staybolt, square inches
s = maximum allowable stress for staybolts obtained from table P-7, selected according to type and dimensions of stays.

Then

$$P = \frac{s \times a}{p \times p'}$$

P-212 (b). The maximum allowable working pressure for a stayed wrapper sheet of a locomotive type boiler shall be determined by the two methods given above and by the method which follows, and the mimimum value obtained shall be used.

$$P = \frac{11{,}000\ t \times E}{R - s\ \Sigma\ sin\ a}$$

in which,

a = angle any crown stay makes with vertical axis of boiler

$\Sigma\ sin\ a$ = summated value of $sin\ a$ for all crown stays considered in one transverse plane and on one side of vertical axis of boiler

s = transverse spacing of crown stays in crown sheet, inches

E = minimum efficiency of wrapper sheet through joints or stay holes

t = thickness of wrapper sheet, inches

R = radius of wrapper sheet, inches

P = maximum allowable working pressure, pounds per square inch

11,000 = allowable stress, pounds per square inch.

The above formula applies to the longitudinal, center section of the wrapper sheet, and in cases where E is reduced at another section, the maximum allowable working pressure based on the strength of that section, may be increased in the proportion that the distance from the wrapper sheet to the top of the crown sheet at the center, bears to the distance, measured on a radial line through the other section, from the wrapper sheet to a line tangent to the crown sheet and at right angles to the radial line.

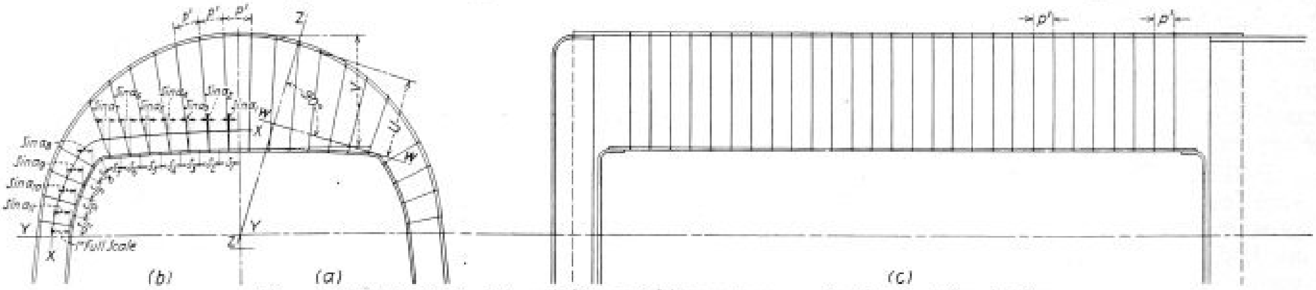


Fig. 1.—Method of determining working pressure of a locomotive boiler

The above formula for finding the maximum allowable working pressure at the top longitudinal section of the wrapper sheet, applies only when the crown stays are spaced with a uniform transverse pitching. When the transverse pitching is not uniform more accurate results are obtained by taking $sin\ a$ for each individual stay and multiplying by the pitch of that stay.

To get accurate results, a layout of the wrapper sheet as shown in Fig. 1 (*b*) should be made. This layout should be made sufficiently large to permit accurate scaling, about 3 inches to the foot.

The simplest method of obtaining the *sin* of the angle that the stay makes with the vertical axis of the boiler is by drawing a line *x–x* parallel with and one inch (full scale) from the top of the crown. Then draw lines parallel with the vertical axis of the boiler intersecting the stay at the top of the crown and the stay at the one-inch line *x–x*. The distance (full scale) between these two vertical lines, is the *sin* of the angle the stay makes with the vertical axis of the boiler.

The stays and pitching should be considered down to the horizontal line *y–y* which intersects the center of the wrapper sheet radius.

Then $(S^1 \times sin\ a_1) + (S^2 \times sin\ a_2) + etc. = S\ \Sigma\ sin\ a$.

If the pitch of the stays is uniform from the vertical center line down to horizontal center line *y–y* then $\Sigma\ sin\ a$ can be multiplied by s the uniform pitching.

The last paragraph of P-212 (*b*) is intended for use when the staybolt pitching or other construction results in a lower efficiency at some point on the wrapper sheet than is obtained at top center. To illustrate this paragraph we will assume that the boiler as shown in Fig. 1 does not have the same staybolt pitching on the third longitudinal row from top center as the top row and that the efficiency of the ligament between the staybolt holes is less than that found on the top row.

Then to employ the formula it is necessary, first, to calculate the maximum allowable working pressure at top center using the formula:

$$P = \frac{11{,}000\ t \times E}{R - s\ \Sigma\ sin\ a}$$

with E = the efficiency of the ligament between the staybolt holes of the third row instead of the efficiency through the first row from top center.

Then draw line *z–z* as shown in Fig. 1 from the center of the radius of the wrapper sheet and intersecting the third row of staybolts from the top center at the wrapper sheet. Next draw line *w–w* tangent to the top of the crown sheet and at right angles to the radial line *z–z*.

Then

$$P^1 = \frac{P \times u}{v}$$

Where

P^1 = maximum allowable working pressure, pounds per square inch at the third row of staybolts from top center.

P = maximum allowable working pressure, pounds per square inch at top center using the efficiency of the ligament between the staybolt holes in the wrapper sheet at the third row from top center.

v = distance from top of crown to inside of wrapper sheet on vertical center line of boiler, inches.

u = distance from point where line *w–w* intersects line *z–z* on line *z–z* to inside of wrapper sheet, inches.

The Botfield Refractories Company, Philadelphia, Pa. has announced that, effective June 1, the distribution of Adamant, fire brick cement, Adachrome and Adachrome fines and the Adamant gun for Toledo, Ohio and vicinity will be handled by The Builders & Industrial Supply Company, 4090 Detroit Street, Toledo, Ohio.

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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
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Cities

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Delaware	New York	Utah
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Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Memphis, Tenn.	Philadelphia, Pa.	Tampa, Fla.

Selected Boiler Patents

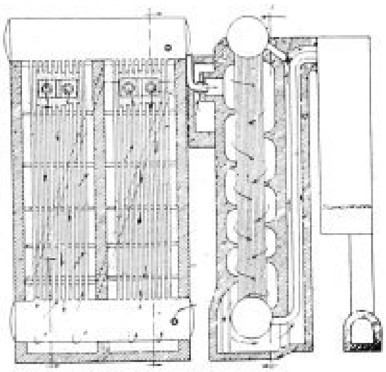
Compiled by
DWIGHT B. GALT, Patent Attorney,

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.

1,651,646. GUSTAVE TRASENSTER, OF OUGREE-LEZ-LIEGE, BELGIUM, ASSIGNOR TO SOCIETE ANONYME D'OUGREE-MARIHAYE, OF OUGREE-LEZ-LIEGE, BELGIUM. BOILER FURNACE.

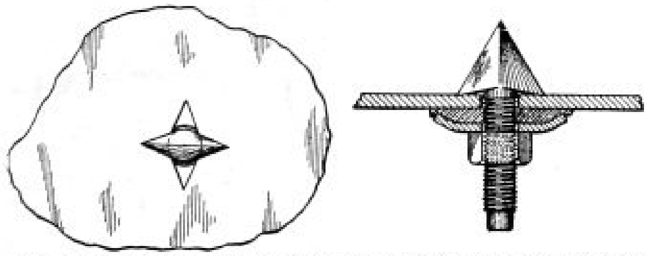
Claim.—1. In a boiler furnace, in combination, a furnace housing, a partition dividing said furnace housing into two compartments, water



tubes arranged in each compartment, a burner disposed at the top of the first compartment for burning fuel with a limited quantity of air therein, a flue for conducting the gases from the bottom of the first compartment to the top of the second compartment, a burner disposed at the top of said second compartment for burning the gases with an additional supply of air, and a flue for conducting the products of combustion away from the bottom of said second compartment. Three claims.

1,636,135. BEN H. HUGHES, OF EAST CLEVELAND, OHIO. BOILER PLUG.

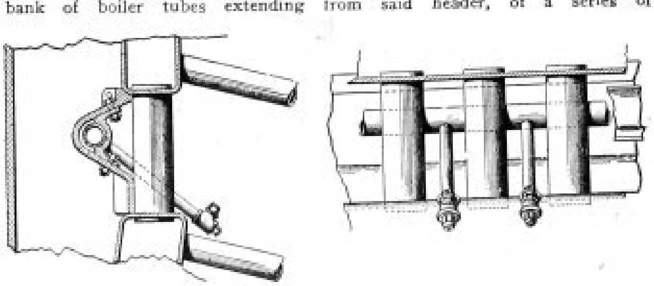
Claim.—As a new article of manufacture, a boiler plug comprising a member having one end portion formed like an arrowhead terminating in a sharp point and having a plurality of separated barbs projecting in a di-



rection away from said point, another portion being fashioned with screw-threads and a nut cooperating with the latter and adapted to draw said barbs against the interior surface of a boiler.

1,637,546. FRANK BOWERS, OF DETROIT, MICHIGAN, ASSIGNOR, BY MESNE ASSIGNMENTS, TO DIAMOND POWER SPECIALTY CORPORATION, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN. SOOT BLOWER.

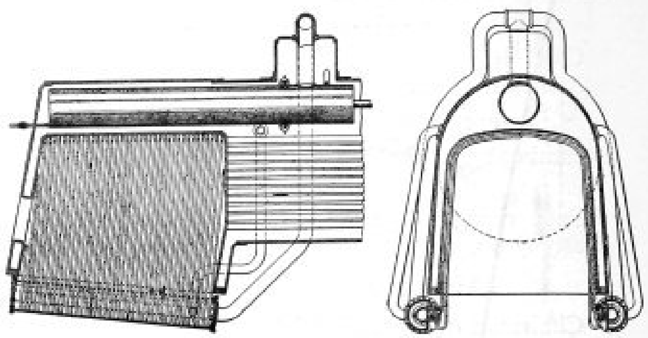
Claim—In a boiler structure, the combination with a header and a bank of boiler tubes extending from said header, of a series of



water circulation tubes extending from said header at an angle to said boiler tubes, a rotatable blower header extending transversely to and adjacent said water circulation tubes and a plurality of branch discharge pipes projecting from said blower header between said water circulation pipes and adapted to discharge upon said boiler tubes. Five claims.

1,634,604. HARRY S. ANDERSON, OF LOS ANGELES, CALIFORNIA. STEAM GENERATOR.

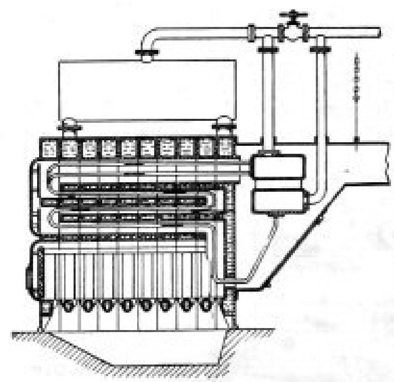
Claim—In combination, a tube, means for supplying a fluid to the tube including a valve, means for receiving the fluid from the tube including a valve, and means responsive to change in pressure of the fluid as received by said means for maintaining the first valve in open position when



the pressure of fluid in the tube is at or above a predetermined degree and for closing the first valve when the pressure of fluid in the tube is below the predetermined degree to disconnect the fluid supply means from the tube, the second valve being responsive to fluid pressure to close and disconnect the fluid receiving means from said tube when the pressure of fluid in the tube is below a predetermined degree. Six claims.

1,636,230. WALTER HONTSCH, OF NIEDERSEDLITZ, NEAR DRESDEN, GERMANY. STEAM SUPERHEATER OF LOW-PRESSURE SECTIONAL BOILERS.

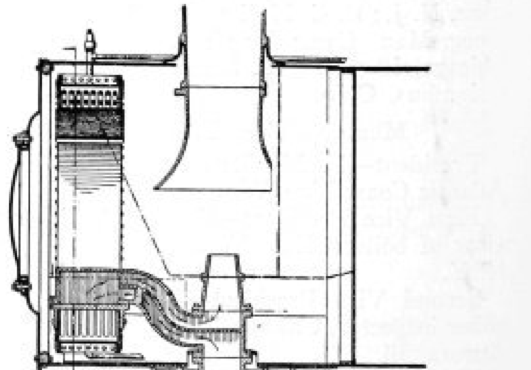
Claim—In a low pressure sectional boiler having a steam collector and a zig-zag gas pass communicating at one end with the flue and at the other end with the combustion chamber, a steam superheater compris-



ing correspondingly shaped zig-zag tubes extending longitudinally in the gas pass and connected at their ends adjacent the flue with said steam collector and communicating at their other ends with a steam delivery pipe, whereby the flow of steam in said superheater is counter to the flow of heating gases. Two claims.

1,652,037. EDWARD E. MERCKLE, OF BRUNSWICK, MARYLAND. FEED WATER HEATER.

Claim.—1. In a locomotive having a smoke box provided with a water heater having heat transfer means, an exhaust steam passageway leading into said smoke box, an exhaust steam nozzle positioned above said passageway, and a unitary member having communication with the passageway,



the heat transfer means of the water heater and the exhaust nozzle, said member having a partition wall dividing the latter into lower and upper passageways for conducting a portion of said exhaust steam to and from the heat transfer means, respectively, said partition having means permitting the passage of a portion of the exhaust steam directly to the exhaust nozzle. Two claims.

The Boiler Maker

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Contents

Meeting of Inspectors

THE National Board of Boiler and Pressure Vessel Inspectors at its sixth annual meeting again demonstrated its worth in the field of promoting uniformity in the construction and inspection of power boilers in this country. The officials of the group are to be congratulated for the degree of success with which their efforts in preparing and executing a broad and comprehensive program were crowned.

Although only a brief account of the meeting appears in this issue, the extent of the ground covered in committee reports and the valuable cooperative work of the board with the American Society of Mechanical Engineers Boiler Code Committee as well as the excellent papers delivered at the technical session, is indicated.

Not the least valuable function of this board is the collecting of boiler statistics covering the number of boilers built, inspected and repaired, pressure vessel data, boiler accidents and the like which occurred in the territory coming under the jurisdiction of members of the body. Except for a small amount of like data compiled by the United States Department of Commerce, there are no figures other than those of the board available to indicate the status of the boiler manufacturing or steam power industries in this country. As time goes on, not only are these statistics becoming more complete but they also furnish the basis for a permanent record of the entire industry.

The complete report of the meeting is not yet available but the statistical and other reports will be published in an early issue of the magazine for the benefit of all our readers who build, repair or inspect boilers.

Improvements in Boiler Design

IN the report of the sub-committee of the American Railway Association, Mechanical Division on the subject of the use of higher pressures in locomotive boilers may be found an indication of the trend to be taken in the design of the locomotive boiler of the future. It might, however, be stated that changes more radical than any in the past will inevitably occur in order to maintain the steam locomotive in its position as the principal prime mover in the railroad field. The railroads recognize this fact and also that the boiler offers the most hopeful field of development if the economy and efficiency of the steam locomotive are to be improved.

Within the past two years the accepted limits of boiler pressures have successively been increased from 250 pounds up to 350 pounds per square inch in the case of the Delaware & Hudson locomotive *Horatio Allen* and to 400 pounds per square inch in the case of this railroad's locomotive *John B. Jervis*.

These two locomotives, which have been described in past issues of THE BOILER MAKER, are equipped with watertube fireboxes. In addition to these locomotives, however, the Delaware & Hudson has also placed in successful operation two locomotives having radial stayed boilers operating at 275 pounds and 300 pounds per square inch respectively. In these boilers, the steam temperatures have been as high as 800 deg. F. without showing any serious effect on the metals of the structure.

The Santa Fe is now developing locomotives with radial stayed boilers to operate at 275 pounds per square inch while the Baldwin Locomotive Company watertube firebox locomotive and the New York, New Haven & Hartford locomotives equipped with the McClellon watertube firebox have demonstrated their soundness of principle over a more or less extended period.

Although in Europe the tendency even with radial stayed boilers seems to be towards considerably higher pressures, in this country the limit of working pressure for this type will probably remain below 400 pounds per square inch. However, with this pressure limit and high superheat great economies can be expected.

The use of alloy steels in the construction of high pressure boilers such as the high tensile silicon steel used by the Canadian National Railway on an order of 52 locomotives, will gradually be developed. These locomotives, utilizing a design which with ordinary boiler steel would operate at 200 pounds pressure, were able to increase the working pressure to 250 pounds per square inch with practically no changes in size or weight. Similar results have been obtained by the Canadian Pacific Railway on 44 locomotives using 250 pounds per square inch pressure in which the boiler shells are constructed of nickel steel.

Rapid progress in the right direction has been made in a comparatively short time and the applications of the new principles of design that are now working out in practice will unquestionably be adopted by many more railroads in the near future.

A Welding Code

THE formula proposed by the American Society of Mechanical Engineers' Boiler Code Committee to determine the ultimate strength and elongation in fusion welded joints, which appears in this issue, bids fair to revolutionize the status of welded joints of all kinds and, in addition, the understanding of certain other materials that have presented problems similar in character.

This formula is based on the general agreement of engineers engaged in the design and fabrication of steel construction that a certain amount of ductility is essential to the safety of any structure subjected to unknown stresses. Its applicability to a large extent is founded on the newly devised method of determining the ductility of metals by the free and unrestricted bend-test process that substitutes for the usual methods of bending a specimen around a pin or forcing it between two anvil blocks the more accurate plan of placing a kinked specimen between the jaws of a vise or in a testing machine so that it will bend freely to a U shape. This method, which gives consistent results produces an elongation in the outside fibers of the specimen that can be measured directly with a flexible scale and eliminates the uncertainties of measurement of the bend-angle which was formerly used as the criterion.

The details of the proposed method and formula are published with the sanction of the American Society of Mechanical Engineers Boiler Code Committee for the information of all those interested in the applications of fusion welding. The studies made by the committee in cooperation with the American Welding Society are outlined in the report and, after careful study it is requested by the committee that manufacturers and others who may wish to discuss the tests and offer constructive suggestions should do so as soon as possible.

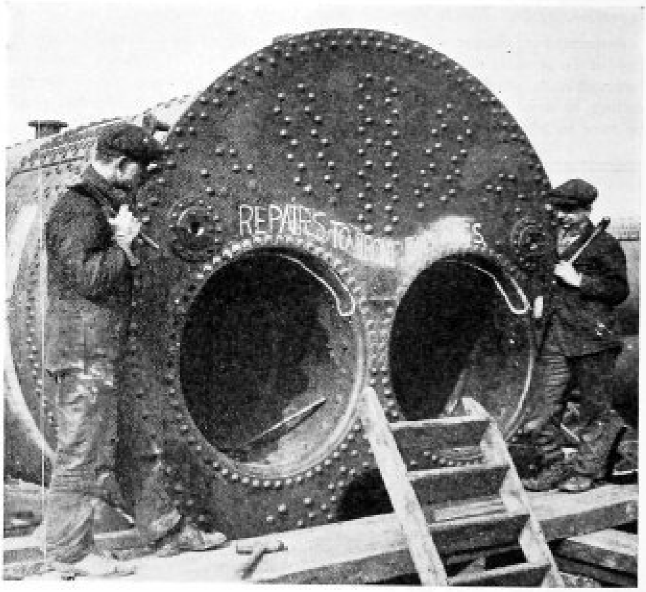
When the problem has been sufficiently investigated and discussed by interested individuals the resulting welding procedure will be embodied in a code that will insure the construction of safe welded pressure vessels and, at the same time lower the barriers that have until now prevented a wider application of the fusion welding processes in industry.

Communications

Lancashire Boiler Repair

TO THE EDITOR:

The illustration shows a successful repair to a Lancashire boiler. The roots of the flanges of the furnaces were grooved right through, due to expansion and contraction and showed signs of leaking. The faulty portions of the furnace were cut out with the torch and holes were drilled in the furnace body. The original



Welding used for repairing a Lancashire Boiler

plate thickness of the furnace was 7/16 inch, so a 5/8-inch plate was used for the repair; one on each furnace.

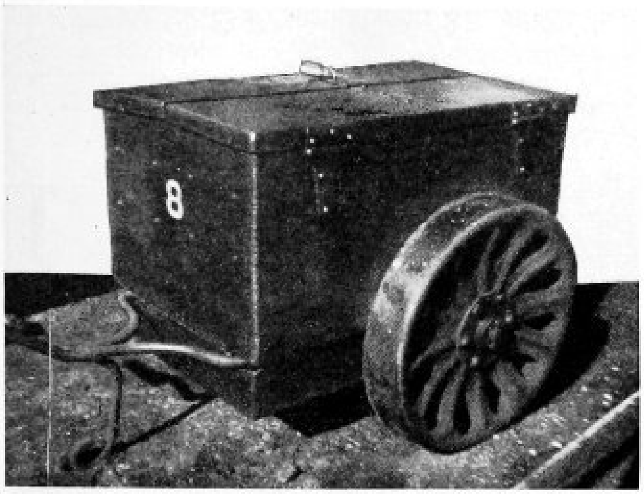
The plates were rolled, then flanged over 3 inches. They were then taken down and marked off. Several tack holes had to be put in before marking all off. The plates were drilled and then bolted up in place. The body rivets were put in first, as any closing up on the body could not be done owing to the gusset plates overhead. The bolts were allowed to pull the flange away from the front a little, this flange being closed after the body rivets were in. Great care was taken that the root of the patches were down to the furnace. The plate edges were chipped, stamped up, and calked. This job was tested to 300 pounds on the cold water test and showed no leaks.

Hull, Yorkshire, England. F. SNOWDEN

A Mechanic's Tool Wagon

TO THE EDITOR:

Although this is the first time I have taken the opportunity of writing to you I have been a subscriber to THE BOILER MAKER since January, 1908. In fact, I have in my possession nearly every copy of the magazine since that date, including five annual volumes bound of the years 1908-1912 inclusive.



A convenient wagon for carrying workmen's tools

I am enclosing a photograph and a sketch of a mechanic's tool wagon. The value of this wagon you will readily understand. It is made of ⅛-inch boiler plate and is of fire-proof construction. This wagon enables the mechanic to carry practically all his tools with him in a convenient way to any location in which he may be called upon to do his work. The only exceptions

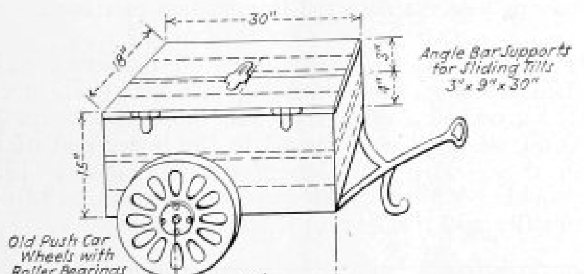


Diagram of the construction of the tool wagon

are, of course, tools which must be checked in and out of the shop tool room.

From my own experience I know there are many boiler makers and foremen who have received much value from seeing such shop kinks as the one above mentioned, in your magazine.

Port Arthur, Ont. G. E. BENDELL

Broken Condenser Tubes

TO THE EDITOR:

I received your reply some time ago in regard to broken tubes also note the answer in THE BOILER MAKER (May issue, page 145). I will agree that some of the tube holes were too large and that meant shimming the tubes, but I have done this on the last few that I put in. The condenser is working better than it did, but I have a few to renew occasionally. Some tubes break off at the top end but more of them at lower end. If I had my say in doing this work I would have shimmed all tubes that needed it, but I did as I was told.

I have noticed since I wrote you that there is some vibration to this condenser. I think this would have a tendency to crystallize the tubes and break them. The holes for the 4-inch tubes I mentioned were about the right size and they fractured in places the entire length of the tube. How would you account for this? Probably some of your readers might solve this problem. I must thank you for the information you gave me in regard to this tube trouble.

Nashua, N. H. D. T. S.

Riding the Gage from 5 Pounds to 1,400

STEAM pressures that only twenty years ago would have been regarded by engineers as dangerously high, now are accepted as not only practical but desirable in power production.

Early attempts by pioneers to apply steam to useful work were handicapped not alone by the mechanical inadequacy of their crude boilers safely to withstand pressures greatly above atmosphere, but also by a skeptical and timid public which, one writer tells us, besought the British Parliament to pass a law limiting pressure to five or six pounds. While boiler accidents still occur, particularly where equipment is allowed to deteriorate for want of inspection, public confidence in the science of engineering has increased in the last hundred years to a point where pressures up to 1,400 pounds in industrial installations cause no great alarm and the traveling public raises no protest in the name of community safety at the announcement of a new locomotive which will use a pressure of 400 pounds.

When engineers determined that by the use of these higher pressures more work could be accomplished by a given weight of engine, boiler designers met their challenge by producing equipment capable of enduring the greater stress and at the same time giving greater fuel economy than was ever before dreamed of. And in the early stages of this evolution the name of one Richard Trevithick, a Cornish mine foreman, must be given a prominent place, for it was he who in 1802 evolved the Cornish boiler, regarded by some as the ancestor of the present type of boiler construction and was among the first to apply high pressure steam alternately to both piston faces.

The historic condensing or atmospheric engine had the disadvantage of necessitating a bulky machine for even a small amount of useful work. It used steam propulsion on only one face of its piston and even then the pressure was ridiculously low. After steam had forced the piston the length of the stroke the steam was condensed and atmospheric pressure called on to drive the piston back. Trevithick built an engine in which steam actuated the piston through both strokes, thus discarding a principle limiting piston pressure on one side to 14.7 pounds and giving us in its stead the fundamental idea on which reciprocating engines still are built.

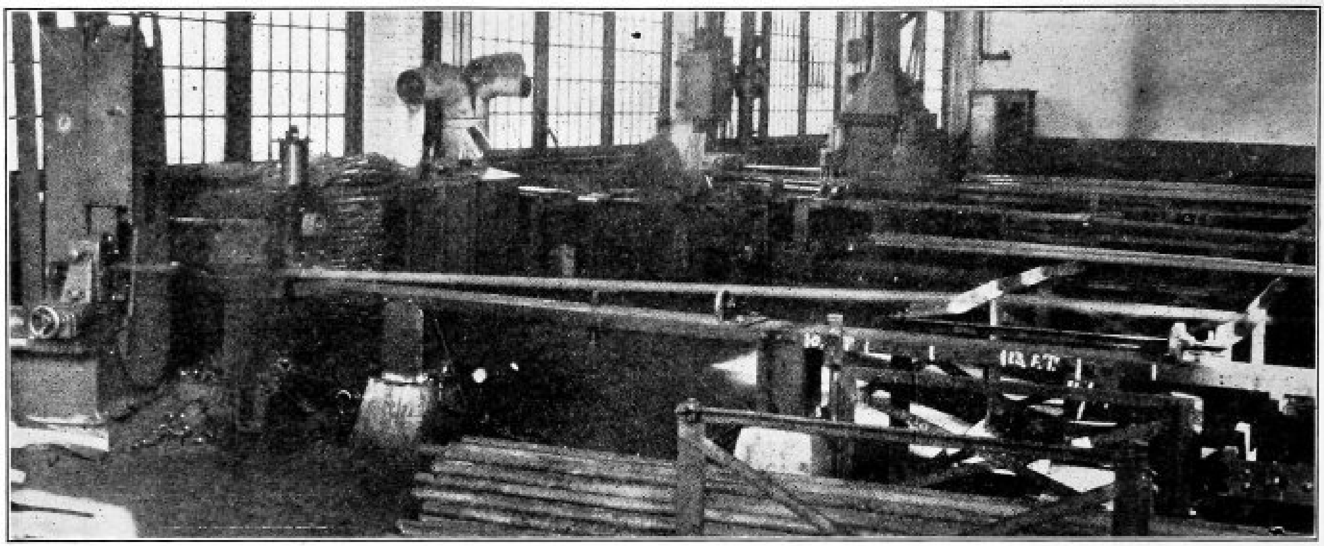
Unfortunately, Trevithick's contribution to civilization brought him no material benefit; he died in poverty. But modern engineers owe him at least a vote of thanks, for he helped prepare a field from which they have reaped a rich harvest of efficiency and economy. —*The Locomotive.*

Repairing Tubes at N.Y., N.H. & H. Readville Shops

General layout for continuous production — Output increased and tube failures and shop force reduced

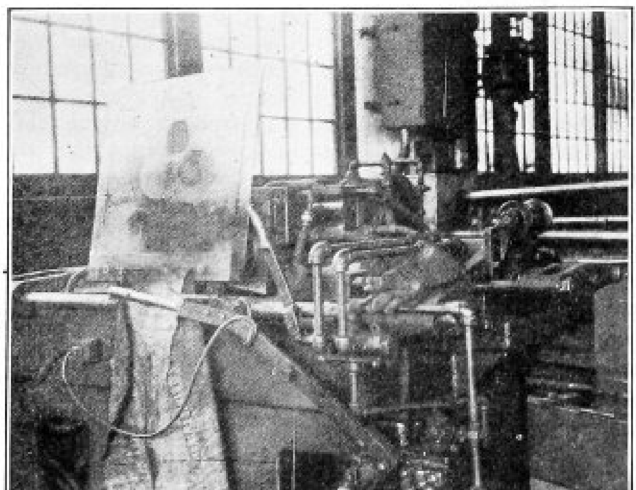
THE New York, New Haven & Hartford in keeping with the general scheme of modernizing the repair facilities at Readville, Mass., has relocated are rebuilt the flue shop at that point. At Readville are the main repair shops for the New Haven system. An average of 40 heavy class repairs are turned out at these shops every 25-day period, and approximately 5,500 small tubes and 400 superheater flues are repaired during the same period.

Until about a year ago this shop was equipped to safe-end the flues using oil furnaces for heating. This method was not entirely satisfactory for several reasons. First, owing to the excessive heat of the furnaces, the labor turnover was high. Second, the percentage of tube failures while undergoing the hydrostatic test was excessively high. Third it was felt that the cost per tube was considerably higher than it should be.

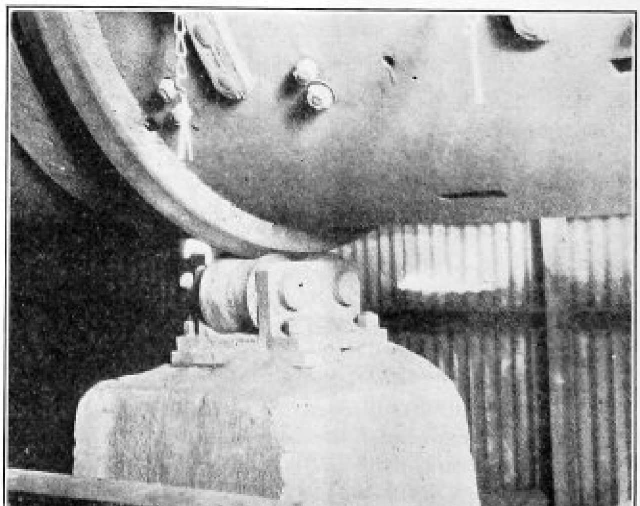


A general view of the New Haven flue shop at Readville showing how the flues roll from station to station

It was decided to change from oil furnace welding methods to the electric welding method. This necessitated a complete change of flue shop machinery. In addition, the shop was moved to the lower end of the main shop. This was done for two reasons: First, to provide additional floor space, and second, to be near the rattler and the new tube storage racks.



The electric flue welder

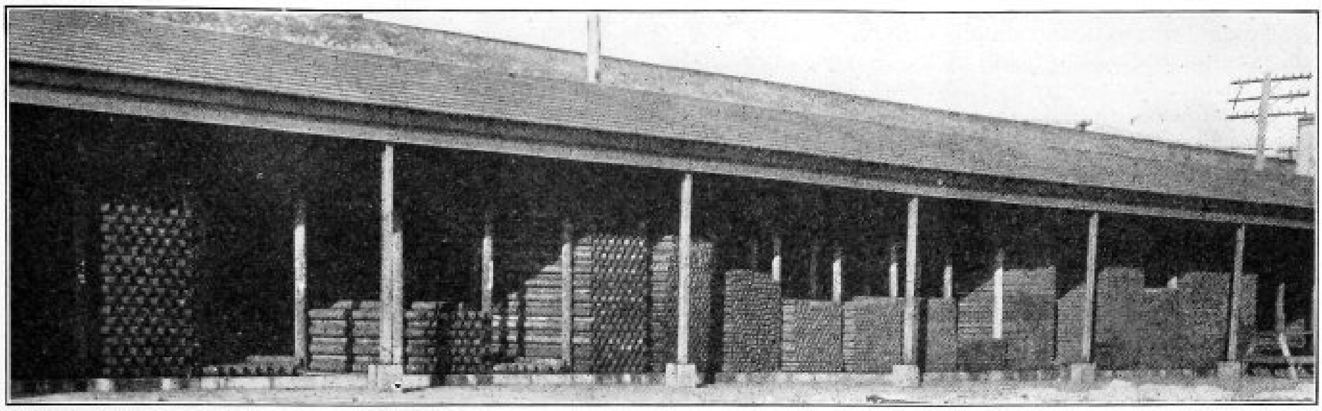


The third pier that supports the drum at the middle

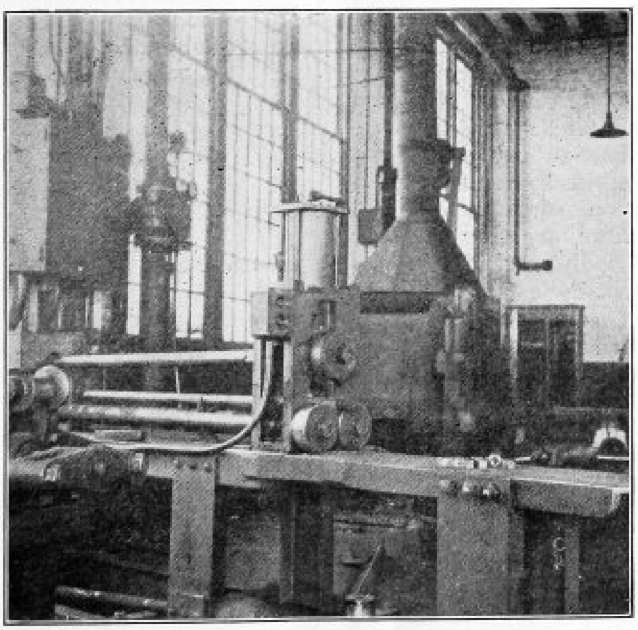
As may be seen from the general view of the shop shown in one of the illustrations, the shop is laid out so that the tubes as they come from the rattler, pass from one operation to the next without back-tracking.

The rattler is located outside of the end of the shop where the tubes begin to pass through the shop for repairs. The rattler is housed in a fireproof building resting on a concrete foundation and constructed of corrugated galvanized sheets fastened to a framework of angle irons welded together. The building is served by two, 10-ton Shepard electric mono-rail hoists. The rails extend outside of the building a sufficient distance to make it possible to pick up a set of tubes for placing in the charging cradle located alongside of the rattler.

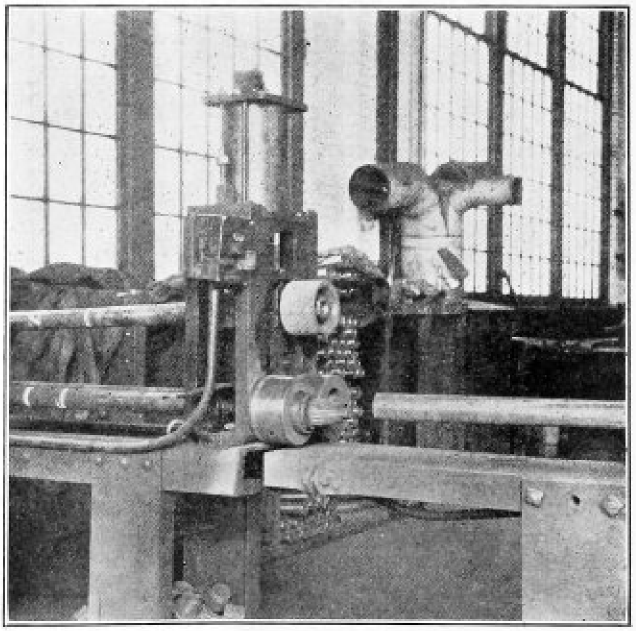
The drum of the rattler, which is driven by a 25-hp. motor, rests on three concrete piers. As shown in one of the illustrations, the third pier supports the drum at the middle to prevent sagging and to prolong the life of the two end trunnions. A locomotive tire, the tread of which has been cut vee-shaped, has been welded around the drum. This tire revolves in two vee-shaped rollers. The fact that one set of rollers has been worn out since the rattler has been put into operation indicates the amount of sag that occurs at the middle of the rattler.



A fire proof flue shed designed for easy handling of the flues



The welded safe end is rolled in this machine



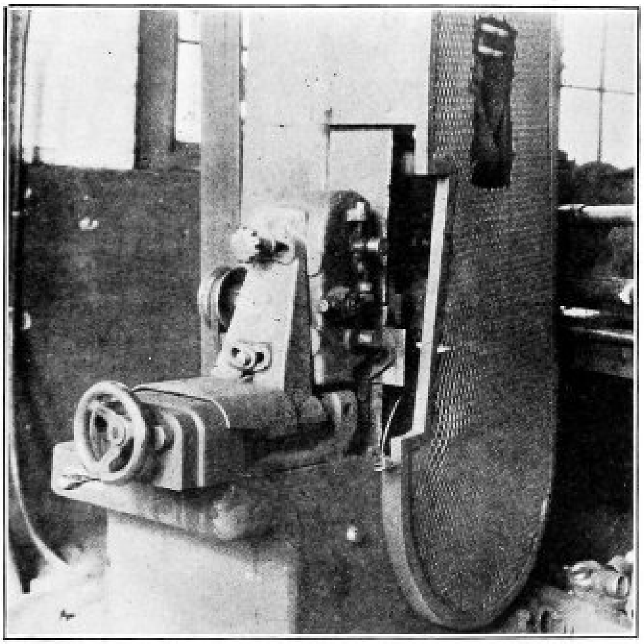
After the flues come from the polisher they are reamed on this machine

Four tee bars are equally spaced around the inside circumference of the drum, parallel to the center line. Holes have been drilled 12 in. apart in these four bars for the purpose of adjusting the end plates. The mill will handle tubes from 10 ft. to 19 ft. 6 in. in length The tubes are lifted by the electric hoists into a cradle which automatically trips, allowing the tubes to roll into the drum. The tubes remain in the rattler from three to six hours depending on their size and condition.

The tubes are then taken to the shop and placed at the head end of the frame work on which they are passed from one operation to the other. This frame is made from angle irons, channels and other material reclaimed from dismantled cars. Concrete piers on which the frame rests; have been set in the floor. The angle irons on which the tubes roll, are sloped so that the tubes will travel from one position to the next, where they come in contact with two stops. Located in front of each machine is a channel on which are two sets of rollers in which the tubes revolve during the repair operation. At the end of the frame, the tubes roll off into a cradle ready either for delivery to a locomotive or to the storage rack located near the rattler. The fireproof storage rack is divided into 27 bins which are located on an angle for easy handling of the flues. A concrete roadway extends along the front of the bins.

Passing a Tube Through the Shop

The first operation in the shop is to pass the ends of the tubes through a polisher built by the Production Machine Company. Here, the ends of the tubes are prepared for the electric welding machine. The tubes then pass to the next machine where the inside of the ends are reamed. This machine can also be used for polishing the ends. Attached to the end of the top spindle of this machine is a knurled roller which is forced onto the tube by air pressure. The tubes next pass to the electric welder built by the Winfield Electric & Machine Company. The machine welds on the safe ends from 6 in. to 60 in. long, cut from new tubes. It requires one minute for each tube to complete the electric weld and roll it in the machine located next to the welder. Two men are employed on this operation. The tubes then



The flue polishing machine

pass to the swedging machines which are served by an oil furnace. Two swedging machines, one located at each side of the furnace are used to swedge tubes in size from 2 in. to 5½ in. in diameter. The tubes then pass to the cutting-off machine.

The last operation is the application of the hydrostatic test. Owing to the excellent results obtained in the safe ending and swedging operations, the hydrostatic test has been discontinued. The records show that it is necessary to remove from the boilers only one tube in every thousand. It should be noted from the illustrations that each machine is motor driven and push button controlled.

The Results Obtained

As a result in this change in the shop, the force has been reduced from 15 to 8 men, the labor turnover has been reduced to practically nothing, the percentage of tube failures has been reduced to a minimum and the cost per tube has been materially reduced, with a corresponding increase in production.

Taps from the Old Chief's Hammer

"SOME of these days St. Peter will get handshakers' cramp while welcoming a squad of new arrivals whose passports have been vised by a neglected steam boiler," began the Old Chief. "He'll empanel a Celestial grand jury and dig out some facts that are going to queer the chances of a lot of fellows who might go to heaven when they die."

The lesser lights at the inspectors' table straightened up from their writing and leaned back in attitudes suggesting a desire to hear the rest of it. The Chief pointed to a sheaf of papers in front of him.

"Take this bunch of first inspection reports, for example. We can't issue a dollar's worth of insurance on these fellows. Most of these applications are from owners of seasonally-operated mills, and as far back as I can remember the steam generator in many of these mills has been the one thing the manager cared less about than any other. You know the kind I'm thinking about. There are plenty of them.

"Usually, when we are called on to insure one of these boilers the inspector visits it during the off-season when the plant is shut down. After you've been in this game as long as I have you boys will find that a seasonally-operated plant in the off-season is something that has to be seen to be appreciated. With few exceptions these old vessels are left in exactly the condition one would expect to find them at the end of the operating season—except now and then the boiler room is piled so full of riff-raff that the inspector has to go outside for a peek at the smokestack before he knows which end of the boiler room to look into.

"I have a keen recollection of one that was typical of this class. After we had drained the water out we had a sweet job trying to locate the man-hole cover. Apparently the owner had had a hunch his boiler was getting ready to ask for a pension and had tried to keep the old fellow in harness a little longer by the simple expedient of covering the plates and rear head with a good, husky reinforcement of concrete. What we discovered when we dug down to the shell accounts for some of my gray hair."

"Badly cracked, I suppose," ventured the junior member of the group of inspectors.

"Listen, son," said the Chief, "when we got that concrete picked off and saw what was underneath, it started me figuring a problem I haven't solved yet. For the life of me I can't explain why that rust-eaten shell didn't collapse of its own weight. That old steamer was about set to cash in its checks. The chances are it would have taken a couple of innocent boiler room hands along for company.

"Sooner or later St. Peter is going to subpoena the owners of such boilers and his ultimatum will read something like this: 'Look here, boys. You've been getting away with murder long enough. Get that? I called it MURDER. These killed-by-uninspected-boiler cases have got to stop or there won't be the customary harps and wings waiting for you when you apply for entrance.'"

"You think that'll bring 'em to time?" the junior member wanted to know.

"Darned if I know," grunted the Chief, turning again to his work. "Some of those fellows are almost hard-boiled enough to tell St. Peter where to get off at."
—*The Locomotive.*

Boiler Corrosion and Pitting*

Serious locomotive maintenance problem analyzed by boiler makers — Water service engineers take part in discussion

IT was the thought of your committee that this subject should be considered and reported from the practical viewpoint, leaving the theoretical consideration to those technical associations which are now engaged in carrying on extensive research into the causes and the methods for the control of boiler corrosion and pitting. In addition to the work of this association, committees of the following national technical organizations are actively studying this subject: American Boiler Manufacturers Association, American Railway Engineering Association, American Water Works Association, National Electric Light Association, American Society for Testing Materials, American Society of Mechanical Engineers, American Chemical Society, American Electrochemical Society, American Institute of Chemical Engineers, American Society of Refrigerating Engineers, American Foundrymen's Association. A joint committee sponsored by the first six associations named is now carrying on research work to determine the fundamental principles underlying certain phenomena which take place in steam boilers. It is hoped and expected that the knowledge of such phenomena including boiler corrosion and pitting, will be largely extended to the end that greater control over these problems may be had.

Owing to the importance of the subject, your committee sent inquiries to 17 railroads having a total number of locomotives of 22,392 and a total mileage of 109,519 miles, serving principally the central states but extending from the Atlantic to the Pacific, and from Canada to Mexico. It is felt that the replies to the inquiries may be considered as representative, to a large extent, of the general conditions existing at this time in respect to boiler corrosion and pitting.

Briefly the inquiries included: "Extent of boiler corrosion and pitting, as to certain engine districts or general over system. Conditions as to water quality, type of power, etc. on pitting territories as compared with non-pitting territories. Whether the following conditions were found—pitting of flues and tubes, pitting of firebox sheets, wasting away of staybolts, pitting of belly of boiler, and grooving of flues near flue sheet. Preventive measures in use—boiler water treatment, feed water heaters, care of material before installation, increased circulation in the boiler, etc. Comparison as to resistance to pitting and corrosion of the following or other boiler metals; steel, charcoal iron, copper content, steel and leadized or lead coated steel. Whether pitting and corrosion is on the increase or decrease and factors to which such increase or decrease may be attributed."

Extent of Trouble

Without exception, all replies stated that there is a considerable difference in intensity of corrosion and pitting on different engine districts, the trouble usually being confined to certain districts. One road replied that corrosion and pitting was general in road service but confined to certain yards or terminals.

All roads reported that the chief difference on pitting and non-pitting territory was in the quality of the water; the type or class of power was practically the same and its effect on corrosion and pitting is of but a minor nature. One member replied as follows: "Corrosion is attributed chiefly to water taken. Type of power is not considered as important as the difference in service as between through freight, passenger or local trains. On some runs more corrosive water is taken than on others." Another replied, "Pitting usually increases as the quality of the water decreases."

Natural waters of very low carbonate hardness and total solids, waters high in alkaline salts (sulphates and chlorides), and waters containing appreciable quantities of calcium and magnesium chlorides are all reported as conducive to and responsible for corrosion and pitting. Surface waters receiving acid mine drainage and similar industrial wastes are invariably of a corrosive nature.

Effect of Trouble and Extent

All roads reported corrosion and pitting of flues and tubes, the extent of trouble varying to some degree—"mostly in front part of boiler," "full length of flues," "small flues attacked more than superheater flues," etc.

With one exception, all replies indicated corrosion and pitting of firebox sheets but to a lesser degree than flues and tubes. One road replied in reference to location; "Principally on crown sheets and upper firebox" and another "At mudring and around stays." Some "grooving" was reported.

Two roads reported no trouble due to wasting away of staybolts but the majority of replies indicated this condition as rare, occasional, or only in worst water districts.

In regard to the pitting of belly of boiler, this trouble also seems to be of a generally minor nature. One road reported corrosion and pitting "in bottom of shells after 10 or 15 years service; more serious in front than back of boiler." Another reported "some grooving at front flue sheet flange at bottom," while a third replied that they "have had many cases of this but rather inconsistent on same type of engine operating in same district."

Grooving of flues near flue sheets was reported, most commonly occurring near front flue sheet and occasionally next to back sheet. This trouble often occurs on districts where no other form of corrosion and pitting takes place, and appears to be due to bending movement and strain in long flues. A few of the replies are quoted: "We believe primary cause to be excessive rolling of tubes. Bottom two rows on bottom side of tube only give trouble. Overcome trouble by applying steel half round shims making holes slightly larger to accommodate." "One or two classes of engines and including engines with 23 foot flues are subject to grooving of flues near the front flue sheet." "In some power having very long flues."

Preventive Measures

All roads reported some form of boiler water treatment—complete softening with lime and soda ash, soda ash only or compounds, and varying degrees as to extent of territory covered by water treatment. One reply stated: "Lime and soda ash treatment on two districts has alleviated pitting and corrosion somewhat. Soda ash

* Paper read at the twenty-first annual convention of the Master Boiler Makers' Association.

in moderate quantities on districts where water is not treated, to assist in precipitating the scale in the form of sludge. Proprietary compounds on two divisions are reducing pitting and corrosion materially." Another road replied: "All water containing any sulphate hardness is treated with enough soda ash to neutralize this sulphate hardness and provide about two grains excess sodium carbonate. This treatment reduces but does not eliminate pitting. As the excess sodium carbonate is increased the pitting is further reduced." Another member reported: "Extensive use of lime and soda ash. The water is overtreated carrying a caustic alkalinity in excess from 5 to 10 grains per gallon in bad pitting districts. This treatment seems to prevent the pitting almost entirely and seems to be the only preventive method for pitting which we have found."

Fifteen of the 16 roads reporting the use of feed water heaters, showed a total of 1,417 heaters, 688 open type, 555 closed, 156 exhaust injectors and 18 unnamed. In general the replies stated that the roads' experiences to date do not indicate any decrease in pitting or corrosion either by use of one type over the other or of any type over engines not so equipped. However, one member reported: "We have tested an open feed water heater attached to a locomotive, for the exclusion of oxygen from feed water for 2½ years over one of our worst pitting districts with fairly good results in the prevention of pitting. Have purchased four more open feed water heaters and five closed heaters for comparison."

The majority of replies indicated that flue and sheet material is given no especial care before installation with respect to mill scale and rust other than storage in sheds away from the weather as much as possible. Several roads reported that the material on receipt is given a protective coating of oil or rust preventive compound and every precaution is taken to prevent rusting of material while in storage and before it is applied to the boiler.

The installation and use of syphons and arch tubes to increase the circulation within the boiler, reported by a number of roads, has apparently had no perceptible influence on corrosion and pitting. One road reported: "All boiler checks have upturned elbows inside the boiler so that water is jetted upward instead of dropping to the bottom of the boiler."

One road reported very excellent and remarkable control of corrosion and pitting by means of an "Electrolytic Polarization Method." The following is quoted from its report:

"The electrolytic system referred to has been in service for three years and has for that time protected locomotive boilers in very corrosive waters. It consists essentially of electrodes inserted into boiler and perfectly insulated from any metal portion, submerged in the boiler water, from which anodes an electric current of correct magnitude is passed making the boiler shell tubes and firebox negative or cathodic. A chemical is then plated out each month to complete the protection, costing about 15 cents per month. The required current is shunted from the turbo-generator, which is always over capacity to amply supply this current. The cost when generator is run for headlight in extra steam consumption is about ½ cent per hour and when run for electrolytic system alone it costs approximately 2½ cents per hour."

Pitting Resistance of Various Boiler Metals

The replies received relative to resistance to corrosion and pitting of steel, charcoal iron, copper content steel, leadized or lead coated steel and other metals or alloys showed varied experiences, some members reporting practically no difference in the life of the first three metals—others indicating a preference. The majority of replies indicated a slight decrease in pitting of the charcoal iron or copper content steel as compared with steel. One road reported: "Made service test of steel tubes containing about one-fourth of one percent copper. We found that the number of pits was reduced but the pits were deeper, resulting in earlier failure than steel tubes."

Six roads reported use of lead coated flues and four roads reported nickel alloy. The two reports on service of the lead coated steel were as follows: "Leadized about 40 percent better than plain steel"; "lead coated flues resist pitting as long as the coating stays on but when the coating wears off the flues seem to pit just as badly." The three reports on service of nickel alloy were as follows: "Nickel alloy steel about 40 percent better than plain steel flues"; "has given very satisfactory service to date," and "nickel alloy good." One road reported "several alloys tested but haven's found anything to give better results than steel."

Progress as to Control of Corrosion and Pitting

Ten of the 17 roads reported a decreasing amount of corrosion and pitting while seven roads reported an increasing amount.

Those reporting decrease attributed it to some or all of the following factors in order of importance: Boiler water treatment, the securing of better sources of water supply, the extensive use of hot water boiler washing and fill-up plants and to improved mechanical apparatus.

The seven roads which reported increase in pitting and corrosion listed the following factors: Higher boiler pressures and temperatures with larger power and train loads, longer runs and average higher concentration of boiler waters between washouts, increase of industrial wastes in surface water supplies, and poorer quality of boiler metal. One road reported as follows:

"We have experienced more pitting and corrosion in the last four or five years than previously. Some of the factors which may possibly account for this are as follows: Engines are now kept on certain districts more regularly, whereas they were formerly changed from one district to another frequently and this change tended to neutralize the effects of the conditions which now produce pitting on certain districts.

"The water treatment in preventing scale formation on heating surfaces has exposed them more to the pitting action and unless the treatment is so maintained to provide an excess of caustic soda, this might result in an increase in the pitting and corrosion. The use of treated water has extended the time between the application of flues so that on districts where conditions are right to promote pitting, the pitting will naturally be more noticeable than previously when flues were more frequently changed out.

"The material from which the flues are made is probably not as uniform and as good as formerly. We notice that old flues which have been safe ended two or three times and placed in a boiler together with new flues are much more resistant to pitting than the new flues. This might indicate superior material in the old flues or it might indicate that the old flues have been immunized against pitting by some condition which prevailed in the boiler during previous service."

Those roads which reported a decrease in corrosion and pitting emphasized the fact that conditions are yet far from satisfactory. Only a few years ago, the principal feed water problem was the removal of scale; however, at the present time, the scale problem is of minor importance. The control of corrosion and pitting remains as the major problem yet to be solved.

This report was prepared by a committee composed of T. P. Madden, chairman, H. A. Bell, and A. W. Novak.

Following the presentation of this paper, a number of water service engineers were invited to address the convention. An abstract of their remarks and of the subsequent discussion follows:

The Corrosion Problem

By Dr. C. H. Koyl*

Since this association commenced the systematic study of boiler corrosion, a few years ago, there has been a great increase in knowledge of the causes of pitting and grooving and means of preventing it, particularly in locomotive boilers; and there has been a vast dissemination of this knowledge through the work of this association and other groups.

There are now three known and proven methods of preventing, or at least greatly reducing, the pitting of locomotive boilers and though the methods are entirely different in operation yet they all work on the same principle, and this principle I shall try to explain.

You know from your own experience that iron and steel pit only when they are wet. In the case of a boiler tube, it may pit when working and entirely covered by water or it may pit when idle and covered by wet scale. Even plain rusting takes place only in damp air. This means that water is absolutely essential to the process, and when we examine closely enough we find that every atom of iron that disappears from a pit has been actually dissolved in the surrounding water just as does a molecule of sugar or of common salt.

Explanation of Ionization

You will remember from last year's meeting that when anything except organic matter is dissolved in water it is partly separated into its component parts; that is, sodium sulphate, for instance, is no longer in solid molecules but is separated into sodium atoms and sulphate molecules. These atoms and molecules travel around independently of each other and for this reason have been called *ions*, and the process is called ionization or dissociation. A still stranger fact is that each of these ions is electrified, the metallic ions positively and the other ions negatively, and just enough to balance each other, that is, there is just as much positive electrification as there is negative.

We do not yet know why these dissolving molecules break up physically and electrically, but they do, and the fact of the exact balance of the positive and negative electric charges gives us the key to the prevention of pitting. When an atom of iron goes into solution in the water it carries its positive electric charge with it and since that would increase the positive charge in the water without equally increasing the negative charge, it follows that somewhere in that water a positively charged ion must get out.

Now, the relative strength of the tendency of these metals to dissolve in water is easily measured and it has been found that the tendency of hydrogen to dissolve in water is very weak while the tendency of iron to dissolve in water is much stronger, and what happens is that each atom of iron as it leaves the flue forces out of solution an ion of hydrogen. This happens because in ordinary water there is nothing that can be forced out of solution by iron except hydrogen, and just imagine what would happen to the iron atom if it were not strong enough to force out the hydrogen ion. Why, it could not get into the water and there would be no such thing as pitting, nor even ordinary rusting.

This then is the key to all present methods of preventing corrosion of iron and steel under water—just prevent the hydrogen ions from coming out of solution and you thereby prevent the iron atoms from going into solution, and that means you prevent pitting.

I said that there are three methods which have been successfully tested; and the first is the simplest of all, though in practice it can be used only on soft waters. The method is to deprive the water of its hydrogen ions by artificial means. I shall not attempt to lead you through the chemical reactions involved and it will be sufficient to say that the presence of caustic soda dissolved in water prevents the presence of hydrogen ions, and if there are no hydrogen ions to go out it is useless for iron ions to try to get in.

Lime-Soda Process

When we soften water by the lime-soda process, it is a simple matter to use a small excess of both lime and soda-ash and these two substances combine under water to form caustic soda. On the Great Northern Railway, the water engineer, B. W. DeGeer, has used this method with success for some years on the treated-water district. He treats each water, on districts where serious pitting was once experienced, with an excess of both lime and soda-ash, so that each water as it goes to the boiler is almost perfectly soft and contains also from 6 to 15 grains per gallon of caustic soda. As the water is concentrated in the boiler, the amount of caustic soda becomes relatively greater, so that from water-change to water-change it averages about 80 or 90 grains per gallon.

Because of this method of treatment and the resultant softness of the water, there is a very little sludge in the boilers, and the tendency to foaming is small.

Mr. DeGeer says that before the use of this excess soda, pitting on this district was excessive, now it is light; locomotive flues having a calculated life of ten to twelve years, as against about three years with treated water carrying very little excess caustic soda, and about 2.8 years with raw water.

Use of Open Feed Water Heaters

Method No. 2 uses different means for preventing the discharge of hydrogen ions. You will remember that these hydrogen ions are merely atoms of hydrogen electrically charged, and that each one sails up to a flue and, by touching it, gives up to the flue its little charge of positive electricity. If these atoms were as large as a small bubble or if they came up in sufficient numbers to make a bubble, they would rise to the surface of the water, but they are infinitesimally small and therefore they merely stick to the metal where they touch it and slowly accumulate until the metal is covered by a thin film of hydrogen which separates it from the water.

But as soon as the metal is thus insulated from the water, the next hydrogen ion cannot reach the metal to give up its charge of positive electricity and therefore the next atom of iron cannot get into the water, and therefore pitting is stopped. As long as this film of hydrogen covers the flue there is no pitting, but the trouble is that there is also oxygen dissolved in the water (oxygen from the atmosphere taken up by the water before it entered the boiler) and this dissolved oxygen unites chemically with the film of hydrogen (eats it up) and destroys the wall that separates flue from water, so that the next hydrogen ion can reach the metal and give up its electric charge and the next atom of iron can dissolve in the water, and pitting proceed.

Under these circumstances the remedy is to take this dissolved oxygen out of the water before the water goes

* Chemical Engineer, Chicago, Milwaukee, St. Paul & Pacific Railroad, Milwaukee, Wis.

into the boiler, and in practice we do it by heating the water to the boiling point before it reaches the boiler, and allowing the oxygen to escape through a half-inch vent pipe in the heater. On the Milwaukee Railroad, on a bad pitting district, we have had a locomotive boiler thus fitted with an open feed water heater, and for 2½ years we did not find a pit on any flue, while during that time the companion boiler, without a heater, lost nearly all its flues. We now have 4 more engines similarly fitted and being tested, each on a different kind of water.

Metallic Arsenic Method of Preventing Pitting

Method No. 3 uses still other means of preventing pitting. L. O. Gunderson, of the Chicago & Alton Railroad, the inventor of this third method, recognized the value of the film of atomic hydrogen in preventing the access of hydrogen ions to the metal of the flue, but he accomplishes the same result by coating the flue with an artificial film of metallic arsenic, which, though a metal, still prevents the hydrogen ions from giving up their electric charges to the metal of the flue, and thus prevents pitting just as does method No. 2.

Now, these are not merely theoretical considerations, they are methods in regular use on locomotives. Mr. DeGeer has had the first method in use for several years on the locomotives on the treated-water district of the Great Northern Railway. On the Milwaukee Railroad we have had the second method under successful test on one locomotive on the treated water district for three years, and have now fitted up four more locomotives for the same purpose. On the Chicago & Alton Railroad the third method has been under successful test on three locomotives using softened water for three years, and twenty to thirty more locomotives are being fitted in the same way.

No one of these three men claims to be the first man to have thought out or tested his particular method, but each one claims to be the first to make it work on a locomotive doing ordinary road work.

Discussion

R. C. BARDWELL (water service engineer C. & O. R. R.): Dr. Koyl has explained the technical end far better than I could ever hope to be able to do, and I am sure that if any of you will follow any one of the three suggestions that he has made, you will get results that are very apt to be astonishing.

As the Doctor has said, there are three methods of greatly alleviating pitting conditions; the maintaining of caustic soda in the boiler either by external or internal treatment, relieving oxygen conditions either by the feed water heater or in some cases it can be successfully handled with certain types of internal treatment, and the electrolytic method.

In either or all of these methods, the most important thing in my opinion is cooperation. The water chemist may be the best chemist in the world, but he cannot get to first base unless the boiler maker is with him. The boiler maker may be the best boiler maker in the world, but he cannot get the best results unless the chemist does his part. In other words, if the chemists and the boiler makers work together and give each individual situation the study that it deserves, there is no question about the results that can be obtained.

R. E. COUGHLAN (water service engineer, C. & N. W. R. R.): I think the practical way to demonstrate the use of carrying a little caustic soda excess, is to tell you about a little experience we had on a territory where boiler troubles were our main difficulty. It was a question of about ninety days service out of a locomotive, and then it was necessary to drag in extra boiler makers from the boiler department and get everything tight. There were broken bolts, and flues lasted a very short time because of pitting.

The natural water in this territory was very low in hardness and contains approximately ten pounds of soda ash for every thousand gallons. In addition, the water comes out of the ground at a temperature of 120 degrees, so it was necessary to equip the locomotive with what we call Hancock hot water guns.

This happened some six years ago. Last fall we had two passenger locomotives in from that territory. The engines had been operated six years without a broken bolt, with no sign of corrosion, and with no scaling.

Of course, when you operate a treating plant, you can not get water down that low, unless you have the same kind of water over the entire division. Fortunately on this particular territory, it is all the same. There is no sludge in the boiler, nothing to cause foaming. The water is loaded with natural gas.

When we come right down to the practical solution of pitting and corrosion, it seems to me the job is for the chemist to outline a method and for the boiler maker to cooperate with the chemist. Never mind what the name is called, whether it is hydrogen ion concentration or excess caustic treatment. By the simple cooperation of the mechanical man and the technical man, I believe we would get mighty close to what is going to be the finest solution of a problem that has cost the railroad companies millions of dollars.

M. V. MILTON (Canadian National Rys.): In listening to the illustration of the heaters put up by Dr. Koyl, I notice he spoke of the feed water heater, open type.

Is there any way you can take care of this water or heat the water when the engine is drifting or starting off from a standing condition?

DR. KOYL: When we were making our first test, two years ago, with the open feed water heater, which had no means of heating the water except by exhausting from the cylinders, it followed that when a way freight was spending a half hour maybe at his station and needed some water, it was absolutely necessary to use the injector, because if you do not, you would pump the water into the boiler cold.

I notified the makers of that heater that if they wanted to have a heater which railroad men would buy and utilize to some effect, they must put on some kind of live steam connection which would automatically cut in when the engine was standing still or when the engine was drifting and the amount of steam that came into the heater was very small. They have been working at it ever since. They know that is a necessity if they are going to have a perfect heater and they are working at it.

But I don't know yet just how far they have been successful. I have seen it in operation on our road, one which they put out first, and it does pretty well, but it isn't all that it ought to be.

I think some of these days there will be automatic live steam connection, that is, a connection which will come on automatically when the exhaust steam doesn't amount to anything. But I don't know that it is in use yet.

R. C. BARDWELL: I think it is a little bit early to be entirely discouraged with the closed feed water heater. It is a good thing to have a vent on your heater and let the gases escape, but when water is heated above the boiling temperature, a greater part of the oxygen is freed from it. Water that goes through the closed feed water heater is above the boiling temperature when the oxygen is separated. When it gets into the boiler, the oxygen should flash into steam and not give much trouble.

On our road we have a few open feed water heaters and a great number of closed feed water heaters, and we do not have any particularly bad pitting conditions in the engines using closed feed water heaters.

I believe there may be something to the possibility that a closed feed water heater is pretty nearly as good as the open, in eliminating oxygen. Before we make up our minds on this subject, we should await the tests the Doctor is going to make in running the closed feed water heaters against the open feed water heaters.

Carl F. Totterer (Chicago & Alton R. R.): I have been testing the system which Dr. Koyl has been speaking about, Mr. Gunderson's, for the last three years, and we are having wonderful success, and the results are 100 percent.

Just about six or seven years ago, I got orders from the superintendent of motive power to put this metallic arsenic system of treatment on an engine. We have switch engines out at Bloomington all taking water at the same place. They have been out of the shop about sixteen months. One of them has the system and the other hasn't. The latter engine has 68 flues and they were pitted and had to be scraped when inspected. On the other I removed 18 flues and haven't found a spot with any kind of pitting on it at all.

K. E. Fogerty (Chicago, Burlington & Quincy R R.): In this system you have applied, is the motor continually running while the locomotive is standing still?

Carl F. Totterer: When the engine is working, you have to run the motor.

A. W. Garrick (Water service engineer—Wabash R. R.): It has been my good fortune to have supervision of the use of soda ash in treating all the boiler waters on our system. We have been able to make a very good showing by neutralizing the sulphates of magnesium and the sulphates of calcium. By this means we have prevented the scale formation in the boiler, and have made it possible to run our engines four years between flue renewals.

However, we have not been able to prevent corrosion in the boiler. We haven't a serious corrosion problem, but we do have corrosion. It is somewhat erratic. On boilers of the same type, running the same territory, one will not have any pitting whereas the other boiler will show pitting, especially on our locomotives running between Chicago and St. Louis, where we have the type of corrosion known as grooving. This grooving takes place at the front flue sheet, and since the boiler makers have been experienced, they have been able to find these flues in the round house when they are beginning to fail through the groove and will remove it.

C. A. Seley (Locomotive Firebox Company): I was very much interested in attending the railroad demonstration some years ago and the competition, by the chemists on this subject of corrosion. One of the chemists was Mr. Gunderson, who was mentioned before. One was the mechanical engineer of a railroad. The third was the metallurgical engineer of a tube company. These three men delivered papers, which have appeared in the technical press.

In these papers there was one point in regard to mechanical handling of operation and design of the boiler and its use which was not considered at all by the chemist, and that was the matter of circulation.

At the meeting there has been no reference to foreign practice, which started perhaps years before we started here, and they are still continuing, although not altogether on the lines we are here.

I have information that on the German State Railways the standard arrangement calls for a pump which delivers water to a closed heater on top of the arch of the engine outside. This water is then taken from this pre-heater to a ring in the dome on the first course. This ring is perforated so that the water can be sprayed down onto a sort of built-up system of angle irons in this dome. Thus the water is sprayed and trickles from the time it leaves these perforations over the angle irons and gets down to the bottom of a sort of container which runs around the sides of the boiler, and delivers this water which has been sprayed into fine particles into the steam.

There is a complete separation of dissolved gases. In this method the oxygen goes into the steam. This water when it arrives at the bottom of the boiler is practically distilled water, perfectly free of oxygen, and I am told that the boiler maintenance, has been greatly reduced by the adoption of this system.

The question of circulation of water in the boiler may be a contributing factor to a considerable extent in the matter of pitting and corrosion. I don't know that I have positive evidence of the truth of that. As I stated, I don't believe that any one thing is a cure-all for pitting and corrosion.

O. H. Kurlfinke (Southern Pacific R. R.): We have some boilers which are working in the finest water district. These boilers are constructed with a pre-heater in the front end, where the feed water goes, and this is solid. There is no steam space here. The feed water goes in at this point and comes out on the top and goes over to the water check on the side. In the pre-heater, where the circulation is very slow, these tubes pit and we don't get on the average more than 27,000 miles in round numbers.

We have been experimenting on the proposition of trying to get the air out of the water. We have placed on the delivery line of the injector an air separator. It gives the feed water a centrifugal movement. We put these on both sides. The engine is equipped with injectors. We put them on October, 1926. We think we have proof that we can get the air out of that water. From the appearance of certain tubes that were taken out, there are still certain points that we can correct. We believe that the tubes have now nearly made their mileage.

Extension for Oil Heater

By C. E. Lester

The extension heater as shown in the illustration was developed particularly for Scotch boiler heads. Changes in size and shape however, will permit of its advantageous use in many other places.

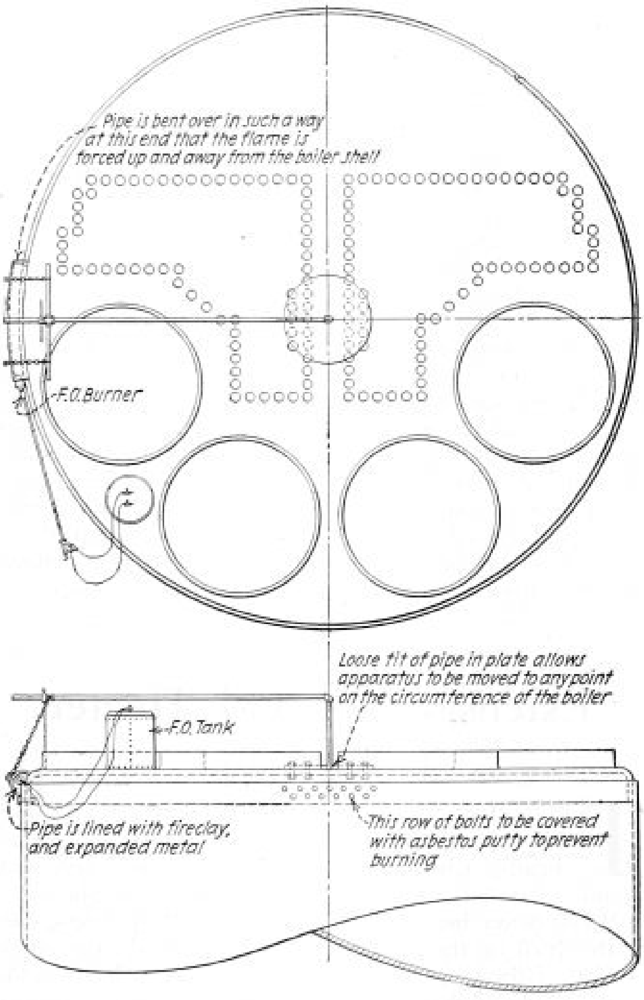
When heavy heads are fitted to heavy shell sheets, due to the draft on the flanging dies for the heads, the outer section of the lap cannot be pulled tight with bolts, cold, as the head and flange angle are slightly obtuse. This is easily taken care of by squeezing the plates together with the hydraulic riveter on the back head. On the front head which is pneumatic driven the laps must be brought together by heating. The practice at the Newport News Shipbuilding and Dry Dock Company for several years has been to use two oxy-acetylene heaters for this work.

On a 15-foot head the approximate time required for laying up has been 12 hours while the cost has amounted to about $96 for labor and gas, using two torch operators, a boiler maker and two helpers. With the use of the apparatus as shown, the time has been reduced to eight hours and the actual cost to $14.75. The operating gang consists of four men.

The bolts in the bottom row of holes are covered with wet asbestos putty in order to keep them cool so that they may be easily removed. The extension to the heater fits fairly close to the head and shell and any openings are chinked with fireclay. Having made one heat, the two helpers quickly move the extension to the opposite side of the head and set it in place, after which they return to the heated portion and work it down. During this time, the torch operator moves the remainder of the apparatus to the new location and takes up another heat.

Rest Period Permitted

This method allows about a five minute rest period between heats for the strikers and runs about 20 heats 30 inches long in 8 hours. This exceeds by 18 inches anything that could be done previously with the two oxy-acetylene torches. The 30-inch heat is about the limit of what can be worked before that portion of the head becomes cool.



The oil heater set up on the head of a Scotch boiler

The extension is made by bending to the radius of the head a piece of 6-inch pipe and lining it with fire clay. The clay should be reinforced by netting or expanded metal to prevent breaking out. One end should be belled out to fit the nozzle of the heater and the other end should be bent over at an angle to throw the waste gases upward and away from the shell. A segment cut the full length of the pipe and corresponding to the head and shell contours permits it to set close up. With proper care in the use of fireclay one pipe will last 60 heats.

Sixth Meeting of National Board of Inspectors

PRACTICALLY the complete membership of 60 state and municipal chief boiler inspectors were in attendance at the sixth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors, held at Erie, Pa., June 18 to 21. Chairman C. D. Thomas, chief inspector of the state of Oregon presided at all sessions of the meeting.

On the opening day after several addresses by local officials, Mr. Thomas addressed the group and was followed by C. O. Myers, chief inspector of the state of Ohio, who is also secretary-treasurer of the National Board. Mr. Myers reported the status of the board's affairs. His report covers practically the same ground as the paper he presented at the American Boiler Manufacturers Association meeting earlier in the month and which appears on page 175 of the June issue of THE BOILER MAKER. Mr. Myers also reported recommendations of the executive committee on the stamping of boilers not completely assembled in the shop as well as the stamping of repair drums. This recommendation follows:

1. When the original boiler was not constructed in accordance with the American Society of Mechanical Engineers Boiler Code, the repair drum shall be constructed in accordance with the A. S. M. E. code and inspected during construction by a qualified inspector, and stamped with the A. S. M. E. symbol, the manufacturer's serial or A. S. M. E. number.

2. When the repair drum is to be furnished for a boiler that has been constructed in accordance with the A. S. M. E. code and original boiler is stamped with the A. S. M. E. symbol, manufacturer's serial or A. S. M. E. number, and not stamped in addition to this with a state standard or National Board stamping, the repair drum shall be stamped with the A. S. M. E. symbol and manufacturer's serial or A. S. M. E. number with which the original boiler was stamped.

3. When the repair drum is furnished for a boiler that is stamped National Board, the repair drum shall be stamped National Board and carry the same National Board number that the original boiler was stamped with.

4. Repair drums shall be stamped immediately above the state, National Board or A. S. M. E. stamping with the words "Repair Drum." When repair drums are furnished for boilers in code states a manufacturer's data report shall be filed with the secretary-treasurer of the National Board, in duplicate. One copy of this data will be filed with the proper state department.

The executive committee unanimously agreed and so advised the boiler code committee that boilers should be stamped with the year built.

Another question discussed by the board was on revisions to the American Society of Mechanical Engineers' Boiler Code.

Since revisions of the code are made from time to time, as they are called to the code committee's attention, there has been some confusion regarding the date at which such revisions become mandatory. After thoroughly discussing this question it was unanimously agreed that the code committee be advised that a fixed date for revisions to be promulgated and a fixed date for them to become effective be put into effect. It was also suggested that July 1 be fixed as the date for promulgation, and January 1 be fixed for the date such revisions should become effective.

The uniform stamping of the National Board up to this time has only been used on boilers constructed in accordance with the Power Code. The board ruled that the National Board stamping be extended to cover all of the codes formulated by the boiler code committee of the American Society of Mechanical Engineers.

Action was also taken on the matter of manufacturers data reports as follows:

Manufacturers' Data Reports

For boilers that are not completely assembled in the shop, or are not assembled in the field by the maker of the drums, headers or other major parts, the responsibility for the stamping on the drums shall rest upon the manufacturer of those parts and the qualified inspector who witnessed the construction. A manufacturer's data report covering the drums, headers, etc., shall be prepared and filed, and shall be signed by that manufacturer and the inspector.

On the complete assembly and final inspection and hydrostatic test of the boiler in the field, a complete report shall be filed on the boiler when ready for use by a commissioned inspector making final inspection.

Each drum of multiple drum boilers, shall be stamped with the same standard number and shop number.

F. C. Peal, statistician of the National Board, presented a report on boiler statistics covering construction, inspection, accidents, and the like.

Technical Session

On Tuesday morning the technical section of the meeting opened with the reading of a joint paper by J. B. Romer and W. W. Eaton of the Babcock & Wilcox Company, New York on the "Properties of Various Alloy Steels and Their Abilities to Meet Present Conditions Imposed by Higher Pressures and Temperatures in Boiler Practice as well As Corrosive Resistance". An abstract of this paper will be published in a later issue of the magazine.

Dr. D. S. Jacobus, chief engineer of the Babcock & Wilcox Company, New York, was to have presented a paper on the subject of dished heads. In his absence C. W. Obert reviewed briefly conditions leading to the recent changes in the American Society of Mechanical Engineers' Boiler Code formula for the strength of such heads.

R. K. Hopkins of the M. W. Kellogg Company, substituted for H. O. Whitney of that company in reading a paper which described tests made to ascertain the comparative stresses existing around nozzle openings with and without reinforcement.

"The Relationship of the Boiler Manufacturer to the National Board of Boiler and Pressure Vessel Inspectors" was the subject of a brief address by George W. Bach, vice-president, Union Iron Works, Erie, Pa.

The Wednesday session was devoted to committee reports of the members while Thursday was devoted to inspection trips to local boiler shops and other nearby plants. At the Erie City Iron Works a demonstration of burning pulverized fuel was given while at the Union Iron Works the flanging of heavy plates was demonstrated. Methods of constructing welded low pressure heating boilers were observed at the Sims Company plant. The members of the board and their guests also inspected the largest welded pressure vessel in the world at Orville, Ohio; while at Reeves Bros. plant in Alliance, procedure control of welding longitudinal and girth joints of large unfired pressure vessels was demonstrated.

Entertainment features of the meeting included a boat trip to Canada, a fish fry and a luncheon as guests of the Erie City Iron Works.

A complete report of the transactions of this meeting will be published in a later issue of the magazine.

The Naylor Pipe Company, of Chicago, Ill., formerly known as the Naylor Spiral Pipe Company, has completed a new plant which increases its facilities some 200 percent.

A Helpful Factor for the Layerout to Use

By Phil Nesser

ALL layout men and boiler makers know the old factor 3.1416, which is the circumference of a circle whose diameter is one inch. To find the circumference of any circle, we simply multiply the diameter by 3.1416 because for each inch in diameter there are 3.1416 inches in the circumference. Now let us introduce another factor, the versed sine of 30 degrees, 0.134. Some of our readers will say they always knew that 0.134 is the versed sine of 30 degrees, but the writer will endeavor to give a few cases where this new factor can be applied to layout work.

Referring to Fig. 1, we have shown a sector of a

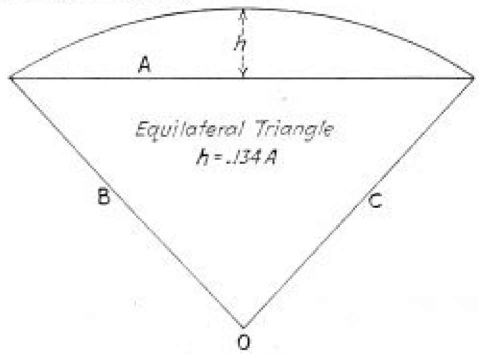


Fig. 1.—Diagram showing the theoretical determination of the factor

circle, the angle is 60 degrees. In such an angle the chord A is equal to the radius of the circle, or the sides B and C. This makes what is called an equilateral triangle, and using B or C as a radius, scribing an arc from the intersection of B and C as a center, completes the figure and the distance h will always be 0.134 times the length of A, B or C.

Applying the Factor

Now the first case in which we will try to use this new factor is as follows: Suppose we wish to make a tank with a dished head and wish to take off the depth of the head so that we can lay out the shell sheets, keeping the overall length correct. In common practice the radius of the dish is equal to the diameter of the tank and from close inspection of Fig. 1 we can recognize A

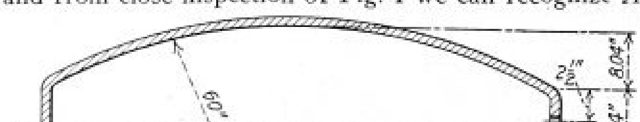


Fig. 2.—An application of the factor in measuring the amount of dish in boiler heads

as the diameter of the tank, and B and C as radii of the dish. Then the depth of the dish from the back of the flange to the bottom of the dish is 0.134 times the diameter of the tank. If the tank is 60 inches in diameter then 60 times 0.134 equals 8.04 inches, the amount to take off "from the back of the flange" in allowance for the total length in laying out the shell. Again, the flanger could use the factor to tell when he has the head dished to the proper radius by putting a straight edge across the flange adding flange and dish together.

Then if the flange is 4 inches long $4 + 8.04 = 12.04$

inches, which totals the depth of both flange and dish.

If the distance from the back of the flange to the hole is 2½ inches, the thickness of the head ½ inch and the depth of the dish 8.04 inch, the sum of these; $8.04 + \frac{1}{2} + 2\frac{1}{2} = 11.04$ inches. The layout man subtracts 11.04 to get his total length correct on each end if both heads dish outward.

Fig. 2 shows a head with 4-inch flange dished 8.04 inches deep from the back of the flange, 2½ inches from the back of the flange to the hole; the head is ½-inch thick.

Rolling Plate

Another case in which the factor 0.134 will save a lot of time occurs whenever we bend a ring or shell in

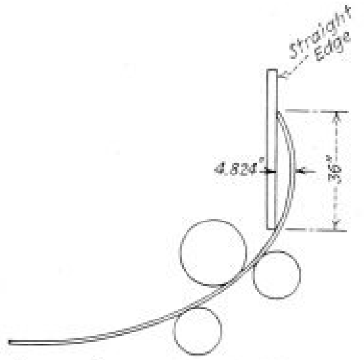


Fig. 3.—The factor in use for checking the curvature of plates in the rollers

the bending rolls. The common practice is to cut out a template to try on the rolled sheet. This also can be picked out of Fig. 1 by considering the sector above *A*, the arc to be the radius *B* or *C* equal to the radius to which the sheet is to be rolled. As we all know, this is half of the required diameter. Get a straight-edge about 1-inch wide and ⅛-inch thick, and slightly longer than the radius (half the diameter) of the ring to be rolled. From one end of the straight-edge measure off one radius and mark on the edge of the straight-edge this length.

Put the sheet in the rolls and start to bend a little at a time, trying to bend the full length of the sheet at each setting of the rolls; for this reason it should at no time be set to bend too much. As the sheet comes out from the rolls, the straight-edge is held across the arc formed by the bent sheet, keeping the end even at one point and the mark even at another point. Referring again to Fig. 1: *A* is the length marked on the

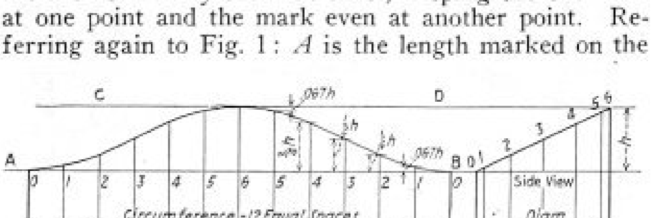


Fig. 4.—The layout of elbows is simplified by this factor

straight-edge, the bent sheet is the arc, the distance from the center point of the chord, as *h* in Fig. 1, is the radius multiplied by 0.134. Suppose the boiler to be 72 inches in diameter, then the length marked on the chord is 36 inches and the height of the segment is $36 \times 0.134 = 4.824$ inches.

Fig. 3 shows the end of the rolls, the edge of the sheet being bent, and the straight-edge across the arc with the dimensions shown for bending a shell sheet 72 inches in diameter. A nice straight yardstick would be good for this job, because the edge has all graduations marked; but for over 72 inches, we would have to use a longer rod. Now the rule to go by on this is: Mark off half the diameter on a straight-edge, multiply this length by 0.134. The result will be the height of the segment or the distance from the chord to the arc at the middle of the chord. To make things a little clearer, in Fig. 1, *A* is the chord and *h* is the height of the segment. When $A = 1$ inch and the radius = 1 inch, then $h = 0.134$.

Pattern for Elbow Section

The next case in which we could use 0.134 is in making a pattern for an elbow section. The side view and pattern layout are shown in Fig. 4, in which *h* is the rise of one side, but as *h* is the rise for the full diameter then we take half of 0.134 for the rise of the first division in the pattern and if *h* is 1 inch then division No. 1 rises above the base line *A-B*, Fig. 4, 0.067 inch, i.e., sixty-seven thousandths inch; division No. 2, is ¼ *h* high above line *A-B*; division No. 3 is ½ *h* high above line *A-B*; division No. 4 is ¾ *h* stepped from line *A-B* on line 4; then division No. 5 is measured 0.067 *h* down from line *C-D*, the line *C-D* is parallel to *A-B* a distance equal to *h*. Then line 6 reaches to line *C-D* and this completes the pattern without drawing a profile of the pipe. By drawing a curved line through the points, the base line may be re-divided into any number of equal spaces.

If *h* in Fig. 4 be multiplied by 0.067 it gives the height of the first division and the drop of the fifth division. When the full circumference is divided in 12 divisions, we must use 0.067 to keep from working on the radius. If we used 0.134 we would have to then take half of *h*. We hope this will be clear enough for all to understand.

Conditions for Award of Miller Medal Revised

THE Board of Trustees of the Samuel Wylie Miller Medal, which has been established by Past President Miller, of the American Welding Society, had no paper submitted to it during the calendar year 1927 of sufficient value to merit the award for that year. The board has, therefore, revised the conditions under which the medal may be awarded as follows:

1. The medal may be awarded annually for any meritorious achievement which, in the judgment of the Board of Trustees, has contributed conspicuously to the advancement of the art of gas fusion welding and cutting or the art of electric arc fusion welding and cutting.
2. The award for any calendar year shall be announced and the medal, together with a suitable certificate, presented at an annual meeting or a fall meeting of the society as the Board of Trustees may elect.

The conditions governing the award of this medal have been made very broad so that it can be granted for an achievement of any character which has contributed conspicuously to the advancement of either of the two branches of the welding art which are specifically mentioned. Thus, the award may be made for a meritorious paper or an invention or a conspicuous application of welding in industry which has advanced the art either on account of unique technical features or important economic advantages. The award may even be made for conspicuous service of a non-technical character which distinctly advances the welding art.

Effect of Increasing Locomotive Boiler Pressures

Advantages and disadvantages of working pressures that are higher than 200 pounds

AMONG other subjects discussed at the American Railway Association, Mechanical Division meeting at the Atlantic City, N. J., convention, June 20 to 27, was the report by a sub-committee of the committee on locomotive design and construction which dealt with the use of high boiler pressures for locomotive service.

The sub-committee which prepared this report was composed of A. H. Fetters, chairman, W. I. Cantley, H. M. Warden and M. F. Cox. An abstract of the report follows:

Up to a year ago it was generally thought that 250 pounds was the practical limit of pressure in boilers of the radial stayed type, particularly in capacities suitable for railway service in this country. However, the Delaware & Hudson now has in operation two locomotives with radial stayed boilers in which pressures of 275 pounds and 300 pounds respectively are used, and a third using 325 pounds is contemplated. The operation of these locomotives will be closely observed in comparison with that railroad's two watertube firebox locomotives, the *Horatio Allen*, using 350 pounds pressure, and the *John B. Jervis*, using 400 pounds pressure.

Reports on the operation of all these locomotives are encouraging and it will be of interest to note such comparisons as may be made of the two types of fireboxes.

During the four months in which the 300 pound radial stayed type has been in operation, high temperature conditions reaching 800 degrees F., at the steam chests have existed at times. No serious effects have been noted from this high temperature and no packing renewals have been required.

Several roads are using, or are interested in the development of equipment using pressures exceeding the conventional and are thus contributing to a fuller knowledge on this subject. The Santa Fe is working on radial stayed boilers for pressures of 275 pounds.

Use of Alloy Steels

Two roads are doing considerable development in connection with the use of alloy steels in the construction of high pressure boilers. One, the Canadian National, has 40 locomotives and 12 additional on its subsidiary line, the Grand Trunk Western, in which use is made of high-tensile silicon steel for the construction of the boilers. This steel shows an average tensile strength of about 76,800 pounds and yield point of about 46,100 pounds. The use of this steel has permitted an increase of boiler pressure from 200 pounds to 250 pounds with but little change in design, size, or weight.

Similar results are obtained by the Canadian Pacific with 44 locomotives using 250 pounds pressure, in which the boiler shells are constructed of nickel steel. This steel shows an average tensile strength of 76,700 pounds with a yield point of 59,200 pounds. This represents a gain in strength of about 29 percent as compared to the carbon steels usually used.

It is evident that the use of alloy-steel and steel stays will contribute to the successful use of high pressures in conventional forms of boilers.

Radial Stayed Boilers

While Europeans still continue their development with ultra-high pressures, the prevailing tendency in this country is to remain below 400 pounds pressure and not depart far from conventional design. This conservative attitude seems preferable at this time, as it is a relatively simple matter, even with conventional cylinder arrangements, to obtain considerable added economy by taking advantage of the highest possible pressures in radial stayed boilers, coupled with increased superheat up to 800 degrees F.

The highest pressure, it seems evident, must remain below 400 pounds, as higher pressures will necessitate the use of watertube boilers or, to the extent that pressures are increased, freak constructions.

With reference to present European ultra-high pressure locomotives, it is noted that the reciprocating types do not use condensers—the use of condensers being confined to turbine types.

Watertube Boilers

The utilization of watertubes in high pressure boilers involves the use of relatively pure water, but condensing, as a solution of the water problem, involves overcoming some difficulties when used in connection with reciprocating engines. In particular, there is considerable difficulty with the coating of the condenser tubes with congealed oil carried over in vapor form in the exhaust steam.

The Schmidt-Henschel three-pressure locomotive exemplifies one system of using ordinary water in that the steam produced from distilled water in the fire heated surfaces of the firebox is used only as a means of heat transfer to the steam producing drum which is isolated from contact with the flame and gases of combustion. Untreated water is used in the production of the working pressures.

Another means is adopted by Dr. Buchli in his locomotive wherein the feedwater is brought to a high temperature in the preheater and economizer, and practically all foreign matter precipitated before the water enters the watertube boiler. These preheater and economizer units are protected from direct action of the flames and are so constructed that they may be readily cleaned.

The Buchli locomotive referred to, is of special interest at this time, representing as it does the simplest possible conception of an ultra-high-pressure locomotive.

Both boiler and engine are relatively simple in design and the necessary auxiliaries are reduced to a minimum.

Weight and cost are approximately that of an ordinary high grade locomotive.

The engine and other operating parts are accessible and simple to service.

Operation of the locomotive is no more complex than conventional types.

Vibration is reduced to a minimum and torque at the drivers is uniform.

Tests have indicated an economy of both coal and water as compared to conventional types.

Comparative data is given herewith covering the Buchli locomotive and a comparable one of conventional form:

	Buchli	Conventional
Boiler pressure	850 lb.	170 lb.
Heating surface, sq. ft.	1040	1290
Superheater surface, sq. ft.	215	346
Water capacity, boiler, imp. gals.	594	1080
Number of cylinders	3	2
Diameter of cylinders	8½ in.	21¼ in.
Stroke of pistons	13¾ in.	23⅝ in.
Ratio of gear drive	2½ to 1	No gears
Diameter of wheels	60 in.	60 in.
Maximum speed, m. p. h.	50	46½
Wt. in working order, tons	75	90.8

Comparative tests were made of these two locomotives on runs out of Winterthur, Switzerland, under approximately the same operating conditions. Detail figures are not at present available, but Dr. Buchli states that a coal economy of 35 to 40 percent and water economy of 47 to 55 percent was obtained in favor of his type of locomotive. It is unlikely, however, that such large economies would be realized, as compared with the large, efficient locomotives in use on the better equipped American railroads.

For those roads wishing to avail themselves of further economy in locomotive operation without departing materially from conventional practices, there exists the opportunity, previously referred to, for deriving substantial economies by availing themselves of the upper limits of boiler pressures possible in properly designed radial-stayed boilers in conjunction with considerably higher superheat than is now in general use. With this combination of higher pressure and higher superheat, it is still practical to use the conventional two and three-cylinder single expansion arrangement.

Solid Forged Boiler Drums

By G. P. Blackall

A RECENT development of steelworks practice in the United Kingdom, which is now being undertaken by several of the leading firms, is the solid forging of steel drums for high pressure boilers. Greatly increased strength is given by the forging of a drum or shell in a single piece, as compared with the method of building up a boiler of plates which are riveted or welded together.

The new solid forging process is a difficult one, and a rather elaborate plant is required for it. For a number of years the drums of turbines have been rolled hollow in a single piece from ingots, but whereas these are of a large diameter, running up to 14 feet, they are short in length, while solid boiler drums have been forged up to a length of 40 feet. One of the largest British firms now engaged upon this class of work is John Brown & Company, which last year turned out nearly a hundred such drums. This year the same firm will be making approximately the same number. Several of the drums completed have been for large generating plants abroad. Vickers Armstrong is another important concern carrying out the process.

Determining Working Pressure by a Simplified Method

By R. J. Furr*

WHEN traveling about the country making boiler inspections the inspector meets with many difficult problems and is asked some very perplexing questions (which only a well informed inspector can answer) as to repair and methods of calculation in solving the various formulas in the several codes governing boiler construction. Observation indicates that the 1924 American Society of Mechanical Engineers' Boiler Code is foremost in discussion as it is more universally used. Section 1 page 29, Par. 212a apparently is the most difficult of understanding, therefore, an article discussing this part of the code setting forth the formulas for the first two requirements and incorporating a simplified method for requirement 3 or "*b*" would not be amiss for various reasons. First: The average inspector knows little or nothing of higher mathematics due to the fact that highly trained men are not employed except as a matter of policy and the states requiring examination for a certificate of competency do not require higher mathematics. Second: Due to petty jealousy, in the office where the report is reviewed, resulting in many instances in antagonism and disagreeable correspondence by persons who apparently hold the opinion that the field men will have greater possibilities of advancement. Third: There are engineers and inspectors who claim the methods are impractical and were inserted in the 1918 and 1924 Codes for want of one that was more simplified hence, for these reasons, they are usually ignored. The methods are:

> *P-212a.* The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:
>
> *First:* the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays or riveted longitudinal joint or other construction. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in Par. P-199, using 70 for the value of *C*.
>
> *Second:* the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays or riveted longitudinal joint or other construction. To this pressure there shall be added the pressure corresponding to the strength of the stays or braces for the stresses given in Table P-7, each stay or brace being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay or brace.
>
> *b.* The maximum allowable working pressure for a stayed wrapper sheet of a locomotive-type boiler shall be determined by the two methods given above and by the method which follows, and the minimum value, obtained shall be used:
>
> $$P = \frac{11{,}000t \times E}{R - s\sum \sin \alpha}$$
>
> in which,
>
> α = angle any crown stay makes with vertical axis of boiler.
>
> $\sum \sin \alpha$ = summated value of sin α for all crown stays considered in one transverse plane and on one side of vertical axis of boiler.
>
> s = transverse spacing of crown stays in crown sheet, inches.
>
> E = minimum efficiency of wrapper sheet through joints or stay holes.
>
> t = thickness of wrapper sheet, inches.
>
> R = radius of wrapper sheet, inches.

*Supervising inspector, London Guarantee and Accident Company, Ltd.

P = maximum allowable working pressure, pounds per square inch.
11,000 = allowable stress, pounds per square inch.

The above formula applies to the longitudinal center sections of the wrapper sheet, and in cases where E is reduced at another section, the maximum allowable working pressure based on the strength at that section, may be increased in the proportion that the distance from the wrapper sheet to the top of the crown sheet at the center, bears to the distance, measured on a radial line through the other section, from the wrapper sheet to a line tangent to the crown sheet at right angles to the radial line.

The following may not take into consideration all the refinements but it is close enough for safe practice as will be shown, and Figs. 1 and 2 are submitted to assist in illustrating the problem and provide a working plan for those who may be skeptical of the use of the protractor. The reason for submitting the two figures is to give a variance of design covering classes of locomotives of the radial stay type both large and small and it is to be observed that Fig. 2 is of poor design and are used to show that the formula will give results.

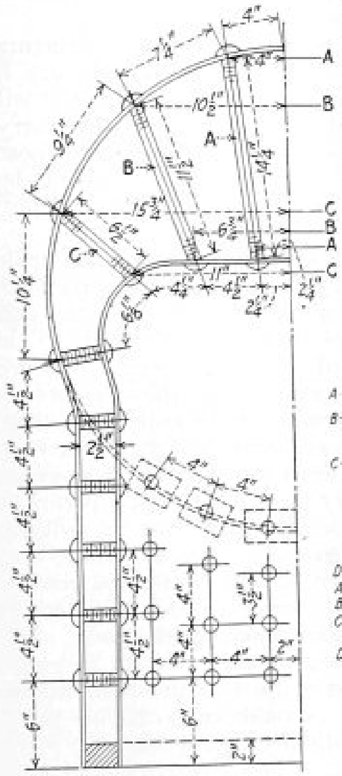


Fig. 1

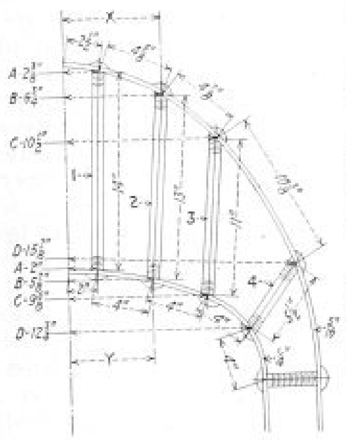


Fig. 2

The calculations hereafter considered are taken from Fig. 1 and are as follows: Diameter 32 inches, shell plate 5/16 inch, staybolt diameter 7/8 inch, pitch of staybolts 4.5 inches, tensile strength 55,000 pounds per square inch.

In P. 212a, the first requirement is to ascertain the allowable working pressure between stays, that is the net plate section, in accordance with Par. 180. The formula is:

$$\frac{TS \times t \times E}{R \times FS}$$

in which

TS = 55,000 pounds per square inch tensile strength of plate
t = minimum thickness of plate.
E = efficiency of longitudinal joint or net section of plate between stay holes.
R = radius of wrapper sheet.
FS = factor of safety or 5 for new construction.

The efficiency of the net plate section is found by the following formula.

$$\frac{P - D}{P}$$

in which, P = maximum pitch of stay-bolts in inches.
D = diameter of stay in inches.

$$\text{Then, } \frac{4.5 - 0.875}{4.5} = 0.804$$

Substituting these values and those in the example,

$$\text{Then, } \frac{55{,}000 \times 0.3125 \times 0.804}{16 \times 5} = 172 \text{ pounds per}$$

square inch, maximum allowable working pressure without allowing for the holding power of the stays.

To this pressure is added the pressure obtained by the formula in P-199, in which, 70 is used for the value of C. The formula is:

$$P = C \times \frac{t^2}{P^2}$$

in which; P = allowable working pressure in pounds per square inch.
t = thickness of plate in sixteenths of an inch.
p = maximum pitch between stays, inches.

The value of $t = 5$
The value of $p = 4.5$
Substituting these values in the formula.

$$\text{Then, } P = 70 \frac{5 \times 5}{4.5 \times 4.5} = 86 \text{ pounds}$$

The pressure 86 is to be added to that found for the net plate section. Then in accordance with the first requirement of P-212a the allowable pressure equals 172 + 86 = 258 pounds per square inch.

For the second requirement the pressure is based on the sum of the allowable pressure on the net plate section already determined and that allowed on the stays.

The safe load allowed on a 7/8-inch stay using an allowable stress of 7,500 pounds per square inch, as given in table P-7 equals the area of the stay multiplied by the allowable stress on the cross section; equals 0.419 × 7,500 = 3,142 pounds.

The area supported by the stay is 4.5 × 4.5 = 20.25 square inches. Then 3,142 ÷ 20.25 = 155 pounds per square inch and 172 + 155 = 327 pounds per square inch allowable working pressure in accordance with the second requirement.

Determining the Pressure

The next requirement is to determine the pressure by the formula in P- 212 b, as previously stated.

In the application of this formula ascertain the sine of the respective angles *A-A-A, B-B-B, C-C-C,* and add them together and—as the purpose of this article as stated above is to simplify P- 212 *"b"* of the formula, hence we have the following.

To obtain the sine of the angle of any radial stay without measuring the angle, measure X, Y, E, then the

$$\sin = \frac{X - Y}{E}; \text{ see Fig. 2 in which,}$$

X = Horizontal distance from center of stay to center axis of boiler at wrapper sheet.
Y = Horizontal distance from center of stay to center axis of boiler at crown sheet.
E = the lengths of the several stays.

In applying this method care should be taken in adding and subtracting the several values; for example in Fig 2, the distance X from the center axis of the boiler to stay No. 1 is 2⅜ inches at the wrapper sheet and at the crown sheet the distance Y equals 2 inches, and the length of the stay is 14 inches for the sine of the first angle. Now the distance from center of axis to stay

No. 2 would be the sum of the distance of stays No. 1 and No. 2 at the crown and wrapper sheet for X and Y respectively, subtracting and dividing by the length of the stay No. 2 or 13 inches; in like manner for all remaining stays. For convenience and to eliminate possibility of error the measurements in the drawings are lettered A-A-A, etc.

Thus, for Fig 1, substituting the values for X, Y, and E;

$$\sin A = \frac{4 - 2.25}{14.25} = 0.1228$$

$$\sin B = \frac{10.5 - 6.75}{11.5} = 0.3260$$

$$\sin C = \frac{15.75 - 6.75}{6.5} = 0.7307$$

$$\Sigma \sin a = 0.1228 + 0.3260 + 0.7307 = 1.1745$$

The values to be substituted in the formula are as follows: $t = 0.3125$, $E = 0.804$, $R = 16$, $S = 4.5$, $\Sigma \sin a = 1.1795$.

$$\text{Then, } P = \frac{11{,}000 \times 0.3125 \times 0.804}{16 - (4.5 \times 1.1795)} = 258 \text{ pounds per square inch}$$

The allowable pressure is the smallest value as found in accordance with the three methods given and in this case is 258 pounds per square inch. It should be remembered that the allowable pressure on the drum or barrel must also be computed for it may be the weaker of the two, likewise, other parts of the boiler.

For the purpose of comparison, the sine of the angle of the stays as obtained by calculation and by the use of the protractor are hereafter given for both figures.

	Instrument	Calculation
Fig. 1	A — 0.1349 — 7° 45′	0.1228 — 7° 5′
	B — 0.3434 — 20° 5′	0.3260 — 19° 7′
	C — 0.7490 — 48° 30′	0.7307 — 46° 56′
Fig. 2	A — 0.0320 — 1° 50′	0.0267 — 1° 31′
	B — 0.0741 — 4° 15′	0.0673 — 3° 52′
	C — 0.0770 — 4° 25′	0.0795 — 4° 33′
	D — 0.5771 — 35° 15′	0.5681 — 34° 37′

The Erie City Iron Works, of Erie, Pa., has established a direct sales office at 1105 Leader Building, Cleveland, Ohio, with Eugene Smith as manager.

Horizontal Tank Supports

By David E. Stitt

In response to a request appearing in the March issue of THE BOILER MAKER for information concerning supports for horizontal storage tanks, the following is submitted with the hope that at least a part of the information contained herein will be of assistance to whomever desires it.

The design of supports for horizontal tanks for the storage of oils and other liquids presents no difficult problem, but rather depends upon the conditions governing the tank installation. The types of supports employed are most generally the same except that certain details of construction may differ to suit each particular case. Generally speaking, horizontal tank supports may be divided into three types, i. e.—structural steel supports, concrete piers and cast iron cradles.

The drawing Fig. 1 shows a typical set of structural steel supports for a 20,000 gallon capacity tank, size 10 feet diameter by 34 feet long. This construction, it will be noted, consists of lateral plate and angle cradles carrying the tank load by means of vertical double angle posts to the concrete footings. Diagonal angle bracing between the posts takes the wind loads and gives rigidity to the structure.

Since the width of shell courses for horizontal tanks is generally between 5 and 6 feet the common practice is to place a support at the center of every alternate shell course. The end posts are set in from the ends of the tank to permit location of draining openings. Care, however, should be taken not to space the uprights too far apart to cause undue strains in the tank shell, creating a leakage through opened seams and a resultant fire hazard. The distance between posts should not exceed 10 feet except where heavy tank construction permits a greater span. Efforts to lessen initial cost by reducing the number of supports beyond a limit of safety, even though the limited number of members used may in themselves be sufficient to carry the load, will prove a disastrous and expensive experiment in the end.

The lateral cradles should be wide enough to give a bearing surface of at least a third of the tank circumference. In no instance should supports be placed directly under the longitudinal or girth seams.

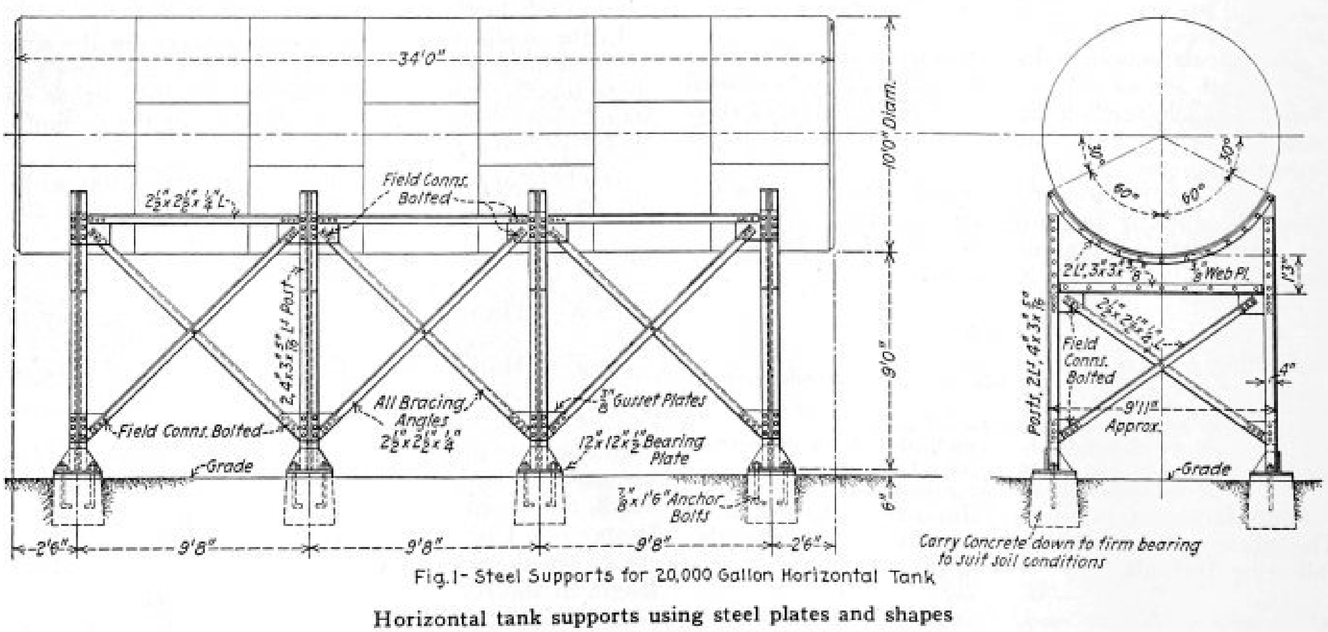
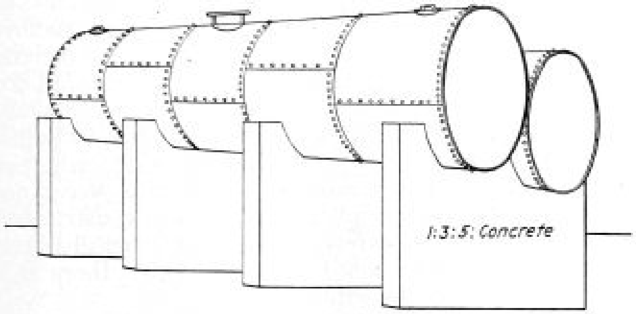


Fig. 1- Steel Supports for 20,000 Gallon Horizontal Tank

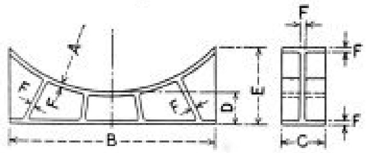
Horizontal tank supports using steel plates and shapes

Tanks elevated on structural supports are usually from 6 to 10 feet from the ground to the tank bottom. The vertical posts usually consist of two 4-inch by 3-inch by 5/16-inch angles with the long leg turned in. While this size of angle may be too heavy for some cases it is adopted by a good many oil companies to meet the loadings under varying heights which usually do not exceed 10 feet.

on one cradle = 44,650. Bending moment (considered roughly at uniform load) $= \frac{wl}{8} = \frac{44{,}650 \times 108}{8} = 602{,}775$. Section modulus $= \frac{602{,}775}{16{,}000} = 38$. If the web plate be ⅜-inch by 15-inches deep and the flange angles 3-inch by



Sketch Showing Typical Concrete Support Installation for Two Horizontal Tanks
Fig. 2



Diam. of Tank	Length of Base	Width of Base	Height at Center	Height at End	Thickness of Metal	Weight of Cradle
A	B	C	D	E	F	G
24"	18"	5"	4½"	8½"	⅜"	60 Lb.
30"	20"	6"	4½"	8"	¾"	70
36"	20"	6"	4½"	7"	⅝"	70
42"	24"	6"	4½"	8"	⅝"	90
48"	32"	7"	5"	10"	⅝"	140
60"	40"	7½"	5½"	13"	¾"	230
72"	46"	8"	6"	14"	¾"	300
78"	45"	9"	6"	13½"	¾"	340
84"	48"	8"	6"	13½"	⅞"	345
96"	48"	8"	6"	12½"	⅞"	385
108"	50"	9"	7"	15"	1"	440
120"	56"	9"	8"	16"	1⅛"	525
126"	Build from 120" Cradle					600

Cast Iron Cradles for Horizontal Tanks
Fig. 3

Concrete supports and cast iron cradles for horizontal tanks

The web plate of the lateral cradle is ⅜-inch with 3-inch by 3-inch by ⅜-inch top and bottom flange angles. The depth of the cradle at the tank center is from 12 inches to 24 inches depending on the load. Diagonal bracing angles are made 2½-inches by 2½-inches by ¼-inch.

The post loads are transmitted to the concrete footings by bearing plates of sufficient area to distribute a bearing on new concrete not in excess of 350 pounds per square inch. Sizes of anchor bolts are usually ⅞-inch diameter by 1 foot 6 inches long. The concrete footings should be carried down to firm bearing to suit soil conditions and not less than 2 feet and about 6 inches above grade.

Structural steel supports are often made to support a pair or a battery of tanks or a continuous number of tanks in line. Steel supports, whether they be for single tanks or pairs, are generally made portable, with the posts and cradles shop riveted and the diagonal angle bracing field bolted, thus permitting the installation to be taken down and erected elsewhere should the occasion arise.

Although, as mentioned above, the design of this type of support has become generally standardized as to size of members, the method of calculating the size of a few of the members is given below to assist in the design of this type of structure shown by Fig. 1.

Total load including weight of tank and oil contents = 178,600 pounds. Load on each of the eight posts = 22,325 pounds. Height of post = 120 inches. Least radius of gyration for 4-inch by 3-inch by 5/16-inch angle with long leg turned in = 1.26. Area of two angles = 4.18. $\frac{l}{r} = \frac{120}{1.26} = 95$. Unit stress based on formula, $19{,}000 - 100 \frac{l}{r} = 9{,}500$. Angles good for $9{,}500 \times 4.18 = 39{,}700$ which is more than sufficient. Load

3-inch by ⅜-inch a section modulus slightly above this value is obtained. Area of base plate to distribute load not to exceed 350 pounds per square inch on new concrete = 127 square inches. Use 12-inch by 12-inch bearing plate ½-inch thick.

The second type of support is that consisting of concrete piers, shown by Fig. 2. This type is rapidly being replaced by structural supports because of the latter's portability and cheapness.

Use of Concrete Piers

Concrete piers are distributed to take the load of the tank in the same manner as steel supports, one to every alternate course. The best practive is to make the piers not less than 18 inches wide at the top with a batter of 1 inch in 12 inches. Concrete mixture; 1 part cement, 3 parts sand, 5 parts stone. Piers should be carried down to firm bearing to suit soil conditions and care should be taken that concrete is thoroughly set and hardened before placing load on same.

Where irregularities in pier elevation due to pouring, variances in forms, settlement, etc, are encountered wood shims or grout may be used to make the tank sit level. Concrete piers may also be constructed to support a number of tanks in groups or batteries.

The third type of support is the cast iron cradle as shown by the drawing and table in Fig. 3. The table gives dimensions for cast iron cradles for horizontal tanks from 2 feet diameter to 10 feet diameter.

This type of support is generally used for interior installations such as sprinkler and blow off tanks, etc., where the tanks are to be elevated but a few inches above the floor. Cast iron cradles can also be used for greater heights but the initial cost of pattern, material and particularly their cumbersomeness for higher elevations renders them inferior to the structural type where head room is required and in many instances they are being supplanted by the latter.

Maximum Allowable Working Stress for Fusion-Welded Joints*

THE question as to what unit working stresses should be allowed for fusion-welded joints of pressure vessels has been under consideration for several years by the Boiler Code Committee of the American Society of Mechanical Engineers. Par. U-68 of the Code for Unfired Pressure Vessels specifies 5,600 pounds per square inch for the limits of size and working pressure of vessels named therein. In specifying the working stress of 5,600 pounds per square inch for fusion-welded joints, the Boiler Code Committee leaned toward the side of safety with the idea of broadening out the rules as the art advanced rather than to reach out too far at the start with the risk of accidents. There is a feeling on the part of many that a higher working stress should be used with certain types of joints, and that there should be different types of joints and some way of differentiating between different qualities of fusion welding.

A comprehensive series of tests of welded pressure vessels was carried out by the American Bureau of Welding about five years ago with a view to assisting the Boiler Code Committee in its study of this problem. The data obtained from these tests were of material benefit in establishing desired information, but certain types were not included in these investigations and further studies were found to be necessary in order to codify the practice of fusion welding so that not only good results in joining metals will be insured, but also a rating of stress may be assigned to any welded joint, depending upon its soundness and dependability.

The committee is now in position to announce that studies under way in cooperation with the American Welding Society give promise of the early development of a welding procedure suitable for embodiment in a code that will, if followed, insure safe pressure vessels, and that in addition there has been submitted to it a proposed method of evaluating the welded joint on the basis of tests made of representative specimens thereof. With a view to obtaining discussion and constructive suggestions thereon, the latter method is herewith submitted for the information of every one interested, as follows:

Strength of Welded Joints

It has been proposed to interrelate in a suitable formula the ultimate strength and the elongation obtained by free and unrestricted bend of sample test specimens of the welded joint. This formula which attempts to give due credit to the ductility factor in the welded joint is as follows:

$$S = \frac{T}{7.15\sqrt{\frac{E}{10}}}$$

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

T = ultimate tensile strength, pounds per square inch.

E = elongation, in percent, shown by test specimen subjected to free and unrestricted bending.

The stress determined by the formula should be the maximum stress allowed in the structure. Particular attention should be paid to conditions where this maximum stress may be be actually greater than often considered, as in lap or corner joint, if it is desired to apply the formula.

The above formula is based on the general agreement by engineers engaged in the design and fabrication of general steel construction, that a certain amount of ductility is necessary for the safety of any structure subjected to unknown stresses. There is no definite knowledge of the exact amount of ductility needed for any particular case, but information is of course available that certain structures built of material having a certain definite ductility, have proven safe, whereas structures built of materials of low ductility have not shown as consistent results. In ordinary construction work the factor of safety, which has generally been taken as 5, has been based on the fact that there is a certain amount of elongation.

The applicability of this formula is based to a large extent on the newly devised method of determining the ductility of metals by the free and unrestricted bend-test method that substitutes, for the usual methods of bending a specimen around a pin or forcing it between two anvil blocks, the more accurate plan of placing a kinked specimen between the jaws of a vise or in a testing machine so that it will bend freely to a U shape. This method, which gives consistent results, produces an elongation in the outside fibers of the specimen that can be measured directly with a flexible scale, and eliminates the uncertainties of measurement of the bend angle which was formerly used as the criterion. With this method any gage length may be used but one which takes in the width of the weld appears to be most logical for this purpose as it gives a direct measure of the elongation in, and therefore the ductility of, the weld metal.

Inasmuch as it is the purpose in rating welded joints to obtain a measure of the ductility of the weld metal proper, both the tensile and bend tests, as made for this determination, are applied to specimens with the weld reinforcement ground off. In the application of this formula there is no need to be concerned with what may be accomplished in strengthening a weld by reinforcement, as if a welded specimen with no reinforcement breaks outside of the weld, it will be obvious that the weld is stronger than the plate. The ductility of the welds will vary with the welding rod and the process, but it seems reasonable that if two welds, made by different processes or with different rods, have the same tensile strength and ductility, they should be allowed the same working fiber stress.

In developing the above formula the ductility factor was so incorporated that a lower working fiber stress will be allowed where the material has low ductility, and the working fiber stress will depend directly upon the tensile strength. Using varying values for the factors T and E in the formula, tables of proposed maximum allowable working fiber stresses in pounds per square inch of plate section for welded steel pressure vessels have been prepared. The first table represents the manner in which the formula was first worked out to determine its practicability of application to ordinary working conditions, but Table 2 shows the form in which the cal-

*These formulas are published for public criticism at the suggestion of the American Society of Mechanical Engineers Boiler Code Committee.

culations will probably be most convenient for ordinary use.

The factor of safety in the last column of Table 1 is the same for any given percentage of elongation. The ultimate strength is either that of the weld metal if the weld breaks during the test, or of the base metal if the fracture occurs in it, and obviously a structure cannot be designed, as far as tensile strength is concerned, except on the strength of the weakest part. It is easily worked out that a factor of safety of 5 is reached at an elongation of somewhat over 29 percent.

PROPOSED MAXIMUM ALLOWABLE WORKING FIBER STRESSES IN POUNDS PER SQUARE INCH OF PLATE SECTION FOR WELDED STEEL PRESSURE VESSELS

TABLE 1

Percent elongation by bend test	Ultimate strength in 1000 lb. per sq. in. 45	50	55	60	65	70	75	Factor of safety
5	5,000	5,800	6,100	6,700	7,200	7,800	8,300	9
7½	5,800	6,400	7,000	7,700	8,300	8,900	9,600	7.8
10	6,300	7,000	7,700	8,400	9,100	9,800	10,500	7.15
12½	6,800	7,600	8,300	9,000	9,800	10,500	11,300	6.65
15	7,200	8,000	8,800	9,600	10,400	11,100	12,000	6.25
17½	7,600	8,400	9,300	10,100	11,000	11,700	12,700	5.9
20	8,000	8,800	9.700	10,600	11,400	12,300	13,200	5.7
22½	8,300	9,200	10,100	11,000	11,800	12,800	13.700	5.5
25	8,600	9,500	10,500	11,400	12,400	13,200	14,200	5.3

TABLE 2

Percent elongation by bend test	Ultimate strength in 1000 lb. per sq. in. Over 45 up to 50	Over 50 up to 55	Over 55 up to 60	Over 60 up to 65	Over 65 up to 70	Over 70 up to 75	Over 75
5 to 7½	5,400	6,000	6,500	7,200	7,700	8,300	8,900
Over 7½ to 10	6,000	6,700	7,300	8,000	8,700	9,300	10,000
Over 10 to 12½	6,500	7,300	8,000	8,700	9,400	10,100	10,900
Over 12½ to 15	7,000	7,800	8,500	9,300	10,100	10,800	11,600
Over 15 to 17½	7,400	8,200	9,000	9,800	10,700	11,400	12,300
Over 17½ to 20	7,800	8,600	9,500	10,300	11,200	12,000	12,900
Over 20 to 22½	8,200	9,100	9,900	10,800	11,600	12,500	13,400
Over 22½ to 25	8,500	9,400	10,300	11,200	12,100	13,000	13,900

It will be observed that the part of the formula covering the factor of elongation decreases the allowable working fiber stress more rapidly than the elongation decreases, and on the other hand increases the fiber stress more slowly than the elongation. This seems quite logical, because there must be a point beyond which an increase in elongation increases the value of the metal but slightly, and because as the brittleness increases, the metal becomes less reliable in service.

For the purpose of applying this formula or the above tables to a specific tank in order that the welds therein may be rated as to allowable working stress, it is proposed that the tensile and bend-test specimens be prepared from samples of plate that are identical with the material to be used in the pressure vessel under consideration, and welded with the same filler rod and type of joint as are to be therein used. The sample of the plate is then to be cut into strips 2 or 2½ inches wide, extending at right angles to the welded joint, so that the weld metal in the joint can be subjected to either the tensile or the bend test. The tensile and bend tests shall be recorded in the manufacturer's data report form under items 8 and 9 covering joints. These figures of the ultimate strength in pounds and the elongation in percent, when applied to the table, give directly the allowable unit working stress on the vessel in which the joint is used.

Laying Out a Square

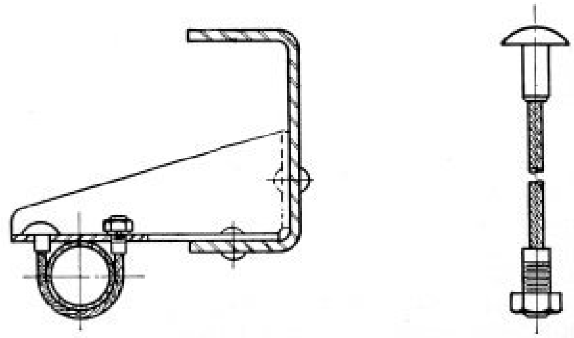
WITH an accurate straight edge draw a straight line upon a smooth steel plate and make a center punch mark exactly upon the scribed line and approximately at its center. Place one point of a tram, or a pair of large dividers in the center punch hole and describe a semicircle across the straight line.

From any point in the semicircle, but preferably near its middle, draw straight lines to each intersection of the circumference and diameter lines. The angle at the circle circumference, between these two lines, will be "square", or a right angle of 90 degrees. The above depends upon the geometrical proposition that "an angle in a semicircle is always a right angle."

Flexible Bolt Developed

THROUGH the development of the preformed type of wire rope which makes possible the attachment of fittings by the processing method that compels the fitting to become an integral part of the rope, the American Cable Company has recently perfected the Tru-Lay—Tru-Loc flexible bolt illustrated by the accompanying drawing.

This new bolt may be used where rigid U bolts are impracticable. They are finding ready use as auxiliary hangers for power shafts, suspension brackets for overhead steam or water piping, shackle bolts for temporary wall boxes, tanks etc., for scaffolding and tackle, on various parts of machinery, and in other places where semi-flexible connections are necessary.



The new flexible bolt

The principle on which the new flexible bolt rests is the preformed type of wire rope. Preforming the wires and strands to the exact helical shape they must assume in the completed rope results in a cable that does not require seizing but may be cut like a rod. This type of rope permits a close fitting attachment to be slipped over the unseized end of the rope and to be processed so that the steel of the fitting cold flows into the interstices of the rope and thus becomes practically an integral part thereof. Naturally such fittings can be threaded for a nut or capped for a head. The flexible bolt which has resulted from these developments is available in varying lengths.

BAFFLE WALLS—"Which Do You Prefer?" is the title of a new bulletin which compares the Turner boiler baffle wall with the Beco baffle wall. Both baffles are built exclusively by the Boiler Engineering Company, Newark, N. J. The Turner baffle tile is one inch thick while the Beco corrugated sheet metal separator is only 0.0126 inch thick. Numerous actual installation photographs of the Beco baffle are shown in all makes and types of watertube boilers.

WELDED PIPE.—The Linde Air Products Company of New York has published a booklet entitled "Welded Piping—The Modern Better Way for Installing Plumbing and Heating Systems". In this work is explained the method of welding pipe for household use in order to eliminate the usual couplings and to obtain a much neater result than has hitherto been possible.

Development of a Rectangular Transition Piece

By I. J. Haddon

TO develop a figure having a rectangular base and square top and to find the bevel at the corners, set out the elevation as *A, B, C, D* above the base *X-Y*, also the plan as shown in *1, 2, 3, 4, 5, 6, 7, 8*. Although *C-D* represents the corner of the figure *7-3*, it is also the true length of the line *9-10*.

To obtain the true length of the line *B-D*, which is also represented by the line *6-3* in the plan, draw the arc *6-11* with center *3* and radius *3-6*, and project *11* to the line *B-C* produced in *E*. Join *E* and *D* and *E-D* will be the true length of *B-D* or *6-3*.

To develop the surface of the figure, set off on the line *X'-Y'* from any point *10'*, the points *3'-4'* equal to those shown in the plan. Erect the perpendicular *10'-9'* and make the line *10'-9'* equal to *C-D*. Through *9'* draw a line parallel to *3'-4'* and make *7'-9'* equal to *7-9*, also *9'-8'* equal to *9-8*. Join *7'-3'* and *8'-4'*. From *3'* and *4'* as centers and with a radius *D-E* draw arcs *E'* and *F*. From *7'* and *8'* as centers and radius *6-7* in the plan, draw arcs crossing those already drawn in *E'* and *F*. Join *E'* and *7'* and *F* and *8'*. From *3'* and *4'* as centers and radius *A-D* draw arcs as shown in *A'* and *B'*. From *E'* and *F* as centers and with a radius *7'-3'* cut the arcs already drawn in *A'* and *B'*. Join *E'-A'* and *F-B'*. From *A'* and *B'* as centers and radius *3-10*, draw arcs as shown in *H* and *J*. From *E'* and *F* as centers and radius *7-9*, draw arcs as shown in *K* and *M*. From *A'* and *B'* as centers and radius *3'-9'* in the development, draw arcs cutting those already drawn in *K* and *M*. Join *K-E'* and *F-M*. With *K* and *M* as centers and radius *9'-10'* cut the arcs already drawn in *H* and *J*. Join *K-H* and *H-A'*, also *M-J* and *B'-J* to complete the figure.

The lines *H-K* and *M-J* represent butts. If a lap joint is required those lines would represent the centers of holes. Bend on the lines *A'-E'*, *3'-7'*, *4'-8'* and *B'-F*.

Now if this figure had to be made of heavy material, it would perhaps be made in four separate plates, either flanged at the corners or else joined with angles; in either case the flanges would not be square.

To find the bevel required at the corners, draw the line *Q* at any convenient place at right angles to the line *8'-4'* meeting the line *X'-Y'* in *3'* and the line *4'-B'* in *R*. Now measure from point *4* in the plan along the line *4-1* the distance *4'-R* and mark it as shown in *R'*. From *R'* as center and with radius *R-S* draw an arc; then from *3* as center and radius *3'-S* draw an arc cutting that already drawn in *T*. Join *R'-T* and *3-T*; then the bevel of the angles or flanges will be shown as *3-T-R'*.

British Civil Engineers Discuss Boiler Problems

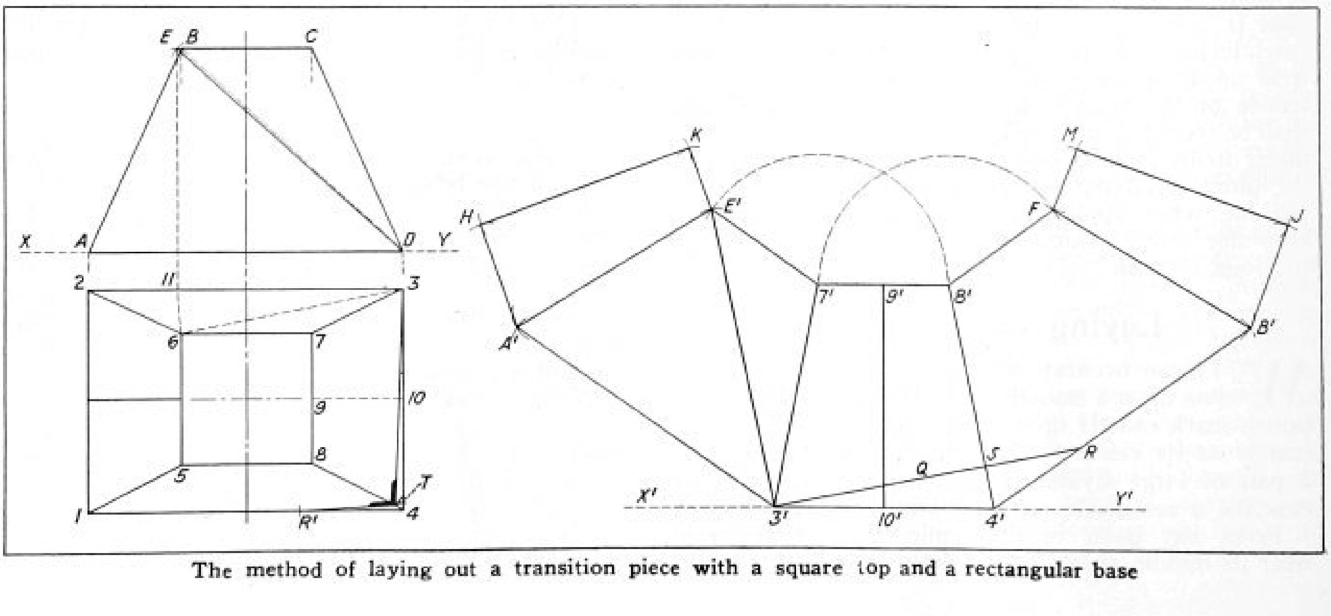
By G. P. Blackall

AN engineering conference was recently held in London in connection with the centenary celebration of the Institution of Civil Engineers. It was attended by a large number of delegates from all parts of the world. The conference was divided into five sections, one of which dealt with boiler practice. Interesting addresses were delivered before this section by R. G. C. Batson and W. H. Patchell.

Discussing the properties of materials for use at high temperatures, with special reference to boilers for superheated steam, Mr. Batson concluded that it was possible to obtain materials which would meet the requirements for increased steam pressures and temperatures, but as they involved the use of costly alloys their application in boiler construction was at present limited. He said that there was therefore great need for further research to obtain a material suitable for the needs of the power production and boiler making industries.

Mr. Patchell declared that the modern trend in boiler practice appeared to be towards the development of still larger steam-generating units, which would utilize the space occupied to better advantage and towards still higher steam pressures to meet the more exacting demands of the steam cycles now becoming fashionable, sometimes at a gain in thermal efficiency which is often more in evidence than increased financial or commercial efficiency.

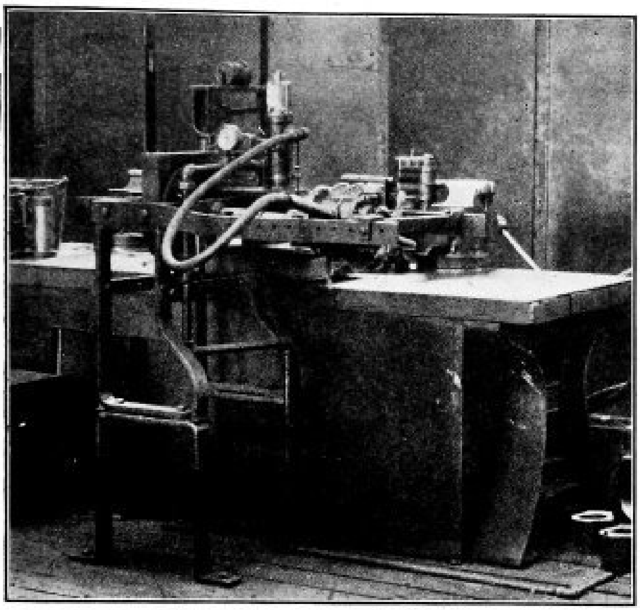
The data available on over 50 plants working at steam pressures of 500 pounds or more indicate that the use of higher pressures has not brought with it the extensive application anticipated.



The method of laying out a transition piece with a square top and a rectangular base

Testing Air Operated Motors in the Shop

THE illustration shows a rack for testing pneumatic drills and reamers or portable air operated motors of similar design in the shops of the Central Railroad of New Jersey at Elizabethport, N. J. The rack can be adjusted to take any size of motor used



Test rack for testing pneumatic drills and reamers

in the shop. It consists essentially of a Prony brake, a pressure gage, platform scales, and a meter for measuring the air consumption in cubic feet per minute. To test a motor, the spindle is fitted to the Prony brake and the hose is attached to a connection on the rack which leads to the shop air line. A small platform scale for ascertaining the resistance on the Prony brake arm sets on the bench.

The brake horsepower of the motor is calculated from the regular formula for the Prony brake; namely,

$$\text{B.h.p.} = \frac{2\pi\, l_n\, (W - W_o)}{33{,}000}$$

in which

l = the length of the brake arm
n = the number of r.p.m.
W = the load on the scales, in lb.
W_o = the weight of the pedestal and brake arm

All of the known quantities, such as the length of the brake arm and the weight of the arm and pedestal on the scale, were determined at the time the rack was installed. The formula, in which the known quantities have been substituted, is painted in small letters on the rack, for the guidance of the operator.

This rack has proved to be valuable in checking the power, not only of new motors, but of motors that have undergone repairs. All new motors received at the shop are tested on this rack and the results of the test are checked against the specifications by which they were purchased. Each motor coming out of the toolroom after repairs have been made is also tested on this rack to make sure that it develops the required amount of power.

Previous to the installation of this rack, it was a frequent occurrence to have the men complain that the motors they were using did not have sufficient power. However, since the installation of this rack, more care has been taken by the workmen to see that each motor is properly used.

New Welding Process Test

FURTHER developments of the electronic tornado which was discovered in the research laboratories of the Lincoln Electric Company, Cleveland, Ohio, about a year ago may modify all ideas as to the ductility, strength and cost of welds made by electric arc welding. This new process, based upon an electric phenomenon, which was originally considered as of only scientific interest, has been further developed so that it may become commercially practical.

Not only are the welds produced by this new process more uniform in structure and ductility but the cost of welding may be reduced. The cost of welding ½-inch plates, including operator's time, electric current and carbon electrode, is estimated not to exceed three cents per running foot.

It is not thought that this new process, will affect the manual arc process, but where equipment can be automatically welded, a reduction in cost is expected.

Heretofore metal deposited by electric arc welding has developed the same characteristics as cast steel, but tests show that the electronic tornado process will produce better physical characteristics in the weld metal than in the joined plates.

The illustrations show welds on ½-inch plate. The weld was sawed from the plate and the resultant bar was twisted 1,080 degrees showing no indication of

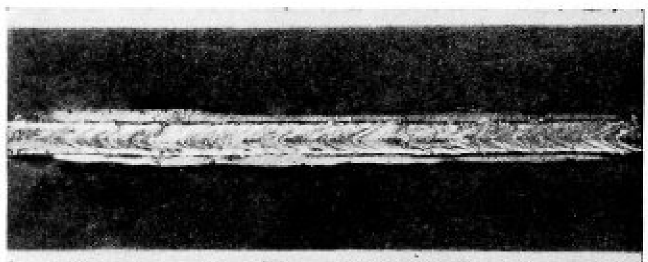


Fig. 1.—Weld made by electronic tornado process on ½ inch plate

failure. In other tests, bars of weld metal were twisted cold and tied into knots; heavy plates were bent and twisted, all without sign of fracture. Tensile tests proved the welds to be satisfactory.

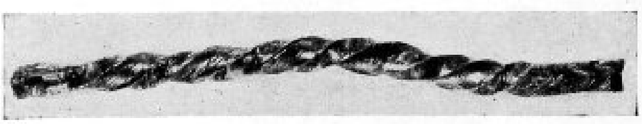


Fig. 2.—Welding material twisted through 1,080 degrees

The new process gives a smooth finish to the weld metal due in part to the higher speed of travel of the welding heads. Microscopic examination shows that the weld metal deposited by the new process has a fine and uniform grain structure, whereas the metallic arc weld produces an irregular and coarse structure.

To come directly to the application of the electronic tornado to a commercial machine, Fig 3 shows the machine at rest. It will be seen that there are two of the new type welding heads with their electrode holders

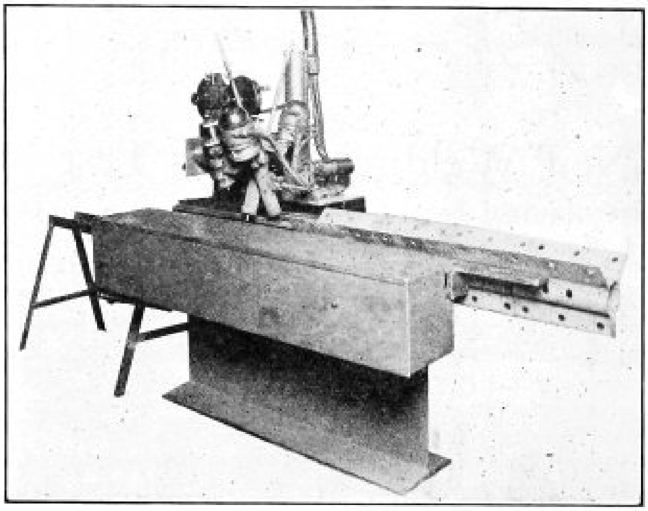


Fig. 3.—The complete electronic tornado welding machine

crossing each other at a sharp angle. This construction is of interest, for with an uncontrolled arc it would be impossible to operate two flames in such close proximity. One would continually blow the other out. With the electronic tornado head, however, they work smoothly and without conflict.

The welder in operation is shown in Fig 4 where the operation of the crossing arcs is clearly visible. This new automatic electronic tornado welder is placing welds at the rate of better than 40 feet an hour for each head, which is an exceptionally high velocity. No filler rod is used, the arc fuses the various plates inseparably together.

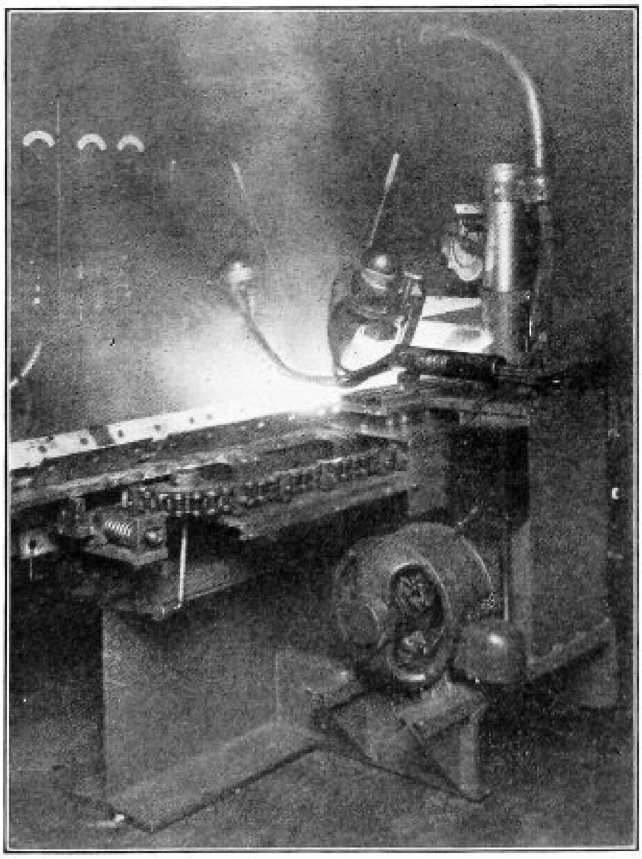
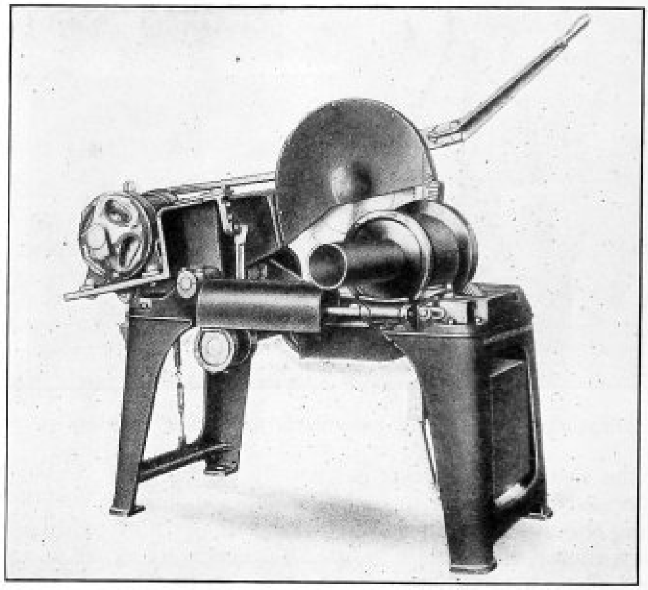


Fig. 4.—The electronic tornado automatic welder in operation. The guards over the chain have been removed to show the method of carrying material under the arc

High Speed Metal Cut-off Saw

THE Hunter Saw and Machine Company, Pittsburgh, Pa., has recently announced the manufacture of its No. 1-B high-speed metal cut-off saw equipped with a tube revolving device. This machine is fitted with a circular-toothed saw operating at high rotative speed, designed to cut cold tubes up to 7½ inches outside diameter, as well as small round and square solid stock and small structural shapes.

Tubes are clamped in an adjustable chuck which automatically revolves when the saw is pulled down, and in so doing feeds the tube into the saw, presenting the least section of metal to the saw, which results in a small amount of burr. The chuck automatically stops when the saw is raised from the work. The chuck revolves at an approximate speed of 20 revolutions per minute



Hunter No. 1-B cut-off saw with tube-revolving device

and is driven through reduction gearing from the main motor. The machine is also equipped with a quick-acting eccentric vise to clamp work of small section. This vise may be used without removing the revolving chuck.

Saw Blade Mounting

The 10 horsepower motor and saw blades are mounted on opposite ends of a tilting frame. The saw is driven by an endless belt, an idler pulley mounted in the frame being used to give maximum belt contact. The saw arbor and the idler pulley are mounted on double-row deep-groove ball bearings, which are enclosed in oil-tight dust-proof housings. The belt and saw blade are protected by steel guards to conform with safety specifications. The belt guard may be quickly removed for belt renewals without dismantling other parts of the machine. A pan is attached to the under side of the table, enclosing the saw at its lowest point to catch the cuttings; this may be dropped for removal of the cuttings. The motor support is provided with a screw for adjusting the belt tension. The motor end of the tilting frame has a cushioned stop and is connected with a spiral spring to return the frame to the height necessary to clear the work. The saw is fed down through the work by an off-side hand lever attached to the forward end of the tilting frame.

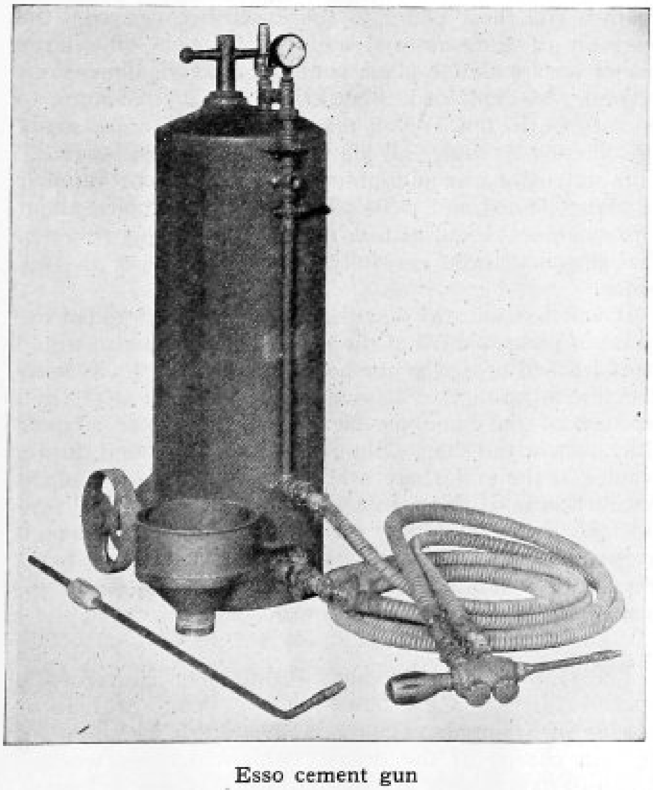
Cement Gun Developed

THE S. Obermayer Company, Chicago, Ill., has developed the new Esso cement gun for the maintenance of furnace linings, boiler settings, and similar refractory surfaces. Among the features of the new gun, as given in the advance statement by the manufacturers, are ability to build up a refractory wall from ½ inch to 1½ inches, mechanically mix its own cement, operate on air pressures as low as 30 pounds, prevent waste of cement, be operated by one man, and to spray 20 gallons with only one filling.

Each gun is fed by a 20-gallon brazed tank equipped with an adjustable reducing valve suitable for the air pressure with which the gun is to be used. Two interchangeable nozzles, one short nozzle for places easily reached and a long one for more difficult locations, are also standard equipment. Air and cement reach the nozzles through two 25-foot lengths of hose attached to the storage tank, and both air and cement are regulated at the gun head by two valves. By varying the amount of air and material the density of the spray is easily controlled. This enables the operator to spray evenly and build up a compact, homogeneous patch or covering despite differing conditions.

When through spraying the operator has only to close the cement valve, leaving the air on, and let the air clean the nozzle ready for the next time. Then the cement left in the hose can be forced back into the tank by releasing the pressure on the tank with the bleeder valve, and by-passing the air pressure into the cement hose by placing a finger over the nozzle. The cement valve on the gun is opened again for this operation and when the hose has been cleared, the valve at the cement outlet on the tank can be closed to retain the cement in the storage chamber.

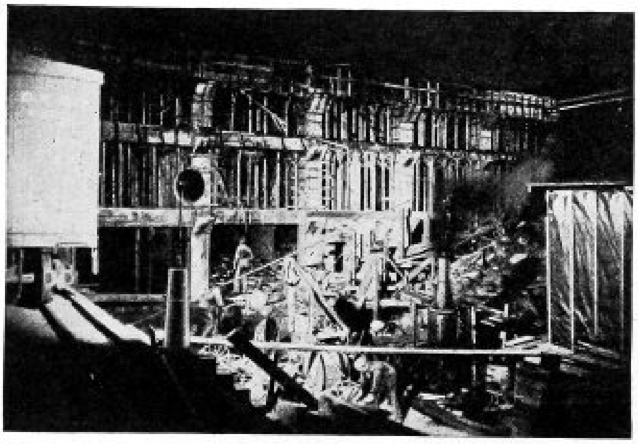
A large funnel with a removable 16 mesh screen is used for charging the gun. It is screwed into the tank at the top in place of the plug which is ordinarily found there. This plug is attached to a long pipe which extends down into the tank, so that the amount of water or cement in the tank can be easily measured. Two strong arms project out sidewise from the top plug, and these serve as handles when the gun is to be moved. To facilitate the moving, two small wheels are attached to the base of the tank in such a way that they carry the tank when it is tilted, but the wheels are out of the way and the tank sets firmly on its base, when placed in an upright position.



Esso cement gun

A Portable Lighting Unit

A PORTABLE acetylene flare light has been added to the line of the Oxweld Acetylene Company, 30 East 42nd Street, New York City. This flare light is extremely powerful and many outstanding advantages are claimed for it as a portable lighting unit.



An application of the acetylene floodlight

The fuel used is acetylene, produced from Carbic. This material is in the form of cakes of uniform size and cylindrical shape. Several cakes of Carbic, enough to operate the flare continuously for 12 hours, can be placed in the light at one charging. If the use of the light is discontinued before the entire charge is used, the portion remaining can be left in the holder, or, being dry, solid and clean, can be slipped back into the drum for later use. The operating cost of this light per hour of service is low.

An automatic feed allows water to come into contact with the lowest cake of Carbic until sufficient acetylene is generated to drive the water out of the gas bell to a level below the bottom of the cake. This process is continually repeated during the operation of the light and gas generation is uniformly and safely maintained at a pressure of less than 1 pound per square inch. The Carbic never rests on a pad of sludge since the residue settles to the bottom of the water.

In case the light is accidentally upset, the water runs out of the container and gas generation stops immediately.

Carbic flare lights are manufactured by the American Carbolite Company, Inc., and the Oxweld Acetylene Company, New York City is the sole distributing agent. Carbic, the fuel used, is marketed exclusively through Union Carbide Sales Company, New York City. Both products are handled by jobbers in principal cities.

Shearing Plates at the Steel Mill*

By E. N. Treat

MY employer had instructed me to see that our plates at the steel mill were sheared to size. His idea of shearing to size was rather critical, for although we at the shop were not in the habit of shearing to the exact size, my employer was under the impression that our material should be sheared to at least within 1/8 inch of the measurement ordered.

At the mill I became very much aware that our order was not the only order in the mill. Although our order was considered by us as large, and consisted of hundreds of pieces, it was but a small part of the daily output of the mill. In order to convince me that it was not practicable for the mill to attempt to shear to our exact size as the plates came from the cooling beds, the engineer of tests requested that I accompany him to the shears and see the conditions under which the shearing was done.

At a safe distance from the shears and roller bed we watched the plate coming direct from the rolls at the distant end of the several acres of goose neck rollers upon which the plate travelled to the shears. Mechanical arms turned this unsheared plate in the course of its travel. Heavy arms lifted the plate and gently turned it over so that the mill inspector might examine both sides of the plate even before it was laid out for shearing.

When each plate approached a given point the layer-out, the soles of his shoes protected by thick wooden clogs strapped to his shoes, stepped upon the hot plate and, with the aid of a large steel square, laid out the dimensions from which the smaller sizes would be sheared. This man worked rapidly and fairly accurately, I was told. With soapstone he marked hundreds of small circles or outlined one or more plates in accordance with the order. His work must be fairly accurate and though the plates were very hot he must continue laying out as the plates came from the rolls or the routine of the mill would suffer.

"Do you believe you could mark the dimensions of your order to exact size?" the engineer of tests asked. Truthfully I admitted I did not think I could do that. The rapidity with which the plates were moved along the rollers toward the shears, the width of a soapstone mark, and the swiftness under which shearing was done would prove difficult I agreed. A slight toleration under or over the desired size was the usual procedure I was told, but it was more desirable that the size should be greater rather than less. This excess dimension might prove of benefit in case a second shearing was desired, or if the pattern were shifted it did not eliminate the plate from that order.

Having seen the conditions under which shearing was done at the mill, we turned to go, when my attention was attracted to a man who was apparently dancing on the smooth surface of a large plate. Smoke came from his feet, and in a moment the unfortunate man was trying desperately to stand. His neat fitting trousers were now burning, and though it had been but a few seconds since I had first noticed him, he was badly burned when the layerout reached his side and drew him from the hot plate. He happened to be the representative of a manufacturer. His hands and feet were blistered and it was evident that he required medical attention. This was forthcoming, for he was immediately placed in the ambulance maintained by the company, and within a few minutes he was placed in the company's first aid rooms where a nurse and doctor did their part to relieve his injuries. The man, I was told, had not previously been at the mill, and he had taken it upon himself to examine plates while hot from the rolls. Not having taken advantage of the company's clogs, he stepped upon the hot plate, and a moment later his rubber heels were melted and he could not leave his position.

I was now fully convinced that the cooling bed was not the most desirable place to layout to exact sizes. In fact to have attempted to shear but a few of the plates to the exact size would have caused a stoppage in the routine of that part of the mill. This would have caused other parts of the mill, working in conjunction with the shears, to restrict their regular work and the loss would be excessive.

The men working about the shears apparently must be familiar with their duties. The ease with which they handled large or small plates while themselves standing between the rollers, and apparently in danger of accident was evident. As plates were laid out they were rolled to the shears where these men held them in place as the excess material was sheared. The excess material was at once placed in several charging boxes arranged upon flat cars on a narrow gage railway, and when the boxes were filled were hauled to the open hearth furnace and recharged.

When the shearing of a plate was completed, it was rolled to the weighing section. Having been weighed, it was marked with white paint and taken to the loading bank. An inspector in the employ of the company examined each plate after it had been weighed and before going to the loading bank. In the event he found one that did not conform to the requirements it was rejected at once.

To me it was evident that the mill could ill afford to attempt to shear plates where a great degree of tolerance was denied. As our material must be very close to size it was evident we must accept plates full to dimensions and work them down to the desired size. "We can furnish you these plates to the exact size desired," the engineer of tests assured me. "By means of a large planer we are able to plane your plates to the dimensions desired," he explained. "Naturally, it will cost more to do this work, but as you may observe there are many customers who desire all plate edges planed or beveled." This statement was undoubtedly true for a great number of plates planed and to be planed were assembled about this machine. Examination of the plate edges revealed that they had been carefully planed and were in good order.

It was but natural that there should be an added expense to plates planed at the mill as there likewise would be if worked to size in our boiler shop. There was however the advantage of having this work done at the mill because of the handling facilities being better adapted than ours at the shop. Should a defect be found during planing at the mill, there would be another plate made at once whereas, if the defect were found at our shop, considerable delay would be experienced through correspondence alone, and where time was a consideration, the extra expenditure at the mill over what we could finish the plates for, would be of little consideration.

* One of a series of short articles describing the various processes in manufacturing boiler plate at the steel mills.

The Linde Air Products Company has recently opened district sales office at 48 West McLemore avenue in Memphis, Tenn. H. N. Smith will be manager in charge of the district which includes western Tennessee, northern Mississippi and eastern Arkansas.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by C. J. Zusy

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.*

Locomotive Firebox Layout

Q.—Please show me how to lay out a firebox like the enclosed blue print. Please make drawing large enough so that the layout of the firebox wrapper sheet, stay bolt holes and tube holes in the flue sheet will be very clear.—J. F. D.

A.—To properly explain the procedure followed in laying out the firebox and developing all of the sheets, would require a good deal more space than is allotted to this department.

I would suggest that you obtain a copy of the book entitled "Laying Out for Boiler Makers," which thoroughly explains the laying out of the firebox and the development of the various sheets.

Heating Surface and Rating of Boilers

Q.—Having subscribed to The Boiler Maker for several years, I would like you to answer a question for me. Will you please give me a method of calculating the heating surface of a boiler as well as a definition of boiler horsepower and methods of determining the commercial rating of boilers. H. S.

A.—(1) The heating surface of a boiler is that part which is exposed to the products of combustion on one side and available for the evaporation of water on the other and is always expressed in square feet.

In locomotive type boilers the heating surface is usually divided into firebox heating surface and tube heating surface.

The firebox heating surface is the outside of the firebox sheets. The heating surface of the combustion chamber and arch tubes is usually included in the firebox heating surface. It is the area calculated from measurements of the firebox sheets, above the level of the grates, less the total gas area of the tubes, the area of firedoor openings and the area of air inlets through the firebox sheets.

The heating surface of the fire tubes is the outside area of the tubes between tube sheets and is found by multiplying the outside circumference of the tube, in feet, by the distance between the tube sheets, in feet, and by the number of tubes, which result is the heating surface of the tubes in square feet.

(2) One horsepower is the equivalent of 33,000 foot-pounds of work done in one minute. The term boiler horsepower as applied to boilers is not a measure of power but rather a measure of evaporation.

One boiler horsepower is equal to an evaporation of 34.5 pounds of water per hour from and at 212 degrees Fahrenheit.

At the present time manufacturers of stationary boilers generally consider 10 square feet of heating surface sufficient to evaporate 34.5 pounds of water per hour from and at 212 degrees F. A boiler having 1,000 square feet of heating surface would be considered a 100 horsepower boiler.

The maximum capacity of a boiler can only be determined by a boiler test and the boiler horsepower rating as given above which is generally adopted by stationary boiler manufacturers is simply a matter of convenience in rating boilers.

Design of Girder Stays

Q.—Explain how you would find the depth and thickness required for girder bars which stay the tops of combustion chambers in locomotive and marine boilers. I have been endeavoring to solve this question but have no method of checking my conclusions, so I turn to your department for help.—C. H. W.

A.—Paragraph P-230 (a) of Section I, power boilers American Society of Mechanical Engineers Boiler Code gives a formula for calculating crown bars and girder stays as follows:

P-230. Crown Bars and Girder Stays. (a) Crown bars and girder stays for tops of combustion chambers and back connections, or wherever used, shall be proportioned to conform to the following formula:

$$P = \frac{C \times d^2 \times t}{(W-p) \times D_1 \times W}$$

where

W = extreme distance between supports, inches

P = maximum allowable working pressure, pounds per square inch

p = pitch of supporting bolts, inches

D_1 = distance between girders from center to center, inches

d = depth of girder, inches

t = thickness of girder, inches

C = 7,000 when girder is fitted with one supporting bolt

C = 10,000 when the girder is fitted with two or three supporting bolts

C = 11,000 when the girder is fitted with four or five supporting bolts

C = 11,500 when the girder is fitted with six or seven supporting bolts

C = 12,000 when the girder is fitted with eight or more supporting bolts.

Example: Given W = 34 inches; p = 7.5 inches; D_1 = 7.75 inches; d = 7.5 inches; t = 2 inches, 3 stays per girder; C = 10,000; then substituting in formula:

$$P = \frac{10{,}000 \times 7.5 \times 7.5 \times 2}{(34-7.5) \times 7.75 \times 34} = 161.1 \text{ pounds per square inch.}$$

Sling stays if used between crown bars and boiler shell or wrapper sheet, shall be proportioned so as to carry the entire load without considering the strength of the crown bars.

The formula as written above gives the maximum allowable working pressure. To find the depth of crown bar the formula becomes:

$$d = \sqrt{\frac{P \times (W - p) \times D_1 \times W}{c \times t}}$$

and to find the thickness of the girder

$$t = \frac{P \times (W - p) \times D_1 \times W}{C \times d^2}$$

Allowance of Flange Lap

Q.—Will you please explain the proper method of allowing flange lap on the tapered course of a locomotive boiler for two rows of rivets. Are the holes put in before or after bending? How is the flange or kink usually put in? F. C.

A.—I know of no rule covering the allowance that should be made on the length of the plate at the lap of a tapered course. Some boiler makers make allowance while others do not. The amount of allowance is largely

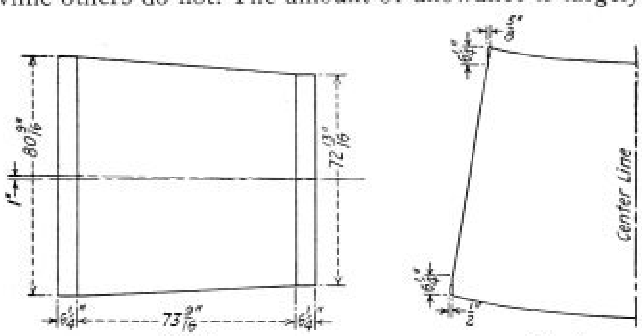


Fig. 1 Fig. 2

Layout of plate showing flange lap

a matter of opinion based on the experience of the boiler maker.

For a tapered course where the taper is not too pronounced as shown in Fig. 1, the allowance as shown on one half plate development, Fig. 2, has been found satisfactory.

The holes for the lap seams as well as all the other holes are punched or drilled in the sheet before rolling. The holes are necessarily made small to permit alining the holes properly after assembling by reaming the holes to the proper size.

The kink or flange is usually made by sledging after the sheet is rolled into the conical shape.

External Fittings for Marine Boilers

Q.—What materials may be used for external fittings of marine boilers?

A.—The United States Steamboat Inspection Service approves cast steel fittings of any size or character and for any pressure and temperature for steam pipe and feed pipe connections and for valves, cocks and all appliances subject to pressure when made by regular processes and by manufacturers who stamp such fittings with their identifying stamp and guarantee the castings to possess the following physical characteristics:

Tensile strength, minimum, 50,000; maximum, 70,000 pounds per square inch. Elastic limit, not less than 45 percent of tensile strength; elongation in 2 inches, minimum, 25 percent. Coupons from each heat shall be tested or furnished to the local inspectors for test when required. All steel castings shall be thoroughly annealed.

Cast iron, semi-steel or ferro-steel having a tensile strength of not less than 22,000 pounds per square inch may be used in the construction of valves and fittings for pressures not exceeding 300 pounds per square inch or a temperature of 450 degrees Fahrenheit. Such fittings, if 3 inches in diameter or over, must be stamped with the identifying stamp of the manufacturer.

Malleable iron, possessing a tensile strength of not less than 30,000 pounds per square inch, may be used in the construction of valves and fittings up to and including 6 inches in diameter and for pressures not exceeding 300 pounds per square inch and a temperature not exceeding 450 degrees Fahrenheit. Such valves and fittings, if 3 inches diameter or over, shall be extra heavy, the fittings beaded or banded and the valves and fittings stamped by the manufacturer.

Hard brass, bronze or other composition, of which 95 percent is copper, tin and zinc, having a tensile strength of not less than 30,000 pounds per square inch may be used for valves and fittings up to and including 12 inches in diameter and for pressures not exceeding 300 pounds per square inch and for temperatures not exceeding 470 degrees Fahrenheit. If the manufacturer stamps such fittings with the temperature they are guaranteed to stand without disintegration, they may be used for temperatures not exceeding 550 degrees Fahrenheit. This rule also applies to any composition meeting the physical requirements and stamped in accordance therewith. No material shall be used for pressures exceeding 300 pounds per square inch or temperatures exceeding 550 degrees Fahrenheit other than steel or a composition whose tensile strength exceeds 50,000 pounds per square inch with an elongation of 10 percent in 2 inches and such fittings must be stamped as above.

Embrittlement of Boiler Plate

THE University of Illinois has published Bulletin No. 177, entitled "Embrittlement of Boiler Plate", by Samuel W. Parr, and Frederick G. Straub. In this work is assembled data obtained from tests, power plants and from the laboratory and the results obtained are discussed. Further investigations have been made in the causes of embrittlement in steam boilers and the preventions of its occurrence have been set forth in this report.

STRUCTURAL SHAPES—The Bethlehem Steel Company, Bethlehem, Pa., has published a new hand book on steel joists and stanchions for plant construction, which is known as Catalog S-28. The joists described in this hand book are lighter than the beams of the same depths. Because of their weight the Bethlehem joists are adapted for use where the floor or roof load is such that a heavy beam is not required.

ARC WELDING EQUIPMENT.—The Lincoln Electric Company, Cleveland, Ohio, has recently issued the Engineering Bulletin No. 206 in which the variable voltage, single operator type and the constant potential, multiple operator type welders are compared. The discussion covers the first cost of the equipment plus installation cost, the problem of interference between operators on multiple operator sets and the economy of power of variable voltage equipment.

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

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

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Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.

Vice-Chairman—William H. Furman, Albany, N. Y.

Statistician—L. C. Peal, Nashville, Tenn.

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

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Treasurer—George R. Boyce, A. M. Castle & Company, Chicago, Ill.

Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

American Boiler Manufacturers Associtan. .rCbiolce

President—H. E. Aldrich, Wickes Boiler Company, Saginaw, Mich.

Vice President—Charles E. Tudor, Tudor Boiler Company, Cincinnati, O.

Secretary-Treasurer—A. C. Baker, 801 Rockefeller Building, Cleveland, Ohio.

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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

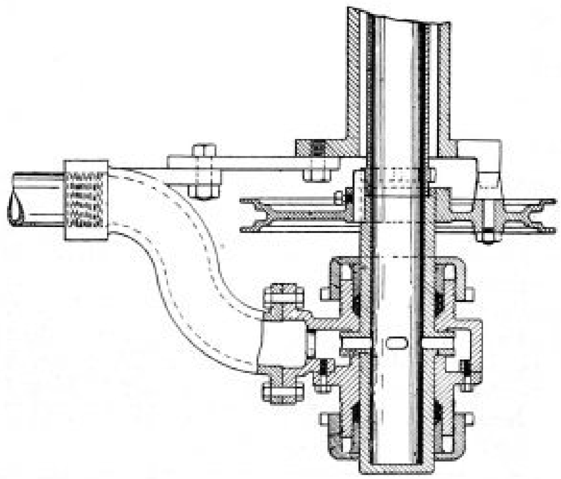
Compiled by
DWIGHT B. GALT, Patent Attorney,

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.

1,649,001. EVERETT P. STROUP AND WILLIAM A. COOK, OF MARION, INDIANA, ASSIGNORS TO MARION MACHINE, FOUNDRY & SUPPLY COMPANY, OF MARION, INDIANA, A CORPORATION. SOOT BLOWER.

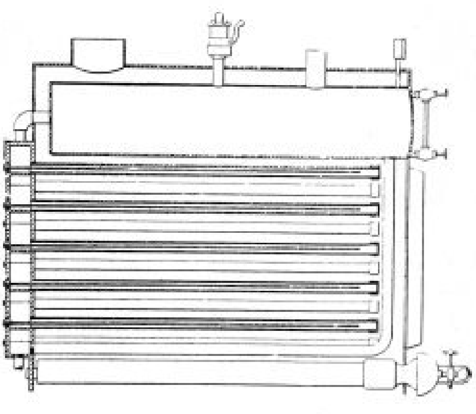
Claim.—1. A soot blower mechanism including the combination of a wall box head plate in a steam boiler, a rotatable blow tube mounted therein and extending slightly beyond said head-plate, a blow-tube extension removably connected with the outer end of said blow tube and extending outwardly therefrom and in alinement therewith, so that the blow tube and said extension are rotatable as a unit, said extension tube being closed at its outer end and intermediate its ends having a peripheral series of inlet ports and an outwardly radially extending shoulder at each side of the series



of inlet ports, a stationary valve controlled steam conduit, a steam head mounted on and carried by said steam conduit and surrounding the blow tube extension and spaced from the series of ports therein so as to furnish a steam chamber surrounding the ports, said steam head being formed of separable end portions secured together with one of said end portions surrounding the blow tube extension at each side of the series of ports and adjacent to the shoulder of the blow tube extension, and packing means surrounding the blow tube extension for providing a steam-tight mounting thereof in said steam head.

1,651,446. FELIX LOUIS DECARIE, OF MONTREAL, QUEBEC, CANADA. BOILER.

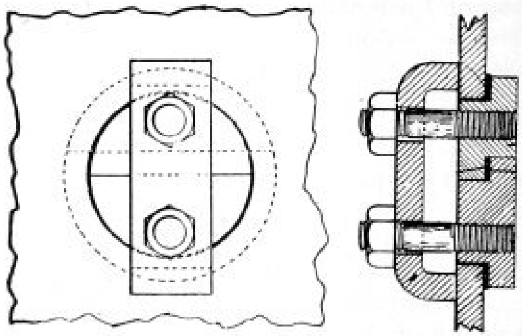
Claim.—In a boiler construction, a body portion, a header at one end of the body portion, tubes extending into the body portion and communicating with the header, said tubes being disposed in staggered relation with respect to each other, removable partitioning members, alternate



vertical and obliquely disposed partitioning walls in said header contacting with the ends of adjacent tubes and with opposite edges of the respective removable partitioning members to form two longitudinal passages through said header, there being an inlet to one of said passages through one end of the header, and an outlet for the other passage at the opposite end of said header.

1,649,720. FRANK MOFFITT, OF MIDDLETOWN, NEW YORK. HANDHOLE PLATE.

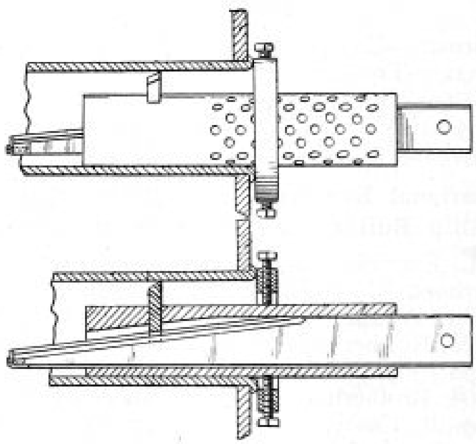
Claim.—1. In a closure for round openings of boiler shells, sectional plates adapted to fit in an opening of the boiler and having projections at their edges which extend beyond the wall of the aperture in the boiler and having overlapping joints at the meeting edges of the said plates, a unitary



gasket fitted between the sectional plates and the inner wall of the boiler shell and between the overlapping edges of the said plates, a stud anchored to each section and adapted to project outwardly beyond the boiler shell, and means engaging the studs for exerting a pull on the said sections for compressing the gasket between the overlapping edges of the said sections and against the inner wall of the boiler shell. Two claims.

1,653,186. FRANK WILLIAM LARC, OF MONCLOVA, MEXICO. BOILER TUBE CUTTING DEVICE.

Claim.—In a cutting tool of the class described, a mandril having a longitudinally extending bore, a pin slidable longitudinally through the bore and having a side edge tapered towards and to one end thereof, said mandril provided with a transversely extending opening, a blade extending

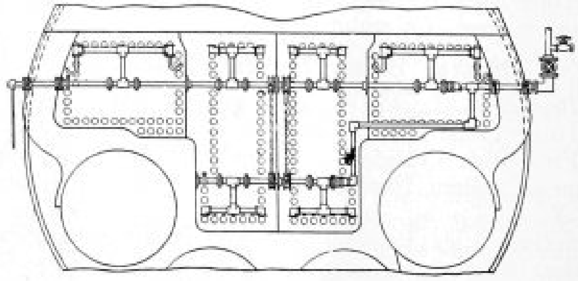


through the opening and having its inner edge cooperating with said side edge, one of said edges being formed with a T-shaped rib and the other edge being formed with a T-shaped slot for the reception of the T-shaped ridge and a reinforcing runner strip fixed to the other edge of the pin to engage with the inner wall of the bore, said runner strip being extended up over said one end of the pin to function as a stop for the blade.

In testimony whereof I affix my signature.

1,653,503. NORMAN EMILE McCLELLAND, OF LONDON, ENGLAND. APPARATUS FOR REMOVING SOOT FROM STEAM BOILERS.

Claim.—In a steam generator having a pluralty of furnaces of which a central furnace is at a lower level than the wing furnaces, an apparatus



for removing soot from the smoke box and fire tubes of the furnaces comprising an upper rotatable jet supply pipe and normally upwardly directed nozzle branches leading therefrom, a lower rotatable jet supply pipe and normally downwardly directed nozzle branches leading therefrom and entirely enclosed within the smokebox, and means for simultaneously rotating the two jet supply pipes opposite directions. Four claims.

The Boiler Maker

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Contents

Locomotive Boiler Construction

A GREAT majority of our readers are interested in some form of locomotive boiler design, construction or maintenance. Since it is difficult to cover all phases of the work in a connected way through the medium of separate articles, it was decided sometime ago to offer a series of practical shop articles on the subject of "Locomotive Boiler Construction." This series, the first instalment of which appears in this issue, was prepared by W. E. Joynes of the American Locomotive Company, author of a former series entitled "Laying Out the Locomotive Boiler," which appeared in THE BOILER MAKER through the year 1925.

Whereas the first articles on the subject were devoted exclusively to the theory and practice of laying out as applied to locomotive boiler work, the present series will cover not only the practical application of these principles on the laying out floor of the shop, but will include details of each operation occurring in the fabrication of the boiler from the plates to the completed unit and the subsequent hydrostatic and steam tests. By covering each special operation that is carried out in the production of the finished boiler, the information, based as it is on the best practice and experience, should be of decided value to readers in every branch of the trade. The work of laying out, rolling, drilling, punching, fitting, assembling, riveting, calking, staybolt application, tube installation and the use of welding equipment and cutting torches will all be discussed. The proper tools for carrying out any given operation, both heavy machinery and hand tools, will be considered, so that a complete picture of the fabrication of a boiler may be obtained.

Primarily such material is of benefit because, with a thorough general understanding of all operations going into the building of a boiler, those men detailed to carry through any particular part of the work can do so with greater facility. Furthermore, in these days of highly specialized groups in a shop, it is of advantage for the members of the various gangs to acquire at least a working knowledge of other operations than their own particular specialty. Gang leaders, shop foremen and even those higher up did not arrive at their present positions of responsibility without a thorough knowledge of boiler construction in general.

Although the articles are based on the construction of new boilers of large size and advanced design, the principles employed, which are the best of their kind, may also be adapted to practically any one of the special repair operations occurring in maintenance work. Many readers will be familiar with a great deal of the work as outlined but, from the suggestions made, they may discover better methods for accomplishing the same results that are new in their experience. It is hoped that a great deal of benefit may be derived from a careful study of these articles. The author will be pleased to answer all questions addressed to THE BOILER MAKER in connection with any details of the work.

Boiler Code Uniformity

ALTHOUGH organized to regulate the construction of boilers and pressure vessels in states and other territorial subdivisions governed by the A. S. M. E. Boiler Construction Code, the National Board of Boiler and Pressure Vessel Inspectors has been instrumental in promoting uniformity in the interpretation of the code itself. An instance of the activity of the board in this connection recently occurred in the State of Indiana.

In the past, the boiler inspection laws of this state specified that sizes of safety valves should be based on the grate area of a boiler. This provision occasioned great confusion among the manufacturers, as the resulting sizes were at wide variance with the sizes required in the A. S. M. E. code. With the exception of this provision, the State of Indiana accepted all other A. S. M. E. requirements as standard.

For some little time the National Board has been cooperating with J. M. Wood, chief boiler inspector of the state, to the end that this situation might be cleared up and that safety valves based on the A. S. M. E. code might be accepted. A solution to the problem was finally developed, which was satisfactory to the state authorities, so that in the future boilers will be accepted for operation in the state when they are equipped with safety valves based on the code standards.

A Modern Power Station

NO BETTER example of the tremendous strides, made during recent times in the field of steam power generation, is in evidence than the New York Edison Company order for steam generating units to drive the 215,000 horsepower, single-unit generator soon to be installed in the East River, New York city, station of the company. The four new steam generators for the station are to be installed by the Combustion Engineering Corporation of New York city. They will be of the water-wall type and, because of the requirements, will be the largest units in the world. Each will have an aggregate heating surface of 45,120 square feet and will produce 550,000 pounds of steam per hour. Studies now being conducted on the design of these steam generators may make a maximum capacity of 800,000 pounds per hour possible.

Thomas E. Murray, senior vice-president of the company, in addressing the New York Electrical Society recently, gave a vivid comparison of this present development in steam power generation with conditions of a few years ago in the following remarks:

"On account of the property available, and for reasons of economy, it is necessary to get from three to five times the capacity per square foot of ground area as that used in other great generating stations.

"A short time ago, some calculations showed most interestingly the extraordinary reduction, through recent inventions and improvements, in the space required for steam generating equipment. Were we using the boilers of 20 years ago at the East River station, standing side by side with an aisle between, they would extend on Fourteenth Street, from the East River almost to the Hudson River. Such, however, is the present relative economy in this respect that the site for this station including boilers, generators, switchboards and all else hardly exceeds an area equivalent to two New York city blocks."

Communications

Length of Sheet in a Cylinder

TO THE EDITOR:

"Three times the plate thickness," briefly mentioned on your page of "Communications" in the June issue of THE BOILER MAKER, was a rather indefinite answer to the "green" hand by his foreman. Now, if there are any "green" hands reading and studying the problems contained in THE BOILER MAKER, probably the method used by the writer in deciding the length of sheet necessary to make up a cylinder of any diameter may be of service to them. Discarding the addition or subtraction of plate thickness, we simply take the neutral diameter; thus, a shell or cylinder, 36 inches inside diameter, with material ½-inch thick will have a neutral diameter of 36½ inches. A shell, or cylinder, 36 inches outside diameter with material ½-inch thick will have a neutral diameter of 35½ inches, that is, to the seam lines. This rule applies to any thickness of material.

Again we have been asked, "Well, how do you get the parts of an inch in your circumference, when you do not know how to figure fractions?" The rule we use and which is to be found in Courtney's *"Boiler Makers' Book,"* works out the problem for a shell, or cylinder, with 36½ inches neutral diameter as follows:

$3.1416 \times 36.5 = 114.6684$ inches, or 114 inches plus a fraction.

By multiplying the remaining fraction by 8, the whole resulting number will be the number of eighths in the fraction, thus,

$0.6684 \times 8 = 5.3472$ or ⅝ of an inch plus a further fraction of an eighth.

If this fraction is multiplied by 4, the result obtained will be in 32nds of an inch.

$0.3472 \times 4 = 1.888$ or nearly 2 or 2/32 of an inch. Now by adding the results, $114 + 5/8 + 2/32 = 114\ 11/16$ inches circumference, which is close enough.

Lorain, Ohio. JOSEPH SMITH.

Welding Progress in Mexico

TO THE EDITOR:

I have just returned from a vacation of several weeks spent in Mexico, and found much of interest there in connection with fusion welding. I learned that welding rods, oxygen and acetylene are manufactured in Mexico, but nearly everything else is imported.

Nearly every large company has at least one arc welder and there is some gas welding. Managers and engineers, for the most part Americans who have lived in Mexico for ten to twenty years, are keenly interested in extending the use of welding in their shops. For some reason, which I was unable to determine, they refused to enthuse over any process except metallic arc welding. For the most part, the men I met were directing very large enterprises. They possessed all the intelligence and business ability that men must have in similar positions in this country. They all directed their efforts toward impressing me that Mexican metal-making and using industries are not in such great need of welding equipment and supplies as they are of trained welding engineers. Few Americans have gone to Mexico to live during the last fifteen years and so Mexican management had its American technical training before welding became so highly developed and universally practiced.

Mexican industry hears almost daily of the results obtained by welding in the United States and has no prejudice against purchasing welded articles, but almost completely lacks the trained men to even start to obtain similar results in Mexico. Men are wanted who understand what can be successfully arc welded and how, who know procedure control, who know something about redesign for welding, in short welding engineers. To such men, Mexican industry will pay higher salaries than apply in the United States.

I was repeatedly approached by managers asking if I knew of competent welding engineers between the ages of 28 and 35 years who might be induced to go to Mexico. Men over 35 years old going to Mexico to earn their living probably should provide their own capital, but for the younger man who is capable, who has the ability to keep sober and work hard, there appear to be many opportunities to earn more and live better at a lower cost than in the United States.

The application of welding in Mexico has not progressed and probably never will to the point it has reached here. I have in mind particularly what we call "production welding." Some such welding is done in Mexico, and more will be, but the country will never in this generation become a nation of manufacturers. The minerals in the earth and the products of the soil, together with providing the men who mine and farm with part of their facilities and requirements, are the sources of Mexican income. Welding, therefore, is more a matter of repair and salvage with only a small amount of construction work.

Opportunity for the welding engineer lies among the railroad shops, the tramways, the steel works and foundries, the oil refineries, the mines and smelters, etc. There are some enormous enterprises of this kind in Mexico with invested capital as high as a hundred million dollars per company. These companies are aggressively in the market for American welding talent, not of the consulting professional sort but of the man who goes to Mexico in their employ and in the beginning possibly devotes only a few hours a day to welding and the rest of the time to related engineering work. If they succeed in purchasing enough of such talent they will then look to the United States for much of the required welding equipment and supplies.

Chicago, Ill. J. B. Greene,
President,
Fusion Welding Corporation.

Mass Production of Locomotive Firebox Copper-Stud Stays

To the Editor:

On most of the British railroads it is the general practice to use the ordinary type of stays for staying the firebox sides to the casing plates. These are either made of soft mild steel or copper, but the majority of the railways prefer to use copper stays and fireboxes, mainly because copper boxes give better economical results and have a longer life than the steel ones. Another point in favor of copper boxes is of course that even when scrapped the metal fetches a good price.

Copper stays are preferred to steel ones because they are more flexible and therefore are not so liable to break due to the expansion and contraction of the firebox.

The object of using the ordinary type of stay instead of the more complicated ones as used in the United States, is that they are cheap to manufacture. This can readily be understood when I say that to manufacture 100 copper stays in an up-to-date British railway machine shop costs approximately 50 cents; this of course, does not include the cost of the copper.

We have little trouble in detecting broken stays of this type, so that hollow stays, etc., do not become necessary. All railway locomotive boilers in this country are regularly examined by inspectors who are experts and specialists at the business and they can detect by sounding which stays are broken. It is very seldom that a mistake is made in detecting a broken stay by this method, indeed it is a rare occurrence to have a boiler accident due to this cause on a British railway.

Manufacturing Copper Stays

A word or two on the method now adopted in the manufacture of these stays, in one of the most up-to-date railway shops in this country, may be of interest to the readers of The Boiler Maker.

The copper which is practically the same diameter as the finished stay is supplied to a No. 4 Herbert capstan lathe in bar form, varying in length from 8 feet to 12 feet. The bar is drawn up to a stop on the turret, straightened and center drilled; the turret is brought round to the fixed center and the stay is turned. The center portion is also recessed to the diameter of the bottom of the thread, stops being used for depth and distance. The cut is fed by handwheel using the tool in the cross slide. Rough screwing is the next operation which is done by a vee tool in the slide-tool box, a stop being used again for depth. Two cuts will see the thread roughed out, the leading screw of the machine being used to keep the thread in pitch. The fixed center is now withdrawn and the threads finished by Herbert die-heads. One die-head is used to finish and size the front end of the stay and a second one, set 0.01 inch larger, to finish and size the back thread of the stay. Two die-heads are always used to avoid waste of time in changing the size for each end of the stay, unless of course parallel stays are being made.

The final operation has now to be carried out, namely, the stay is cut off to length by a parting tool held in the back end of the cross slide and one stay is completed, guaranteed turned to gage, and threads exactly in pitch, which is very important.

When describing the sequence of operations on paper it does not appear to be a very quick method of production but the average time taken to complete one stay is only 1¾ minutes, so that one can readily see that a good few dozen stays can be produced in a day and at a very cheap rate. It should be understood that apprentices operate these machines in the course of their workshop training and become very proficient after a short time.

Streatham, London, England. P. G. Tamkin.

Automatic Arc Welding.—The new electronic-tornado process of fusion welding, developed by the Lincoln Electric Company, Cleveland, Ohio, has been made the subject of a complete illustrated bulletin issued by this company. The text discusses the characteristics of the metal structure of welds made by the new process, the operation of the equipment and applications of the automatic welding machines.

Locomotive Boiler Construction

General outline of shop equipment and arrangement—Material requirements—Layout of a cylindrical course

By W. E. Joynes

A SHOP for manufacturing any considerable number of locomotive boilers should be a large and modern building, constructed with three bays. In this type building, the center bay forms a monitor which provides head room for the heavy traveling cranes, used in handling the assembled boilers.

The necessary machinery and other equipment for the complete fabrication of a boiler should be at hand or near this shop.

The pumps for generating the hydraulic pressure, used to operate the bull riveters and flanging presses, should be located in the boiler shop. The riveting of an assembled boiler, hoisted vertically by an overhead crane, requires the frame design of such riveters to be very tall, hence, a floor pit or a tower, adding height to the shop, is necessary, for the installation of the riveters. In order not to interfere with the operation of the main shop traveling cranes, it is obvious that a good location for the riveters would be at the end of the shop. The water pumps and the accumulators, required for controlling the hydraulic pressure, are conveniently located near the tower space, which location shortens the piping to the riveters and flanging presses.

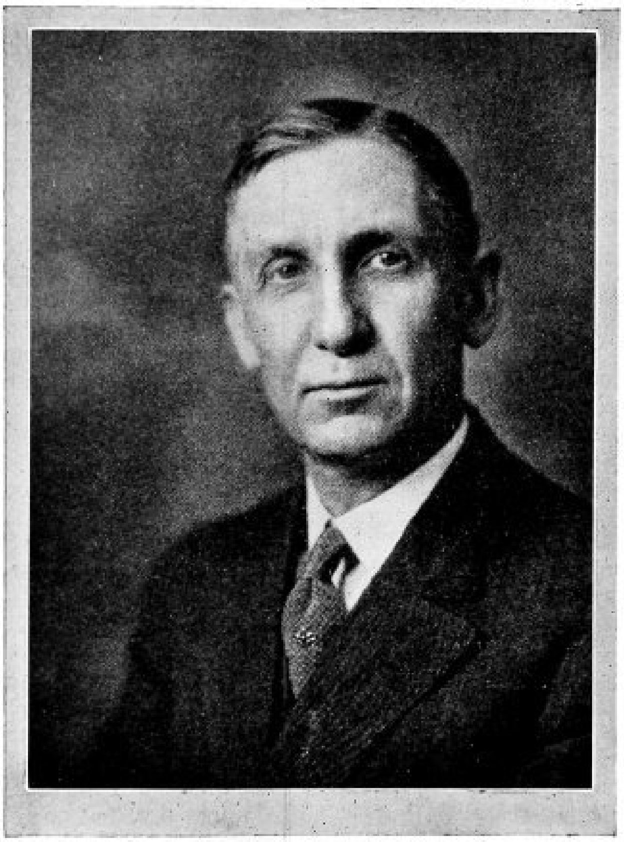
The electric and pneumatic power, required for a shop of this class, may be taken from the main power supply of the factory and used for operating the plant machines and equipment. Several electrically-operated traveling or overhead cranes, of various capacities are required. These cranes must be capable of handling all sorts of materials from a single plate up to a completed boiler.

The Laying Out Floor

The laying out floor is located in one of the side bays at the opposite end of the shop from the hydraulic riveters which are placed in a special tower.

With this issue the second of a series of articles by W. E. Joynes on the layout of locomotive boilers is inaugurated. The first series was conducted throughout the year 1925, the articles later being combined and published as a chapter in the book "Laying Out for Boiler Makers." The present articles will discuss practical methods of laying out metal plates in the shop from the developed plate drawings. So far as is practicable the various operations of fabrication will be included, such as the handling of plates, machine work, rolling, flange work, fitting, assembling, riveting and calking. The firebox ring, smokebox ring, dome, longitudinal braces, brace tees, waist sheet, angles, tube sheet ring, staybolts, staybolt application, tubes, tube setting, and the like, will be discussed. In addition, the application of electric and gas welding, the use of the burning torch, miscellaneous boiler shop tools, and other equipment and materials used in the manufacture of the complete boiler, will be covered.

The author, W. E. Joynes, has been connected with the American Locomotive Company for the past twenty years, more than sixteen years of which have been devoted to boiler design and plate development work. During this period he has been largely responsible for the simplification of the laying out methods used both in the drafting room and in the shop. It is believed that the present series of articles will prove of value to all of our readers, as it represents the last word in advanced methods of locomotive boiler construction.

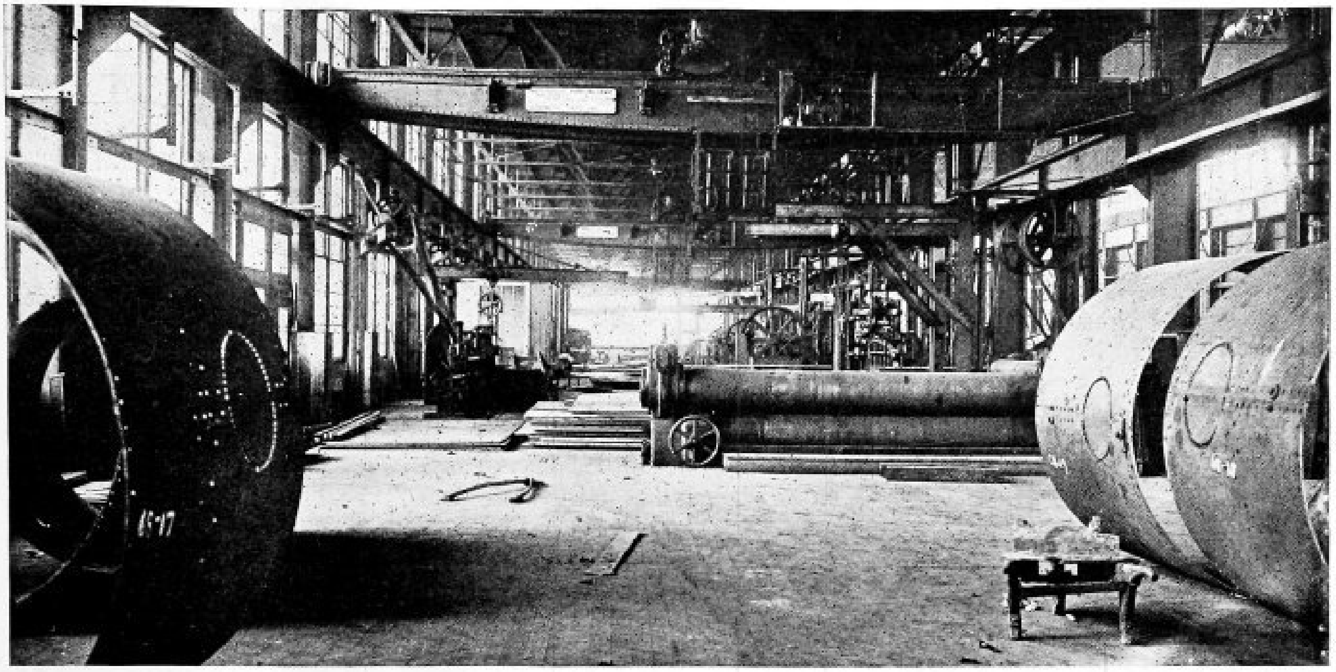


W. E. Joynes

The location of the machinery for fabricating the plates should adjoin the laying out floor and extend along the side bay. These machines include multiple and single drilling machines, punching machines, straight and bevel shears, plate planers, plate bending rolls and scarfing hammers, all of which are electrically driven.

Passing to the main or center bay of the shop, we find the fitting and lining up of the boiler going on; then the final assembling for riveting, most of which is done on the hydraulic bull riveters. Following the riveting, the longitudinal braces, staybolts and tubes are applied, then, the calking of the seams, rivets, liners, etc., which completes the boiler for the hydrostatic and steam tests.

Air power is required for operating certain drilling, reaming and riveting machines, chipping and calking hammers, jib-lifting cranes and air machines for reaming and threading staybolt holes and applying the stay-



General view of plate machining and rolling section

bolts. Portable electric machines are also used for drilling, reaming, threading, etc.

A number of machines are required for the machine work in connection with such boiler details as firebox rings, smokebox rings, tube sheet rings, tube sheets, domes, etc. These machines include single and multiple drilling machines, planing machines, vertical and horizontal milling machines and boring mills. All of these machines are electrically driven and are conveniently located on the opposite side of the shop from the plate working machines.

Floor space for laying out the firebox and smokebox rings should also be available here.

Flanging Department

Further on, in this bay of the shop will be found large oil burning furnaces for heating the flange plates, waist sheet angles and other miscellaneous flanged plate work required for the locomotive. Adjoining each furnace is located a hydraulic flanging press. The furnaces consume many gallons of crude oil in a day, therefore, oil-storage house pits are necessary near the furnace side of the shop. Open-air blast fires are also necessary for the heating of plates for hand-bending and straightening operations.

Manufacturing rigid staybolts and radial stays should be a part of the boiler shop duties. This work requires specially constructed heaters and upsetting machines for the straight-upset, taper-end and buttonhead style of bolts. Also, a large number of threading machines are required for the threading of all styles of staybolts, and radial stays. Together with these, the following machines are essential; lathes, drilling machines, chamfering machines and a staybolt-head swaging machine. The threading and other machines and the shop-tool supply should, of course, be separated from the main shop by substantial walls.

Nearing the end of this side of the shop, there should still remain space for handling the longitudinal and firebox tube sheet brace work, swaging and cutting of tubes and other miscellaneous detail work which has to be heated for bending into shape. This work requires oil furnaces, power hammers, shearing, upsetting and drilling machines and rotary tube cutters. All of the above staybolt and detail-working machines are electrically driven. Oil furnaces and tube-swaging machines are operated by air.

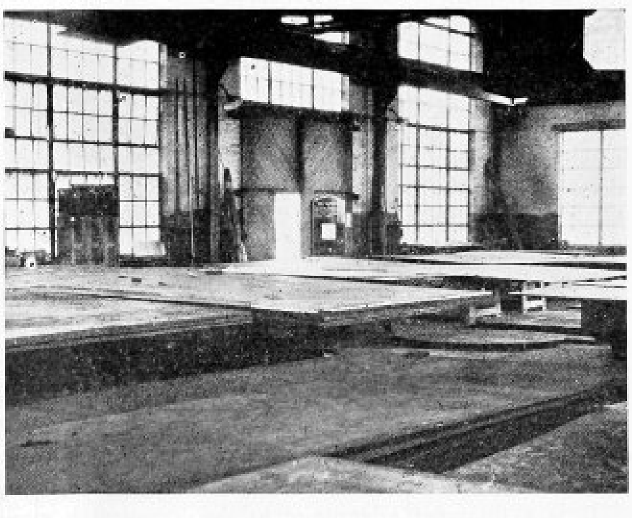
The flanging dies can be kept in the storage yard, near the flanging press side of the boiler shop.

The plate storage should be convenient to the laying-out floor and traveling cranes should be available for handling the dies and plates.

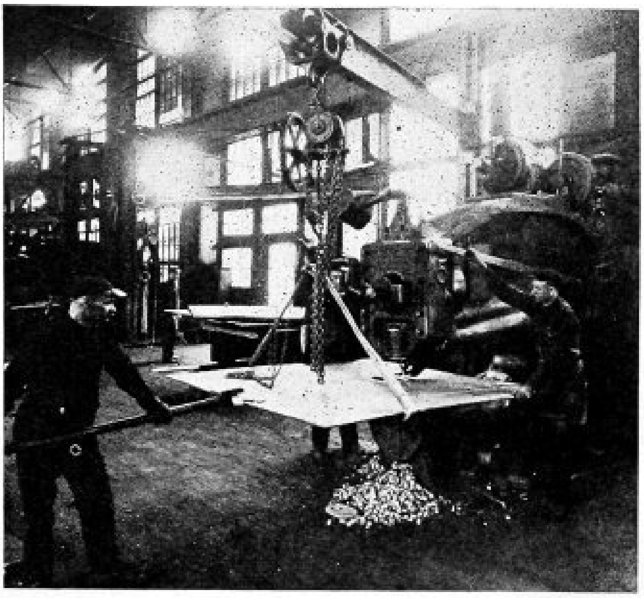
The burning torch and electric- and gas-welding equipments make possible the present-day standards of manufacture, as well as the production rate of steel fabrication. The shop should be sufficiently equipped with these units.

It is hoped that the foregoing description of the equipment of this specialized shop, will give an insight into the operations of manufacture which are to follow.

If the boiler shop is distant from the locomotive erecting shop, the hydrostatic and steam tests of the



View in a corner of the laying out section



Punching machine in operation

boiler are carried on to better advantage and more economically in the latter shop. This saves the transportation of valves, turrets, superheater headers, etc. Also, all studs required in the boiler should be located according to the boiler and locomotive erecting cards and applied before the test.

Laying Out the Metal Plates from Development Plate Drawings

In this treatise on laying out the metal plates of a locomotive boiler, the writer feels that the order of the plates selected to lay out should be reversed from that of the development plate series.

In the development series, it was felt, due to the great amount of information necessary in leading up to the development of locomotive boiler plates, that the plates comprising the firebox end of the boiler should be presented first.

In this series we will lay out the actual plates from the development plate drawings. Therefore, it seems logical to begin with the more simple plates at the front end of the boiler; accordingly, the layout of a cylindrical shell course will be presented first.

In actual shop practice, the flanged plates, such as the backhead, throat and tube sheets, are the first to be laid out. This allows the flanging of these plates to be done while the back end or firebox work is in progress.

Nomenclature

The terms *course* and *ring,* wherever used in this treatise have the same meaning and refer to the cylindrical end of the boiler. *Shell* may refer to any of the outside boiler plates or to the smokebox. The term *gusset* means a conical (any type) shaped course. A conical course is also referred to as a *ring,* and as a *conical connection.*

Material Orders

In order to have the plates available when required, the sizes are determined by the drawing room from the boiler pencil layout. These plates are ordered from the mills some time in advance of the completion of the boiler drawings.

It is a financial advantage to the locomotive manufacturer to order all boiler plates cut rectangular or square, in shape. The exception to this rule occurs in the case of round flange plates, such as a one-piece flanged dome, dome base, dome ring, dome cap, and the front tube sheet. It is not practical to lay out the holes required in dome plates before flanging. Therefore, it is more economical to order these plates to the correct flanging size, since they are not handled for laying out until after they are flanged.

The front tube sheet is an exception to this rule. The trim is of little value and most of the holes are put into the sheet before it is flanged. The dome base is also handled for making an opening through the center which allows the collar flange to be formed.

The throat, backhead, firebox back and back tube sheet are of irregular shape. This makes it necessary to handle these plates for laying them out to the correct flanging size. Also, most of the plates have a number of the holes put in before they are flanged.

If the crown, roof, throat, backhead, firebox back, and back tube plates were ordered by sketch drawings, to save material and freight cost, it would be necessary to pay the plate manufacturer to lay out and trim the plates to the sketch dimensions and also to lose the trim pieces, part of which are of value to the fabricator, who uses them as reinforcing liners.

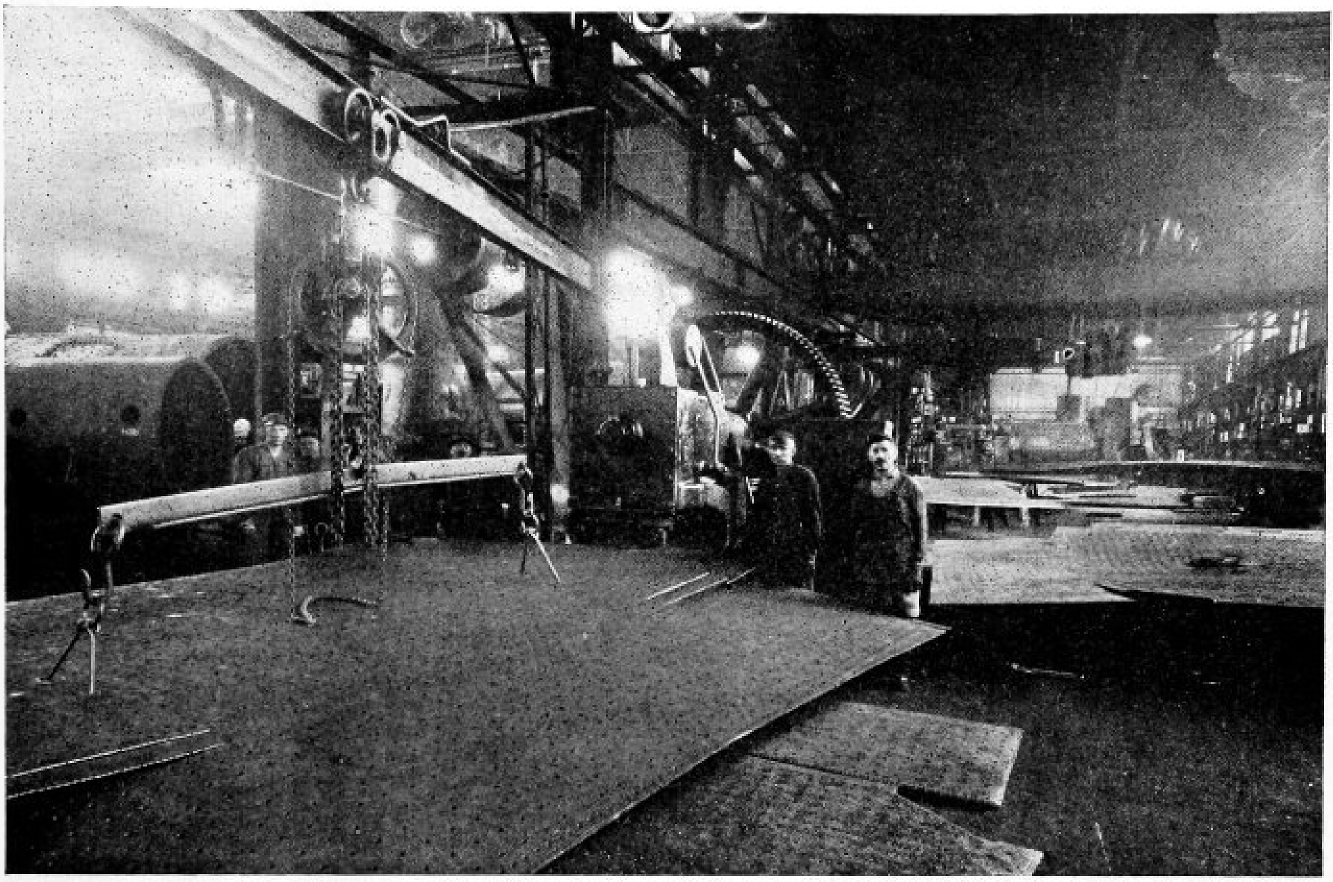
Laying Out a Cylindrical Course With Longitudinal Seam Off Center

The first sheet to be laid out is a cylindrical course with the longitudinal seam off center.

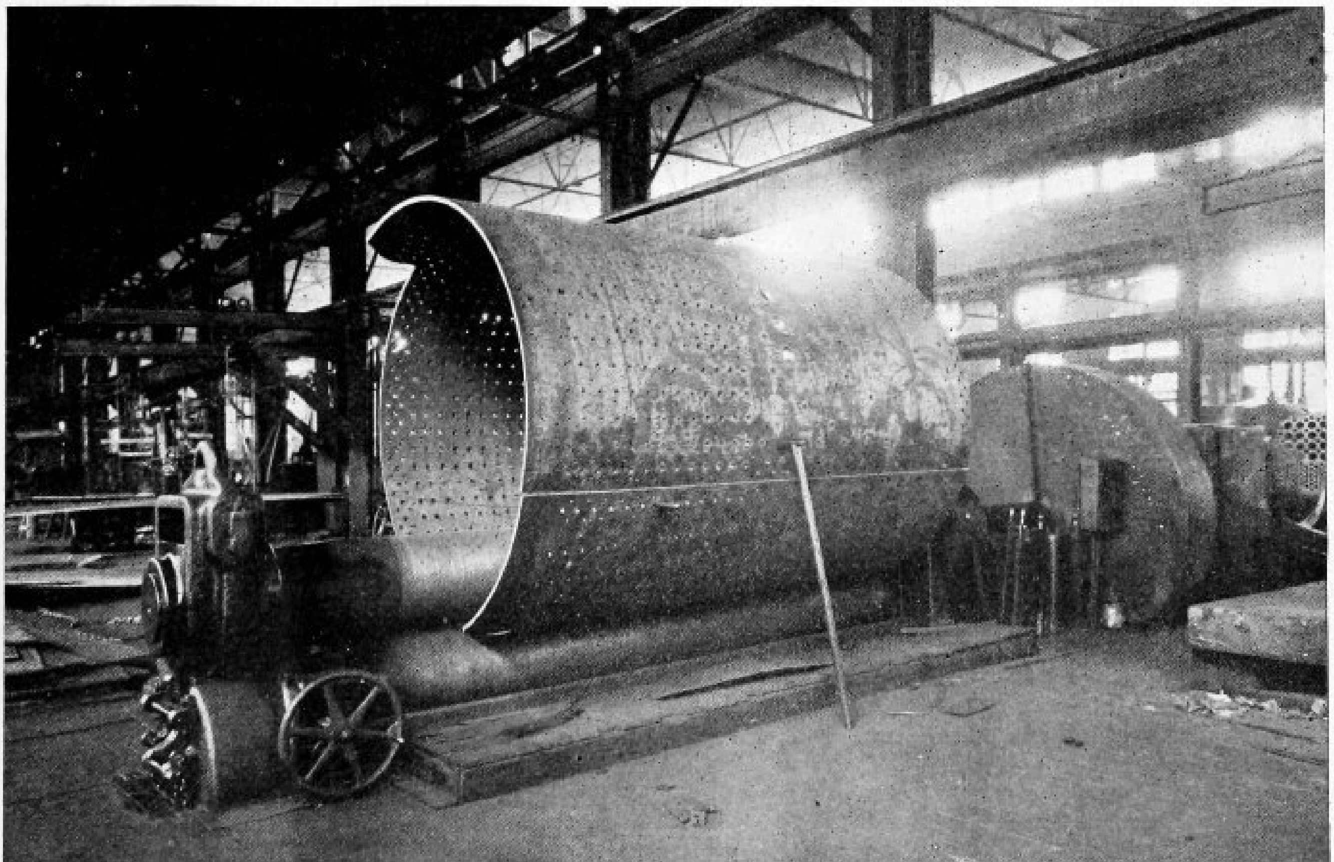
The plates are delivered to the fabricator with the dimensions and the construction and serial number marked thereon for identification.

One plate is placed on the layout table. The edges of the plate will be found approximately straight and square and should have been ordered with an allowance equal to the actual size required, plus an amount all around equal to at least one-half the thickness of the plate.

Rolling a ring into shape. The planing and drilling machines are in the background



Method of suspending a large plate for the operation of shearing the edges



Final part of the operation of rolling a ring into shape

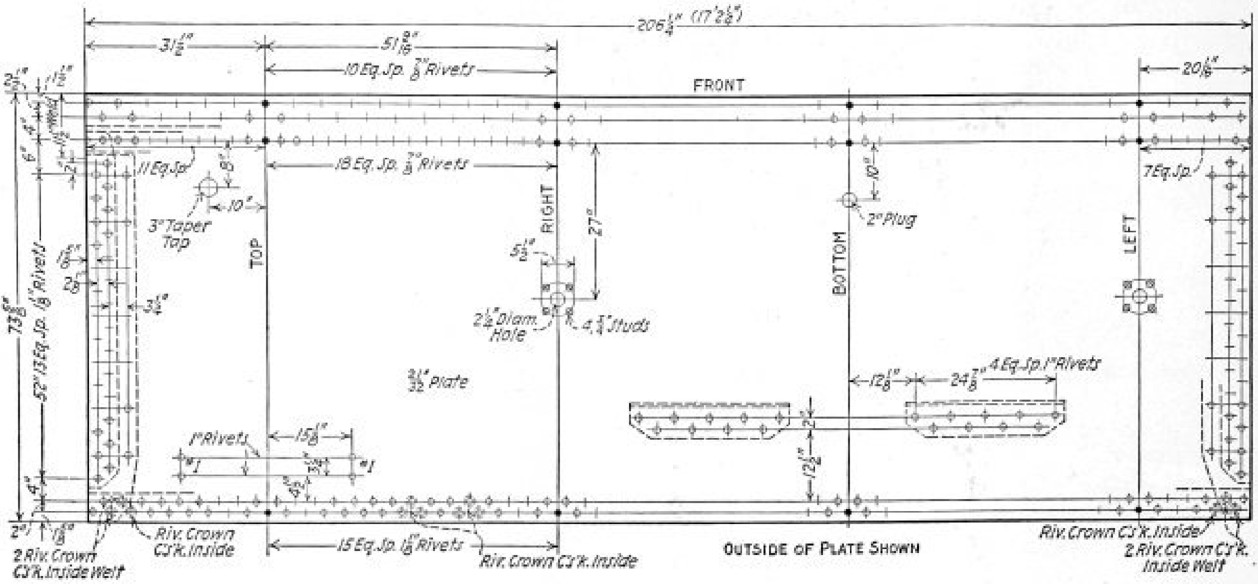


Fig. 1.—Cylinder course development with longitudinal seam off center

How to Measure the Dimensions and Draw the Lines

All lines should be made with a steel straight-edge and a sharp chisel-edged soapstone pencil. Chalk lines should not be used. All straight dimensions over 24 inches long should be measured with a steel tape.

The order of laying out the plate is as follows: One man can square up the plate alone. Starting at the back end of the plate and far enough from the edge to allow a straight line for planing (about ⅛ inch), draw a line for the full length of the plate. This line is to be the finished back edge of the plate and will also be used as a base line for squaring up and laying out the plate.

With a folding rule, find the center of the plate on this line. Measure from the edge at each end of the plate, Fig. 2, dividing the remaining distance between the measurements, by two. Erect a right-angle line at the plate center by the intersecting-arc method as shown. Measure the longitudinal length of the plate at each end and at the center of the plate and draw a line for the finished front edge of the plate. Refer to developed plate drawing, Fig. 1, for dimensions. When the straight-edge is not long enough to draw the base line the full length of the plate with one setting, erect a perpendicular at the center of the plate and then tram intersecting arcs, bisecting the plate right and left of the center as shown. Tram half the longitudinal length of the plate from these intersections and continue drawing the outline the full length of the plate.

Draw in the circumferential rivet lines 1½ inches, 2½ inches and 4 inches from the front end and 1⅝ inches and 2 inches from the back end.

Right and left of the right-angle line, erected at the center of the plate, measure half the length of the plate, 103⅛ inches, front and back; then the quarter length, 51 9/16 inches from the plate center and the edge of plate. From these measured points draw a line to extend across the circumferential rivet lines, as shown. These short lines are the plate center lines and are

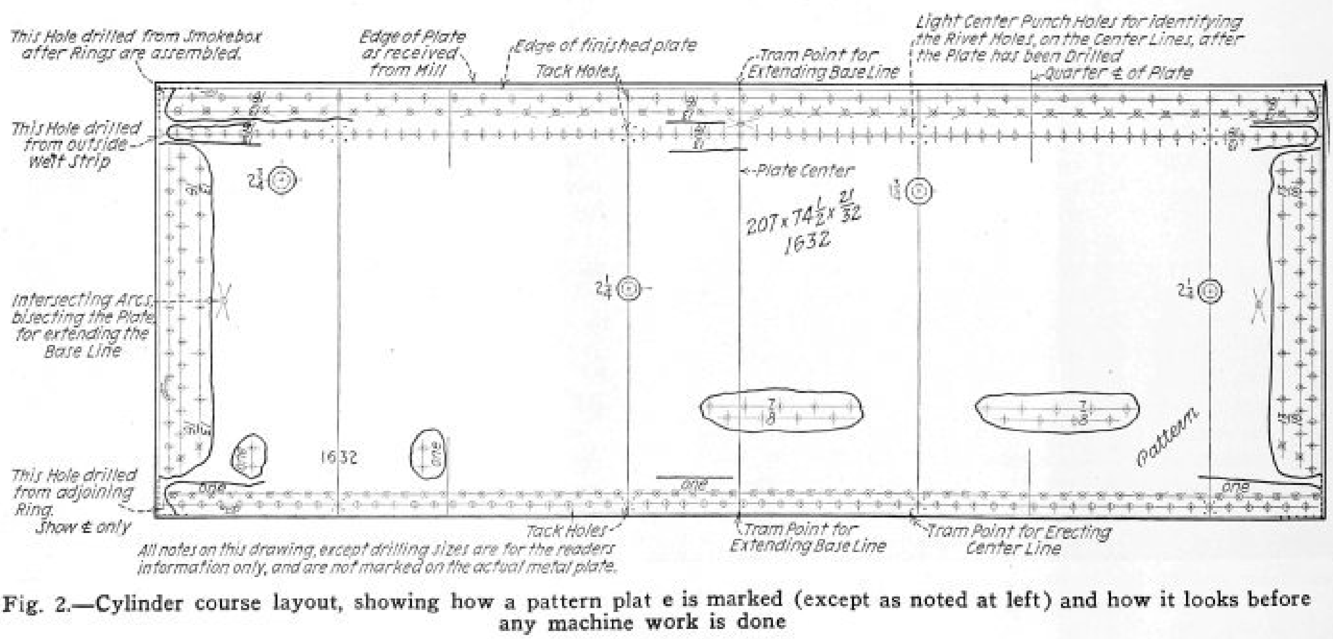


Fig. 2.—Cylinder course layout, showing how a pattern plat e is marked (except as noted at left) and how it looks before any machine work is done

used for spacing the front, tube-sheet rivet holes or front, circumferential-seam rivet holes for rings other than the first ring, instead of the center lines shown on the plate development drawings, Fig. 1. The side center lines, shown on the plate development drawings, may be either the center line of the assembled ring or the boiler center line or both.

Now divide up the rivet spaces for the circumferential seams and the tube sheet. The plate development drawing, having been drawn to a scale of one-eighth actual size, is accurate enough to set the dividers to eight of the spaces as shown on the blue print for a trial spacing. The longitudinal seam is located a number of rivet spaces up from the ring center line. In this case, at seven spaces of the tube sheet rivets, the division of the rivet holes begins on this line. With the dividers set for a trial division, commence at the edge of the plate and space 18 spaces to the first quarter center. If the trial set does not space off the 18 spaces exactly, reset the divider slightly and repeat the operation until the divider point comes exactly on the quarter center for the eighteenth division. When the spacing is correct, continue the divisions across the plate to the opposite edge. Mark the location of each division, by drawing a soapstone pencil along the point of the divider when the space is made.

Lay a rule on the first seven spaces from the edge of the plate; 20 1/16 inches should check with the measured distance. Now locate the center lines as shown on the plate development drawing, Fig. 1, by measuring 20 1/16 inches from the edge of the plate, front and back, and to the left of the plate center lines.

Next, set the divider to space off ten equal spaces, for a quarter of the distance in the front row of the smokebox seam rivet holes. Locate the rivet holes in the inner row with bisecting arcs centered from the holes in the front row as shown. Note that these rivet holes do not begin at the edge of the plate but from the ring center lines.

Also, space off the rivet holes in the back circumferential seam from the center lines, as shown on the plate development drawing. Locate holes along the inside row by bisecting the location from the holes of the outside row.

Longitudinal Seam Rivets

Measure 1⅝ inches, 2⅛ inches and 3¼ inches, front and back and right and left of the plate and draw in lines. Locate the front and back rivet hole in the first row and space off 13 equal spaces in 52 inches. Now mark these spaces off on a metal strip. From the holes in the first row bisect the back end hole location in the second row. Lay the strip on the second row in line with the bisection and mark off the rivet holes in this row. Locate the rivet holes in the third row from the holes of the second row, by bisecting the first hole at the end, or, with a steel square, square up the end hole of the third row from the first row hole. Lay the strip on the third row and mark off alternate holes, as shown.

Locate the longitudinal brace-feet rivet holes off the top center and ahead of the circumferential seam holes as dimensioned on Fig. 1. Also locate the guide-yoke angle rivet holes as dimensioned. Locate the washout plugs and the injector check holes. Omit the stud holes shown on the 5½-inch circle around the injector check hole. Stud holes for appliances should *not* be laid out on the flat plate. These studs are *not* radial to the boiler shell, therefore, best results are obtained after the boiler is built. A thin metal template, showing the stud arrangement, bent against the boiler and center punched onto the shell solves the problem of laying out the flange studs. The same template should also be used for marking off the appliance flange.

When the center of a longitudinal or a front-end circumferential-seam rivet hole is centered on the edge of the plate, the hole is drilled directly from the outside welt strip, after the strips are bolted in place for riveting. A back-end circumferential-seam rivet hole on the edge of the plate, or one that does not come well within the plate edge, is drilled from the adjoining ring, after the rings are assembled.

This completes the laying out of the plate, inasmuch as the outline has been laid out and all of the rivets and other holes located that are required in the sheet before it is rolled into shape. The plate layout should now be checked thoroughly by a competent layer-out before the location of the holes are center punched to a larger size. Now center punch a large hole for all the rivets and other holes. A large center-punch hole is best made by making a small one first, then finish with a heavy blow. This method assures the correct location for the hole. The light center-punch holes should be made as soon as each line of holes is located. This is to avoid errors and the holes are necessary for centering the dividers when bisecting the rivet hole locations. Also, circle all rivet center-punch holes, free hand, with a soapstone pencil, before the plate layout is checked. To check the driller, center punch the outline of all holes except rivet holes.

Block off and mark the drilling size of all rivet holes with white lead, as shown. Mark the drilling size of larger holes such as washout plugs and injector check holes, etc., with steel stamping dies. Also, circle large holes with white lead.

The Drilling Operation

The plate, Fig. 2, is now ready to be drilled. When duplicate plates are required, tack holes (for bolting the plates together for drilling) are first punched in this—the pattern plate. Location of the tack holes in the duplicate plates are centered with a marker punch, directly from the pattern plate. Holes on the quarter centers of the ring are used for tack holes. Four light center-punch holes (as shown) around the tack holes, at each end of the plate, identify the ring center lines after the plate has been drilled. All the remaining rivet holes, and other holes not larger than 2⅛ inches in diameter are drilled on the multiple drilling machines when the plates are bolted together.

It is not practicable to indicate the countersunk rivet holes or the weld bevel of a seam on a plate before it has been drilled. This information should be marked on the plates when the work is ready to be done.

The shearing outline of duplicate plates is also marked off after drilling. For shearing information, the distance from the center of the outside row of rivet holes to the edge of the plate (lap) is marked on each edge of all plates with steel stamping dies by the layerout.

The actual outline as laid out on the pattern plate should be center punched at the corners of this plate only, in addition to having the outline laps stamped on the pattern plate.

The order number is also stamped on the plate, in the location as shown by the layerout. This completes the work of the layerout on a cylindrical course plate.

The manufacturer's name, kind of steel (boiler or firebox steel), tensile stress, heat and serial numbers will be found stamped on the plate when received.

Size of Rivet Holes in Flat Plates

In order to have rivet holes true when the plates are assembled, the actual diameter required to receive the rivet is obtained by reaming or redrilling the holes after the parts are assembled. The drilled diameters of rivet holes that have been found to assure true holes when reamed or redrilled are as follows:

Drilled holes in longitudinal seams and welt strips equal diameter of rivet before driving minus 5/16 inch. All circumferential seams (except roof to ring and ring to throat) under steam pressure equal diameter of rivet minus ⅛ inch. Roof to ring and backhead, ring to throat, and front tube sheet equal diameter of rivet minus 3/16 inch. Rivet holes in rings for angles and liners equal diameter of rivet minus ⅛ inch. All brace feet, supports, and roof sheet liners holes equal diameter of rivet before driving.

Crown sheet rivet holes, equal diameter of rivet minus 1/16 inch. Roof, backhead, throat sheet, and firebox ring rivet holes equal diameter of rivet minus ⅛ inch.

Where the rivet hole drilling allowance is 3/16 inch smaller (except crown sheet) than the rivet diameter, the plate connection is to a flanged plate, which has punched rivet holes instead of drilled holes.

Having more metal to cut on account of a greater minus allowance, below the rivet diameter for longitudinal seam rivet holes, these holes are redrilled to the correct rivet-driving diameter, instead of reamed.

Smokebox circumferential seam; punch rivet holes equal diameter of rivet before driving: Longitudinal seam and front ring rivet holes equal diameter of rivet plus 1/16 inch.

Drilling Size of Tapped Holes

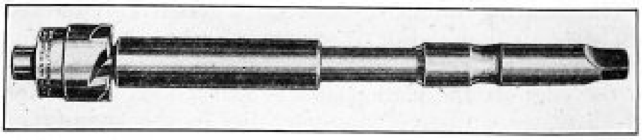
Make the drilling size of washout plugs and other tapped holes, including screw rivets and studs when larger than ⅞-inch diameter, equal to the diameter of the thread given minus ¼ inch. Drilled holes for staybolts are given with the crown and roof sheet laying out instructions.

(To be continued)

Interchangeable Counterbores and Tube Sheet Cutters

THE Bicknell-Thomas Company, Greenfield, Mass., has developed a line of cutters, counterbores and drills that are interchangeable in their holders within their respective size ranges. Three of these tools are shown in the illustrations.

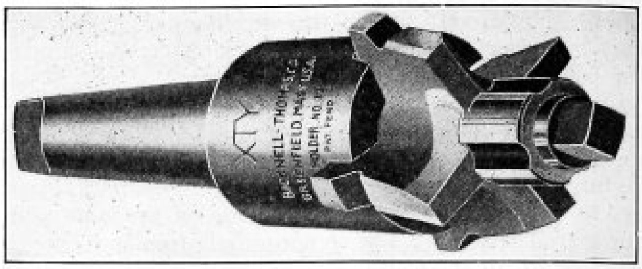
The standard counterbore cutter of the Christy XTY



The type H back-spot facer

design, is shown with a four-fluted cutter and pilot, assembled with the holder and also disassembled. This design has the advantage of enabling the user to renew any one of the three parts and use it with the other two. The cutter is furnished in a variety of sizes ranging from ½ inch to 4 inches and the sizes are grouped to fit eight different holders.

The flue sheet tool is designed to cut and countersink holes in flue sheets in one operation. The pilot is intended to enter a punch or drilled hole in the sheet and



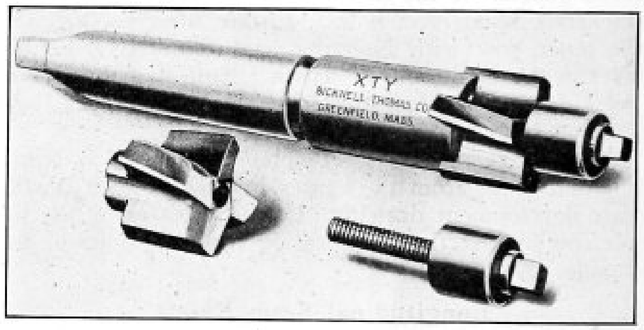
The type A flue sheet cutter for cutting and counter-sinking holes in one operation

guide the cutter. The cutters are furnished with either two or four flutes and are constructed to withstand severe service.

Back-Spot Facer

The type H back-spot facer has a double-key drive, with no pins or set screws, which insures more strength and accurate alinement under working pressure. The bars are made of an alloy steel, heat treated to withstand the driving strains. The high-speed back-spot facing cutters are also interchangeable and are easily removed by hand without the aid of wrenches. A feature of this tool is the pilot, which is interchangeable and is provided with either a slip or pressed fit. Solid pilots can be furnished when the interchangeable type has the wall worn too thin to permit interchanging.

All of the above tools are forged and twisted while



The XTY design of standard counterbore cutters

hot, which tends to increase the original strength and density of the high speed steel from which the tools are made.

Portable Air Compressors

INGERSOLL-RAND Company, 11 Broadway, New York, has added a seventh size to its line of portable air compressors. This new size (4¾-inch bore by 4-inch stroke) has a piston displacement of 82 cubic feet per minute. It requires a unit of slightly larger capacity than the 4¼-inch by 4-inch 66-cubic foot machine.

The new compressor, like the other I-R portables, is equipped with a four-cylinder, tractor-type Waukesha motor. It is available on broad-faced steel wheels, on steel wheels with rubber tires, on I-R trailer mounting, on Ford or Chevrolet truck, or without running gear for mounting on skids, railway car, etc. The 4¾-inch by 4-inch unit embodies all the exclusive Ingersoll-Rand features which are found on the other six sizes.

Welding Jacketed Pressure Vessels*

Spiral-pipe-coil form of vessel developed to simplify construction and eliminate leakage

By T. K. Lowery and W. H. Eichelman

THE subject idea of this paper, that of welding jacketed vessels, is contrary to accepted practice, and therefore faces a handicap at the outset.

For generations the design and general shop practice employed in this type of work have been of a standardized character.

We are all familiar with the proverbial open-top jacket kettle, the walls and usually the bottom of which are jacketed and staybolted to withstand steam pressure. Many of us have repeatedly sought to work out a new and better process that will overcome the deficiencies in present-day constructions, where steam is first introduced into the jacket for heating the contents of the kettle, and then alternated with a cooling medium for extracting the heat from the contents. I dare say, we have all met with the same results, namely a leaky jacket. In fact, the staybolted surfaces as well as the rivets invariably will leak due to the expansion and contraction caused by the introduction of steam alone, without taking into consideration the application of the additional cooling operation.

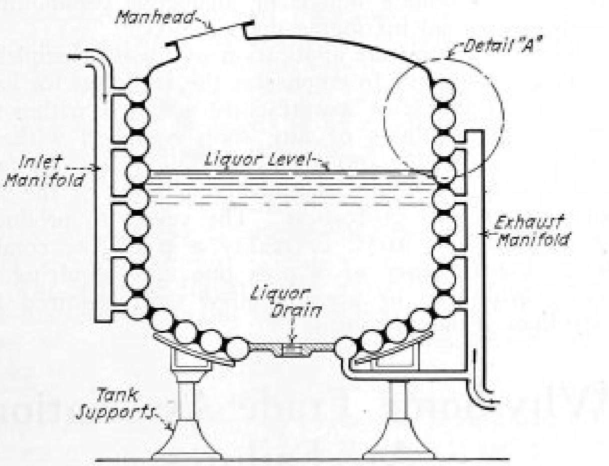


Fig. 1.—Sectional view of pasteurizer built up of spiral coil pipe and welded

Adamson and Morison Furnaces

It may be true that through the introduction of the Adamson type furnace or flanged ring, and also the corrugated or Morison type furnace, we have to some extent overcome the use of stayed surfaces. Admittedly these shells are a great improvement and will withstand a collapsing pressure with a relatively thin wall of metal, as compared with a plain metal cylinder. Such shells have been successfully adapted to many types of boilers, but still they have failed to meet requirements of the plant engineer in his needs for a practical jacketed kettle.

When these furnaces are used in process work, or jacketed kettles, you will invariably find the prevalent mud ring, a carry over from the old staybolted construction. For the benefit of those not familiar with these types, I have illustrated them as follows:

Fig. 2 is the ordinary stayed shell.

Fig. 3 is the Adamson type.

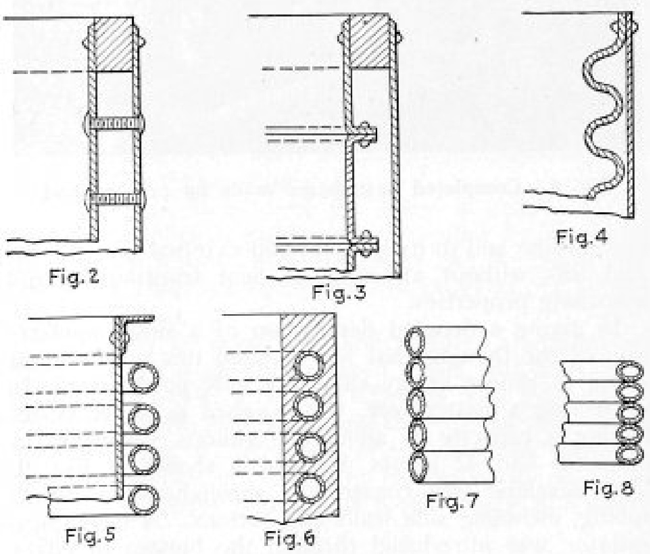
Fig. 4 is the Morison or corrugated shell.

All of these illustrations are enlarged sections at point marked *A* on Fig. 1.

Two other constructions are radical departures from the foregoing designs and methods and as a matter of fact they do approximate to some extent the subject of this paper.

One is used in the plant of one of our large starch manufacturers in the middle west. He has been building the equivalent to a jacketed kettle, and this by employing merely a plain steel tank having a pipe coil wrapper around the outside and lying adjacent to the outer wall of the tank, Fig. 5. By insulating the outer face of this coil, the heat from the coil is deflected against, and transmitted to, the shell of the tank and thence to the product contained in the tank. As the coil may readily be made tight against leaks he has developed a construction which is really the equivalent of a jacketed kettle—and he has a tight job which stays tight. Even if the coil should leak there is no possibility of the product within the tank being damaged.

The other construction referred to has been marketed by an eastern concern and consists of the embodiment of a spiral pipe coil as a core in a solid casting, which casting forms the wall of a kettle, Fig. 6. This construction submits to the same criticisms as the other



Details of various forms of jacket construction for pressure vessels

furnaces, and whereas the construction is thick walled, making of it a heavy cumbersome vessel, it is necessarily slow in the transmission and absorption of heat. The construction is likewise costly and also subject to the paramount criticisms applying to all cast iron work as applied to pressure vessels.

*Abstract of a paper submitted before the American Society of Mechanical Engineers in competition for the Lincoln Arc Welding Prize.

Construction of the Spiral Coil Vessel

With the last two applications in mind, if the reader will visualize the forming of a spiral coil constructed so that the continuous helices will lie in juxtaposition with one another, and visualize the amalgamation of these adjacent members by means of a welding, thus forming in themselves a continuous wall, you will have grasped the idea back of the subject matter of this paper. This construction permits of the use of a relatively thin gage metal. It eliminates the necessity of using reinforcing members which, as has been set forth, have been universally employed for the purpose of affording the strength necessary to resist both the bursting and collapsing pressures to which such a structure is subjected. It will furthermore, due to the relatively thin gage material employed, also augment the transmission and absorption of heat to and from the commodity contained in the vessel. Such a construction readily permits of vast variations, both as to its general outline and to its internal and external dimensions, and this without affecting its heat transmitting and absorbing properties.

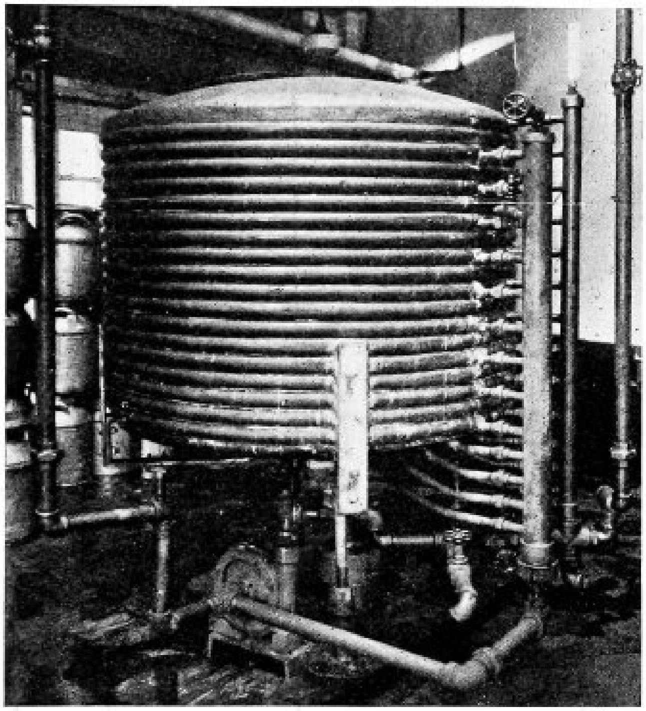


Fig. 9.—Completed pasteurizer made by new method

In giving a detailed description of a single application of the thought that has inspired this paper, I am going to choose as my subject a milk pasteurizer. In perfecting a pasteurizer, we designed a jacket vessel having a capacity of about 300 gallons, 48 inches in diameter and 42 inches deep as is shown in Fig. 9. This machine was constructed throughout of 2-inch tubing, including side walls and bottom. A mechanical agitator was introduced through the bottom to effect a violent circulation of the commodity being worked upon. As a heating element we employed hot water at 160 degrees F. which was fed into the coils through a header at intervals of every third coil, and removed from the coils at every third coil through a like header.

This machine has been torn down and rebuilt to various designs. We have taken sections of the tubing after they were welded and subjected them to tests endeavoring to destroy the weld, and have even put them under a drop hammer and literally destroyed the tubing, but the weld still held.

In submitting such a structure to a high temperature and then dropping this temperature to a low point, (we have upon tests run live steam into these coils at a temperature of 250 degrees and immediately turned cold water into the same coil at 40 degrees F. or a potential drop of 210 degrees), there must necessarily be considerable expansion and contraction of the metallic parts. We have not had the fine laboratory instruments to measure this expansion and contraction, but it is our opinion that the coils, when welded one upon another, are free to elongate or broaden out as the case may be, under either expansion or contraction. Figs. 7 and 8 of the drawing illustrate this point. The weld affixes the adjacent members so as to form a section similar to a cross section of a honeycomb, and in action, resembles the walls of an accordian.

Whereas the welding of pressure vessels as such is not permissible under many of the state codes, in this instance we are not welding against the pressure, instead we are merely affixing a plurality of pressure vessels superimposed one upon the other to form in itself a vessel for retaining liquids or analogous commodities. Thus we are not infringing upon the code.

In summarizing the application of these principles it is hardly necessary to emphasize the fact that we have evolved an article of manufacture which is within the means and facilities of any shop equipped with an electric arc welder and a coil bending rolls. In fact, it is strictly a welding job embodying many of the best elements of this profession. The vessel so produced is simplicity in itself, in reality a pipe job, coming under the category of a pipe line and requiring no boiler inspection or permits other than required for pipe lines of like pressures.

Why Some Trade Associations Are Failures

IN making an analysis of the causes of the failure of some trade associations to fully realize their opportunities, E. St. Elmo Lewis, counsel in trade and consumer relations, National Services, Inc., of Detroit, Mich., a business analyst of international reputation, who has made a special study of trade associations, recently said to an industrial group:

"These are among the main causes for trade association failures:

"(1) Failure to realize that a trade association is a business with unique problems of economic and human relationships, and that there is a special technique and experience necessary in organizing and conducting a trade association, just as there is in any other 1928 business activity.

"Nearly 40 percent of trade associations fail to produce tangible results for this reason.

"(2) Failure to make a proper analysis of the job to be done by the trade or industry, which means fixing the relative position and tendencies of the trade; listing the various abuses and difficulties which retard its profitable progress, thus finding the trade problems common to the members as a basis of the association program.

"This is among the causes of 70 percent of the failures.

"(3) Failure to realize the necessity for both administrative and executive leadership, thus putting the work of the association in the hands of cheap, incompetent, time-serving men who waste time and money in theoretical futilities or the selfish pursuit of personal ends.

"Successful associations are invariably those that have set up their plans of organization, and program of operations only after the most careful analysis to determine the real situation in and out of the trade—and then let such facts lead them to practical decisions.

"(4) Failure to realize that busy men will not and cannot give the time necessary to working out the details of association operation—no matter how great their personal interest—and thus fail to provide for the selection and maintenance of a competent staff necessary to skilled execution of well-defined and considered policies.

"The most successful associations are asking members to do little but pass on policies and results—leaving the execution to paid staffs.

"(5) Failure to realize that the job of a trade association executive is not a sinecure for a friend, or a refuge for a business failure.

"Associations are rapidly getting away from this early mistake. Associations of outstanding success are invariably manned by skilled, specially-trained executives who have displayed definite qualities of leadership.

"(6) The trade association fails whose membership expects its sales problems to be solved, its competition to become enlightened, its technical education to be developed, its public to become informed, at no greater annual charge to each member than the expense of a salesman's evening entertainment of a first class prospect.

"The business leaders who have developed successful associations know that budgets are fixed by the plan of work, and they cannot afford to employ a cheap staff. Compensation is going up.

"(7) The trade association fails that spends its money and time trying to evade the price-fixing provisions of the Sherman Anti-Trust Act, and thereby hoping to make real cooperation in the development of its markets, the education of the membership in better business methods, unnecessary.

"The Federal Trade Commission and court records demonstrate the futility of handling such trade problems in a spirit of fighting resistance to public opinion. Successful trade associations guide and develop a favorable public opinion.

"(8) The trade association fails that exhausts its cooperative effort in passively 'resoluting,' or in drawing up vague ethical 'creeds,' or in formulating codes of practice that are impractical; or, that expects, by merely displaying practical codes on office walls, it can automatically eliminate all the human cussedness that makes a warfare of business.

"Successful associations have found ways to make codes effective in raising the standards of practice.

"(9) The trade association fails when it does not furnish practical working data on production, finance, marketing, merchandising, advertising, sales, and general business control; and specialists who can interpret the data in such a way as to give each member a true picture of the tendencies in the whole trade and his relation to them.

"Successful associations have developed affirmative, constructive programs of helpfulness in all functions of a business.

"(10) The trade association fails that does not realize in fixing its plan of organization, and program of operation, and in selecting its executive personnel, that the effective trade association is a cooperative method of furnishing skilled staff guidance to the entire trade in the keen competition between trades for a share of the consumer dollar.

"The most successful associations are all staffed by specialists in the different business problems that research and analysis have shown to be important in the effort to maintain profits, and the relative place of the trade.

"(11) The trade association fails that stops at the golf-playing, good-fellowship stage, however much friendliness helps at every stage of a more practical program.

"The demand for practical results and the reorganization of associations prove this.

"(12) The trade association fails whose members do not play the game because they are too big and don't have to, or so little it does not matter.

"Otherwise the association is a futile gesture.

Suggestions for Trade Associations

"(13) There are four things every trade association must do—

(a) It must have an aggressive, faithful and competent leadership and a membership loyal to the purpose and plan.

(b) It must have a plan of action based on a competent, unbiased analysis of the trade's requirements.

(c) It must have an adequate and competent staff to do the work.

(d) It must have a program that realizes the necessary time, and a budget that fully covers the expense of putting the plan into execution."

Grinding Cold Chisels

PROCURE a small set-collar such as is used upon shafting. The set-collar should be large enough to slip over the cold chisel. The set screw should be replaced by a screw with a knurled head. Slip the collar over the cold chisel and bring the collar against the front of the steady rest of the grinding wheel, which should be set back sufficiently to allow room for the collar in front of the rest.

Adjust the chisel until the wheel is cutting at the proper angle, then tighten the set collar by means of the knurled screw. Slide the collar and the chisel back and forth along the rest and a true bevel will be ground upon the chisel.

By rolling the chisel over and grinding alternately on both sides, a perfectly balanced chisel will be secured as the bevels will be exactly alike on both sides of the tool. Furthermore, the cutting edge of the tool will be exactly in line with the axis of the chisel so there will be no springing of the tool or jarring of the hand, no matter how heavy may be the blows struck against the chisel.

The National Soot Blower Company, Inc., of Groveville, N. J., has appointed new southern representatives, as follows: Fuel Efficiency Engineering Company, Birmingham, Ala.; A. S. Furtwangler, Charleston, S. C.; Reed & Duecker, Inc., Memphis, Tenn.; Buckmaster-Luch-Malochee, Inc., New Orleans, La., and Henry Eggelhof, Dallas, Texas.

Tables for Laying Out Pipe Templates*

These simplified tables will enable you to prepare templates for any turn of any pipe

TEMPLATES for use in cutting pipe at an angle to form bends and turns are usually laid out by applying the principles of descriptive geometry. All who have made or used pipe templates have undoubtedly noticed that templates for various sizes of pipe but the same angle of turn have the same general shape, differing only in size. In fact, an exact proportionality exists between corresponding dimensions in all templates for the same angle of turn. This fact makes it possible to calculate a single simple table which will serve to cover an entire series of similar templates.

Template for 90-Degree Elbow

Fig. 1 shows a template for a 90-degree turn, drawn to scale. The length of the template is equal to the exact circumference of the pipe. The curve of the template is laid out from the base line, using 16 equally-spaced ordinates to give the points on the curve. In Fig. 1 the ordinates for the left half of the curve are designated by the letters *a* to *i*, *i* being the ordinate at the center of the curve. These are all the ordinates that are required in making the curve, for the right half can be laid out using the same ordinates starting from the right end.

The length of each of these ordinates bears a certain relationship to the circumference which can be expressed as a ratio. Thus ordinate *i* is equal to the circumference times 0.318. This holds true for any circumference, so that having measured the circumference of a piece of pipe, the ordinate *i* for a 90-degree turn can be immediately calculated by multiplying the circumference by 0.318.

Constructing a 45-Degree Template

Table 1 gives the complete set of ordinate factors for a 90-degree turn. The use of the table may be illustrated by constructing a template for a 45-degree cut on a 6 inch pipe.

Cut a strip of stout paper perhaps 12 inches wide

* Published through the courtesy of *Oxy-Acetylene Tips.*

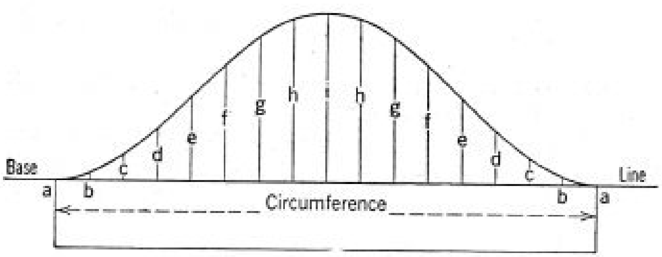


FIG. 1

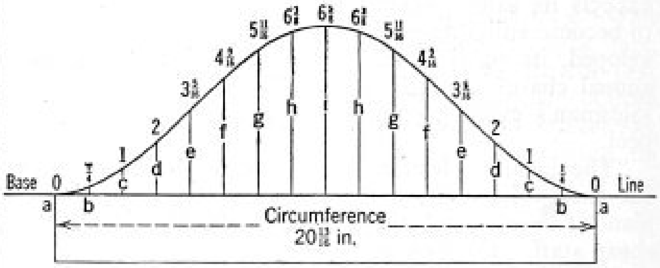


FIG. 2

Table I—Ordinate Factors for 90-Deg. Turn (45-deg. cut)

For Ordinates	Multiply Circumference of pipe by	For Ordinates	Multiply Circumference of pipe by
a	0.0	f	0.220
b	0.012	g	0.272
c	0.047	h	0.306
d	0.098	i	0.318
e	0.159		

Table II—Factors for Other Angles

For angle of turn equal to	Multiply circumference of pipe by	Note
90 deg	1.000	1 weld for 90-deg. turn
80	.839	
70	.700	
60	.577	
50	.466	
45	.414	2 welds per 90-deg. turn
40	.364	
30	.268	3 welds per 90-deg. turn
22½	.198	4 welds per 90-deg. turn
20	.176	
10	.087	

Then use Table I

Example I
Template for 90-degree turn in 6 inch pipe
Circumference = 20 13/16 inches or 20.81 inches

Ordinate	Circumference	×	(Table I) Factor
a	20.81	×	0.0 = 0.0 or 0 in.
b	20.81	×	0.012 = 0.25 or 1/4 in.
c	20.81	×	0.047 = 0.98 or 1 in.
d	20.81	×	0.098 = 2.04 or 2 in.
e	20.81	×	0.159 = 3.31 or 3 5/16 in.
f	20.81	×	0.220 = 4.58 or 4 9/16 in.
g	20.81	×	0.272 = 5.66 or 5 11/16 in.
h	20.81	×	0.306 = 6.37 or 6 3/8 in.
i	20.81	×	0.318 = 6.62 or 6 5/8 in.

Example II
Template for 30-degree turn in 8 inch pipe
Circumference = 27.1 inches

For 30-deg. turn, multiply 27.1×.268 (from Table II)=7.26

Ordinate				
a	= 7.26 × 0.0	= 0.0		0
b	= 7.26 × 0.012	= 0.09	or	1/8 in.
c	= 7.26 × 0.047	= 0.34	or	3/8 in.
d	= 7.26 × 0.098	= 0.71	or	3/4 in.
e	= 7.26 × 0.159	= 1.15	or	1 1/8 in.
f	= 7.26 × 0.220	= 1.60	or	1 5/8 in.
g	= 7.26 × 0.272	= 1.98	or	2 in.
h	= 7.26 × 0.306	= 2.24	or	2 1/4 in.
i	= 7.26 × 0.318	= 2.33	or	2 5/16 in.

Table III—Decimal Equivalents of Fractions

1/16	0.063	5/16	0.313	9/16	0.563	13/16	0.813
1/8	0.125	3/8	0.375	5/8	0.625	7/8	0.875
3/16	0.188	7/16	0.438	11/16	0.688	15/16	0.938
1/4	0.250	1/2	0.500	3/4	0.750		

and long enough to wrap clear around the pipe with a small overlap. Mark the point of overlap in such a way that when the template is laid out flat the distance from this point to the other end of the strip will represent the exact circumference of the pipe. Measure this distance—it will be found that the circumference of a 6-inch pipe is $20\frac{13}{16}$ inches. This distance is then divided into 16 equal spaces and perpendicular lines erected. This is most easily done by folding the template over on itself once, halving the length, folding again, quartering the length, folding a third time, dividing the length into eighths, and folding a fourth time, dividing the length into sixteenths. When unfolded, the creases represent the required ordinates. Then rule a straight line parallel to the straight edge somewhat below the middle of the strip. This will be the base line. Multiply the ordinates in Table I in turn by 20 13/16 inches and lay the values off on the ordinates starting at one end, as indicated in Fig. 2. The calculations are indicated in example 1.

For convenience in multiplying, fractions of an inch should be converted into decimals. Table III gives these decimal equivalents for fractions of 1/16 interval for ready reference.

When all the ordinates have been measured, draw a smooth curve through the points. Then cut the strip along the curve line. This gives the desired template. To use it, wrap it around the pipe, putting the longest ordinate *i* at the point where the extreme outer end of the elbow is desired. Scribe off the curve on the pipe with a piece of soapstone and make the proper cut by following this line with an oxy-acetylene blowpipe.

Permanent Templates

The paper template may be used directly where only a few cuts are to be made. Where a more permanent template is desired than paper, one can of course be used as a pattern for cutting a more substantial template out of thin sheet metal or heavy tar paper.

With the nine ordinate factors given in Table I, a template for a 90-degree turn in pipe of any size can be quickly calculated.

For any other angle of turn, a second factor is required. These factors are given in Table II. The pipe circumference is first multiplied by the proper factor in Table II and this product is then used instead of the circumference in Table I. Example II shows the method of using Table II in conjunction with Table I.

To summarize, the general rule for figuring 16 ordinates for any turn in any pipe is as follows: Measure the circumference of the pipe; multiply this by the factor for the desired angle taken from Table II, and then multiply this product by each of the factors from Table I in turn, laying the computed distance off on the respective ordinates measured from a base line.

The smooth curve connecting these points will be the desired template.

The firm of Manning, Maxwell & Moore, Inc., New York, international engineering specialists, has purchased the American Schaeffer & Budenberg Corporation, of Brooklyn, N. Y. and Worcester, Mass. The newly-acquired company, founded in 1851, is the oldest and one of the largest manufacturers of industrial instruments in the United States. The business of this company will be coordinated with that of the Consolidated Ashcroft Hancock Company, Inc.

Lazy Civilization

By W. F. Schaphorst

THE MAN who is physically lazy and mentally alert should, according to facts handed down by history, do more for his concern than the one who is physically alert and mentally lazy.

Lazy men have done more toward inventing and improving things than have hard-working physically alert people. It is easy to imagine that the man who put the first sail on a raft and invented the sailboat thought that paddling was too strenuous.

The bow and arrow was invented to make living easier. Horseback riding eliminated walking. But horseback riding isn't 100 percent comfortable so someone invented the wheel and placed wheels on a chariot behind the horses to make traveling smoother. Defeated and enslaved nations in the old days were compelled to do the work that the victors didn't like to do. The windmill, the water wheel, the treadmill, and then the steam engine were invented by lazy humans who didn't like hard manual labor.

All of us have heard of the boy who invented the first automatic valve on a steam pump. His name was Humphrey Potter. He preferred play to work and his active mind conceived a string leading to the valve he was operating by hand which would make the pump operate its own valve. It worked. As a laborer Humphrey Potter was lazy, but his mind was constantly active.

Of course there may be exceptions. Nobody has ever accused Thomas Edison of being lazy. Yet, probably as a laborer he was lazy too. He always did the work he *liked* to do, which, according to the late Dr. Steinmetz, isn't work at all. Steinmetz devoted four hours out of every day to doing things that he didn't like to do. He claimed that a man *works* only when he does that which he doesn't like to do—an explanation we don't all like.

Better Riveted Joints

THINGS don't stay put: machines or methods are never safely established, for better or cheaper devices or processes may displace them overnight. Sometimes the ones displaced struggle feebly and succumb. On the other hand, many of the older processes have secured firm positions in fields other than those for which they were originated. When the light and power possibilities of electricity came to be realized some years ago, the obituary of the gas industry was prepared. Mourners are frequently called for the steam locomotive. These two are still lusty because they used the latest developments of progressive science.

Now the talk is about the passing of the riveted joint, which is meeting strong competition from new processes. In the rush of conflict the older method may be pushed too far back and an undesirable action may result. Certainly there are many conditions under which the riveted joint cannot be replaced. There has been no new treatise on riveted joints in the last fifteen years or more, but in that time our materials and our methods of mathematical analysis have taken great strides. The time has come to re-study the riveted joint.

Facts are needed, and the A. S. M. E. is organized, equipped, and willing to assist in getting them.—*Mechanical 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, 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 and simultaneously published.

Below are given records of the interpretations of the committee in cases Nos. 588, 595, 596, 597, 598, as formulated at the meeting on May 11, 1928, all having been approved by the council. In accordance with established practice, names of inquirers have been omitted.

CASE No. 588 *Inquiry:* Will it be permissible in the forming of water legs in vertical tubular and firebox types of boilers to attach the OG or flanged-in bottom edges of the plates by fusion welding as shown in Fig. 25? Case No. 313 permits of this construction for

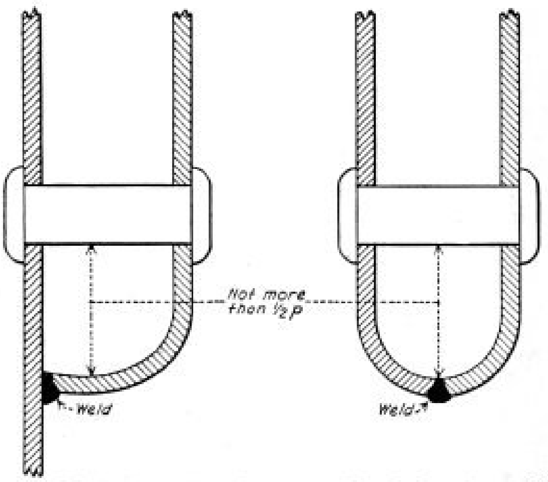


Fig. 25.—Methods of forming water-leg joints by welding

water legs of detached smokeless fireboxes, but the opinion of the committee is requested in regard to this construction for water legs forming parts of boilers.

Reply: Par. P-186 of the code has been revised to provide for joints between the door-hole flanges of furnace and exterior sheets of boilers, provided these sheets are properly stayed or supported around the door-hole opening. It is the opinion of the committee that where the load due to internal pressure on the plates forming the water leg is carried by staybolting, the construction shown in the figure to the right where both plates are flanged, will meet the requirements of the revised paragraph. The plates may be considered as fully supported if the distance from the weld to the nearest row of staybolts is not more than one-half the pitch allowed by the formula in Par. P-199.

CASE No. 595 (In the hands of the Committee).

CASE No. 596 *Inquiry:* The opinion of the Boiler Code Committee is requested as to the suitable value for the constant *C* in the formula of Par. P-199 of the code when applied to miniature boilers constructed of rectangular open-hearth steel pipe or tubing for the shells, the lengthwise edges of which have a continuous support instead of the intermittent support obtained from the use of staybolts. The cross section of the pipe or tubing will be from 6 to 9 inches in its longest dimensions and 3 to 5 inches in its shortest dimension, and it is pointed out that for the conditions of use intended it will be desirable to use the thinnest wall permissible down to a minimum of 5/16 inches.

Reply: It is the opinion of the committee that for the construction specified, the strength should be calculated by the method given in Par. P-207, and that the plate forming the sides of the box should have a thickness to give the proper transverse strength with a factor of safety of 5 at the maximum allowable working pressure. The length of the plate subjected to transverse stress should be taken as the distance between the inside surfaces of the two sides of the box.

CASE No. 597 *Inquiry:* Does malleable iron have any rating of allowable strength in the Code for Unfired Pressure Vessels? In other words, will a cored malleable-iron head in which the steam chamber could be made ½ inch deep, meet the requirements of this section of the code, and how will a correct thickness of the walls thereof be determined?

Reply: It is the opinion of the committee that any of the materials permitted in Section I of the Code for Power Boilers, although not referred to in Section VII of the Code for Unfired Pressure Vessels, may be used in the construction of unfired pressure vessels, provided the requirements of the Code for Power Boilers corresponding thereto are met. The use of malleable iron for a steam chamber is therefore permissible.

CASE No. 598 *Inquiry:* Will it be permissible under the rules of the Power Boiler Section of the code to use for cleanout openings a special type of plug with gasket attached, which fits into a thimble or nipple threaded into the water leg, instead of the usual form of threaded opening with pipe plug as referred to in Pars. P-266 and P-267? It is pointed out that with this construction there is no danger of crossing threads in inserting the plug and that the tightness is dependent upon gaskets rather than tapering threads.

Reply: There is nothing in the code to prevent the use of the type of plug described, provided it will meet the requirements of the code where reference is made therein to such plugs.

Shop Junk

DIVIDE the net earnings of your shop for a year by the square feet of shop area. The quotient will be the yearly value of each square foot of shop floor space. Assume a net profit of $5,000 for your 50x100-foot shop of 5,000 square feet of floor space. Then, that space is worth just $1.00 per square foot per year.

Now, estimate the number of square feet of shop floor occupied by junk or obsolete tools or material. Is that floor space paying you $1.00 per foot per year? No? Then, hadn't you better clear out the junk and put that floor space under something which will pay?

In other words give thought to utilizing the available space in your plant in some productive way.

Revisions and Addenda to 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 of the rules and 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 the secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the committee for consideration.

After 30 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 American Society of Mechanical Engineers 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.

PAR. P—195. REVISED:

P—195. *Heads.* The thickness OF [required in] a BLANK unstayed dished head with the pressure on the concave side, when it is a segment of a sphere, shall be calculated by the following formula:

$$t = \frac{8.33\ [5.5] \times P \times L}{2 \times TS} [+1/8]$$

where t = thickness of the plate, in., P = maximum allowable working pressure, pounds per square inch, TS = tensile strength, pounds per square inch, and L = radius to which the head is dished, MEASURED ON THE CONCAVE SIDE OF THE HEAD, inches.

Where two radii are used the longer shall be taken as the value of L in the formula.

When a dished head has a manhole opening, the thickness [as found by these Rules] shall be increased by not less than 15 PERCENT OF THE REQUIRED THICKNESS FOR A BLANK HEAD COMPUTED BY THE ABOVE FORMULA, BUT IN NO CASE LESS THAN 1/8 INCH ADDITIONAL THICKNESS OVER A BLANK HEAD [over that called for by the formula]. Where a dished head has a flanged opening supported by the attached flue, an increase [of 1/8 inch] in thickness OVER THAT FOR A BLANK HEAD is not required. If more than one manhole is inserted IN A HEAD, THE THICKNESS OF WHICH IS CALCULATED BY THIS RULE, the minimum distance between the openings shall be not less than one-fourth of the outside diameter of the head.

THE RADIUS TO WHICH THE HEAD IS DISHED SHALL NOT BE GREATER THAN THE DIAMETER OF THE SHELL TO WHICH THE HEAD IS ATTACHED.

Where the radius L TO WHICH THE HEAD IS DISHED is less than 80 percent of the diameter of the shell [or drum to which the head is attached] the thickness OF A HEAD WITH A MANHOLE OPENING shall be at least that found [by the formula] by making L equal to 80 percent of the diameter of the shell [or drum]. THIS THICKNESS SHALL BE THE MINIMUM THICKNESS OF A HEAD WITH A MANHOLE OPENING FOR ANY FORM OF HEAD.

A BLANK HEAD OF A SEMI-ELLIPTICAL FORM IN WHICH THE MINOR AXIS OF THE ELLIPSE IS AT LEAST ONE-HALF THE DIAMETER OF THE SHELL SHALL BE MADE AT LEAST AS THICK AS THE REQUIRED THICKNESS OF A SEAMLESS SHELL OF THE SAME DIAMETER. IF A MANHOLE IS PLACED IN AN ELLIPTICAL HEAD THE THICKNESS SHALL BE THE SAME AS FOR AN ORDINARY DISHED HEAD.

THE DIAMETER OF THE SHELL TO BE USED IN APPLYING THESE RULES SHALL BE THE INNER DIAMETER OF THE SHELL FOR A HEAD FITTED TO THE INSIDE OF THE SHELL, AND THE OUTER DIAMETER OF THE SHELL FOR A HEAD FITTED TO THE OUTSIDE OF THE SHELL.

Unstayed dished heads with the pressure on the convex side shall have a maximum allowable working pressure equal to 60 percent of that for heads of the same dimensions with the pressure on the concave side.

PAR. P—196. REVISED:

P—196. When dished heads are of a less thickness than called for by Par. P—195, they shall be stayed as flat surfaces, no allowance being made in such staying for the holding power due to the spherical form UNLESS ALL OF THE FOLLOWING CONDITIONS ARE MET:

A THAT THEY BE AT LEAST TWO-THIRDS AS THICK AS CALLED FOR BY THE RULES FOR UNSTAYED DISHED HEADS.

B THAT THEY BE AT LEAST 7/8 INCH THICK.

C THAT THROUGH STAYS BE USED ATTACHED TO THE DISHED HEAD BY OUTSIDE AND INSIDE NUTS.

D THAT THE MAXIMUM ALLOWABLE WORKING PRESSURE SHALL NOT EXCEED THAT CALCULATED BY THE RULES FOR AN UNSTAYED DISHED HEAD PLUS THE PRESSURE CORRESPONDING TO THE STRENGTH OF THE STAYS OR BRACES SECURED BY THE FORMULA FOR BRACED OR STAYED SURFACES GIVEN IN PAR. P—199 USING 70 FOR THE VALUE OF *C*.

If a dished head is formed with a flattened spot or surface [for the attachment of a connection or flange], the diameter of the flat spot shall not exceed THAT ALLOWABLE FOR FLAT HEADS AS GIVEN BY THE FORMULA IN PAR. P—195 (the formula for flat heads to be published later on) [the value of p as given in the formula in Par. P—199 or in Table P—6 for the pressure and thickness of head involved].

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 3 times [plate] thickness OF THE MATERIAL IN THE HEAD [up to t — 1/8 inch]; BUT IN NO CASE LESS THAN 6 PERCENT OF THE DIAMETER

OF THE SHELL [for thicker plates the corner-radius shall not be less than 3 percent of L in Par. P—195, and in no case less than 1½ inches].

PAR. P—198. REVISED:

P—198. A FLANGED manhole opening in a dished head shall be flanged to a depth measured from the outside OF THE HEAD AT THE MAJOR AXIS of not less than 3 times the required thickness of the head FOR PLATE UP TO 1½ INCHES IN THICKNESS. FOR PLATE EXCEEDING 1½ INCHES IN THICKNESS THE DEPTH SHALL BE THE THICKNESS OF THE PLATE PLUS 3 INCHES. A MANHOLE OPENING MAY BE REINFORCED BY A RIVETED MANHOLE FRAME OR OTHER ATTACHMENT IN PLACE OF FLANGING.

PAR. P—230*b*. REVISED:

b In a form of CONSTRUCTION [reinforcement] for crown sheets where the top sheet of the firebox is a part of a circle, THAT PART OF THE CROWN SHEET, not exceeding 120 degrees in arc, MAY BE [and is] braced with arch bars extending over the top and down below the top row of staybolts [at the sides] CONNECTING THE FIREBOX SHEET AND WRAPPER SHEET WHERE THESE SHEETS BECOME PARALLEL, these arch bars being riveted to the water side of the crown sheet through thimbles, and the maximum allowable working pressure should be determined by adding to the maximum allowable working pressure for a plain circular furnace of the same thickness, diameter, and length determined by the formula in Pars. P—239 and P—240, the pressure P_1 determined from the following formula, which is a modification of that in Par. P—241*a*:

$$P_1 = 10{,}000{,}000 \frac{b \times d^3}{D_1 \times D^3}$$

provided that the maximum allowable working pressure must not exceed that determined by the formula for furnaces of the Adamson type, in Par. P—242 when L is made equal to p, and also provided that the diameter of the holes for the staybolts in the crown bars does not exceed 1/3*b*, and the cross-sectional area of the crown bars is not less than 4 square inches Par. P—199 would govern the spacing of the staybolts, rivets or bolts attaching the sheet to the bars, and Par. P—212*d* the size of the staybolts, rivets or bolts.

where b = net width of crown bar, inches
d = depth of crown bar, inches
D_1 = longitudinal pitch of crown bar, inches
D = 2 times radius of crown sheet.

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, OR OF SUCH OTHER THROUGH-BLOW CONSTRUCTION AS TO PREVENT STOPPAGE BY DEPOSITS OF SEDIMENT, AND TO INDICATE BY THE POSITION OF THE OPERATING MECHANISM WHETHER IT IS IN OPEN OR CLOSED POSITION; 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. S—258*c*. REVISED:

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 LOCATED IN a [diametral] plane perpendicular to the axis of the forging WITH ITS MIDDLE POINT ON A RADIUS OF THE FORGING AND THE AXIS OF THE SPECIMEN PERPENDICULAR TO THAT RADIUS.

PAR. M—12. REVISED:

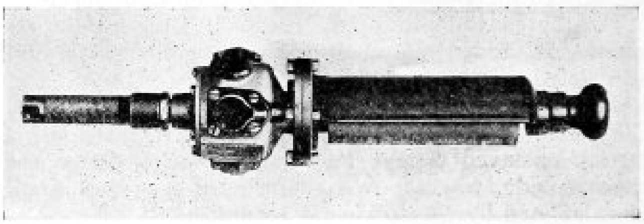
M—12. Every miniature boiler shall be provided with at least one feed pump or other feeding device, except where it is connected to a water main carrying sufficient pressure to feed the boiler OR WHERE [except that when] the steam generator is operated with no extraction of steam (closed system) [no feeding device is required but]. IN THE LATTER CASE, in lieu OF A FEEDING DEVICE [thereof] a suitable connection or opening shall be provided to fill the generator when cold. Such connection shall not be less than ½ inch pipe size.

PAR. M—15. REVISED:

M—15. Each miniature boiler shall be equipped with a steam gage having its dial graduated to not less than 1½ times the maximum allowable working pressure. The gage shall be connected to the steam space or to the steam connection to the water column by a BRASS OR BRONZE COMPOSITION siphon tube or equivalent device that will keep the gage tube filled with water.

Pneumatic Rod Grinder

THE size 63 rod grinder is a new portable pneumatic grinder which has been developed by the Ingersoll-Rand Company, 11 Broadway, New York city. This tool, which takes a 6-inch grinding wheel and is provided with an outboard bearing and hand grip, has been developed primarily for grinding locomotive side and main rods and valve motion rods on the polishing operation. Its compact and light construction and its wide-faced wheel, however, make it an ideal machine for grinding any wide surface which is to have a smooth finish.



New Ingersoll-Rand pneumatic rod grinder

While the machine is new, the construction is the same as that used on the other Ingersoll-Rand portable grinders. The motor has three cylinders spaced about the center line of the spindle, all delivering power to one crank pin. This arrangement, together with a counterweighted crank, almost entirely eliminates vibration and insures a steady torque at the spindle. Each of the three cast iron cylinders is a part separate from the aluminum case. They are all interchangeable and readily removed and replaced. The valve, crank, and spindle are one piece, so that there is no intermediate valve or spindle driving mechanism to wear. This crank spindle is supported by three sets of ball bearings, which reduce friction to a minimum and keep the valve portion from bearing on its bushing and causing wear.

Grinding wheels for these machines are 6 inches long by 2½ inches diameter, and have a 9/16-inch arbor hole. They are made in two different grits and grades. The weight of the tool with grinding wheel is 16¼ pounds; the average free speed 6,000 revolutions per minute; and length overall is 23¼ inches.

Sixth Meeting of the National Board

The complete report of the sixth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors was received too late for it to appear in the July issue of THE BOILER MAKER. *A short account, however, appeared on page 196 of that issue. The following abstract of the transcript of the proceedings indicates the scope of the work covered and the far-reaching effect that this body has on the manufacture and use of power boilers and pressure vessels in the United States. The sessions were devoted to the reading of papers on subjects dealing with technical and practical features of boiler construction and inspection, and to the discussion of specific inspection problems, which have occurred in the various states and cities, operating under the A. S. M. E. Boiler Code.*

ALL attendance records were broken at the sixth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors, held at the Hotel Lawrence, Erie, Pa., Monday, June 18 to Thursday, June 21; about 100 members and guests of the body were present, including chief boiler inspectors of states and cities, boiler manufacturers, insurance inspectors and supply men. Chairman C. D. Thomas, chief inspector, state of Oregon, presided throughout the four days' duration of the meeting.

After the formal welcome to the city by Thomas Mahaffey, substituting for the mayor, Chairman Thomas introduced Henry Sims, of the Sims Company, Erie, Pa., who spoke in part as follows:

Abstract of Mr. Sims' Address

Yesterday I had the pleasure and responsibility of enjoying my eighty-first birthday. I suppose I was there eighty-one years ago, but I do not remember it. I remember some things, however, a very short while after; so short that I can hardly assume the responsibility of telling you how young I was when I came in contact with the steam boiler and the steam engine. My father was an engineer at that time, in a small rolling mill in England. As a boy, I visited my father when at work, and I have very vivid recollections of that plant. I can see it now, with all the characteristics of that early day in steam engineering. In the first place, as you older men, for I see there are some gray hairs here, will remember, a boiler in those days was made of a series of patches. About the biggest thing you could get in sheets would be 36 inches square. Since then, I have been in contact with the methods of making those patches out of which boilers were constructed; the piling up of several chunks of iron and putting it under the sling hammer and tossing it around here and there to weld it together.

At fourteen years of age, I took charge of a steam plant. Of course it was a small one because I was small, but nevertheless I had charge of an engine and boiler. Now the boiler I took charge of was just as up-to-date as the one I just referred to; that is to say, there were neither tubes nor flues in the boiler; it was simply a tank set in brickwork out of doors. There was not even a shed over it, and when it rained there was just a cloud of steam, which of course was interesting to my young mind, but which I have thought of many times since as being a wasteful procedure. The coal was just dumped in front of the boiler, rain or shine, and when the fireman fired this coal in he might have half a shovel full of water and half a shovel full of coal, and that was the way they economized in those early days. Then, with regard to the refinements. I remember the lack of them in comparison to these days. The boiler I had charge of had no water gage; it had not a glass gage or a try-cock. There was, however, a float in the boiler, a little rod shoved up through the shell of the boiler with a stuffing-box and a chain around a wheel and a balance weight, and when we wanted to know where our water was, we gave it a swing around and it would finally find the level. When we wanted to empty a boiler like that, we did the reverse of what we did when we had to fill it. When we filled the boiler, we took a club and put it into a hole about 7/8 inch in diameter, and that was our stopcock, and when we wanted to empty the boiler, we had to reverse the thing and just drive it out. When we drove it out, then we had to run. That was the way we handled boilers in those days.

Later, when I came in touch with marine engineering, they not only had to have a safety valve on their boilers, but an inverted safety valve, so that when they were working below atmospheric pressure to save the boiler from collapsing, they had an inverted pressure valve and would take in air and break the vacuum for the time being. Those were the early days of engineering and the handling of boilers. Well, they have passed.

I do not believe there has been any period of time worth mentioning that I have not been in touch with boilers from that day to this. Sixty-two years ago, on the eighth of this month, I came to this city from England, an absolute stranger. I did not know a soul in the United States. I perhaps would have gone further, for I did not know anything about Erie, any more than that was about as far as my money would take me, and when I got off the train I had two dollars and fifty cents left, and, as I say, I was an absolute stranger. I have been here sixty-two years, and today myself and my two sons have a very fine plant, making small, low-pressure boilers, among other things, employing about 120 men. I believe it is your plan to go through our plant some time while you are here, and we will be very glad to have you.

George W. Bach, of the Union Iron Works, was next introduced to address the meeting. His remarks in part follow:

Mr. Bach's Talk

Erie, as you know, is particularly identified with your work and your organization, because we are probably the largest producers of boilers in this country; if not in numbers any more, since some of these shops out west have gone into the production of small heating boilers, probably in horsepower. The name of Erie is synonymous with boilers, always has been and always will be. We have in Erie four large boiler shops, the Erie City Iron Works, the Nagel Engineering and Boiler Works, the Pennsylvania Boiler Works and the Union Iron Works, all of them old concerns with which you are all familiar.

You get our test reports and data, practically daily in all your offices. You are going to visit some of the shops here, I understand, and I am sure you will see things that are interesting to you. I am satisfied that the proprietors and the men in charge will welcome you with open arms and will also welcome any constructive criticisms that you men, in your wisdom and judgment, will make in the interest of better boilers for better Erie. The day when the inspector in the boiler shop was unwelcome has passed. We look on the inspector today as a man who comes there, not with the idea of destructive criticism and fault finding, but to give us constructive criticism and in a helpful mood to make better boilers and to increase the public safety, and on behalf of the manufacturers' association I welcome you to Erie and hope that you enjoy your stay.

Following this talk, William H. Haas, safety director of the city of Erie, spoke briefly on the work of his department. Chairman Thomas then made the following address:

Abstract of Chairman Thomas' Address

The boiler manufacturers of the country should be interested in what we do at this meeting; for it is in their interest as well as in the interests of the A. S. M. E. Boiler Code Committee that we are gathered. It would no doubt be to the advantage of both the boiler manufacturers and the National Board if the boiler manufacturers had a permanent representative in our organization, as important questions often arise in the manufacture of boilers which do not necessarily belong to the Boiler Code Committee work. A closer cooperation between the manufacturer and inspectors holding commissions in the National Board would create a better understanding of the proper application of the code. We already have full cooperation with the Boiler Code Committee by having a representative at their meetings and so it should be with the manufacturers.

The American Welding Society is undoubtedly very much interested in the advancement of the welding art as applied to pressure vessels and, since this is a matter of education and requires the dispensing of knowledge from those who have had experience and have proved by tests and various methods what is safe practice, it would be advisable for this society to place every member of the National Board on their mailing list in order that they may be kept informed of the progress made. Also there may be inspectors who are prejudiced against welding as applied to pressure vessels and by this means they will be kept informed of the progress made and this prejudice will gradually disappear. The welding society should bear in mind that the inspection force of this country will have a great influence in formulating amended rules to the Code for Unfired Pressure Vessels and so long as the inspectors are limited in their knowledge concerning this art, rapid progress will be retarded. It is also the duty of the inspector to grasp every opportunity to increase his knowledge along these lines.

Many important questions have sprung up since our last meeting and perhaps the most important of all is the question of stamping boilers and pressure vessels. If the Boiler Code Committee could provide some means whereby all boilers and pressure vessels could be stamped with the A. S. M. E. symbol it would simplify matters considerably. To do this it might be necessary to require all manufacturers of boilers and pressure vessels to register with the Boiler Code Committee. If a manufacturer attempts to manufacture boilers or pressure vessels in accordance with the A. S. M. E. Code rules it should be mandatory that he register with the Boiler Code Committee. This is required for power boilers only at the present time, but it should apply to all vessels manufactured in accordance with the various codes.

Another important question is the qualification of the inspector who makes the shop inspection. The code at the present time requires only that the inspector be a man employed by a state, municipality or insurance company. While it is true that most states and municipalities which have laws regulating the manufacture and installations of boilers are governed by the code, yet some are not and yet by the code regulations, the inspectors of such states and cities are qualified to pass on a code boiler in the shop. It is also true that many manufacturers require of the inspectors who make their shop inspections that they hold a commission from the National Board, yet all do not by any means make this a requirement. Also many states and cities have no laws regulating the manufacture and installation of boilers, and in such states and cities the only inspector is an insurance company inspector. In some of these states and cities we have manufacturers who make both code and non-code boilers and some of the inspectors in such places do not hold National Board commissions and could not pass the required examination to obtain such a commission.

You can readily see by this that it is possible for an unqualified inspector to make a shop inspection. Conditions of this kind make it possible for an unscrupulous manufacturer to build a boiler which may not meet all the code requirements and undersell his honest competitor who does comply with all the requirements.

The boiler may be stamped code and yet not meet all the requirements of the code. We have no control over the inspector who does not hold a National Board commission. These conditions may be rare, but not so rare as one would suppose. It is therefore necessary that the A. S. M. E. symbol and the letters A. S. M. E. Standard be safeguarded in all possible manner. This can only be done by the National Board having complete control over all inspectors who make the shop inspections. In order to make this control complete it is necessary that all boilers and pressure vessels be stamped with the A. S. M. E. symbol. Also Par. P-332 should be so amended that after the words "or an inspector employed regularly by an insurance company" there should be added "and who holds a commission to inspect boilers from the National Board of Boilers and Pressure Vessels Inspectors." It is possible that the code committee may object to these words. If so, some phrase could be substituted that would mean the same thing.

During the first few years of our organization we seemed to progress rapidly in the way of additional states and cities adopting the A. S. M. E. Code of Boiler Rules as a standard, but for the past two years or more, additions are being made very slowly. In fact, no material progress has been noted. This condition may be the result of natural causes. However, it is easier to assume it to be due to the inactivity of organizations promoted to advance uniformity in the various states and cities. Members of the National Board have had ample time since our organization to readily appreciate that by means of this organization we are able to make uniform application of the code in all the states and cities operating under the code so that there is now one standard in the manufacture of boilers; one standard in the installation and one standard in the operation.

It is presumed that all fully realize the advantage of this condition, yet the thought occurs that we may be just a little bit selfish in that we do not spread this gospel in new and untried fields. True we cannot advertise it broadcast, but when inquiries are made of us from outside sources we can at least tell all the good it has done in our own states and cities and advise the adoption of the A. S. M. E. Code unmodified for new installations and that local laws governing existing installations be made to conform to local conditions.

The American Uniform Boiler Law Society, which has rendered excellent service in the field for the advancement of uniform Boiler law legislation, has been rather inactive of late or at least we have had no reports of progress at these meetings since 1925. It is not our purpose to criticize the action of this society, but rather to commend it for past services in this the most important field of safety and accident prevention. It is most important to the boiler manufacturers and society at large that they continue in their efforts until every state and important city has adopted the A. S. M. E. standard for the construction of all pressure vessels. And further, we wish to assure them that this organization, The National Board, stands ever ready to assist them in every movement for advancement they make.

At the conclusion of the chairman's address, Thomas E. Durban, of Erie, Pa., was introduced and gave an outline of the history of the foundation of the A. S. M. E. Boiler Code and of the promulgation of it through the work of the American Uniform Boiler Law Society. He impressed upon the members their responsibility as inspectors and the need for further spreading the code gospel to the states that have not already adopted it as a standard.

The report of C. O. Myers, secretary of the National Board and chief boiler inspector, state of Ohio, next read his annual report. As the greater part of this report appears on page 175 of the June issue of The Boiler Maker, it will not be repeated here.

The next order of business was the reading of the statistical report for the past year covering the period from June 17, 1927 to June 1, 1928, by L. C. Peal, city boiler inspector, Nashville, Pa.

Report of Boiler Statistics

I have endeavored to arrive at the number of boilers in non-code territory by deducting the number of boilers in code territory from the total number of insured boilers.

We have had 284,378 boilers insured by the various companies. There were a total number of 215,952 boilers reported by the 19 chief inspectors who responded to our questionnaire. This leaves 68,426 boilers for non-code territory. This number covers insured boilers only.

There were 345 accidents reported to the statistician during the year and I have segregated them into various classifications, code, and non-code, type of boilers, or vessels, and major and minor accidents. While it is rather difficult in some cases to make the distinction between major and minor accidents, we arrived at the decision by putting into the minor classification all accidents, where there were no fatalities or injuries and only a small property damage.

Code boiler accidents	49
Non-code boiler accidents	290
Non-code unfired pressure vessel accidents	6
Code boiler accidents fatalities	1
Non-code boiler accidents fatalities	12
Code boiler property damage accidents	$15,676.77
Non-code boiler property damage accidents	$114,431.00
Unfired pressure vessel fatalities	4
Unfired pressure vessel injuries	6
Unfired pressure vessel property damage	$28,000.00
Watertube boiler failures	77
Horizontal tubular boiler failures	35
Vertical tubular boiler failures	8
Firebox boiler failures	15
Cast iron sectional boiler failures	210

Note—There were 42 major accidents, 6 of them to code boilers and 36 to non-code; a ratio of 6 to 1

Ninety percent of the watertube and horizontal tubular boiler accidents were tube and blow-off failures, emphasizing the necessity of safety latches on fire and cleanout doors. There are only five failures reported on low-pressure steel boilers with a loss of $528 while the 210 failures on cast iron sectional boilers total $66,590.82; a 126 to 1 ratio.

In conclusion, I would like to suggest that cards addressed to the statistician, with suitable blanks on the opposite side be furnished all of the boiler inspectors to be mailed to the statistician, while an accident is fresh in mind, in order that we may secure more reliable data, eliminating the possibility of duplication.

Chairman Thomas next introduced F. A. Page, chief boiler inspector, state of California, who gave an address on "The Unfired Pressure Vessel Situation of California." This paper will appear in a later issue.

Charles E. Gorton, chairman of the Administrative Council of the American Uniform Boiler Law Society, next gave an outline of progress made by the society in recent months. A similar report has appeared in connection with the meeting of the American Boiler Manufacturers Association and so will not be repeated.

Routine business and the appointment of special committees completed the work of the first session.

Tuesday Session

The Tuesday business session was brought to order by Chairman Thomas at 9:30 A. M. The first order of the meeting was the appointment of a committee to pass on boiler and accessory designs and appliances, submitted the National Board for approval. The first address of the session was on the subject of "Dished Heads" prepared by Dr. D. S. Jacobus of the Babcock & Wilcox Company, New York, but which, in his absence, was read by C. W. Obert, former secretary of the Boiler Code Committee. This paper will appear in full in a later issue.

The subject "Alloy Materials for Boilers, Shells and Tubes" was presented in an address prepared by J. V. Romer and W. W. Eaton of the Babcock & Wilcox Company. This paper will appear in a later issue.

George W. Bach, Union Iron Works, Erie, Pa., was introduced to address the National Board on the subject of "The Relationship between the Boiler Manufacturer and the National Board." This paper will also appear in abstract form in a later issue.

E. R. Fish, Heine Boiler Company and Ladd Water Tube Boiler Company, New York, both as a boiler manufacturer and as a member of the Boiler Code Committee, discussed the functions of the National Board in an informal talk which will be published later in abstract form.

The final paper presented at the Tuesday session was one prepared by H. Leroy Whitney, of the M. W. Kellogg Company, New York, on the subject of "Reinforcement of Openings." In Mr. Whitney's absence, R. R. Hopkins, of this same company, delivered the talk, which, as space will not permit in this issue, will appear later.

Wednesday Session

The Wednesday session was opened at 9:30 A. M. by the chairman. C. O. Myers, secretary, addressed the meeting on the future progress of the National Board as follows:

Future Progress of Board

The National Board of Boiler and Pressure Vessel Inspectors was organized for the purpose of securing the cooperation of the various states and cities throughout the United States in the administration of boiler inspection laws and ordinances. The cooperation of these state and city officials is voluntary and the success of this organization depends absolutely upon the trust and confidence that the states and cities operated under the A.S.M.E. Boiler Code have in one another. We are pleased to state that up until this time, and there is nothing that we can see that will disturb it, that this confidence has been inspired by these annual gatherings that we have had and the personal contacts made by such meetings.

It is of the utmost importance that this trust and confidence be maintained between the membership of this organization to fulfill the object for which it was organized and we must always bear in mind that these meetings of ours are watched very closely by the various interests who are affected by our actions. To maintain our position and to grow into the position in which we belong, we must not let personalities, petty politics, or petty propaganda govern our actions, as these can bring forth no good. We must always bear in mind the greater things that are before us and the things that are expected of us. I might say that a great deal is expected of this organization.

I have hopes that some day the National Board will be in a position to finance the installation of a testing laboratory for the purpose of approving boiler appurtenances and specific designs of boilers. I would like to develop the statistical department of the National Board to the extent that reliable statistics might be gathered; statistics that would give a true picture of what is happening to the boilers throughout the United States. I would like to see the National Board in a position, and I know the Boiler Code Committee is of the same mind, that they could relieve the code committee of the small detail work which is now placed before it, such as deciding upon matters that pertain to the administration of the code, and leave only such work for the code committee as interpretations and revisions. It will be some time before the National Board is in a position to do all these things, but I am confident that if we work with one another, and have the proper trust and confidence in one another, that these objects will be attained and when they are will be rendering the country a great service.

While confidence and trust between the states and cities is absolutely necessary to obtain uniform administration of boiler inspection laws and regulations, there is still another end toward which we must work, and that is, establishing a confidence in us by other interests that are affected by our decisions. We must remember and have before us at all times that our decisions affect certain interests, either boiler manufacturers, insurance companies, or the users of boilers. These interests have a right to their opinion, and, because we have the authority to insist that our opinion be enforced, does not mean that in all cases we are right. When deciding upon important questions, it is always best to consider the other side and be sure before a decision is made that both sides of the case have been taken into consideration.

We feel that the boiler manufacturers, should be asked to select one or more of their members to represent them upon the executive committee of the National Board. Such an arrangement would show that we desire to be fair in all of our dealings, and that we are pleased to have a representative of their organization to deliberate with us in working out ways and means for the future advancement of the National Board. We must remember that this movement is too great and far-reaching for us to progress alone, and that we are collecting our fees for the registration of boilers, from the boiler manufacturers, which makes it possible properly to finance this movement. Financing of any undertaking is one of the important parts of it, and it is only fair that we request of the American Boiler Manufacturers Association that they select from one to three of their membership to act upon the executive committee of the National Board, for the purpose of assisting in formulating the policies of the National Board. We would like to have this thought thoroughly discussed at this meeting and some action taken upon it.

The progress to date of the National Board is due to the combined efforts and the cooperation obtained by the members of this association together with the cooperation given them by the boiler manufacturers and the insurance companies, and we trust that this good feeling will continue to exist, as it means continued progress and finally the attainment of the position to which the National Board belongs.

The remainder of this session was devoted to business and the discussion of current matters in connection with the work of the board. This discussion appears below.

Discussion

CHAIRMAN THOMAS: A motion has been made that the National Board invite a representative of the American Boiler Manufacturers Association, of the American Welding Society and of the Boiler Code Committee of the American Society of Mechanical Engineers to participate in the activities of this body.

The motion was adopted.

CHAIRMAN THOMAS: During the past year, there have been questions brought up before the executive board which have been acted upon; those questions will now be presented to you for your approval or disapproval.

The action taken by the board on these questions appears on page 196 of the July issue.

SECRETARY MYERS: The next is the procedure on manufacturer's data reports.

"For boilers that are not completely assembled in the shop, or are not assembled in the field by the maker of the drums, headers or other major parts, the responsibility for the stamping on the drums shall rest upon the manufacturer of those parts and the qualified inspector who witnessed the construction. A manufacturer's data report covering the drums, headers, etc., shall be prepared and filed, and shall be signed by that manufacturer and the inspector.

On the complete assembly and final inspection and hydrostatic test of the boiler in the field, a complete report shall be filed on the boiler when ready for use by a commissioned inspector making final inspection.

Each drum of multiple drum boilers, shall be stamped with the same standard number and shop number."

The action of the executive committee was seconded and unanimously adopted.

SECRETARY MYERS: The attention of the Boiler Code Committee was called to the lack of uniformity between certain state laws and the A. S. M. E. Code in that the state laws require the date the boiler was built to be stamped on the boiler upon completion, and the code provides for the date the boiler was put in service. This matter was referred to the executive committee. The executive committee unanimously agreed and so advised the code committee that boilers should be stamped upon completion with the year built.

This action of the executive committee was also approved.

W. P. EALES: These three or four items have been suggested by the report of Mr. Myers, the secretary. In order to handle them properly, we subdivided them a little, and we happened to indicate this as No. 1. It has to do with the use of the symbol in the stamping of boilers and unfired pressure vessels. The committee, in session yesterday, adopted this, and submits it for your consideration. We recommend that the clover leaf symbol of the American Society of Mechanical

Engineers having within it the capital letter S be continued, as at present, for use on boilers built to the requirements of the power section of the code; further, that the clover leaf symbol also be used on all code boilers of other types and purposes, substituting for S the letter L for locomotive boilers and H for boilers built to conform to the heating section of the code. For miniature boilers the size of the clover leaf is to be reduced approximately 3/8 inch and to contain the letter M. Unfired pressure vessels are to be stamped with the full-size clover leaf symbol having within it the letter U. Further, that the use of the stamping A. S. M. E. stencil be discontinued, as well as the manufacturer's registration number.

This meeting approved the committee's action.

W. P. Eales: The next item has to do with the stamping of miniature boilers and unfired pressure vessels, which has been covered in the first, but not the registration of those, so your committee recommends that all boilers and pressure vessels, when properly stamped and on completion, be registered at the office of the secretary-treasurer of the National Board.

Chairman Thomas: Mr. Myers will explain the whys and wherefores of this proposal.

Secretary Myers: Up to this time we have only had provision for registration at the National Board office of boilers that were constructed to the Power Code, and it seems that we have struck our saturation point on power boilers; that is, we are getting practically all code boilers that are being constructed under the A. S. M. E. Code. What leads us to believe this is that for the last three years we have been recording around twenty thousand and are holding at about that point. Since we have covered this matter completely, I feel that it would be a good time to extend it a little further and include these other codes, if it meets with the approval of this board. It will also help our revenue.

Jos. F. Scott: Do you think there will be any objection by the builders of unfired pressure vessels to following out this procedure?

Secretary Myers: I think many of them will welcome it; the better ones want it; they are asking for it. The builders of miniature boilers are asking for it. The State of Pennsylvania made a special request that some action like this be taken on miniature boilers, through their secretary, J. S. Arnold, and that is the reason the question was brought up.

Chairman Thomas: I believe that some action should be taken, because, if the Boiler Code Committee acts favorably on the adoption of these stamps as recommended here on the various pressure vessels and the registration of the manufacturers, then their vessels would be universally accepted where the code is in operation. Therefore, I think that the recommendation of the committee is very good. It has been moved and seconded that the report of the committee be accepted on this subject.

The motion was unanimously adopted.

W. P. Eales: The next item is the revision and addition of several sections of the code. The committee recommends that each revision of a paragraph of any section of the code as well as additions thereto, when adopted, shall be promulgated and published not later than July 1 of each year and shall be effective on January 1 the year next following promulgation.

C. W. Obert: Published by whom?

W. P. Eales: By the Code Committee. This is a recommendation going to the A. S. M. E. Boiler Code Committee.

C. W. Obert: Then you cross yourself again; if this recommendation is going to the Boiler Code Committee, you want to say by whom it is to be made effective.

W. P. Eales: The National Board will attend to the enforcement and effectiveness of it. It is for the purpose of having uniformity between the states and cities as to when a revision becomes effective. The fundamental question in this is, should it be annual or semi-annual? I would like to hear some discussion on it.

Jos. F. Scott: How is that going to affect a boiler manufacturer who wants to change the design of some particular part of the boiler? It comes up before the Boiler Code Committee and he wants immediate action, as soon as possible; would you require him to wait a year and a half?

T. R. Archer: He can put a revision into effect any time he wants to. There is no reason why a man cannot put any revision into effect immediately. Six months after final promulgation of a revision, it is mandatory that it be complied with.

Chairman Thomas: The time set in the recommendation is January 1, which would correspond with the year in which the boiler was built, and it naturally brings it to the proper period. I will entertain a motion to adopt the report of the committee.

Jos. F. Scott: It is thoroughly understood now, that the Boiler Code Committee can go ahead and make a revision and adopt it any time without any delay and give immediate relief to the manufacturing concern or the state.

W. P. Eales: You have not put that quite right. The manufacturer, in my individual judgment, can go on as soon as the A. S. M. E. Boiler Code Committee has approved, but he *must* do it on the first of January.

The report was unanimously adopted.

Chairman Thomas: Next will be the report of the committee on questions sent in by the various members of the Board. Mr. Myers I believe is chairman.

Secretary Myers: What should be the allowable safe working pressure on cast-iron mangles? It is the opinion of the committee that there should be some rules and regulations governing the pressure allowed on cast-iron vessels and we recommend that the National Board request the Boiler Code Committee of the A. S. M. E. to give some study to this question, in view of preparing such rules and regulations.

What is the proper height of the water glass on 3-pass low-pressure heating boilers? It is the opinion of the committee that the water level on 3-pass steel heating boilers should not be fixed until the water level on cast-iron boilers is determined.

What is the minimum distance between tubes and shell in both horizontal return tubular and internally fired boilers? The committee recommends that this question be referred to the Boiler Code Committee, as it comes under their jurisdiction.

What repairs (not shop inspected) might change a code boiler to a non-code boiler?

It is the opinion of the committee that repairs affecting the safety of a boiler should be made under the supervision of a qualified inspector and that the workmanship and material be in accordance with the A. S. M. E. boiler code. After giving considerable thought to the matter, it was the unanimous opinion of the committee that we did not care about minor repairs being supervised by an inspector, but it was major repairs that this affects; that is, when patches are put on the boiler or a staybolt or anything done to the boiler that might affect the safe operation of it. It should be done under the supervision of a qualified inspector; in other words, we did not like to use the term major or minor repairs, leaving it to somebody to decide which is a major or minor repair.

Should boilers that have, in exploding, torn themselves loose from their settings and taken a flight, be allowed to be repaired and used again as boilers? It is the opinion of the committee that each case should be judged individually.

Should boilers that have been damaged by explosives set off inside be allowed to be repaired and used again as steam boilers? It is the opinion of the committee that the boiler damaged should not be allowed to be repaired and used again as a steam boiler.

The action of the committee on these points was approved by the meeting. Later in the session further specific constructions were discussed and action of the board approved.

Thursday Inspection Trip

The entire day, Thursday, June 21, was devoted to an excursion tendered to the membership by the Union Carbide & Carbon Corporation to Orville and Alliance, Ohio, in order to demonstrate the extent to which the construction of large, high-pressure tanks and vessels has been made possible by properly controlled oxy-acetylene welding and improved methods of stress analysis.

Orville was reached at 2:00 P. M. where the members were taken to the plant of the Ohio Wood Preserving Company and allowed to observe two all-welded creosoting kilns that are the largest pressure vessels ever fabricated by fusion welding. These kilns are enormous structures, being 90 feet in length by 7½ feet in diameter, formed of 1-inch shell plate and 1¼-inch heads for 200 pounds pressure. They are each fitted at one end with bolted doors hinged to 5 inches thick special alloy-steel end rings welded to the shell, through which 6 tram cars of railroad ties or lumber are charged for the creosoting operation. One was seen in service, subjected to a 200-pound steam pressure and corresponding temperature.

Each kiln has superimposed above it a rouping or oil storage tank of the same welded construction, which is 55 feet in length and 7½ feet in diameter, formed of 11/16-inch plate and ¾-inch heads for a working pressure of 125 pounds. There were also to be seen at this plant 3 welded measuring tanks 7½ feet in diameter by 15 feet 8 inches high which were formed of 1-inch plate and 1⅛-inch heads for 200 pounds working pressure, and also two vapor drums 5 feet in diameter by 17 feet long, formed of 7/16-inch shell plate and 9/16-inch heads for 125 pounds pressure.

Visit to Reeves Plant

After a further ride the expedition came to Alliance where the members checked their baggage and then proceeded to the plant of Reeves Brothers that closely adjoins the business center. The party was welcomed by H. L. Walthour and O. A. Davis of this company and granted the privileges of their tank shop, where a number of the oxy-acetylene welded vessels were to be seen either under construction or undergoing test.

There was under construction one 7-foot by 50-foot storage vessel that is intended for operation at 200 pounds pressure and, with the welding of the longitudinal joint in progress, an excellent opportunity was afforded the members to observe the provisions made for securing proper alinement of the plate edges, as well as the bracing for maintaining the correct circular shape. The testing and the strain gage measurements were shown on one of the large propane storage tanks on which the customary number of measuring points had been laid out on the shells, heads, joints and other points of stress concentration. On this tank the test pressure was carried up in 100 pound steps in order to demonstrate to the visitors the fact that the expansion of such a vessel is definitely measurable by use of the delicate Berry strain gage. This instrument consists of a dial-type lathe indicator which is mounted on a frame carrying one stationary and one movable measuring point, the movable point being so connected to the indicator that the movement thereof is readable to 0.00005 inch.

At the Reeves Brothers plant a total of 22 welded pressure vessels was observed in the course of construction or under test.

Attendance Record at National Board Meeting

The following members and guests of the National Board of Boiler and Pressure Vessel Inspectors attended the sixth annual meeting:

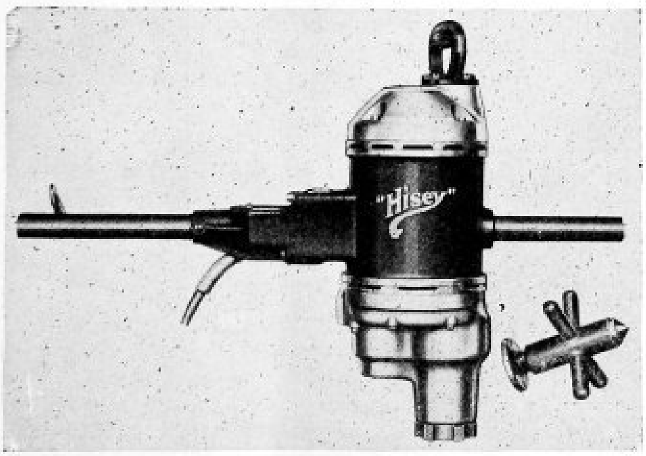
Thomas R. Archer, chief boiler inspector, State of Delaware, Wilmington, Del.
J. S. Arnold, secretary, Industrial Board, Harrisburg, Pa.
Geo. W. Bach, Union Iron Works, Erie, Pa.
A. R. Bailey, Bailey Feed Water Filter Company, Minneapolis, Minn.
Wm. E. Baker, The Stanwood Corp., Covington, Ky.
L. M. Barringer, city boiler inspector, Seattle, Wash.
Clyde Barrow, The Columbiana Boiler Company, Columbiana, Ohio.
R. J. Barrow, The Columbiana Boiler Company, Columbiana, Ohio.
Augustus Black, Travelers Insurance Company, Erie, Pa.
A. D. Blake, representing *Power*, New York, N. Y.
Blaine M. Book, chief boiler inspector, State of Pennsylvania, Harrisburg, Pa.
Geo. D. Bragdon, General Accident Corp., Philadelphia, Pa.
Frank Brinig, Erie City Iron Works, Erie, Pa.
A. P. Campbell, Kewanee Boiler Company, Kewanee, Ill.
H. B. Cannon, Erie, Pa.
Edgar R. Cate, Erie City Iron Works, Erie, Pa.
Hayes Clemens, Erie City Iron Works, Erie, Pa.
L. E. Connelly, The D. Connelly Boiler Company, Cleveland, Ohio.
J. F. Dickson, Kewanee Boiler Corp., Kewanee, Ill.
J. Dilot, The A. O. Smith Corporation, Milwaukee, Wis.
Thomas E. Durban, Erie, Pa.
Wm. P. Eales, The Travelers Insurance Company, Hartford, Conn.
Wm. W. Eaton, The Babcock & Wilcox Company, New York, N. Y.
M. A. Edgar, chief boiler inspector, State of Wisconsin, Madison, Wis.
W. M. Ermine, Erie City Iron Works, Erie, Pa.
Joseph Ernst, city boiler inspector, Buffalo, N. Y.
E. W. Farmer, chief boiler inspector, State of Rhode Island, Providence, R. I.
E. R. Fish, Heine Boiler Company and Ladd Water Tube Boiler Company, New York, N. Y.
Geo. C. Fisher, smoke inspector, City of Nashville, Tenn.
E. W. Fitt, city boiler inspector, Omaha, Neb.
Wm. H. Furman, chief boiler inspector, State of New York, Albany, N. Y.
Gerald Gearon, city boiler inspector, Chicago, Ill.
W. Paul Gerhart, Bethlehem Steel Company, Coatesville, Pa.
G. O. Gondrie, Titusville Iron Works, Buffalo, N. Y.
Chas. E. Gorton, American Uniform Boiler Law Society and American Society of Mechanical Engineers, New York, N. Y.
J. A. Graulty, American Locomotive Company, Schenectady, N. Y.
L. T. Gregg, Hartford Steam Boiler Inspection & Insurance Company, Cleveland, Ohio.
John F. Griggs, Union Iron Works, Erie, Pa.
Wm. G. Haas, safety director, Erie, Pa.
D. C. Harvey, The Fidelity and Casualty Company of New York, New York, N. Y.
T. A. Heringer, chief boiler inspector, State of Utah, Salt Lake City, Utah.
Edward E. Hickey, General Accident Corp., Detroit, Mich.
R. R. Hopkins, The M. W. Kellog Company, New York, N. Y.
S. H. Hunter, U. S. Steamboat Inspection Service, Cleveland, Ohio.
T. McLean Jasper, A. O. Smith Corporation, Milwaukee, Wisc.
A. J. Leary, Korite Incorporated, Boston, Mass.
W. Lyle Linderman, member of industrial board, State of Pennsylvania, Pittsburgh, Pa.
John M. Lynch, Standard Sanitary Manufacturing Company, Erie, Pa.
Thos. Mahaffey, Erie, Pa.
Chas. J. Manney, Ohio Boiler Inspection Department, Columbus, Ohio.
S. W. Miller, Union Carbide & Carbon Research Laboratories, Inc., Long Island City, N. Y.
E. W. Moore, Erie City Iron Works, Erie, Pa.
C. O. Myers, chief boiler inspector, State of Ohio, Columbus, Ohio.
Walter S. McAleenan, The C. H. Dutton Company, Kalamazoo, Mich.
John C. McCabe, chief boiler inspector, State of Michigan, Detroit, Mich.
C. E. McGinnis, city boiler inspector, Los Angeles, Cal.
Lee A. McKinley, The Travelers Insurance Company, Oil City, Pa.
Robert McKinley, General Accident Corp., Detroit, Mich.
F. J. McNamara, Travelers Indemnity Company, Pittsburgh, Pa.
T. J. McNamara, Titusville Iron Works, Titusville, Pa.
H. H. Needham, A. O. Smith Corporation, Milwaukee, Wisc.
Wm. A. Nevin, Heggie-Simplex Boiler Company, Joilet, Ill.
J. D. Newcomb, Jr., chief boiler inspector, State of Arkansas, Little Rock, Ark.
LeRoy Nichels, International Boiler Works Company, Stroudsburg, Pa.

F. W. Norris, Marion Steam Shovel Company, Marion, Ohio.
Frank M. Null, Titusville Iron Works, Titusville, Pa.
C. W. Obert, Union Carbide & Carbon Research Laboratories, Inc., Long Island City, N. Y.
Jas. W. Owens, Newport News Shipping & Dry Dock Company, Newport News, Va.
Frank A. Page, chief boiler inspector, State of California, San Francisco, Cal.
L. C. Peal, city boiler inspector, Nashville, Tenn.
M. A. Pocock, Bailey Feed Water Filter Company, Cleveland, Ohio.
W. O. Prince, Independence Indemnity Company, Cleveland, Ohio.
Wm. J. Ranton, Fidelity and Casualty Company, Rochester, N. Y.
L. V. Reese, Erie City Iron Works, Erie, Pa.
H. E. Rockefeller, Linde Air Products Company, New York, N. Y.
J. B. Romer, The Babcock & Wilcox Company, Bayonne, N. J.
John F. Roney, Erie City Iron Works, Erie, Pa.
Elmer E. Rouscher, A. B. Farquhar Company, Ltd., York, Pa.
D. L. Royer, Ocean Accident & Guarantee Corp., New York, N. Y.
J. Schoestrand, London Guarantee & Accident Corp., Pittsburgh, Pa.
Jos. F. Scott, chief boiler inspector, State of New Jersey, Trenton, N. J.
C. D. St. Clair, Erie City Iron Works, Erie, Pa.
Wm. G. Schafer, The Lima Locomotive Works, Lima, Ohio.
Henry Sims, The Sims Company, Erie, Pa.
Albert J. Singleton, Korite Chemical Company, Pittsburgh, Pa.
Harvey Smith, Erie City Iron Works, Erie, Pa.
Work E. Smith, Union Iron Works, Erie, Pa.
Jas. E. Speed, city boiler inspector, Erie, Pa.
C. D. Thomas, chief boiler inspector, State of Oregon, Salem, Oregon.
S. R. Tymstra, Semet Solvay Engineering Corp., New York, N. Y.
W. H. Walters, representing W. F. Kiesel, Jr., Pennsylvania Railroad Company, Altoona, Pa.
J. G. Warren, Hartford Steam Boiler Inspection & Insurance Company, Erie, Pa.
Jack Wheatley, Columbia Casualty Company, Detroit, Mich.
S. A. Wier, Guiberson Corp., Dallas, Texas.
Geo. Wilcox, chief boiler inspector, State of Minnesota, St. Paul, Minn.
J. F. Wilson, New York Indemnity Company, Pittsburgh, Pa.
G. M. Wilson, American Locomotive Company, Schenectady, N. Y.
J. M. Wood, chief boiler inspector, State of Indiana, Indianapolis, Ind.

A New Universal Drill

THE Hisey-Wolf Machine Company of Cincinnati, Ohio, has announced the new Hisey 1¼-inch capacity universal drill which is equipped with a standard Hisey motor particularly adapted to the service.

The motor is mounted in ball bearings which in turn are fitted in a way to entirely eliminate the slipping and creeping action so detrimental to the motor and other parts. The gear on the armature shaft is removable and made of high grade steel, electrically heat treated.



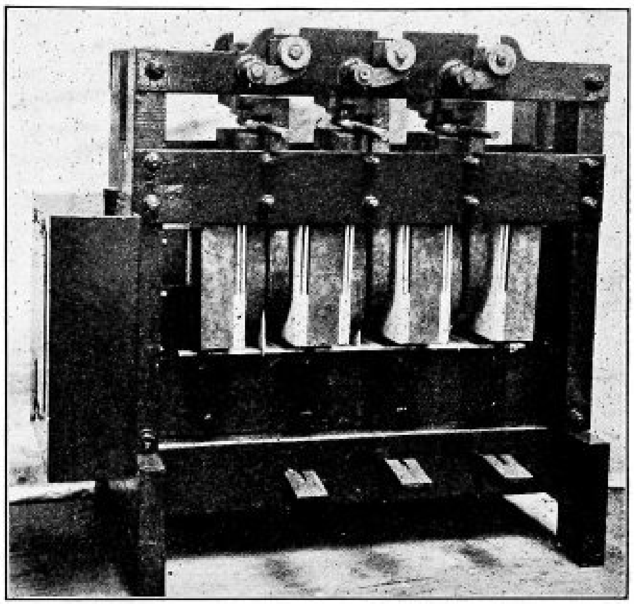
Hisey-Wolf 1¼-inch capacity drill

The drill spindle is fitted with a No. 3 Morse taper socket and is of liberal dimensions hardened and ground and is automatically lubricated through the gear case. Brush holders with adjustable spring tension are mounted as a separate unit on a Bakelite yoke to permit brush adjustment when necessary.

The end handle cover is a rugged casting carrying all pressure applied and is independent of the motor and motor bearings, relieving them of all strain. The Hisey patented and automatic self release switch is standard equipment.

Two-Path Electric Heater for Forging Work

ONE of the recent developments of the American Car & Foundry Company, 30 Church street, New York, is the Berwick two-path electric heater for forging or upsetting work. It is built with one, two, three or five electrodes, as desired. The heating length, as the heaters are now designed, runs from 1 inch to 8 inches, or the heater can be arranged to heat from 3 inches to 11 inches. If desired, the length of heat can be increased by making only a slight change in the design of the standard heater. The No. 3 type heater is recommended for high production where ⅜-inch, ½-inch, or ⅝-inch diameter metal is to be used. No. 4 type heater should be used for heating ⅞-inch to 1⅛-inch stock to get a high hourly production with this heavier material.



No. 3 Three-electrode Berwick two-path heater for forging operations

The method of operation of this heater is somewhat similar to that of the rivet heater. The lower electrodes, which are attached to the left-hand secondary coil of each set, are stationary, while the upper electrodes and right-hand secondary coil of each set are arranged with vertical adjustment by depression of the foot-treadle, which raises the electrodes sufficiently to insert or to remove the material. With the two paths for the flow of the secondary current, the time of heating is said to be greatly reduced and any marring of the stock is also eliminated.

Rivets.—The Champion Rivet Company, Cleveland, O., has sent out a convenient sliding scale, showing the characteristics of various types and sizes of rivets. For boiler rivets, the sliding table is arranged to give rivet lengths for various grips and rivet diameters. A second scale gives the weight per 100 pieces for button-head rivets for various rivet diameters and lengths under the head. The company specializes in boiler, ship and structural rivets; also in toncan rivets, stainless chrome rivets, true tolerance rivets for high pressure work, air brake pins and knuckle pins.

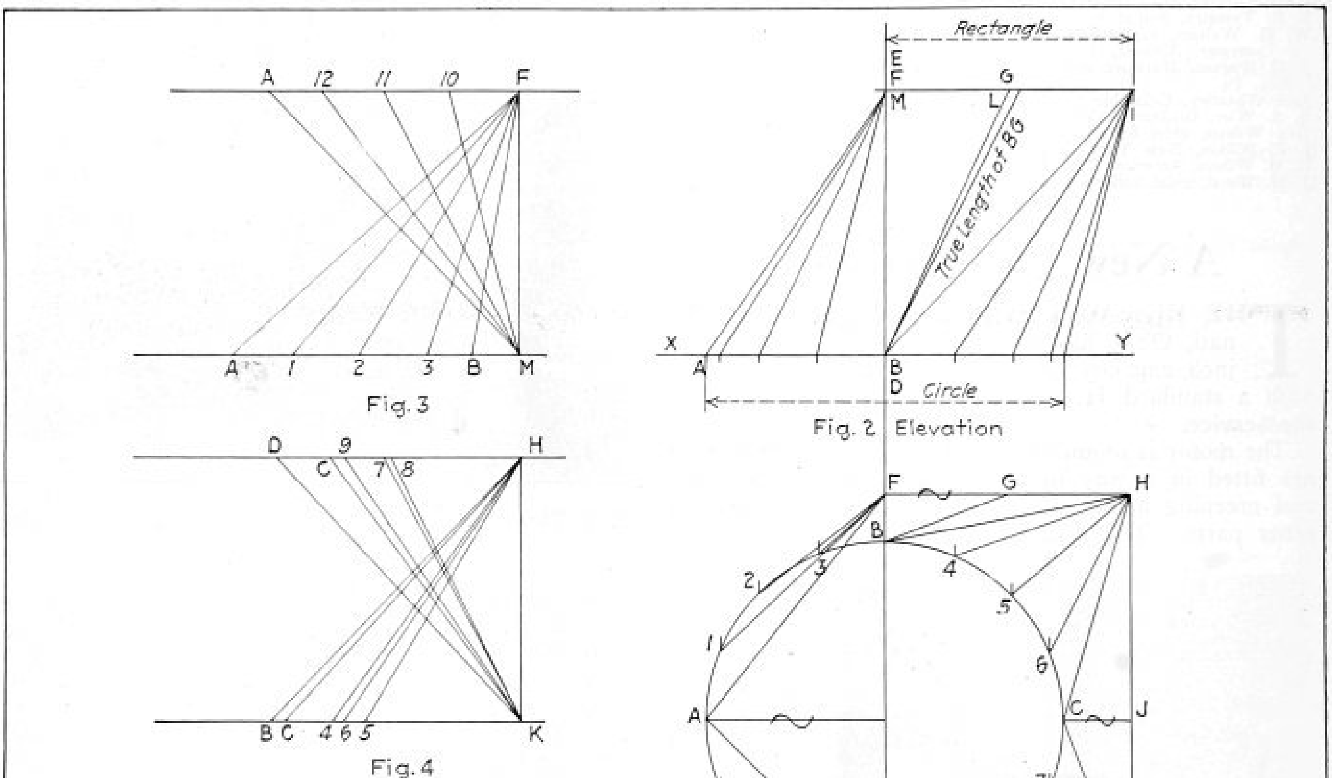
Development of a Transition Piece Having a Circular Base and Rectangular Top

By I. J. Haddon

In Fig. 1 and Fig. 2 are shown the plan and elevation of a transition piece. The top is rectangular, and the bottom is circular, *X-Y* being the ground line.

In order to develop this figure, draw the plan and elevation and divide the circle into any number of equal parts and number them as shown. Draw lines from each number to the sides and corners of the rectangle.

To obtain the true lengths of the lines, draw two parallel lines, as shown in Fig. 3 and Fig. 4, a distance apart equal to *D-M*, the height of the figure, and erect perpendiculars at the ends as shown in *F-M*, Fig. 3, and *H-K*, Fig. 4. Now from *M* as a center in Fig. 3, and with radii *FB*, *F3*, *F2*, *F1* and *FA*, Fig. 1, step off along the ground line the points *B*, *3*, *2*, *1* and *A*. Draw lines from *B*, *3*, *2*, *1* and *A* to *F*, Fig. 3, then these lines will be the true lengths of those shown in the plan and elevation. Obtain the true lengths of the remainder of the lines shown in the plan and elevation in a similar manner, as is also shown in Fig. 3 and Fig. 4.



The layout of a figure with a rectangular top and a circular base

To develop the construction, draw the line *M-E-F*, Fig. 5, equal to *M-F* shown in the plan. Draw *A-E* perpendicular to *M-F* and equal in length to the line *A-E*, Fig. 2. Join *A-F* and *A-M*, then the triangle *M-A-F-M* will be the true shape and size of the triangle *M-A-F-M*, shown in the plan. This is also shown in the elevation by the single line *A-E*. Now set a pair of dividers to one of the divisions on the circle as *A-1* in the plan, and draw an arc from *A* in Fig. 5. From *F* as a center, Fig. 5, and radii *F1*, *F2*, *F3* and *FB*, Fig. 3, draw arcs as shown. With the dividers set at the distance of one division on the circle, cut the arcs as shown in *1, 2, 3* and *B*, Fig. 5, and join *1-F*, *2-F*, *3-F* and *B-F*. These lines will be bending lines, and a curve drawn through the points *A, 1, 2, 3* and *B* will be a part of the development; obtain the remainder of the curve in a similar manner.

If this transition is so large that it has to be made in four plates, convenient places for making the connections of butt or lap joints would be as shown on the triangles in the plan and development. Some readers may object to using the dividers to obtain the points *1, 2, 3*, etc. on the curve of the development, but the inaccuracy, if any, of the length of the fully developed curve is hardly noticeable from the actual length. However, if further accuracy is required, the arcs drawn from *F* as a center, Fig. 5, may be cut at *1, 2, 3* and *B* as follows:

Bend a thin lath to the curve of the circle shown in the plan, and on the lath mark the points *A, 1, 2, 3, B*, etc. Now put *A* on the lath, fair with *A*, Fig. 5, and bend it so that the points *1, 2, 3*, and *B* lie on their respective arcs drawn from *F* as a center and mark the points obtained. Then a fair curve drawn through these points will be the accurate curve. The difference, if any, will hardly be detected from the result obtained by using the dividers.

All laps should be added where required. Any further explanation would be superfluous, as the development has been drawn in every detail, so that it may be easily followed by the reader.

The Hollow Staybolt Calking Tool

By Albert J. Walsh

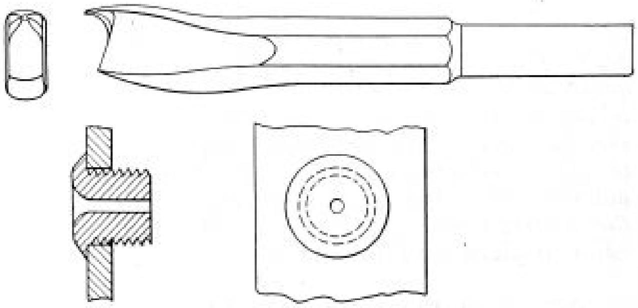
The advent of the hollow flexible staybolt for use in locomotive boilers has been judged the best improvement in boiler construction since the coming of superheated steam and electric arc welding. However, with the increase of pressure, temperature and length of firebox, that is characteristic of modern engines, staybolts have become more troublesome and leakage has become more common.

The problem of keeping "em" tight becomes more and more difficult as pressures and long runs increase. Holding on and re-driving does not hold "em" tight. The bobbing tool which I consider best as a calking tool, after repeated calking, proves detrimental to the bolt and the telltale hole. It is realized that an expensive proposition is promised in the necessity of renewing bolts shortly, unless there is some other way of calking the 200 to 500 odd bolts so often found in the trouble zone.

One dollar each is a fair price in cost of material and labor, for dismantling both outer sides of the firebox and renewing 100 to 250 bolts a side. It is not unreasonable to believe that this might be necessary each year unless an improved tool should be introduced. One that will hold the telltale open and at the same time work the bolt back into the threads in the sheet, and also trim off the ragged edges without cutting the sheet, is desirable.

The B W hollow staybolt calking tool fills all three requirements without the necessity of dismantling the boiler and the engine is ready for service on the 8-hour rest period.

It takes six busy hours of a boiler maker's time at a cost of about $5 to reclaim 500 bolts with this new



The calking tool and its application for hollow staybolt use

calking tool. This means a yearly saving of $200 to $500 on each firebox in bolts alone.

Leaky staybolts are a direct cause of premature crystallization and cracking of side sheets, the renewal of which is another high priced job added to the cost of maintenance.

Foremen and inspectors under whose jurisdiction such conditions exist, should take immediate steps to remove the cause which may be accomplished by the utilization of this tool.

Second National Fuel Meeting

The Fuels Division of the American Society of Mechanical Engineers has promulgated plans for the second national fuels meeting to be held in Cleveland, Ohio, September 17. In addition to the technical program there will be inspection trips and other forms of entertainment.

Thirty-one papers covering every phase of fuel engineering will be read in which such subjects as fuel characteristics, industrial application, marine, railroad and power plant problems, pulverized fuel and smoke abatement will be discussed.

This meeting is open to all engineers regardless of society affiliations, and they may discuss their problems freely and compare notes. There must be a furtherance of knowledge concerning the production and utilization of fuels, and there is no attempt to draw the line as to who shall discuss the subjects.

Acetylene Products.—The new catalogue of the Oxweld Acetylene Company, New York, has been received. It describes in detail products manufactured by this concern, including welding and cutting equipment of all sorts and generators for the production of acetylene.

Arc Welders.—A folder issued by the Fusion Welding Corporation, Chicago, Ill., is devoted to a description of motor-generator arc welding sets produced by this company; their design, construction and application.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by C. J. Zusy

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.*

Neutral Diameter of Heavy Plate

Q.—When rolling heavy plate from ¾ inch to 1¼ inches to a circular shape 54 inches in diameter, is it correct to use the neutral diameter in figuring the length of the plate? The layout books say that heavy plate will stretch more on the outside of the neutral diameter than it will compress on the inside of the neutral diameter. Thus if this is true the plate would be too large to fit the head.

I am about to lay out a tank to withstand 638-pounds test pressure, having dished heads 1⅜ inches thick, machined to the correct diameter, the shell being 1¼ inches thick. The heads are 54 inches in diameter. I do not feel safe in using the neutral diameter in computing the stretch out of the plate, for I believe it will be too large after it is bent. If you have a formula, or table covering the various thicknesses of plate to use in finding the stretchout, when the circumference of the head is known, please let me hear about it.—G. W. M.

A.—The allowance for curvature depends upon the diameter of the curve and the thickness of the plate. The allowance can be calculated, but it often happens that some changes are necessary in order to provide for irregularities in the thickness of the plate and in the bending operation. The inside diameter of the

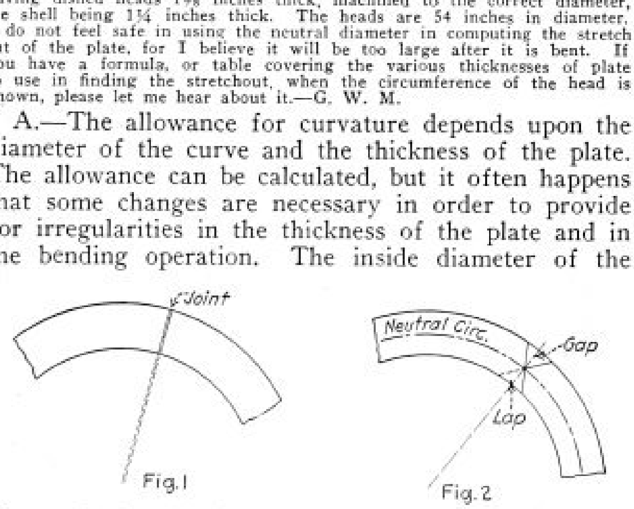


Fig. 1.—Perfect joint in thick plates. Fig. 2.—Result of not allowing for plate thickness

cylinder is stated and the thickness of the plate is given and these figures are used as the basis of the calculations. The inside circumference is supposed to shorten and the outside is stretched in the rolling operation. The line midway between the inside and outside is supposed to be the same length after the plate is rolled as before, and therefore this is called the neutral axis.

If the calculation is made on the neutral diameter, then theoretical results would apply in practice. However, with thick plates, there is such a great difference between the length of the inside circumference and the outside one that a special allowance should be made in order that the two edges of the plate will roll together. The desired condition is shown in Fig. 1 where the two edges match perfectly, and the joint would be finished with cover plates.

In Fig. 2 is shown the condition where the edges meet at the neutral point, but overlap at the inside circumference and fail to meet at the outside circumference. In this instance the ends of the plate were cut square, and there was not enough compression on the inside or enough stretch outside.

Fig. 3 indicates the form of plate when cut according to the calculated length for the inside circumference, the neutral circumference and the outside circumference.

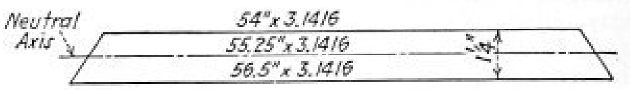


Fig. 3.—Laying out thick plates according to neutral axis

It will be seen that the distance between the lengths of the inside circumference and the outside one is twice the thickness of the plate multiplied by 3.1416, or it is the thickness of the plate multiplied by 6.28. Instead of using this fractional value and making some allowance for the irregularity that may be due to the plate and the rolling operation, some plate workers recommend the use of a factor of 7.

Take the problem of the 54-inch cylinder, made of 1¼-inch plate. The inside circumference is 54 × 3.1416, the neutral circumference is 55¼ × 3.1416 and the outside circumference is 56½ × 3.1416. It should be noted that the plate must be cut for the outside length. The difference between the inside and the outside lengths is 2½ × 3.1416 or 2 × the thickness × 3.1416 which equals the thickness × 6.28. It is recommended that a factor of 7 be used in order to insure that the outside circumference will be long enough to satisfy all the requirements.

Finding Plate Thickness of a Tube Sheet

Q.—Will you give me a formula for finding the thickness of plate for P-234 and P-240 of the A. S. M. E. Code, 1924?—E. M.

A.—For the benefit of those who do not have a copy of the A. S. M. E. Boiler Construction Code at hand, I will quote the necessary parts of the paragraph questioned:

P-234. The maximum allowable, working pressure on a tube sheet of a combustion chamber, where the crown sheet is not suspended from the shell of the boiler shall be determined by the following formula:

$$P = \frac{(D-d)t \times 27{,}000}{W \times D}$$

where,

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

D = least horizontal distance between tube centers on a horizontal row, inches

d = inside diameter of tubes, inches

t = thickness of tube plate, inches

W = distance from tube sheet to opposite combustion chamber sheet, inches

To solve this formula for t then,

$$W \times D \times P = (D-d)t \times 27{,}000$$

$$\frac{W \times D \times P}{27{,}000} = (D-d)t$$

$$\frac{W \times D \times P}{27{,}000\ (D-d)} = t$$

P-240. The following rules apply specifically to unstayed circular furnaces 12 inches in diameter and over:

Furnaces 12 inches to 18 inches outside diameter, inclusive. The maximum allowable working pressure for furnaces not more than 4½ diameters in length or height shall be determined by formulas (1) and (2) as follows:

(1) Where the length does not exceed 120 times the thickness of the plate.

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

To solve this formula for T then,

$$P = 51.5\left[(18.75 \times T) - (1.03 \times L)\right]$$

$$P = \frac{965.625T - 53.045L}{D}$$

$$PD = 965.625T - 53.045L$$

$$PD + 53.045L = 965.625T$$

$$\frac{PD + 53.045L}{965.625} = T$$

(2) Where the length exceeds 120 times the thickness of the plate.

$$P = \frac{4{,}250 \times T^2}{L \times D}$$

To solve the equation for T

$$P \times L \times D = 4{,}250 \times T^2$$

$$\frac{P \times L \times D}{4{,}250} = T^2$$

$$\sqrt{\frac{P \times L \times D}{4{,}250}} = T$$

In both of these formulas

P = maximum allowable working pressure, pounds per square inch

D = outside diameter of furnace, inches

L = total length of furnace between centers of head rivet seams (not length of section), inches

T = thickness of furnace walls, in sixteenths of an inch.

Water Discharge Through Orifice

Q.—What is the proper method of calculating the following:

If a fusible plug has an orifice ½ inch in diameter and the tin in the plug has been melted out, caused by low water, how many gallons of water per minute will be discharged through this orifice with a steam pressure of 150 pounds on the boiler? The injector was of course immediately started.—A. G.

A.—The formula for computing the flow of water under pressure through an orifice is:

$$V = 0.98\sqrt{2g\ (h + h_1)}$$

when,

V = velocity of flow in feet per second

g = 32.16

h = head in feet

$$h_1 = \frac{P}{0.434}$$

P = pressure in pounds per square inch

0.434 = pounds per square inch due to one foot of head.

The formula for quantity of flow is:

$$Q = 0.61\ AV$$

when,

Q = discharge in cubic feet per second

A = area of orifice in square feet

V = velocity of flow in feet per second

Applying these formulas to the problem in question, assuming that the fusible plug burned out because of scale, there being 3 inches of water over the crown, the head h would then be 3 inches or 0.25 foot.

$$V = 0.98\sqrt{2 \times 32.16\ (0.25 + \frac{150}{0.434})}$$

$$V = 0.98\sqrt{64.32\ (0.25 + 345.52)}$$

$$V = 0.98\sqrt{64.32 \times 345.87}$$

$$V = 0.98\sqrt{22246.3584}$$

$$V = 0.98 \times 149.152$$

$$V = 146.168 \text{ feet per second}$$

$$Q = 0.61 \times \frac{0.19635}{144} \times 146.168$$

Q = 0.12157 cubic feet per second; 7.481 gallons per cubic foot.

0.12157 × 7.481 × 60 = 54.56 gallons per minute.

Calculating Manhole Rings

Q.—Will you please interpret P-260 of the A. S. M. E. Code. In the May issue, you show a round hole with a saddle and liner. Made this way it would be somewhat different from the illustration in the Code. Please make it, as shown in the Code.—I. D. L.

A.—P-260 of the A. S. M. E. Code is as follows:

Manhole frames on shells or drums shall have the proper curvature, and on boilers over 48 inches in diameter shall be riveted to the shell or drum with two rows of rivets, which may be pitched as shown in Fig. P-16.

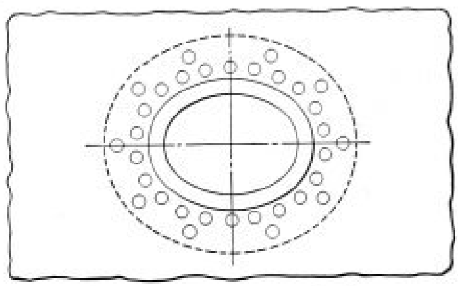


Fig. P-16.—Method of riveting manhole frames to shells of drums with two rows of rivets

The strength of manhole frames and reinforcing rings shall be at least equal to the tensile strength (required by P-180) of the maximum amount of the shell plate removed by the opening and the rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell through the manhole, or other openings.

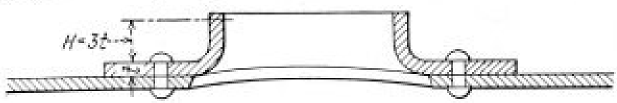


Fig. P-17.—Cross-section of flanged manhole frame

When a flanged manhole frame is used, the flanged portion of the frame may be considered as reinforcement up to a height (h) of three times the flange thickness (see Fig. P-17).

The illustration shown in the May issue of THE BOILER MAKER was the interpretation of this paragraph applied to a more modern construction of manhole ring.

To illustrate paragraph P-260, I have shown in Fig. 1, a manhole ring similar in design to the illustration in the A. S. M. E. Code.

Assume that the tensile strength stamped on the boiler shell is 55,000 pounds per square inch. Then the ultimate strength of the material removed from the shell on account of manhole and rivet holes on a line parallel to the longitudinal axis of the shell, is the 12-inch width of the hole plus two $1\frac{1}{16}$-inch rivet holes, or a total of $14\frac{1}{8}$ inches of boiler steel. The ultimate strength equals $14.125 \times 0.75 \times 55{,}000 = 582{,}656$ pounds.

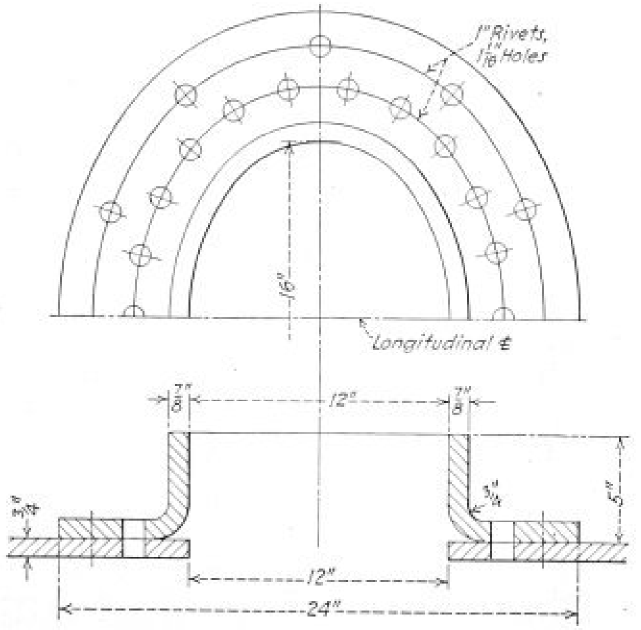


Fig. 1.—Details of manhole ring to conform with the code

The material added is the ring which is assumed to be made of boiler steel, stamped with a tensile strength of 56,000 pounds per square inch.

Part of Ring Considered

The portion of the ring to be considered is the area of the flange up to a height of three times the flange thickness. Fig. 2 shows the area of an enlarged cross section of one-half the manhole ring, shown in Fig. 1.

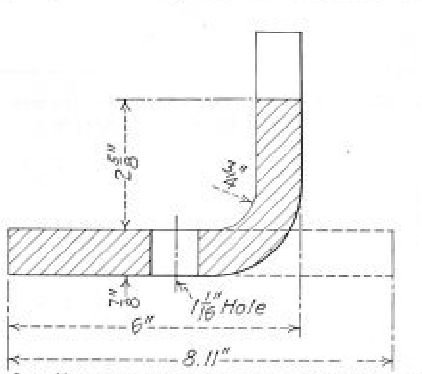


Fig. 2.—Enlarged detail of one-half the manhole ring shown in Fig. 1.

The area for both sides of the ring would then be $6.15 \times 2 = 12.3$ square inches.

The ultimate strength of the material added would then be $12.3 \times 56{,}000 = 688{,}800$ pounds.

The strength of the material added is in excess of the strength of the material removed and therefore meets the requirements of paragraph P-260.

Slope of Locomotive Boiler Firebox Crown Sheet

Q.—I enjoy The Boiler Maker very much for its valuable information and instruction and especially have found the recent articles on "Shop Kinks" very interesting. Will you kindly answer the following question for me:

Why is the crown sheet of the firebox of a locomotive boiler higher in front than in the rear?—J. H. J.

A.—The crown sheet of the firebox of a locomotive boiler is sloped from front to back so that its top surface will remain covered with water when the locomotive is heading down or backing up a grade.

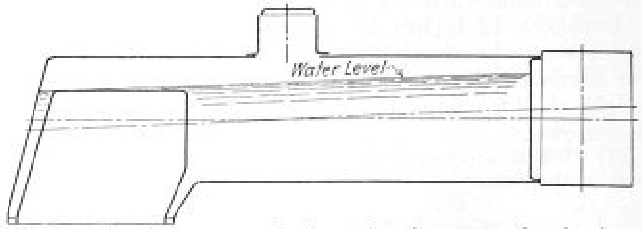


Fig. 1.—Straight-crown firebox showing water-level when on down grade

Fig. 1 shows a straight-crown firebox when the locomotive is on a down grade. The front of the crown sheet is covered with water, while the back is uncovered.

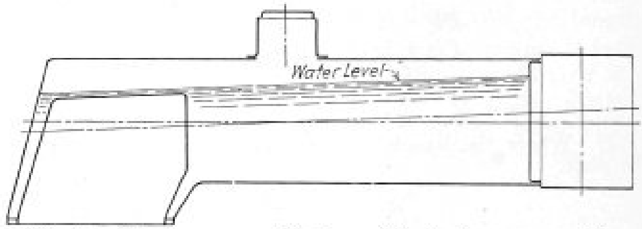


Fig. 2.—Sloping-crown firebox with firebox covered by water at all times

Fig. 2 shows a sloping-crown firebox when the locomotive is on a down grade. The entire crown sheet is in this case covered with water.

Material for Corrugated Furnace

Q.—What material is used for the corrugated furnaces for Scotch boilers?

A.—The rules governing the construction of marine boilers in the United States require that the tensile strength of steel used in the construction of corrugated furnaces shall not exceed 67,000 and be not less than 54,000 pounds per square inch. The minimum elongation in 8 inches shall be 20 percent.

Fall Meeting of Welding Society to Be Held in Philadelphia

The 1928 fall meeting of the American Welding Society will be held in Philadelphia, October 8 to 12. As in the past few years, one of the outstanding features will be the exposition. The exhibit will occupy all the floor space of the exhibition hall of the Commercial Museum. Five days will be devoted to displaying to the industrial world the best in welding equipment and supplies, and exhibits of welded products will be an attractive addition.

Technical meetings and registration will be held at the Bellevue-Stratford Hotel in the mornings and at the exhibition hall in the afternoon of each day. The meetings and papers committee is preparing an unusually strong program of interesting papers containing new information and findings.

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

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—C. D. Thomas, Salem, Oregon.

Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.

Vice-Chairman—William H. Furman, Albany, N. Y.

Statistician—L. C. Peal, Nashville, Tenn.

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.

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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.

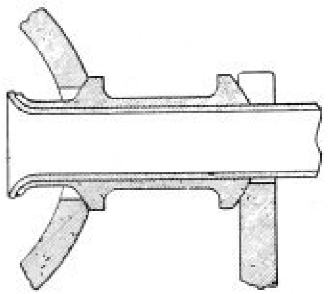
Selected Boiler Patents

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.

1,651,016. ALFRED COTTON, DECEASED, LATE OF ST. LOUIS, MISSOURI, BY LAURA P. COTTON, EXECUTRIX, OF ST. LOUIS, MISSOURI, ASSIGNOR TO HEINE BOILER COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI. TERMINAL CONNECTION FOR REMOVABLE TUBES.

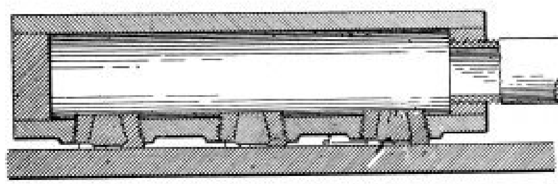
Claim.—A terminal connection for a removable tube, consisting of a member surrounding the tube and provided with convexed portions that are adapted to bear against concaved seats on a retaining element and on



the part with which the tube co-operates, and a connection between said tube and member produced by a deformed terminal portion of the tube and a welded joint between said terminal portion and member. Six claims.

1,657,594. JOHN H. STOCKHOLDER AND WILLIAM A. GILES, OF NEW ORLEANS, LOUISIANA. STEAM-BOILER SAFETY DEVICE.

Claim.—In a steam boiler safety device, the combination with a casing having an outflow pipe, the said casing being constructed for arrangement in the water space of a steam boiler and adjacent to a surface subjected to heat, of a plug carrier having a screw threaded engagement with the said

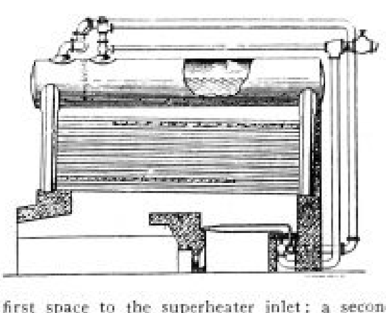


No. 1,657,594

casing, the said carrier having a conical opening therethrough, a fusible plug fitting the said opening in the carrier, the said carrier having spaced members projecting downwardly below the plug for contact with the heated surface whereby water may circulate below the plug, said spaced members having inwardly projecting portions engaging said plug to hold it in position in the said opening.

1,650,184. BENJAMIN BROIDO, OF NEW YORK, N. Y., ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y. BOILER WITH SUPERHEATER.

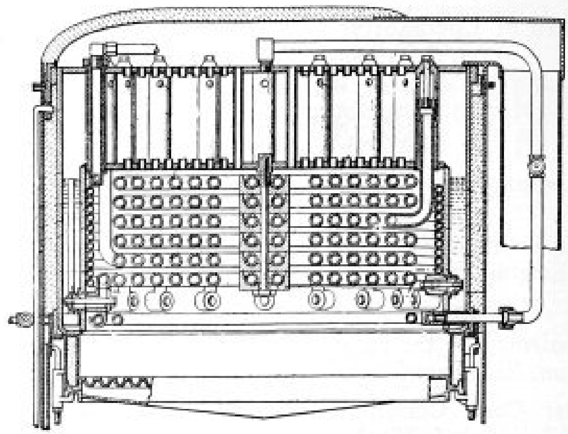
Claim.—In apparatus of the class described, the combination of a boiler having two separated steam spaces one of which is several times as large as the other into the first and smaller of which more of the steam is delivered upon its generation than into the second; a superheater; a pipe



connecting said first space to the superheater inlet; a second pipe leading from the superheater outlet directly to the point of use; and a conduit putting said second space into communication with the outlet of the superheater. Two claims.

1,653,828. CHARLES UEBELMESSER, OF NEW YORK, N. Y. STEAM BOILER.

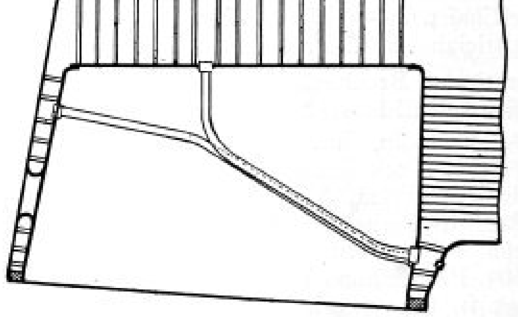
Claim.—In a steam boiler, a steam generating tube having a pair of parallel sinuous coils connected by a return bend and having an outlet and an inlet, said outlet and inlet being spaced from each other and from said return bend to provide three widely separated supporting points, the



distance from said inlet to said return bend being greater than the distance from said bend to said outlet and the sinuous configuration of said coils being such that said tube may be placed in nested intervoluted spaced relationship with a similar tube. Five claims.

1,648,307. CHARLES GILBERT HAWLEY, OF CHICAGO, ILLINOIS, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE. SAFETY METHOD OF INSTALLING FIREBOX ARCH TUBES.

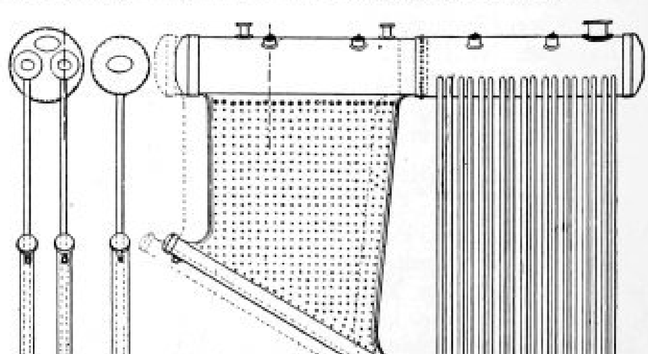
Claim.—In combination with spaced sheets of a locomotive firebox, arch tubes extending between said sheets, a relative heavy collar surrounding the ends of the arch tubes in which said tube ends are expanded and



beaded, said collars being arranged in openings in said firebox sheets of a diameter substantially greater than that of said collars and welds uniting said collars to those edge portions of the sheets defining said openings.

1,655,057. CHARLES GILBERT HAWLEY, OF CHICAGO, ILLINOIS. STEAM BOILER AND SETTING.

Claim.—A boiler unit comprising a top drum, in combination with a bottom drum, many return ducts connecting the said drums, a substantially and operatively triangular water wall occupying vertical planes parallel with



No. 1,655,057

the axis of said top drum communicating directly with both drums and constituting and upflow passage of increasing size from bottom to top, a fire-chamber containing said wall and a gas passage containing bottom drum and said return flow ducts. Seven claims.

The Boiler Maker

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Contents

Revising Steam Boiler Terms

At nearly every meeting of individuals interested in the manufacture or operation of steam boilers, during the past few years, the subject of reforming the methods for rating boilers has been brought up for discussion. Now the agitation for changes in the time-honored expressions used to designate boiler performance has been crystallized by the recent paper presented before the Metropolitan Section of the American Society of Mechanical Engineers by W. A. Shoudy and W. H. Jacobi. An abstract of this paper appears in this issue.

As a result of the discussion at the meeting, and the subsequent interest aroused by the consideration of the subject, it is not too much to hope that new terms will be adopted which will give a real measure of the performance and an engineering basis for comparing boilers. The first step will undoubtedly be the formation of a committee of boiler experts who will solicit the opinions and suggestions of the field at large, using as a groundwork the extensive material on the subject made available in the present paper and others that have preceded it.

The value of such a work need hardly be emphasized for at the present time, although the much misused expression "boiler horsepower" has been practically eliminated from the boiler engineer's vocabulary, an equally misleading expression "percent of rating" has come into wide use. As the authors of the paper point out, any term adopted must be based on the British thermal unit, since the quantity of heat liberated in any steam generator and absorbed by the surfaces is the measure of the efficiency of that unit. The method of rating suggested would seem to offer the most logical solution to the problem of any yet made. As outlined briefly, this method is as follows:

> "Each pound of the gases resulting from the combustion of commercial fuels with 20 percent of excess air has a heat content of approximately 1000 British thermal units (= 1 kilotherm). Since furnace conditions vary so widely, a 'furnace factor' must be used which represents the ratio of the actual heat content of the pound of gases to 1000 British thermal units. As a substitute for present methods the rating of steam-generating units as a whole or in part should be given in kilotherms per hour; heat-absorbing surfaces in kilotherms per hour per square foot, and furnaces in kilotherms per hour per square foot of grate or per cubic foot of volume."

Whether this method is finally adopted or not, it will certainly have served an extremely useful purpose if sufficient interest is aroused in the matter to bring about a much needed revision of the terms used in rating boilers.

Rivets

In recent months considerably more attention has been given to the forming and application of rivets in all manner of structures than ever before. In boiler and pressure-vessel work, this has been particularly in evidence. The greater care exercised in the handling of rivets may be largely due to the more rigid requirements demanded by the use of high pressures both in locomotive and stationary boilers, and in many types of pressure vessels built for industrial purposes. Many of the weaknesses that have developed in these vessels after comparatively short service have been directly traceable to leaks occurring at the rivets. Defects in the rivets, or holes into which they were driven, have in most cases been responsible, and such weaknesses should not be charged to poor inspection.

This rivet problem has recently been analyzed and discussed in the journal of the American Society of Mechanical Engineers, and the findings indicate that the ordinary rivet is likely to have die marks and fins under the head and along the shank; it is apt to be out of round; to have small rolling seams; and to be coated with a forging scale. Any one of these conditions will cause trouble sooner or later under the action of high working pressures, and the specifications should be so written as to preclude their presence. In keeping with modern advanced design, rivets should be produced by a forging process and treated to remove all scale, fins, seams and die marks. The shanks should be accurately round and fitted into carefully reamed holes with a clearance of no more than 1/32 inch. A moment's consideration will reveal the folly of drilling and reaming holes in a boiler shell to be filled with inaccurate, scaled rivets. A full metal-to-metal contact between the rivet and the plate is necessary for tight work and such a result can be accomplished only by the use of a clean perfectly-formed rivet. The control of this factor in the manner indicated will furnish a warranty for prolonged satisfactory performance, because the vessel fabricated in such a manner will equal the designer's expectation of a solid one-piece unit of uniform strength that depreciates no faster at once place than another.

High-Pressure Boiler Materials

SINCE the introduction of high steam pressures in boilers during the last few years, one problem that has not been solved to the entire satisfaction of boiler manufacturers and engineers is the question of the proper materials to be used for high-pressure construction. The use of mild steel in low-pressure boiler construction has met all requirements, but for service in high-pressure structures mild steel has many drawbacks. At pressures below 300 pounds per square inch, the physical characteristics of mild steel are not altered to any marked degree, but above this pressure, because of the correspondingly high operating temperature, mild steel loses its strength, and corrosive action is augmented.

In order to produce materials that will withstand the service conditions of high-pressure boilers, alloy steels have been introduced. The article on "The Use of Alloy Steels for Boilers" in this issue reviews the recent developments made in ferrous alloys.

Such metals containing proper amounts of alloying material have specific properties; some are heat-resisting, some are corrosion-resisting, while others are either brittle or malleable. The combinations possible are without limit, but a single alloy combining all these properties has not as yet been developed.

The discovery of an alloy steel that is suitable for high-pressure boiler construction will be welcomed by the boiler-making industry. A metal that has a high tensile strength and is heat-resisting, non-corrosive, malleable and commercially economical is not only desirable but is required if the wide use of high-pressure boilers in industry is to be assured.

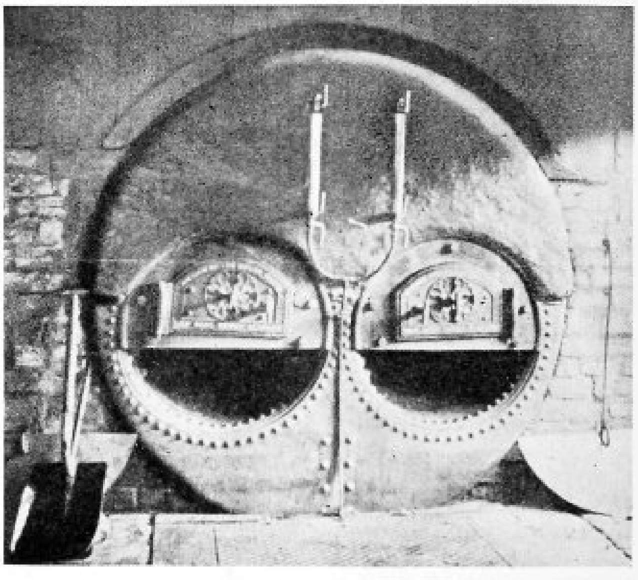
Communication

A Record Boiler

To the Editor:

The accompanying illustration may be of interest to readers of The Boiler Maker. It shows a boiler of the Lancashire type made by Wilson Boiler Makers, Glasgow, Scotland, in 1853 and still working night and day. This boiler is in a factory on the Clyde side, about halfway between Glasgow and Greenock. It is now regularly inspected by a boiler insurance company, although no companies of this character were in existence when the boiler was made. The proprietor reports that he has never had an adverse report on the boiler. Further, the boiler has never required any repair since it was set to work.

Although now working at a low pressure, I think the record of this boiler is unique. The boiler is, of course, entirely constructed of iron plates, steel plates



Boiler constructed in 1853 is still in service

being unknown when it was made, and this doubtless accounts for its long life, such plates being less subject to corrosion than steel boiler plates. This was one of the first Lancashire boilers to be made with the ends flanged on to meet the shell. Incidentally, the Lancashire boiler was invented in 1844 by Sir William Fairbairn, of whom you have no doubt heard in America, and, unchanged except in detail, it remains today one of the most successful types of steam generators ever invented. The hand flanging of the ends reflects great credit on the old-time boiler maker who did this work, and its appearance is quite equal to any flanging done with the best of our modern equipment.

As the illustration shows, the end plate is in two parts, the reason, of course, being that a plate large enough for the end could not at that time be rolled in the plate mill.

The shell consists of some 30 small plates, three to the circle, as compared with the modern boiler in which the shell would consist of three plates only, each rolled to a complete circle and working at a pressure of 200 pounds per square inch.

Crewe, England — J. William Thompson

Burlington 2-10-4 Freight Engine

Boiler designed for 250 pounds working pressure proves to be economical in fuel

TWELVE 2-10-4 type locomotives, built for the Chicago, Burlington & Quincy by the Baldwin Locomotive Works in the latter part of 1927, have now been in service about five months hauling 8000-ton and heavier coal trains up the 0.3 percent ruling grades on the Beardstown division of that road. From the point of view of weight, tractive force, cylinder horsepower, sustained boiler capacity and almost any other factor commonly considered in comparing steam motive-power units, these are believed to be the largest and most powerful two-cylinder locomotives ever built.

Designed to increase the tons handled per train, to effect a reduction in overtime paid for, and to obtain the greatest possible fuel economy, these locomotives replace 2-10-2 type locomotives with a tractive force of 81,600 pounds, Type A superheaters and feedwater heaters and built by the Baldwin Locomotive Works in 1914 and 1915. In the design of the new 2-10-4 type locomotive, the tractive force has been increased 10 percent, or to 90,000 pounds. Owing principally to the use of high steam pressure and large boiler capacity, the available horsepower, however, has been increased 30 percent over that of the 2-10-2 type locomotive, based on a coefficient of mean effective pressure obtained from actual tests of limited cut-off locomotives; but according to the American Railway Association formula, the tractive effort is 93,700 pounds.

Service Test Results

The new locomotives have been in service about five months, and a record of their performance as compared with the performance of the 2-10-2 type locomotives, shows that the average train, northbound, has increased from 97 cars of 6800 gross tons, to 113 cars of 8000 gross tons, also, the overtime per round trip has been cut from 3 hours 20 minutes, to one hour 30 minutes, with a possibility of further reductions after the new locomotives have been in service long enough to permit lifting the speed restriction of 25 miles an hour placed on them. Since the trains hauled southbound are made up mostly of empty cars, the train load in this direction is not materially increased, but depends largely on the number of cars hauled northbound. The increase in tonnage handled by the new type locomotive, in addition to the decrease in overtime, makes a material saving in the cost of engine and train crews as well as a considerable saving in coal and water.

General Features of Design

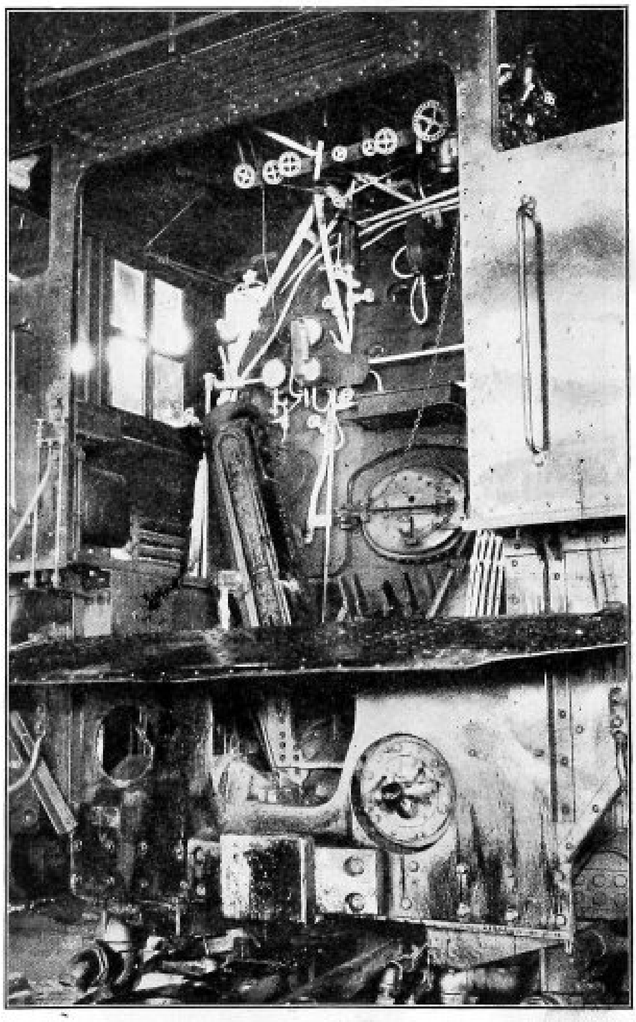
The total weight of the new 2-10-4 locomotive, is 512,110 pounds, of which 353,820 pounds are carried on the drivers. The driving wheels are 64 inches in diameter; the cylinders are 31 inches in diameter by 32-inch stroke, and the boiler carries 250 pounds steam pressure. With the maximum tractive force of 90,000 pounds a factor of adhesion of 3.93 is obtained.

In the interest of fuel economy the locomotive has been built with 61.4 percent limited cut-off, Type E superheater, and feedwater heater. Six locomotives are equipped with Elesco and six with Worthington heaters. Superheated steam is used for operating the two 8½-inch cross-compound air compressors, the feedwater pump, stoker engine, headlight generator turbine, and blower.

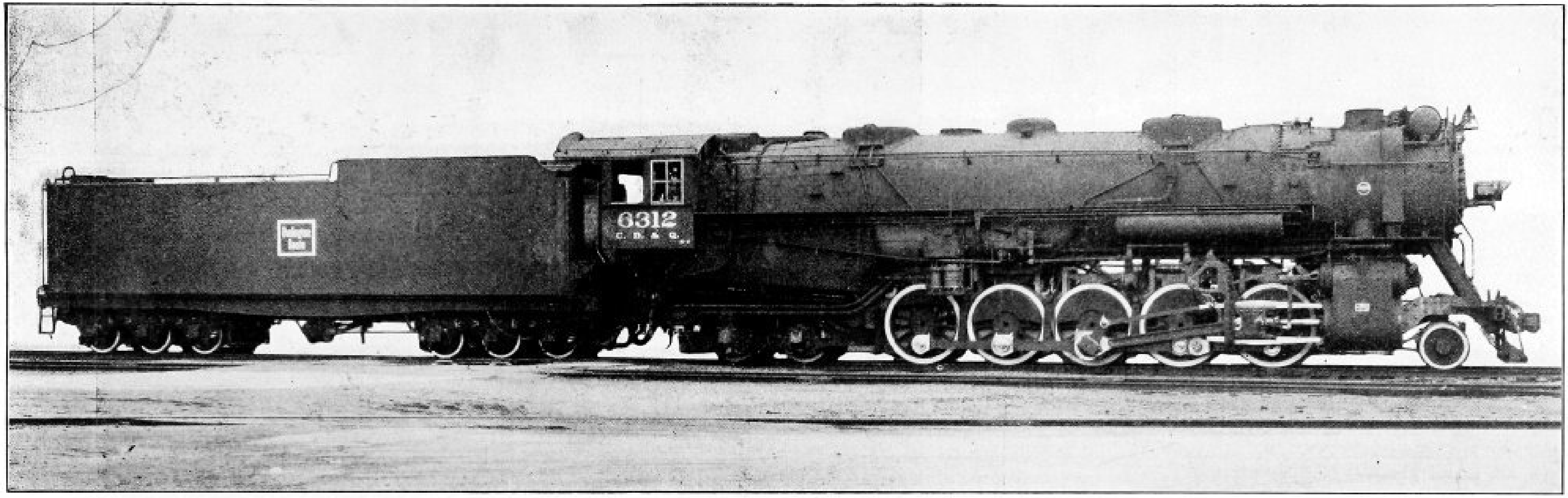
While not provided with boosters, the trailing trucks are arranged for their application later if desired. The Baker valve gear is set to give a normal maximum cut-off of 61.4 percent, the design permitting this to be increased to 65 percent if desired at some future time. However, for starting and at extremely low speeds, a maximum cut-off of about 80 percent is made available by the small auxiliary steam ports in the valve bushings.

Boiler Details

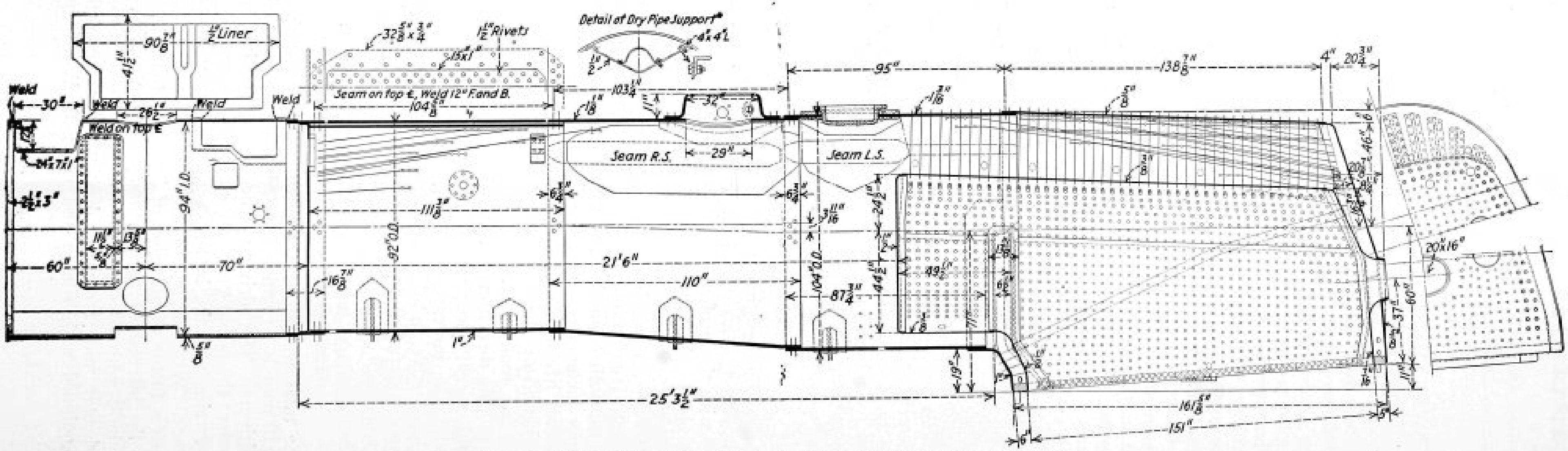
The boiler is of the radial-stay, inverted wagon-top type, 92 inches in diameter. The smokebox ring, which is of ⅝-inch plate, is 126 inches in length. The first course of 1-inch plate has a length of 104⅝ inches; the second course of 1⅛-inch plate a length of 103¼ inches and the last course 95 inches in length is made of 1 3/16-inch plate. The firebox is constructed of ⅝-inch



The cab interior



One of the twelve 2-10-4 type locomotives built for the C. B. & Q. by the Baldwin Locomotive Works



Longitudinal section of the C. B. & Q. 2-10-4 type locomotive boiler plate and has a length of 150 1/16 inches and is 102¼ inches wide. The firebox is made up of three plates, the crown sheet and side sheets and is formed with a combustion chamber, 49½ inches in length and 67 inches in diameter. The grate area is 106.5 square feet.

The boiler is fitted with four 3½-inch arch tubes with eighty-seven 2¼-inch tubes and two hundred and twenty-two 3¼-inch superheater flues with a length over the tube sheets of 21 feet 6 inches. The total heating surface, including evaporative and superheating surface, is 8391 square feet. The boiler is fitted with 64 Tate expansion stays, having a diameter of 1⅛ inches; 350 Tate flexible stays, 1⅛ inches in diameter; 991 Tate flexible stays, 1 inch in diameter; 560 radial stays, 1⅛ inches in diameter with tapered ends; 1257 hollow stays, 1 inch in diameter; 16 screw stays, 1⅛ inches in diameter.

The firebox seams are electrically welded, inside and out, at the calking edges for a distance of 10 inches above the bottom of the mud ring. The stay sheets are welded inside and out around the mud ring at all corners for a distance of 8 inches each way from the corner. Electric welding was also used after riveting on all calking edges on the fire side of the inside throat sheet. The dome-liner seam calking edges are welded, as are the seams around the stoker tube holes in the back head. In addition, welding was used profusely throughout the construction on calking edges and liners where an increase in tightness might be gained by its application.

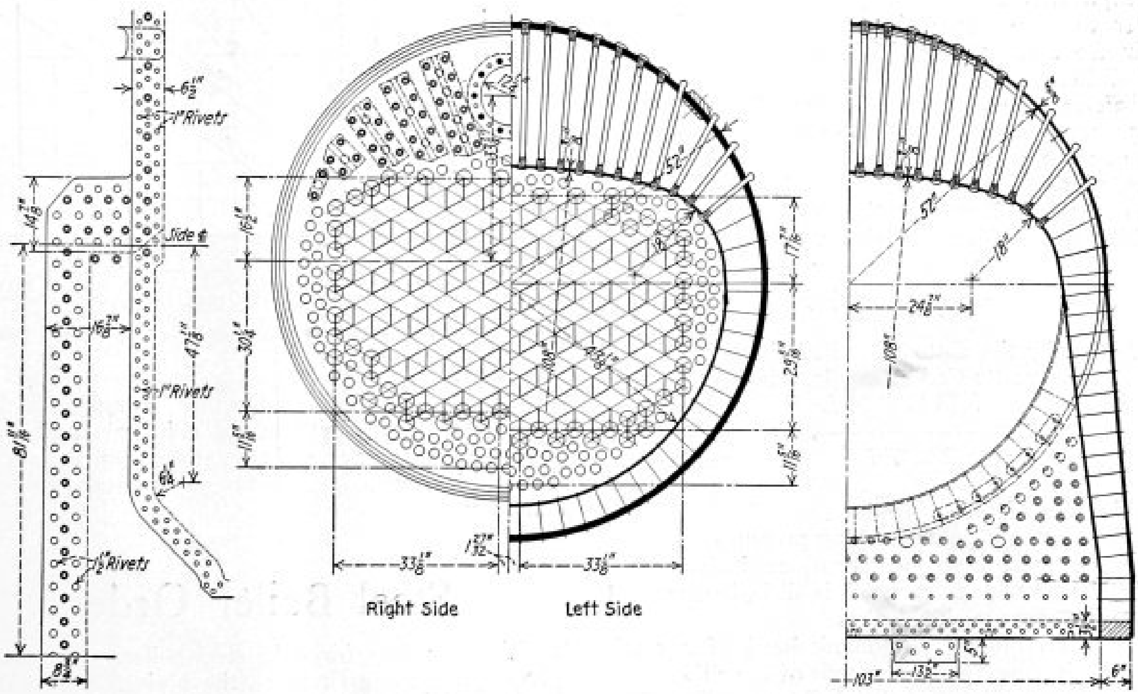
Details of Tender

The tender was designed to make two water stops on the 135-mile division, at least one and possibly both of these stops being made where coal chutes are located. The tank is of the rectangular type, carried on a Commonwealth steel underframe, and Commonwealth six-wheel trucks. The tender has a capacity to carry 24 tons of coal and 21,500 gal. of water. Wheels used under the tender are of rolled steel, 36 inches in diameter, and axles have 6½-inch by 12-inch journals.

The general dimensions of the new Burlington 2-10-4 type locomotive are shown in the table.

Table of Dimensions, Weights and Proportions

Service	Heavy freight
Cylinders, diameter and stroke	31 in. by 32 in.
Valve Gear	Baker
Valves: Piston type, diameter	15 in.
Maximum travel	8½ in.
Steam lap	2¼ in.
Exhaust lap	1/16 in.
Lead	¼ in.
Maximum cut-off, main ports	61.4 percent
Maximum cut-off, auxiliary ports	80 percent
Weights in working order:	
On drivers	353,820 lb.
On engine truck	47,920 lb.
On trailing truck	110,370 lb.
Total engine	512,110 lb.
Tender	385,800 lb.
Total engine and tender	897,910 lb.
Wheel bases:	
Driving	22 ft. 4 in.
Total engine	45 ft. 6 in.
Total engine and tender	95 ft. 11¾ in.
Wheels, diameter outside tires:	
Driving	64 in.
Engine truck	33 in.
Trailing truck	42½ in.
Journals, diameter and length:	
Driving, main	14 in. by 14 in.
Driving, other	12 in. by 14 in.
Engine truck	7 in. by 14 in.
Trailing truck	9 in. by 14 in.
Boiler:	
Type	Inverted wagon top;
Steam pressure	250 lb.
Fuel, kind	Bituminous
Diameter	92 in.
Firebox, length and width	150 1/16 in. by 102¼ in.
Height, mud ring to crown sheet, back	76¾ in.
Height, mud ring to crown sheet, front	95½ in.
Arch tubes, number and diameter	4—3½ in.
Tubes, number and diameter	87—2¼ in.
Flues, number and diameter	222—3½ in.
Length over tube sheets	21 ft. 6 in.
Grate area	106.5 sq. ft.
Heating surfaces:	
Firebox	302 sq. ft.
Combustion chamber	107 sq. ft.
Arch tubes	40 sq. ft.
Tubes and flues	5,455 sq. ft.
Total evaporative surface	5,904 sq. ft.
Superheating surface	2,487 sq. ft.
Total evaporative and superheating	8,391 sq. ft.
Tender:	
Water capacity	21,500 U. S. gallons
Fuel capacity	24 tons



Cross-sections of the boiler and layout of the throat-sheet seam

Wheels, diameter	36 in.
Journals, diameter and length	6½ in. by 12 in.
Maximum tractive force:	
Rated	90,000 lb.
A. R. A. formula	93,700 lb.
Weight proportions:	
Weight on drivers ÷ total weight engine	0.69
Weight on drivers ÷ tractive force	3.93
Total weight engine ÷ total heating surface	61.3
Boiler proportions:	
Tractive force ÷ combined heating surface	10.72
Tractive force × diameter drivers ÷ combined heating surface	686
Firebox heating surface ÷ grate area	4.22
Firebox heating surface in percent of evaporative surface	7.61
Superheating surface in percent of evaporative surface	42.1

New Rules for Dished Heads

ON considering recent revisions made in rules for dished heads by the A. S. M. E. Boiler Code Committee the two most significant changes to these rules are the recommended use of the Massachusetts Code formula for calculating the thickness of blank unstayed dished heads with the pressure on the concave side, and the rule regarding the thickness of blank heads of semi-elliptical form.

In order to show more clearly the effect of these changes in the construction of boiler drums, the thicknesses of dished heads for various drum diameters and for two different pressures were calculated according to the new proposed formulas and the old A.S.M.E. equation. The curves in the illustration show the results of these calculations.

The thicknesses indicated by the solid lines have been calculated by the A.S.M.E. equation, which is as follows:

$$t = \frac{5.5 \times P \times L}{2 \times TS} + \frac{1}{8}$$

Those indicated by the dotted line have been calculated from the Massachusetts Code formula, which is

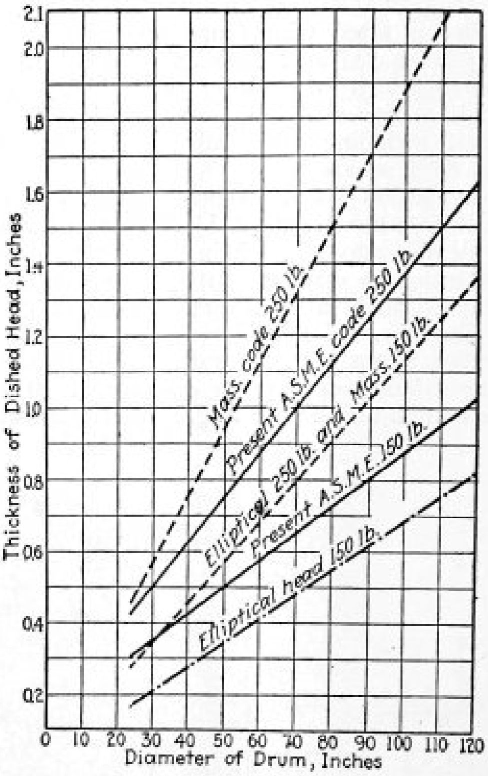
$$t = \frac{8.33 \times P \times L}{2 \times TS}$$

where

t = thickness of plate, inches
P = maximum allowable working pressure
TS = tensile strength, pounds per square inch
L = radius to which the head is dished, measured on the concave side, inches

The thicknesses required in a blank head of a semi-elliptical form, in which the minor axis of the ellipse is at least one-half the diameter of the shell, are indicated by the dash-and-dot curve and are at least as thick as the thickness that is required of a seamless shell of the same diameter. For heads with manholes the new rules require an additional thickness of 15 percent, but in no case less than ⅛ inch.

It will be noted that the Massachusetts formula for low pressures and small sizes gives a lighter head than the present A.S.M.E. formula, while at high pressures and larger sizes the Massachusetts formula requires a greater thickness. The elliptical-head type of construc-



Comparison of methods for calculating dished heads

tion allows a lighter plate to be used than either of the other methods. This is forcibly brought out by the curves which indicate that an elliptical head for 250 pounds pressure may be of the same thickness as a dished head that is designed by the Massachusetts Code for 150-pounds pressure.—*Power.*

Steel Boiler Orders

NEW orders for 1615 steel boilers were placed in July, as reported to the United States Department of Commerce by 72 manufacturers, comprising most of the leading firms in the industry, as compared with 1611 boilers in June and 1516 in July, 1927. The following table presents the number and square footage of each kind of boiler ordered for the past seven months, including comparisons with the corresponding period last year.

Type	Total 7 mos., 1927		Total 7 mos., 1928		July, 1927		April, 1928		May, 1928		June, 1928		July, 1928	
	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.
Grand Total	9,558	10,050,555	9,397	9,123,017	1,516	1,777,598	1,325	1,295,170	1,571	1,456,278	*1,611	*1,469,617	1,615	1,528,053
STATIONARY														
Total	9,425	9,523,984	9,258	8,759,056	1,466	1,349,720	1,301	1,246,852	1,564	1,450,061	*1,591	*1,449,893	1,597	1,478,034
Watertube	845	4,628,339	806	4,079,633	112	535,992	128	580,600	105	735,194	133	627,877	133	563,404
Horizontal return tubular	946	1,138,117	708	927,077	149	183,799	81	103,516	112	135,163	136	159,389	129	185,064
Vertical firetube	1,078	290,886	997	302,175	142	49,301	132	39,403	154	38,966	*133	*45,555	109	41,616
Locomotive (not railway)	183	78,907	195	107,368	32	12,584	54	37,847	21	10,894	24	12,416	17	8,708
Steel heating [1]	5,265	2,543,527	5,880	2,831,877	876	444,424	847	442,440	1,068	456,354	*1,036	*488,194	1,084	567,462
Oil country	650	553,202	253	232,292	99	90,047	4	3,460	45	35,464	64	66,362	64	62,722
Self contained portable [2]	393	263,841	338	235,953	45	28,623	42	30,969	46	34,580	56	45,323	54	45,191
Miscellaneous	65	27,165	81	42,681	11	4,950	13	8,617	13	3,446	9	4,777	7	3,867
MARINE														
Total	133	526,571	139	363,961	50	427,878	24	48,318	7	6,217	20	19,724	18	50,019
Watertube	50	455,343	53	320,237	41	425,848	12	46,033	....	....	4	12,482	9	47,668
Pipe	1	2,091	1	1,881	....	....	....	....	....	....	....	....	....	....
Scotch	76	67,327	73	34,623	7	1,610	13	2,285	5	5,367	13	4,624	4	982
2 and 3 flue	4	1,420	9	3,597	1	220	....	....	2	850	2	1,378	5	1,369
Miscellaneous	2	390	3	3,623	1	200	....	....	....	....	1	1,240	....	....

[1] As differentiated from power. [2] Not including types listed above. * Revised.

Locomotive Boiler Construction--II*

Layout of longitudinal seam welt strips—Machine operations on rings and welt strips

By W. E. Joynes†

TO save the cost of shearing two edges of the plate and to make an allowance for planing only, a side line and a back line, squared to the side line, are drawn close to the edges of the outside and inside-welt strips.

The width of the welt strips is determined from the sum of the combined spaces between the longitudinal rows of rivets. The dimensions for these spaces are not the same as the plate dimensions given on the plate-development and seam drawings, but are proportional to the neutral diameter of the boiler and the welt strips. The spaces between the rivet rows will be increased over the plate dimension for the outside-welt and decreased for the inside-welt strip. These dimensions may be found by laying out a cross section of the shell or by calculation.

* The first instalment of this series appeared on page 218 of the August issue.

† Boiler designing department, American Locomotive Company, Schenectady, N. Y.

The dimensions can be derived by the use of the proportional method as follows:

$$R : A = R^1 : X,$$

$$\text{then } X = \frac{R^1 A}{R}$$

when

R = neutral radius of shell
R^1 = neutral radius of welt strip
A = space between longitudinal rivet rows (shell)
X = space between longitudinal rivet rows (welt)

Having drawn in the longitudinal-rivet center lines according to the proportional dimensions over the plate dimensions, the longitudinal spacing of the rivet holes as laid out on the plate are marked on a metal strip.

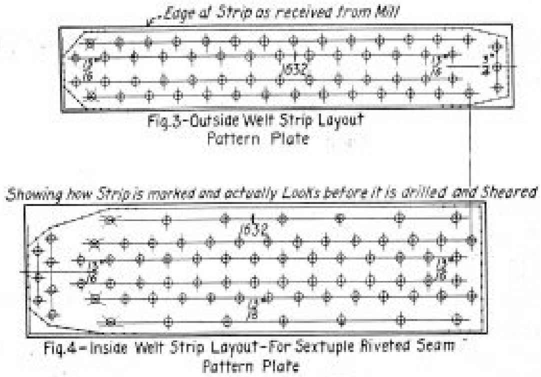
Transfer this spacing as marked on the gage strip onto the welt strips. This is done by first marking the rivet lines on the circumferential seam at the back end. The longitudinal seam rivet hole centers are next marked. Finally the circumferential-seam or front-tube sheet rivet lines are marked at the front end.

Boilers in the riveting tower

The following method is used to layout the outside welt strip: Measure the distance of the first rivet hole of the middle rows from the back-end line. Take the dimension from the seam drawing, Fig. 6. This drawing shows the dimension for the side lap, which also follows around the back end. Line up the corresponding rivet hole on the gage strip with this hole and mark on the spacings on this line. Bisect the first rivet hole in the outside row. Line up the gage strip with the bisection and mark off the holes. The front end of the first-ring outside welt is finished off in line with the front tube sheet flange. For other rings, finish the front end of the outside welt to clear the calking edge of the plate circumferential seam.

The inside-welt strip is laid out in the following manner: Finish the back end of the welt strip to clear the calking edge of the plate-circumferential seam. The usual clearance allowed in practice is ¼ inch less than the dimension given for the circumferential seam lap to the rivet line. Line up the corresponding rivet line of the gage strip with this rivet line, and mark off the middle row of holes. Bisect the end hole of the outer row and mark off these lines of holes with the strip. To allow space at the front end for calking the circumferential seam, show a shearing line on the welt to give ½-inch minimum clearance from the circumferential seam. On first rings, the lap at the front end of the inside welt can be the same as the side lap or ⅛-inch less.

Draw a center line of the welt strip at the front end of the outside-welt and the back end of the inside-welt strip. Measure the tube sheet and circumferential seam rivet hole locations from the ends of the plate. Make a proportional increase for the tube sheet or circumferential seam rivet holes for location in an outside welt and a decrease for the circumferential seam rivet holes in an inside-welt strip. Figs. 3 and 5 are outside



Figs. 3 and 4.—Welt strip layouts

welt strips. Fig. 4 is an inside-welt strip for a sextuple-riveted seam.

Lay out the ends of the strips for shearing around the rivet holes with straight line cuts, as shown. The corners of these straight cuts are made round with an air-hammer chisel, when the edges are chipped for calking. All outside-welt strips are calked. Inside-welt strips are not calked, unless specified to be calked.

A large center-punch hole for each rivet hole, light center-punch holes around the ends of the outline and light center-punch holes to indicate the diameters for drilling complete the welt-strip layout. When duplicate strips are required, these welt strips (outside and inside strips) are used as pattern strips. Send the pattern strips to a punching machine and have the two end holes of the middle rivet rows punched for tack holes. If the strips are very long, six holes will be found necessary for bolting the strips firmly together for drilling.

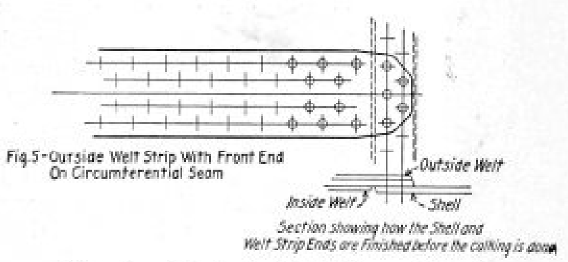


Fig. 5.— Method of finishing welt strip

Now, have the ends and one side edge sheared and return the strips to the layout floor for marker punching the tack-hole locations in the duplicate strips and for marking off the outline.

A center punch operated by an air hammer is used for marking off the outline of duplicate plates when the pattern plate is used as the marking-off template.

Locating the Rivet Holes in Inside-Welt Strips for Seams Wider Than Sextuple-Riveted

The location of rivet holes in the inside-welt strips for seams wider than sextuple-riveted seams may be found by the more practical method of first punching six tack holes in a blank welt strip. The location of these tack holes may be found by the same method as given above for sextuple-riveted seam welt strips.

To assure the welt strip fitting close to the boiler shell have it rolled to a radius slightly larger than the inside radius of the boiler shell.

With the tack holes punched and the strip rolled, bolt the strip tight to the rolled shell and marker punch all of the seam-rivet holes onto the welt strip.

Reroll the welt strip flat; lay out the outline around the rivet holes and then have it sheared. Return the strip to the layout table; marker punch the tack-hole locations in duplicate strips and also mark off the outline from the pattern strip.

Fig. 7 is an inside welt strip for a decuple-riveted

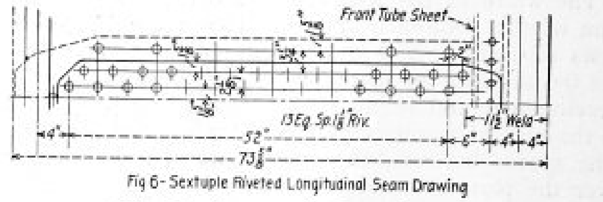


Fig. 6.—A sextuple-riveted seam

seam ready to be rolled and then bolted to the shell for riveting; the holes are drilled and the edges are finished.

Welt strips should have the ring number, (as first, second, third ring, etc.) stamped near the order number

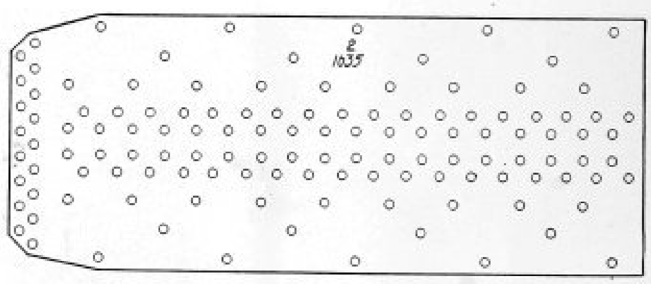


Fig. 7-Inside Welt Strip For A Decuple Riveted Seam-Drilled And Edges Finished-Ready To Be Rolled

Fig. 7.— Welt strip ready for rolling

as shown on Figs. 3 and 4. This identifies the strip for application to the shell without confusion.

The heat and serial numbers should be retained on all plates for record of identification.

Machine Operations on Rings

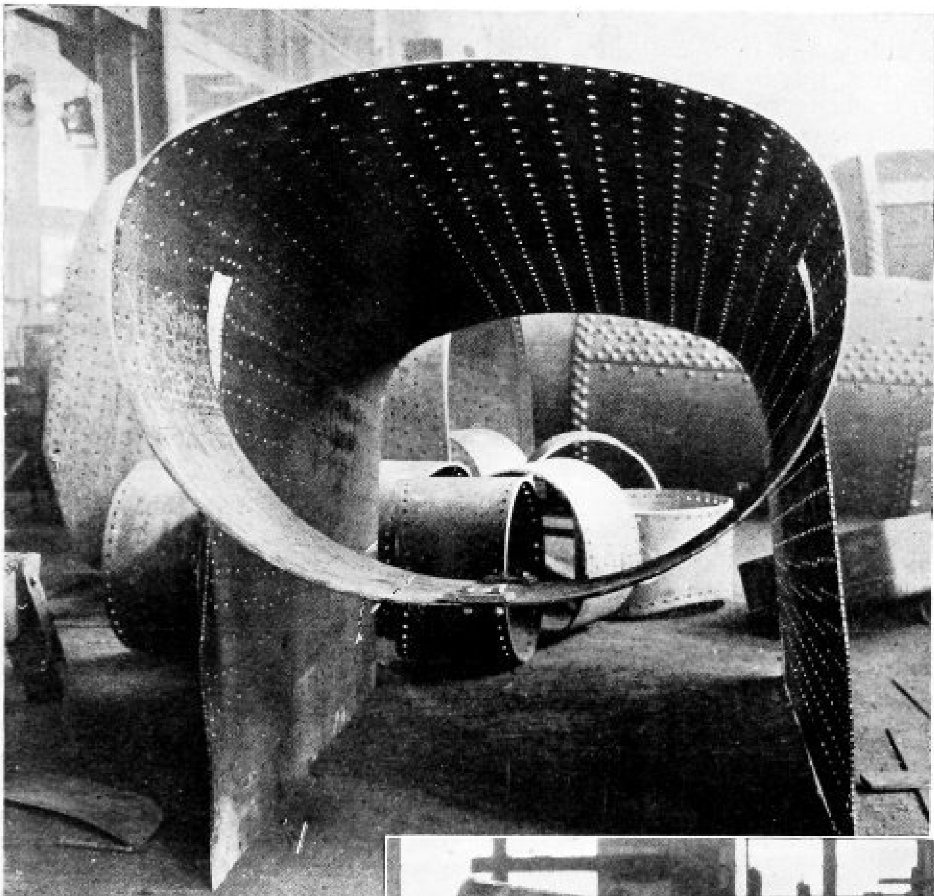
The operations of drilling, shearing, planing, etc., required for rings and welt strips, are carried out in the following manner:

The plates are first drilled. Three to five flat plates (depending on the thickness of the plates) bolted together, make a practical number for drilling. More than this number often causes the drill to divert from a vertically drilled hole.

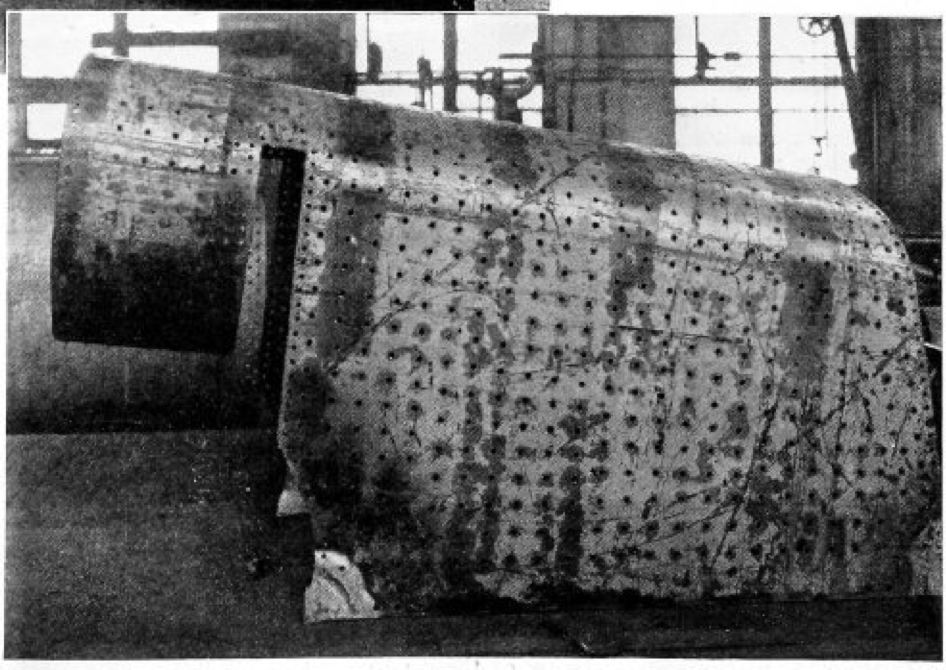
Two multiple, radial-type, drilling machines, one on either end of the plates, are used for drilling the plates. The plates are lifted by an overhead traveling crane and piled on a substantial platform, with wooden top members, between the two drilling machines. The tack holes in the plates are lined up with pointed rods as each plate is piled, and bolted firmly together when the correct drilling number of plates has been placed.

All holes not over $2\frac{1}{8}$ inches in diameter are now drilled. The diameter of drilling is that marked on the pattern plate, Fig. 2, (see page 222 of the Augsut issue) which should be the top plate. Also a lead hole is drilled through all plates for holes larger than 2⅛ inches in diameter. When the drilling has been completed, remove the tack bolts and have the craneman place the plates on the floor near a shearing machine or a radial-type drilling machine.

drilled or the edges of the plate may be planed. The tool for cutting holes $2\frac{3}{16}$ inches to about 3½ inches in diameter in a plate is not a twist drill. A flat piece of steel, edged to cut, is inserted into the holder bar of the vertical revolving spindle of a radial-type drilling ma-



Crown and side sheets for combustion-chamber type boiler rolled in one piece. All rivet and staybolt holes are laid out and drilled before the rolling operation takes place



Another view of the firebox sheet of a combustion-chamber boiler as it appears when ready for assembling with the outside wrapper sheet, backhead tube sheet and mud ring into the finished firebox

If a shearing machine is idle, the outline dimensions stamped on the edges of the plates will be referred to. A line equal to these dimensions plus ⅛ inch for planer finish (from the center of the outside row of rivet holes to the edge of the plate) is marked on the front edge and the two ends of all the plates.

The plate is raised with a jib crane and held suspended while being sheared.

The holes over 2⅛ inches in diameter may now be

chine. Holes about $3\frac{9}{16}$ inches and over in diameter are cut with a cutting tool inserted in each end of the holder bar.

This radial type of plate drilling machine has a metal table under the drill arm, but not of sufficient surface to support a large plate. Heavy wooden horses surround the table for supporting the plate while being drilled. Rivet holes in the plate required to be countersunk are now circled with a soapstone pencil and the countersinking is done before the plate is removed from this drilling machine.

Drilling holes with large diameters requires slow-speed machines. Multiple-drilling machines are usually high-speed machines.

The Planing Operation

The edges of the circumferential length or front and back edges (front edge of the first ring is planed straight) are planed and beveled on the outside of the plate at the front end and on the inside of the plate at the back end. All plate and liner edges that are calked should have the edges beveled to an angle of about 75 degrees to the flat surface of the plate. The longitudinal edges of the plate butt together and are planed straight without a bevel. When the end or ends of the plate are to be welded, the edges (length of weld) are planed to an angle of 45 degrees for receiving the melted metal.

The planer operator puts a taper pin in a rivet hole of the seam, near each end of the plate, and lines the plate up with the pins against the edge of the planer table. He then measures a finish line from the center of the outside row of rivet holes to the edge of the plate, at both ends of the plate.

The planing machines are of the plate-planing type, of great length, with an adjustable head for clamping the plate, and with a cutting tool adjustable to the correct bevel angle, traveling the full length of the plate.

The Bending Rolls

The plate is now ready to be rolled into a ring course; the diameter is given on the boiler drawing. Plates are rolled into cylinders, cones and radial shapes, with a machine constructed of three heavy rollers or revolving cylinders, one or two of which are adjustable for curving a plate to the required diameter. The desired radius is checked with a metal template as the plate is being rolled. The ends of the plate are "broke" (slightly curved) with the rolls to facilitate the rolling of the plate on rolls with one roller adjustment.

Plates up to about 9/16-inch thickness can be rolled into a circle in one run through the rolls. Rolling the plate back and forth a few times about the ends, completes the rolling operation.

Heavy plates require a number of runs through the rolls to obtain a true diameter. The bearing support for the top roller (at one end of the rolls) is hinged to swing down clear of the plate, for removing the plate from the rolls.

Only a man experienced in the art of rolling plates, is capable of doing the work.

Machine Operations on Welt Strips

Four to five welt strips are bolted together for drilling.

In shearing the outside welt strips, one side edge is sheared close to the outline for planing. The front and back ends and the angle cuts around the end rivet holes are also sheared close to the outline, for air-hammer bevel chipping.

In shearing the inside-welt strips, the base side line and back-end line should be drawn as close as possible to the edge to eliminate shearing of these edges. The other side edge, front end and angle cuts at the back end are sheared off on the lines, unless the edges are to be calked.

The edges of the inside-welt strips only are planed when they are to be calked.

The two side edges of the outside welt strips are planed with a bevel for calking against the shell. One edge of one welt strip only is planed at one time on a regular plate planer. A board between the adjusting head of the planer and the welt strip, assures the narrow strip being securely clamped for planing. It is not practical to clamp more than one welt strip securely in the planer at one time.

(To be continued)

Swiss Experimental Locomotive Has Novel Boiler

By G. P. Blackall

UNQUESTIONABLY the steam locomotive of the future will differ markedly from what has been orthodox practice for many years, but whether it will take the form of the turbine-driven type or a modified arrangement of a reciprocator remains to be seen. The latter is generally the simpler from the mechanical viewpoint, and the present tendency is to make use of poppet valve motions such as the Caprotti, which is now being experimented with in England by the London Midland & Scottish Railway.

Both these developments figure on an experimental locomotive recently built at Winterthur by the Swiss Locomotive Company. In addition, the steam cylinders are of the uniflow type and arranged as three cylinders working in parallel.

Boiler of Tubular Type

The boiler is of a rather novel tubular type, comprising an upper drum which functions as a steam accumulator and two lower drums rather smaller and connected by water chambers and a number of tubes. The latter are of relatively large bore, and are arranged vertically. There is another system of vertical tubes which function as a superheater, while a large number of horizontal ones constitute an economizer, raising the water to a very high temperature in accord with modern high-pressure boiler practice. This pre-heating of the feed is claimed to eliminate scale entirely, even with impure water, the fine mud deposited in the lower drums being easily blown out. If any scale should form under adverse circumstances it is restricted exclusively to the pre-heater, from which it can be easily removed. The boiler unit itself is comparatively short, which admits of the location of the engine above the frames. The whole unit is quite simple and compact and involves nothing freakish in its design.

The builders claim this locomotive to be simple to handle and very accessible, while it effects considerable economy in coal and water. The figures given are 35 percent to 40 percent coal economy and 45 to 50 percent water economy. Test runs shows a coal consumption averaging 1 ton per mile and water consumption 1,200 pounds per mile, as against 2,900 pounds and 2,200 pounds respectively for a standard type of engine working on the same trial section with similar fuel. The tests were carried out by the Swiss Federal Railways. As the pressure used, 850 pounds, is by no means excessive, the economies obtainable should certainly appeal for long runs in districts where water is scarce and fuel costly—conditions which often go together.

The Paige & Jones Chemical Company of New York city and Hammond, Ind., has purchased from the American Water Softener Company, Philadelphia, Pa., patent rights and good-will pertaining to the lime-soda water softening business of that company, and will hereafter manufacture and sell this type of lime-soda water softeners.

Revisions and Addenda to Boiler Construction Code

IT is the policy of the American Society of Mechanical Engineers Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and 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 the secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the committee for consideration.

For the convenience of the reader in studying the revisions, added matter is in small capitals and deleted matter in smaller type.

PAR. H-4. REVISED:

H-4. The maximum allowable working pressure on the shell or drum of steel-plate steam-heating and hot-water boilers shall be determined by the strength of the weakest course, computed from the thickness of the plate, the tensile strength stamped theron WHICH SHOULD BE THE MINIMUM SPECIFIED [as provided for in Par. S-17 of Section II of the Code], the efficiency of the longitudinal joint or of the ligament between the tube holes in shell or drum (whichever is the least), the inside diameter of the course, and the factor of safety, but in no case shall the pressure on which the factor of safety is based be considered less than 30 pounds.

$$\frac{TS \times t \times E}{R \times FS} = \text{maximum allowable working pressure, lb. per sq. in.}$$

where TS = MINIMUM ultimate tensile strength stamped on shell plates [as provided for in Par. S-17 of Section II of the Code, lb. per sq. in.]

t = minimum thickness of shell plates in weakest course, in.

E = efficiency of longitudinal joint or of ligaments between tube holes (whichever is the least)

R = inside radius of the weakest course of the shell or drum, in.

FS = factor of safety, or the ratio of the ultimate strength of the material to the allowable stress.

For new constructions, FS in the formula = 5.

PAR. H-5. REVISED:

H-5. Specifications are given in Pars. S-1 to S-263 of Section II of the Code for the important materials used in the construction of boilers [and where so given the]. Material [as herein mentioned] for [boiler] parts OF LOW-PRESSURE HEATING BOILERS required to resist internal pressure, FOR WHICH SPECIFICATIONS HAVE BEEN PROVIDED shall conform TO THOSE SPECIFICATIONS [thereto] except as OTHERWISE specified herein [for autogenously welded boilers].

PAR. H-6. REVISED:

H-6. Steel plates USED for any part of the boiler SUBJECTED TO [where under] pressure, [also manhole and handhole covers and other parts subjected to pressure] (and FOR braces and lugs) [when made of steel plate] shall be of flange or firebox quality IN ACCORDANCE WITH [as designated in] the Specifications for Steel Boiler Plate, except PLATES [for base metal as specified] for autogenous welding AS HEREIN SPECIFIED (SEE PAR. H-74).

PAR. H-8. REVISED:

H-8. *Tensile Strength of Steel Plate.* In determining the maximum allowable working pressure, the tensile strength used in the computations for steel plates shall be that stamped on the plates as herein provided, which is the minimum SPECIFIED [of the stipulated range, or 55,000 lb. per sq. in. for all steel plates except for special grades having a lower tensile strength].

PAR. H-74. REVISED:

H-74. *Material for Base Metal.* The base metal composing the plates of autogenously welded [steel] heating boilers shall be of [good] weldable FLANGE OR FIREBOX quality [and shall be made by the open-hearth process] conforming to the requirements of [the specifications for forge welding] Pars. H-122 [121] to H-136 INCLUSIVE [or to those for flange and firebox classes of steel given in Pars. S-5 to S-17 of Section II of the Code provided the carbon does not exceed 0.20 per cent].

PAR. U-20. REVISED:

U-20. *For Internal Pressure.* The maximum allowable working pressure on the shell of a pressure vessel shall be determined by the strength of the weakest course, computed from the thickness of the plate, the efficiency of the longitudinal joint, the inside diameter of the course, and the maximum allowable unit working stress.

StE/R = maximum allowable working pressure, lb. per. sq. in.

where S = maximum allowable unit working stress in lb. per sq. in.

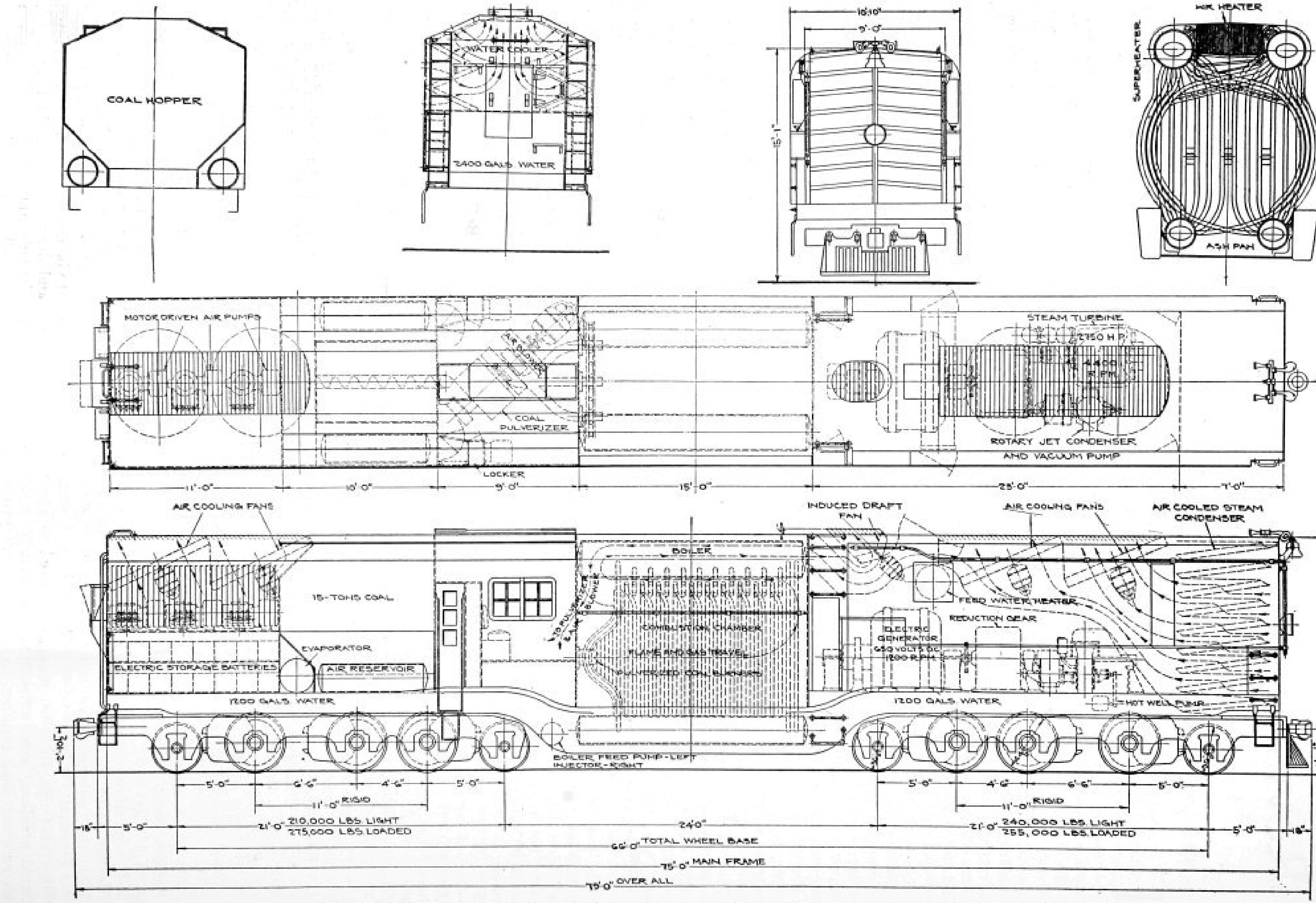
= 11,000 lb. per sq. in. for steel plate stamped 55,000 lb. per sq. in., 10,000 lb. per sq. in. for steel plate stamped less than 55,000 lb. per sq. in., and 9000 lb. per sq. in. for material used in seamless shells.

t = minimum thickness of shell plates in weakest course, in.

E = efficiency of riveted longitudinal joint [percent]

R = inside radius of the weakest course of the shell, in., provided the thickness of the shell does not exceed 10 percent of the radius. If the thickness is over 10 percent of the radius, the outer radius shall be used.

NOTE: When the safe working pressure for welded or brazed vessels is to be determined, E will be omitted from the formula and the values for S in Pars. U-68, U-82, or U-94 will be substituted for the values given above. For seamless shells, E equals 100 percent.



Plan, elevation and cross sections of steam turbo-electric locomotive laid down by the committee

Development of Boiler Design for Steam Turbine Locomotives

Boilers to carry 450 pounds pressure will be one-third of standard boiler weight

AT the twentieth annual convention of the International Railway Fuel Association held last May at the Hotel Sherman, Chicago, Ill., many papers, addresses and reports were made which contained a wealth of information on almost all phases of fuel and related economies.

One of the outstanding reports of the session was that on steam turbine locomotives in which the committee traced the development of this type of locomotive from the first one designed in 1907, by Professor Belluzzo of Milan, Italy, to recent European developments. These developments include the Maffei-Benson turbo-condensing locomotive, generating steam at the critical pressure of 3200 pounds and developing 2000 normal rated horsepower; the Krupp 2000-horsepower turbo-condensing locomotive with a watertube, marine-type boiler, utilizing a steam pressure of 850 pounds; the Henschel turbo-tender driven by exhaust steam from either a piston or a turbine locomotive, and the Ljungstrom type locomotive, which has been in regular service on the Swedish state railways since March, 1927. An abstract of the remainder of the report follows:

Other projected designs, exhibited recently by representatives of the Ljungstrom Company for condensing turbo-locomotives show horsepowers ranging from 4000 to 8000 with tractive forces from 78,000 to 191,000 pounds. The 8000-horsepower locomotive weighs 830,000 pounds including the rear unit, and has ten driving wheels on each unit. A comparison is made with the Virginian Mallet type, which weighs with tender 898,000 pounds and develops 176,000 pounds tractive force. Steam pressures for both locomotives are taken as 215 pounds per square inch.

Some claims made for these locomotives over existing types are more gross ton-miles per hour owing to increased capacity and 25 percent greater starting power with the same adhesion weight. The torque is considerably increased at lower speeds, thus providing greater hauling capacity at the same maximum output. Greater utilization results in fewer locomotives needed. Non-stop runs of 500 to 700 miles are possible.

Full credit should be given the European railways and particularly to the Swedish and German engineers for their fearless and progressive attitude toward improvement of the steam locomotive.

Proposed Turbine Locomotive Design

This committee, after carefully checking the progress made in Europe, believes that this type of locomotive deserves serious consideration. A locomotive of this type should have many advantages over the present type. We believe that the best method of bringing the turbine locomotive to the attention of this association is to make definite recommendations covering a specific design.

This has been done, and we submit herewith a design for a 2500-horsepower steam turbine locomotive suitable for either heavy passenger or fast freight service, the starting tractive force of this locomotive to be 100,000 pounds and the maximum speed 65 miles per hour.

The power for this locomotive is obtained from a steam turbo-electric generating unit furnishing electric current to motors geared to the driving axles. The steam turbine drives the electric generator through a set of single-reduction gearing.

Steam at 400 pounds pressure and 700 degrees F. maximum temperature, at the turbine throttle, is furnished by a watertube boiler of compact design. The exhaust steam from the turbine is condensed by a closed feed water heater, an air-cooled condenser at the front of the locomotive and a combined rotary jet condenser and vacuum pump, having the jet cooling water cooled by an air-cooled radiator at the rear end of the locomotive.

The general construction of this locomotive consists of a main frame of cast steel 75 feet long carried on two 10-wheel trucks, each truck to have three pairs of driving and two pairs of guiding wheels, one pair at each end. The greater portion of the main frame is to have a sheet steel housing on top of it, the cross section to come within the road clearance limits.

The general arrangement of the parts of the locomotive, beginning at the front end, is the air-cooled steam condenser and cooling fans, steam turbine, rotary jet condenser and vacuum pump, electric generator, steam boiler, cab containing coal pulverizer and all locomotive controlling apparatus, coal bunker, water tank, water cooling radiator and cooling fans, an electric storage battery to start and operate the motor-driven auxiliaries, and to furnish electric current for the headlight and cab lighting, and an evaporator to evaporate all the raw water from the storage tanks, and pass it on as steam to the condenser. This will insure clean, pure feed water for the boiler.

Steam Boiler

The steam boiler will be of the watertube type, of compact design. It will carry a maximum steam pressure of 450 pounds and have a superheater to give a maximum steam temperature of about 700 degrees F. The design of the boiler is such as to provide rapid circulation of the water in it, which will insure maximum evaporation from the heating surface the greater portion of which is in the firebox. The weight of this boiler and the amount of water carried in it will be about one-third of the weight and water capacity of a standard locomotive boiler. At the back of the firing end of the boiler an ignition pocket is provided so that powdered coal or oil can be used for fuel.

Steam ash and soot blowers are to be provided for removing the ash and soot from the tubes in the boiler, an ash pan being located under the boiler firebox. The ashes are to be removed from this ash pan by means of a steam ash blower through a door provided at the front of the pan.

An air heater is to be used for heating the air for combustion to a high temperature before it is blown into the combustion chamber. The air is heated by the waste gases from the firebox after they have passed through the superheater. The flow of the air through the heater will be counter-flow to the flow of the waste gases, which will provide highest air temperature and highest efficiency.

A 10-horsepower motor-driven exhaust fan will be used to provide induced draft through the combustion chamber, superheater and air heater and to discharge the gases from the top of the locomotive.

Pulverized Coal Burners

The fuel will be powdered coal. A 50 horsepower motor driven unit pulverizer with a capacity of 5000 pounds per hour will be located in the cab between the boiler and the coal hopper which has a capacity of about 15 tons. The coal from the storage hopper will be conveyed to the pulverizer by a screw conveyor similar to that now used on stoker-fired locomotives. The amount of coal and heated air entering the pulverizer can be regulated to suit requirements. All air for combustion is heated to a high temperature. About 25 percent of this air will pass through the pulverizer for conveying, drying and heating the pulverized coal. About 25 percent of the air will be blown into the coal and air pipe before it enters the burners. The remaining 50 percent of air will be blown into the combustion chamber, as secondary air, at several points around the ignition pocket.

Three flat-flame pulverized-coal burners are to be used, one in the center and one on each side of the ignition pocket of the combustion chamber in the boiler. The construction of these burners is similar to a gas-light burner to give a turbulent, thorough mixing of the air and pulverized coal.

The burners will give a short, intensely hot flame which will ignite close to the burner. The three burners will provide a wide range of capacity. The center burner is to be used when starting the fire or for maintaining heat for holding steam pressure. The two outside burners are to be used when the locomotive is working at low or medium capacity. All three burners are to be used when the locomotive is worked to maximum capacity. Each burner is to have a capacity range of over 50 percent. It will not be necessary to dry or crush the coal before placing it on the locomotive any more than would be required for a stoker-fired locomotive.

Feed Water Heater, Pump and Injector

A closed-type feed water heater will receive steam at 60 pounds pressure, bled from the steam turbine. This heater will raise the temperature of the feed water to about 317 degrees F. before entering boiler. A steam-jet heater will be used to heat the boiler feed water before it enters the boiler feed pump which is of the centrifugal type, turbine driven. The jet heater is to receive the exhaust steam from this steam turbine, the condensation from the closed type heater and the water from the hot-well pump, to mix with water discharged from the booster pump connected to the rotary jet condenser.

The maximum temperature of the feed water before entering the boiler feed pump will be 193 degrees F. The pump will discharge the feed water through the closed type heater where it will be heated to about 317 degrees F. as stated above. A hot water injector will be used to supplement the boiler feed pump and will receive water from the line supplying water to the rotary jet condenser and vacuum pump.

A steam-heated evaporator, receiving steam bled from the steam turbine, will be used to evaporate all water passing from the storage tank to the rotary jet condenser cooling water storage tank. The water evaporated in the evaporator will be drawn as steam into the rotary jet condenser and condensed and returned to the cooling circulating system or to the boiler as feed water.

The evaporator is located between the coal and water storage and provides a positive means of purifying the water to be used in the boiler. No water treatment of any kind will be required for the water entering the evaporator. The amount of make-up for boiler feed would be comparatively small except when the locomotive is used for hauling passenger trains and steam is required for heating.

The percentage of useful work obtainable from the coal for the standard steam locomotive, is 8 percent as compared with 17 percent for the turbo-electric locomotive. This indicates that the turbo-electric locomotive will use less than half the coal used by the standard steam locomotive when doing the same amount of work.

The turbo-electric locomotive should also use very much less coal during stand-by time than the standard steam locomotive, on account of the use of pulverized coal for fuel.

The turbo-electric locomotive has a high tractive force at low speeds which gives it a distinct advantage over the standard steam locomotive. In other words, the turbo-electric locomotive is able to produce a greater tractive force than the standard locomotive at any speed, due to its being able to work its power plant at practically full capacity under all conditions. It can, therefore, handle greater tonnage under all conditions. This makes the turbo-electric locomotive practically on a par with the electric locomotive, within the limits of its power plant capacity.

The turbo-electric locomotive can operate where any standard steam locomotive can be used and can also be designed to operate over electrified zones with electric current received from an overhead wire or third rail.

The turbo-electric locomotive should have many advantages over the standard steam locomotive, particularly when equipped to burn pulverized coal, which should make operation practically as flexible as when oil is used for fuel. The standby-losses, with powdered coal should be very low and the time required for cleaning ash pans reduced to a minimum. The operation should also be practically smokeless.

The use of boiler feed water evaporated and purified on the locomotive should reduce the cost of water to a minimum. It should also reduce the labor and maintenance cost for the locomotive boiler and keep it clean and efficient at all times, and practically eliminate the necessity for boiler washing.

The report of the committee was signed by L. P. Michael (C. & N. W.), chairman; G. S. Goodwin (C. R. I. & P.), C. H. Bilty, (C. M. St. P. & P.), W. O. Moody (I. C.), H. Gardner (Steamotor Company), G. H. Roosevelt (General Electric Company), C. D. Perkins (Modine Manufacturing Company), W. M. Sheehan (Commonwealth Steel Company), V. G. Leach (Peabody Engineering Corporation, and J. Crites (Raymond Bros. Impact Pulverizer Company).

William H. Moore, formerly representative of the Metal & Thermit Corporation, with headquarters at Chicago, has been appointed sales manager of the W & B Company and the Burnside Steel Foundry Company, Chicago.

D. S. Mair, manager of the Houston, Tex., office of Joseph T. Ryerson & Sons, Inc., has resigned to organize the D. S. Mair Machine Company, Houston, Tex. He will handle the sales of the bolt and pipe threading machines and the taps of the Landis Machine Company and the machine tools of the Ryerson Company.

The Use of Alloy Steels for Boilers*

Corrosion and heat-resisting materials necessary to meet high-temperature and pressure conditions

By J. V. Romer and W. W. Eaton†

IN the early days of industry, cast iron was quite generally employed in boiler construction. As boiler working pressures increased, low-carbon or mild-tough steel plates came into extensive use. As the temperature rose, troubles were encountered, namely, the loss of strength of the material and its tendency to oxidize and waste away. As a result of these conditions attention was turned to materials other than mild steel, particularly the alloy steels.

Although mild steel containing carbon and manganese is a true alloy, it is not customary to so class this material and in this paper, the term, "alloy steel" will be used to signify ferrous alloys containing varying amounts of one or more of the alloying metals, nickel, chromium, silicon, manganese, vanadium, tungsten, copper, cobalt, molybdenum, etc., which have been properly added in order to give the finished product some specific property.

Application of Alloy Steels

So far, many different ferrous alloys have been developed for a variety of purposes, some of which have met with wide success in various fields, including that of boiler manufacturing. A great deal of study has been given to many of these alloys, and in some cases the properties are quite thoroughly understood. There is still a great deal of information needed before alloy-drum plates can be considered a commercially accomplished fact. For this reason the boiler code of the American Society of Mechanical Engineers does not yet authorize the use of drum-plate material other than mild-carbon steel. High-pressure seamless drums are usually made of acid open-hearth steel which may be classed as a silicon alloy.

An alloy steel that is meeting with a great deal of favor is a 1.0 to 1.5 percent nickel, 0.5 to 0.75 percent chromium, steel sold under various trade names. This material is being widely used in making studs and bolts for high-temperature, high-pressure service as well as for safety valve parts where a strong material resistant to oxidation is required.

A great deal has been done along the lines of heat-resisting materials for use in castings for baffles, flame plates, oil-burner impellers, etc. One reason for this is the fact that many excellent alloys cannot be machined or forged; hence their use is limited to castings.

Considering all of the alloying elements and the multitude of combinations possible, it is easy to realize that there is a possibility of many new combinations being developed that will have properties that are now being sought. This condition also brings to mind the fact that it is manifestly impossible to study thoroughly every alloy and know its value from the viewpoint of boiler practice.

Many fundamental points must be considered before an alloy can be adopted for any given service. Ultimate tensile strength, elastic limit, elongation and impact resistance over the entire range of temperature for which the material is being considered, must be known. For high-temperature service, the scaling temperature of the alloy is important.

Other properties that must be investigated are the thermal conductivity and the coefficient of expansion. Where the material is to be subjected to high temperatures for long periods, it is quite essential to determine what, if any, changes occur in its structure or properties as a result of such heating. In many cases, the action of various gases and chemicals must be studied before a new alloy can be accepted.

Although the alloy steel applications thus far referred to are not very extensive, no one should feel that their real use is limited. Instead, the surface has merely been scratched and we can look forward to a development paralleling that which has taken place in seamless tubes, where alloy steels are rapidly finding a very extensive use. In this field, alloy materials fall into two groups as follows:

1. Corrosion-resisting materials designed to withstand the effect of bad feedwater or other corrosive influences.
2. Heat-resisting materials designed to withstand the high temperatures incident to modern high-pressure operation.

Corrosion-Resisting Alloys

A commercial material of the first class is the so-called "Toncan" iron. This is a highly refined iron, with which are alloyed not less than 0.40 percent copper and 0.05 percent molybdenum. It is well known that the addition of copper in small quantities to a ferrous material improves its corrosion-resisting properties and the further addition of molybdenum, besides enhancing this improvement, benefits the grain structure and adds strength and toughness. The effect of the addition of copper and molybdenum has been to increase the resistance to corrosion without appreciably altering such properties as thermal conductivity, coefficient of expansion, physical properties, ability to weld, and ability to withstand hot or cold working.

The physical properties of "Toncan" iron are similar to those of the best grade of low-carbon steel, from which boiler tubes are ordinarily made. These properties are as follows:

Ultimate strength	52,000 pounds per square inch
Yield Point	39,500 pounds per square inch
Elongation in 2 inches	47 per cent

Heat-Resisting Alloys

The second group, heat-resisting alloys, is best represented by the chrome-nickel irons. Several of these of approximately the same anaylsis and characteristics are on the market today. Among them may be listed the following:

1. Enduro 18-8, made by the Central Alloy Steel Corporation.
2. Allegheny Metal, made by the Allegheny Steel Company.
3. Rezistal No. 2, made by the Crucible Steel Company of America.
4. Carpenter Stainless Steel No. 4, made by the Carpenter Steel Company.

The general type analysis of these chrome-nickel irons is as follows:

* Abstract of a paper presented at the sixth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.
† Babcock & Wilcox Company, New York city.

Carbon	Under 0.20 percent
Manganese	Under 0.50 percent
Phosphorus	Under 0.03 percent
Sulphur	Under 0.03 percent
Silicon	Under 0.50 percent
Chromium	17 percent to 20 percent
Nickel	7 percent to 10 percent

Rezistal No. 2 contains approximately 2.00 percent of silicon.

The following physical characteristics of Enduro 18-8 may be taken as respective of the group:

	Hot Rolled	An-nealed
Tensile strength, pounds per square inch	110,000	90,000
Yield point, pounds per square inch	82,000	35,000
Proportional limit, pounds per square inch	67,500	30,000
Percent elongation in 2 inches	36	61
Percent reduction of area	52	75
Brinell hardness	223	135
Rockwell hardness	B-95	B-85

The chrome-nickel-iron alloys are not as good heat conductors as low-carbon steel. Tests made at the Massachusetts Institute of Technology indicate that Enduro 18-8 has a thermal conductivity about 40 percent that of carbon steel. The ability of these alloy tubes to conduct heat is, however, ample for all boiler and superheater purposes.

Tubes of chrome-nickel-iron alloys easily undergo the operations necessary for boiler work. They may be readily expanded, swaged or bent.

Properties of Chrome-Nickel-Iron Alloys

The essential qualities of the chrome-nickel-iron alloys are their resistance to oxidation and their ability to retain a sufficient strength at high temperatures. It is stated that Allegheny metal when heated in an oxidizing atmosphere for twelve hours at 1600 degrees Fahrenheit will lose but 0.38 percent in weight, and when at 1700 degrees for the same time will lose 0.53 percent.

In considering the strength of these alloys at high temperatures, it is necessary to make a distinction between tensile strength as ordinarily obtained from pulling test specimens, and the so-called "creep" strength. At elevated temperatures the strength of a given material varies with the rate at which the load is applied. If applied relatively quickly as in a testing machine, the strength is greater than is actually the case when the material is subjected to stress over a long time in actual service. A tube which is sufficiently thick for a given pressure based on its short time tensile strength at a low temperature, but not thick enough to bring the stress below the "creep point" would, if placed in a boiler or superheater and kept under pressure at a high temperature for a long period, progressively stretch or "creep" until the wall became too thin to withstand the pressure. Then the tube would fail. The transverse stress due to the weight of the superheater tubes often exceeds that due to the steam pressure, and in such a case there would be a gradual sagging of the tubes if the transverse stress exceeded the "creep point."

Data included in the Department of Scientific and Industrial Research's Special Report No. 1 on "Properties of Materials at High Temperatures" indicate that the short time ultimate tensile strength and the "creep" stress of 0.17 percent carbon steel is approximately as follows:

932 Degrees Fahrenheit	45,000 pounds per square inch	9000 pounds per square inch
1112 Degrees Fahrenheit	25,000 pounds per square inch	2000 pounds per square inch
1292 Degrees Fahrenheit	11,000 pounds per square inch	not given

The short time tensile strength of the chrome nickel iron alloys is as follows:

	Ultimate tensile strength
932 Degrees Fahrenheit	72,000 pounds per square inch
1112 Degrees Fahrenheit	67,000 pounds per square inch
1292 Degrees Fahrenheit	61,000 pounds per square inch

The determination of "creep" values for alloys over the range of elevated temperatures met in modern practice is a complicated and lengthy process if results that are accurate and trustworthy are to be obtained. In its investigation of the performance of alloys under such conditions, the Babcock & Wilcox organization has developed methods and equipment whereby test specimens may be held for extremely long periods under uniform and measured conditions of load and temperature. Sufficient data have already been accumulated by these investigations to indicate both the accuracy of the method and the extremely valuable properties of the chrome-nickel-iron alloys for high pressure and high temperature service.

Taps From the Old Chief's Hammer

ALTHOUGH his resourcefulness was wrongly applied and might easily have had fatal results, a water tender on a portable steam threshing outfit in the state of Washington displayed something closely akin to ingenuity when he used sand to augment a meager supply of boiler feedwater. The engineer, who was injured in the resulting explosion, recently related the story to one of our inspectors:

"We had been threshing about four weeks when I decided that the boiler needed cleaning. In as much as I had planned to spend Sunday with my family, I persuaded the water tender and another man of the crew to undertake the job. On returning later Sunday evening, I found the boiler filled and apparently ready for a sunrise start.

"Next morning we fired up and everything seemed to be shipshape. Some time later I stepped to the footboard and started the engine. There was a snapping crash and as I leaped from the footboard I saw the rear of the engine bed rise about three inches.

"We found that the crown sheet had dropped, after tearing away from the tube sheet. Each one of us had some theory to offer as to why it happened. That is to say, each one except the water tender. He listened intently to our discussion and said nothing. When we had exhausted every explanation we could think of, he asked casually if we thought a little sand in the boiler could have had anything to do with the accident. Encouraged by our interest in his question, he explained that after he and his partner cleaned the boiler they found that they lacked water enough to fill the boiler so that it showed in the gage glass. Not wanting to haul water that night, they decided on what appeared to them to be a very satisfactory method of coping with the difficulty. They poured sand through the filling plug until the water rose to the proper level in the gage.

"The filling plug being on the front end, a great pile of sand settled on the crown sheet. When I examined the sheet I found it glazed over with a layer of molten silica. Naturally, it was quite impossible for the sheet to escape burning. Had he made a deliberate attempt to blow up the boiler, the water tender could not have chosen a more certain method."—*The Locomotive.*

An Arc Welded Gas Holder

Plate work laid out in the shop—Seventy percent of welding carried out in field

By F. H. Beebe*

THERE has just been completed at Albion, Michigan, the largest all electric arc welded low pressure gas holder ever built. The construction and design are both the work of the Western Gas Construction Company of Fort Wayne, Indiana. The holder with all lifts elevated to their maximum height stands 113 feet 7 inches above the foundation. It has a diameter of 74 feet and weighs 516,385 pounds plus the weight of the welding rod that was used. The gas holder has a capacity of 300,000 cubic feet of gas at a water pressure, when full, of 12 inches.

Fig. 1.—Early stages in construction of gas holder

A 15,000-cubic foot single lift gas holder of all arc welded steel construction was built by the company for the Missouri Gas and Electric Company at Lexington, Missouri, in 1924 and with this one exception, the Albion holder is the only and largest low pressure gas holder built entirely by arc welding. The previous welding work done on gas holders seemed to lead logically to its use, for welded joints have proved satisfactory in structural strength and are gas and water tight. One of the great advantages of using welding on gas holders lies, of course, in the latter fact.

Building a gas holder by welding has inherent practical advantages that recommend it strongly. It simplifies construction and reduces fabricating cost. When a gas holder is made of riveted plates it is necessary to employ the tank shop to lay out and punch all the members. When metallic arc welding is used it is only necessary to layout and punch the members in the shop for fitting up bolts. The plates are, of course, rolled to the proper curvature in the shop. On this job the plates were assembled in position with bolts and tack welded with the exception of the cups and grips, which were fabricated in the shop, assembled in sections on the ground, and welded in place.

Construction of Water Tank

Fig. 1 shows the gas holder with the water tank under construction. The bottom was assembled and welded on the foundation which was 3 feet below yard

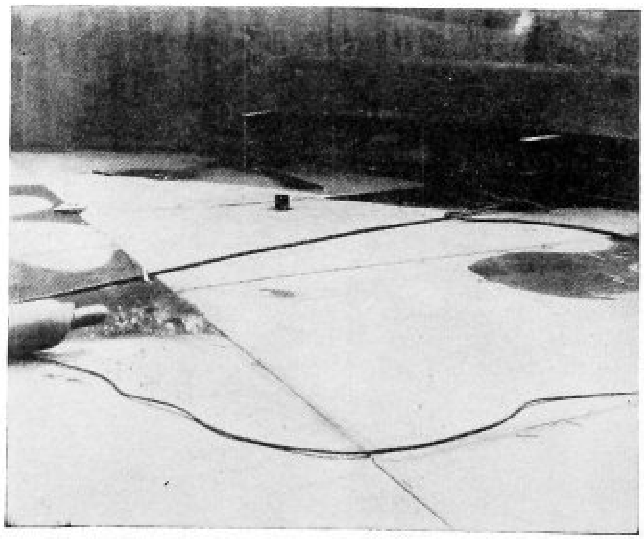


Fig. 2.—Interior of water tank showing welding and cup construction

* Vice-president, Western Gas Construction Company, Fort Wayne, Ind.

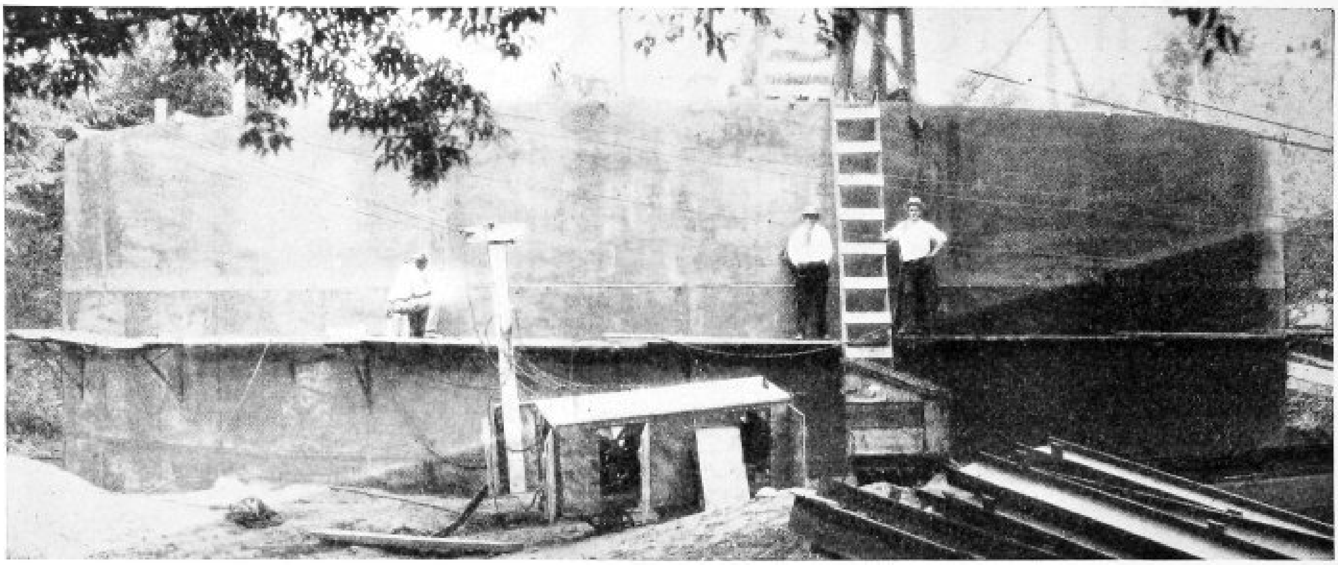


Fig. 3.—Final welding operations on water tank

level and incidentally in this case, below the water line. Excavation was made around the foundation forming a pit, in the center of which was the foundation. The bottom and first course were built on the foundation and water was allowed to stand in the pit at a height of about 12 inches above the foundation. In this manner the bottom and lower curb were tested for leaks and it is interesting to know that none were found.

The structure shown in Fig. 2, against the circular plates in the upper right hand corner, is what is known in gas holder construction as a cup. The ease with which these cups were built by electric welding is quite clearly shown. I-beams were welded together and to the floor forming the landing blocks. In Fig. 2 one of the temporary construction joints can be clearly seen behind the cup. The preliminary bolts and tack welding are just above the right cup support.

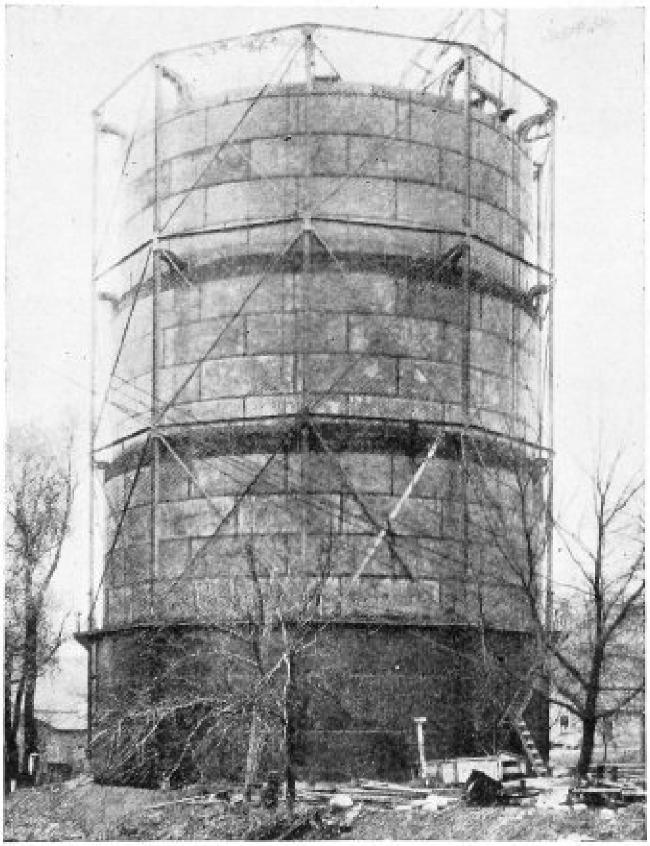


Fig. 4.—Completed gas holder having 300,000 cubic feet capacity

Fig. 3 shows the gas holder at the time of the completion of the water tank. When this photograph was taken the final welding was in process. The joints were of the lap type, a variety easy to weld. In this picture a fairly comprehensive suggestion of the bracing may be glimpsed above the upper course. It was not elaborate and consisted of virtually the same elements that would be necessary on a riveted job.

The finished gas holder is shown on Fig. 4 rising to its full 113 feet 7 inches of height. For the information of those who may wonder about the plates that form the sides, it might be well to state that the water tank ranges from 7/16-inch to ¼-inch stock and the three lifts are of No. 10 gage metal.

In laying the crown of the upper section, a wooden under structure was built on which the plates could be placed. When this was ready, the plates were swung into position and tack welded. They were laid in circular rows from the outside to the center, each succeeding course being lapped over the one before. As the plates were placed they were tack welded to hold them in position and when all was ready the finishing welds were made.

On this gas holder four tons of electrode welding rod were used. If a holder of the same size were made of riveted construction 7½ tons of rivets would be necessary. Four "Stable-Arc" welders manufactured by The Lincoln Electric Company, Cleveland, Ohio, placed 21,414 lineal feet of welding. The entire job was carried through almost without a hitch and with much less difficulty than would naturally be expected with a new structural process.

The holder at Albion, Michigan, was built largely through the cooperation of D. F. Burritt, vice president, in charge of engineering of the Middle West Utilities Company, Chicago, Illinois and Roy Campbell, president of the Albion Gas Light Company.

THE TRUSCON STEEL COMPANY, Youngstown, Ohio, has purchased the Hydraulic Pressed Steel Corporation, Cleveland, Ohio, and will operate it as its pressed steel division. The entire plant is being completely modernized.

A New Problem in Steel Corrosion

Corrosive effect of white lead paint where used to mark sheets for forming at elevated temperatures

ONE of the most recent phases of the iron and steel corrosion problem, requiring immediate investigation, developed not long ago in the boiler department of one of the greatest locomotive works in the country. This company had for some time been using Toncan copper molybdenum iron boiler plate for the flue sheets of the McClellon type boiler with marked success. In one particular instance, a ruptured surface

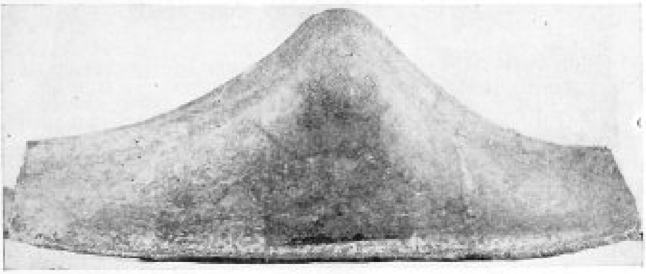


Fig. 1.—Section of flue ring, showing ruptured areas on the surface

condition was discovered on the finished section of one of the sheets. This rupture had apparently occurred where the heat number or other identification numbers had been painted on the surface prior to heating the plate for flanging. Figs. 1 and 2, indicate the ruptured surface condition that was produced.

Micro-Examination of Ruptured Plate

An investigation was immediately started to determine whether or not the white lead paint was entirely responsible for the bad surface condition obtained. Micro sections were cut from various parts of the defective plate, adjacent samples of a good surface and of a bad surface being obtained at three places. The location of these samples is shown in Fig. 3. This examination revealed the ruptures to be cracks of irregular outline and of depths varying from 0.007 to 0.020 inch. At the base of the large cracks numerous smaller cracks were seen which suggested that the cracks were intercrystalline. No foreign substances, such as non-

Fig. 2.—View showing details of ruptured area

metallic inclusions, were found within the cracks. When examined in the etched condition, the grain size around the cracks was found to be smaller and uniform from the surface to the center of the plate. The following photo-micrographs, Fig. 4 and Fig. 5 (at 100 magnifications), show typical etched and unetched views of a good and of a bad surface from adjacent positions on the defective flue ring.

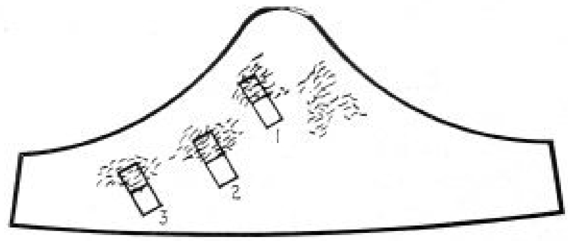
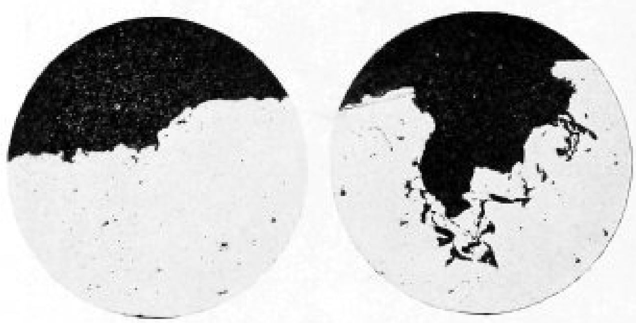


Fig. 3.—Coupons cut from ruptured surface for examination

Effect of White Lead on Sheet Material

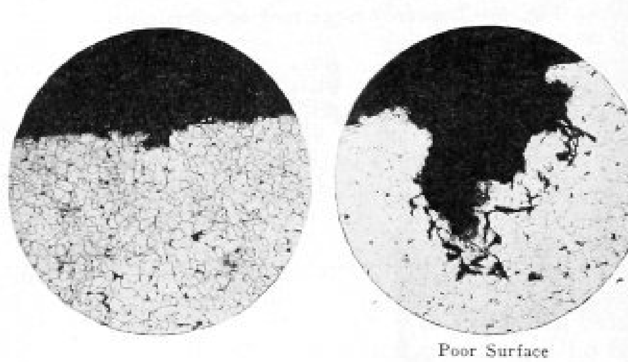
Before making the definite conclusion that the ruptured surface was due to a corroding action of the white lead at forming temperatures, it was thought advisable to make a study of the corrosive properties of white lead on the surfaces of several types of sheet iron and steel when heated above a red heat.

To carry out this experiment, 5-inch by 8-inch sections of 26 gage (0.018 inch thick) Toncan copper molybdenum iron, Toncan enameling iron, copper bear-



Good Surface Poor Surface

Fig. 4.—Unetched test samples



Poor Surface

Fig. 5.—Test samples etched with nital solution

ing steel, commercial pure iron, high phosphorous sheet steel and low carbon sheet steel were used. The defective flue ring from the locomotive boiler had practically the same analysis as that of the Toncan copper molybdenum iron used in the experiment, except that it had a higher manganese content of 0.39.

These sections were painted in the center with white lead, a somewhat heavier coat of paint being used than would ordinarily be the case. After the paint had dried, the sections were placed in an electric furnace and heated to 1550 degrees Fahrenheit (a temperature often exceeded in forming and flanging operations) for one hour. Following the heating, these samples were cooled by air.

Figs. 6 and 7 aptly show the disastrous corrosive action of the white lead in actually producing holes in the sheets. While all six types of sheet used in the experiment were corroded clear through, the Toncan copper molybdenum iron was not attacked as badly as the other types.

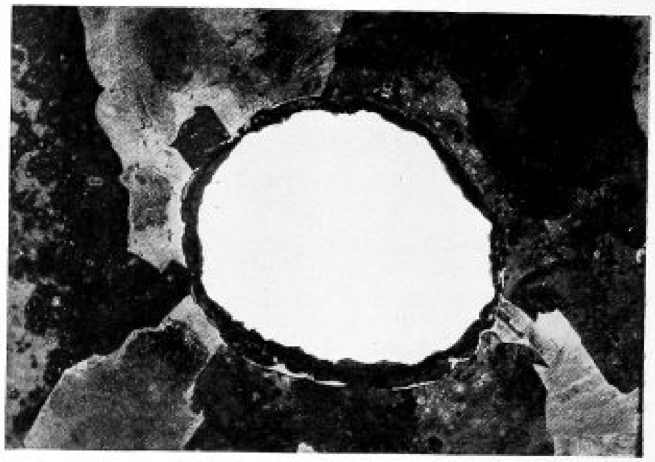


Fig. 7.—High phosphorus sheet steel

Chemical Reactions

White lead paint is composed of a basic lead carbonate [$2PbCO_3 \cdot Pb(OH)_2$] in a linseed oil base. The reactions taking place are (1) a decomposition of the basic lead carbonate by heat alone and (2) a reduction of the resulting lead oxide by iron of the sheets and by carbon from unignited linseed oil.

The decomposition of white lead takes place at about 400 degrees Fahrenheit, leaving the yellow lead oxide, litharge, PbO. Some of this yellow oxide could be observed on the test plates as the heating progressed.

$$2PbCO_3 \cdot Pb(OH)_2 + \text{heat} = 3PbO + 2CO_2 + H_2O$$

The reduction of litharge takes place at a red heat (about 1,000 degrees Fahrenheit) by action of iron

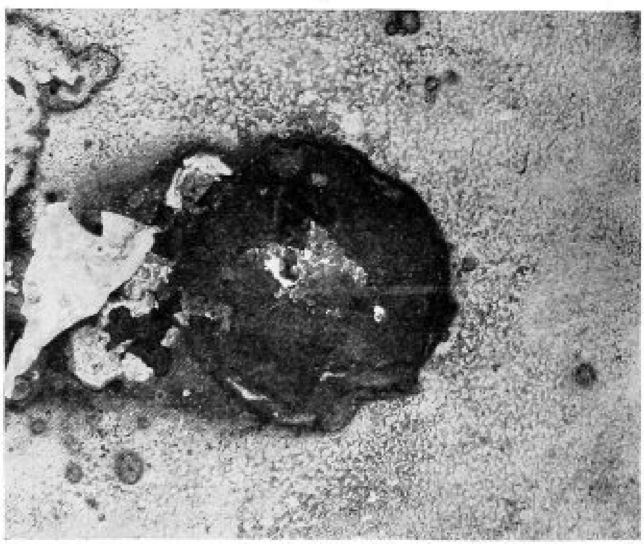


Fig. 6.—Toncan copper molybdenum sheet

from the sheets and by carbon from the linseed oil, after the ignition of its volatile constituents. Metallic lead is formed by the reducing action of iron and carbon. A large button of metallic lead was found on the sheet or on the floor of the furnaces (where the molten lead ran through the sheets) after cooling.

Some of the white lead paint when heated to 1,550 degrees Fahrenheit in a porcelain crucible with no iron present gave a residue of metallic lead. This demonstrated the action of carbon from the decomposed linseed oil in reducing lead oxide. In all cases a black mass was formed on the sheets showing the presence of carbonaceous matter from linseed oil.

It should be mentioned that the soda iron or iron nail method of assaying sulphide ores takes advantage of the fact that iron reduces lead from litharge, as well as from the common lead minerals. This method consists of a reducing fusion of the ore with a large amount of sodium carbonate as well as a limited amount of litharge and borax, together with an excess of metallic iron in the form of nails or spikes.

The equations for the reduction of litharge by iron and by carbon at red heat are given below:

$$PbO + Fe = FeO + Pb$$
$$2PbO + C = CO_2 + 2Pb$$

The iron oxide formed may at this temperature change to common scale, Fe_3O_4.

$$6FeO + O_2 = 2Fe_3O_4.$$

The scale of course flakes off until finally a hole is left in the sheet.

Again it is known that iron oxide (Fe_2O_3) is soluble in litharge to the extent of one part iron oxide in ten parts of litharge. This also aids in the oxidation of the iron.

Conclusions

The investigations performed on the iron sheets show conclusively that white lead paint has an intense corrosive action on iron and steel when heated to temperatures used in forming or flanging operations.

This corrosive action may actually produce holes in sheets of light gage.

The effect of the corrosive action of white lead paint on heavy plate is to produce an over-oxidized or "red-short" surface layer when heated for forming, which results in ruptured or defective plate surfaces.

Obviously the use of white lead paint for marking iron or steel surfaces should be avoided.

The partnership interest of W. O. Washburn in the American Hoist & Derrick Company has been purchased and taken over by Frank J. Johnson, the senior partner and one of the founders. The business will be continued as the American Hoist & Derrick Company under the form of a corporation with F. J. Johnson, as president and treasurer, Howard S. Johnson, vice-president in charge of sales and Frederic Crosby, as vice-president in charge of production. No announcement has been made by Mr. Washburn as to what his future business connections may be.

A Suggestion for Rating Steam Boilers*

Consideration of the possibility of adopting a rating term to replace "boiler horsepower"

By W. A. Shoudy[1] and W. H. Jacobi[2]

THAT the adoption of the Centennial method of rating boilers in horsepower was a serious mistake, has been apparent to engineers for many years. This feeling has grown rapidly of late, and there now seems to be an almost unanimous demand for a change. The only reason such a change has not been made is because thus far no satisfactory substitute has been suggested.

Most engineers and manufacturers have practically eliminated the term "boiler horsepower" from their vocabulary, though far too many still persist in using the equally misleading term "percent of rating." For ten years neither of the authors of this paper has based any of his calculations upon either of these terms except when the public could not understand the omission. They have plotted boiler performances against British thermal units per hour, evaporation, combustion rate, kilowatts, and in one case against pounds of sugar melted. In all cases the curves were more accurately interpreted than when plotted against horsepower or percent of rating, but the terms used were not universal but applied only to a particular industry. All terms used in the last analysis must be based on the British thermal unit, for we are concerned with heat quantities, consequently many engineers are advocating a multiple of British thermal units absorbed per hour per square foot of surface as a standard of boiler performance. Such a suggestion is fundamentally sound, but the authors have found that such a unit is not only inconvenient but is of little value for painting mental pictures of boiler performance.

Obstacles to New Methods of Rating

We believe that there are two fundamental obstacles that must be cleared away before any new term can be adopted. This paper is therefore offered primarily to stimulate discussion in the hope that the authors' suggestions may help clear the atmosphere and ultimately lead to the adoption of scientifically sound units which will also be in such a form that they will become popular by their ease of application.

The mistake that the Centennial committee made was in assuming that the boiler was necessarily an adjunct of the steam engine, and that little improvement in steam-engine economy could be expected. Horsepower rating was at that time of real value because it made easy the selection of boiler sizes to supply engines of known capacity. The use of steam for other purposes than power production soon made the term less valuable. Improvement in combustion rates forced upon us the term "percent of rating," which was of great help between the years 1910 to 1917 because the distribution of boiler surface was fairly uniform and because large stokers had not become common. That time has passed and "percent of rating" is now so misleading that it is valueless. The advent of superheaters, economizers, water walls, and air heaters has added to the confusion.

The principal difficulty in the development of a new term is due to the careless use of the word "boiler." Strictly this should refer to the shell only, but popularly it is made to include furnace, superheater, economizer, etc. A new definition of the word would be of little value, because a generation would pass before the old practice in the use of the word could be eliminated. It is better to supersede it as commonly used by another term.

"Steam Generator" as Definition of Modern Boiler Installation

Although one manufacturer has already used the term "steam generator" as representing a particular combination of boiler, furnace, etc., the expression is not new with him and is therefore public property. It accurately describes the modern boiler installation. We therefore suggest its adoption and offer the following definition:

STEAM GENERATOR. An apparatus for the transformation of heat energy from its commercial form to the heat energy of the steam delivered by the apparatus.

This would mean that the steam generator of a modern boiler plant would consist, for example, of stoker, setting, water walls, boiler shell, superheater, economizer, and air heater. In other words, everything from the stoker hopper to the entrance of the breeching, and from feed valves to the boiler stop valve. An electric boiler would become an electric steam generator, including water tank and heating element.

The authors offer "steam generator" but hope that a simpler and distinctive term can be suggested. The name is unimportant so long as the word boiler is not used.

Since "boiler efficiency" has been so loosely used, we suggest the substitution of the term "gross steam-generating efficiency" for "combined boiler and furnace efficiency." We have included the word "gross" because we recognize the demand of many for a definition of the term "net efficiency," that is, an efficiency which has been corrected for the power expended for draft, feed, etc. We have made no attempt to define "net efficiency," as there are so many variables entering into its determination. It is a definition that may require some compromises, and hence must be written by a committee with authority. It is, however, very important that at least an approximate definition be adopted shortly.

With the adoption of the term "steam generator" or an equivalent, the most important step will have been taken toward a logical and useful method of rating these units. Most of the present confusion is now due to the misinterpretation of the word "boiler"—its common interpretation includes so many other types of apparatus. Let us therefore restrict the word "boiler" to include only the shell, or as an alternative to include superheater, economizer, and water walls, that is, all surface with gas on one side and water or steam on the other. The authors believe that the first is preferable, for to include the economizer with the boiler introduces the commercial objections that may be made by the manufacturer of one that does not manufacture the other. The definition of boiler does not affect the suggested method of rating.

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* Presented at a meeting of the Metropolitan Section of the A.S.M.E., New York city.

The ideal term for rating generating units should, if possible, be equally applicable to all sections of such units. The British thermal unit is the fundamental unit but is so small that for convenience in calculation it must be grouped in multiples. This problem is to adopt a convenient multiple of British thermal unit and a suitable name.

Problem of Furnace Rating

The problem of furnace rating is the other difficulty and appears to be more complicated, for it has been the chief stumbling block. A pound of coal is never a pound of fuel, hence the furnace is a highly complicated chemical manufacturing plant producing hot gases which cannot be accurately weighed nor can the initial temperature be measured with sufficient accuracy. It is impossible to adequately compare furnace performance on a British thermal unit basis because of varying coal analyses, the behavior of the ash alone being a limitation which is not indicated by "British thermal unit per pound."

The capacity of a steam-generating unit is limited not by the extent or arrangement of its surfaces nor by the square feet of grate or cubic feet of furnace volume, but by the heat per pound and weight of gas that is delivered to those surfaces. If we could accurately measure the weight or volume of gas and its temperature our problem would be simple. As conditions are now, in estimating performance we calculate the gas weights and theoretical temperatures, and assume by wide experience those corrections necessary for an estimate. The fuel analysis is *assumed,* a carbon loss is *assumed,* a percentage of excess air is *assumed,* a radiation and unaccounted-for loss is *assumed,* and if these assumptions prove to be correct, the forecasted steam-generating performance is obtained. If one assumption is far out of the way the guaranteed performance is not obtained unless the manufacturer has been able to include a wide margin of safety in his guarantees. The skilled estimator is consequently able to guess at performances with almost the degree of accuracy of his detailed estimates.

The purchaser will not agree to tolerances in measurement in the contract, but unwittingly accepts them when tests are made after erection. The fuel analysis or excess air may not be the same as stated in the contract, and unless the performance is very wide of the expectation he accepts the apparatus, deluding himself into believing that the difference in fuel analysis is probably the cause of the failure to meet guarantees when another false assumption may be the true cause.

At present when boiler shell and furnace are bought separately the purchaser "assumes all risk" whether he recognizes the fact or not, and we do not blame the manufacturers when each of them endeavors to fix the responsibility on the other.

The manufacturers of boilers, superheaters, and economizers can guarantee their equipment within the limit of error of available instruments if the purchaser states the weight of gas per hour and the temperature or heat content of the gas, and the purchaser can fairly hold the manufacturer to such a contract.

The stoker manufacturer can guarantee the percentage of carbon lost in the ashpit and the excess air necessary. For pulverized coal the percentage of excess air and carbon loss can be guaranteed within reasonable limitations.

It would seem, therefore, that if we can find a satisfactory method of measuring gas weights and heat content, such a method might be used as a basis for rating all apparatus comprising a steam-generating unit.

What has seemed to be an insurmountable obstacle has been the number of variable factors entering into such calculation and the difficulties encountered in measuring gas temperatures. Furnace gases are not uniform in temperature or chemical analysis, and gas-passage areas are so large that it is impossible to get better than an approximation of furnace temperature or heat content. Of all gas measurements, the analysis is probably the most easily obtained with reasonable accuracy. Fuel weights are readily obtained. The loss of carbon to the ashpit can be accurately determined when properly sampled. The loss of carbon to the stack is now grouped with the unaccounted-for losses. With these data the weight of gas and heat imparted thereto can be determined with reasonable accuracy. The heat absorbed by the water can also be accurately determined, though some slight inaccuracies still exist in air-heater measurements; but inasmuch as that is so small a part of the whole generating unit, the accuracy of the whole is not greatly affected.

The output of the furnace and the absorption by the water and steam can be measured with an error only of that now included in "radiation and unaccounted for." The principal objection to such analysis has been the necessity of complicated calculations.

When fuel or gas analyses have not been available, estimates are often made of gas weights by multiplying the British thermal unit per pound of fuel by some factor and adding an assumed excess air. It is interesting to note that for *all* fuels the factor used varies from 7.4 to 7.8, but that for any *class* of fuel the factor is constant within the limit of instrument accuracy.

Prof. H. L. Parr of Columbia University has shown that if the velocity pressure and temperature of the products of combustion are known, the British thermal unit per square foot of gas-passage area per second equals the product of a constant and the rise in temperature and the square root of the quotient of velocity pressure divided by the absolute temperature.

Heat Content of Combustion Gases of Commercial Fuels

In a paper presented before the American Boiler Manufacturers Association in 1925, Mr. Jacobi included combustion calculations of substantially all commercial fuels with varying percentages of air. With the exception of producer gas these calculations show that with 20 percent excess air the formation of the resulting gas is accompanied by a heat liberation of approximately 1000 British thermal units per pound the highest being for fuel oil with 1040 British thermal units and the lowest for low-grade lignite with 956, that is, a maximum range of less than five percent.

The fortunate combination of a convenient multiple of British thermal unit and unusually good combustion conditions for coal furnaces, suggests the possibility of using this as a basis for rating both boilers and furnaces and the name "kilotherm" as representing one thousand (kilo) British *thermal* units. One thousand kilotherms would therefore represent 1000 pounds of gas each containing 1000 British thermal units. The absorption of 1,000,000 British thermal units per hour by the boiler would represent the absorption of 1000 kilotherms per hour.

Since furnace conditions vary so widely, some modifying factor must be used with the kilotherm. Calling this the furnace factor it would represent the ratio of the actual heat content to one thousand. An average coal burned with 35 percent excess air would deliver about 900 British thermal units per pound of gas. The furnace factor would then be nine-tenths or 90 percent. Fuel oil might be burned with a furnace factor of 110 percent, and so on. The expression "900 kilotherms per hour at 90 percent furnace factor" would be interpreted as 1000 pounds of gas per hour, each containing 900 British thermal units, and would give an accurate picture of furnace conditions. This would make it unnecessary to include any statement as to quality of the fuel or the class to which it belonged.

Proposed Rating of Steam-Generating Units in Kilotherms per Hour

The authors therefore suggest the rating of steam-generating units as a whole or in any part in kilotherms per hour, heat-absorbing surfaces in kilotherms per hour per square foot, and furnaces in kilotherms per hour per square foot of grate or cubic foot of furnace, with the furnace factor stated in percentage.

Because of the tendency toward heating feedwater with bled steam, it is more convenient to rate turbine performance in British thermal units per kilowatt-hour The conversion of kilotherms is merely that of moving the decimal point three places to the left.

In offering these terms we are not offering any new unit except the furnace factor, and that is only a convenient method of indicating furnace conditions. It will take some time to accustom ourselves to its use, but it will give us a definite standard of comparison. Boiler-performance curves plotted for unity furnace factor will be the same for all commercial fuels, and curves for other furnaces will be equally useful. Instead of percent of rating we can use kilotherms per hour per square foot; 10 kilotherms per hour per square foot is the equivalent of 298 percent of rating. Types of furnace construction can be rated with various kilotherms per cubic foot, depending upon the furnace factor. For example, a furnace found successful with coal for rates of 20 kilotherms per hour per cubic foot at 90 percent furnace factor will be successful for oil *at the same factor,* but oil will be burned at a higher factor because lower excess air is possible.

Considerable misunderstanding now exists in the design of furnaces for pulverized coal, although this was very ably discussed at the December, 1927, meeting of the A.S.M.E., by E. G. Bailey, who called attention to the fact that excess air and fusing point determine the possible rate of combustion. This might be restated in terms of fusing temperature and furnace factor.

The maximum rate of combustion for stokers varies with the type of coal, the percentage of ash and the fusing temperature being the limiting factors. A furnace factor will indicate the excess air for such combustion. The limiting rates of any stoker could be stated accurately for any type of ash by stating the furnace factor.

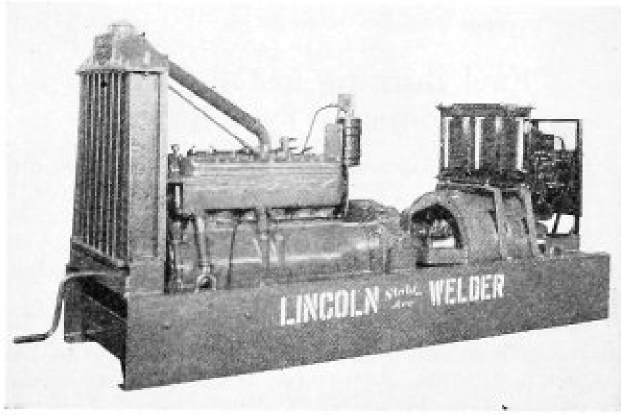
The adoption of these terms will not eliminate the necessity of detailed accurate calculations for research or test work, nor will it eliminate the use of the Orsat apparatus or thermometer. It will permit commercial comparisons of apparatus with reasonable accuracy, and will make possible comparable scales in operating instruments. For example, the CO_2 meter may be calibrated in furnace factors and the flow meter and draft gage in kilotherms per hour, and the ratio of kilowatt-hours to kilotherms per hour in any one plant will be so nearly constant that the load indicators may be calibrated in kilotherms per hour. The application of the term grows as we study it. We are in no way sacrificing accuracy when necessary, but are making approximations more accurate and convenient.

Gasoline Engine Driven Welder

THE Lincoln Electric Company, Cleveland, Ohio, has developed a 300-ampere gasoline engine driven welder, known as model S-1964. The welding generator is rated at 300 amperes in accordance with N.E.M.A. standards and has a current range of from 75 to 400 amperes for metallic electrode welding, and is direct connected to a six cylinder Buda Model HS-6 engine, operating at 1500 revolutions per minute.

Both units are mounted on a welded steel base, thus giving maximum strength and rigidity with minimum weight.

The engine has an S.A.E. rating of 27.3 horsepower and gives a brake horsepower of 41 while running at the operating speed. It is said to be very economical in gasoline consumption. The gas tank is located in the channel iron frame under the engine, thus eliminating fire hazard.



Lincoln welder driven by a six-cylinder Buda motor

The generator has the laminated magnetic circuit with separately excited field, stabilizer, variable voltage and steel construction features characteristic of the company's line of "Stable-Arc" Welders.

The overall dimensions are 93 inches long, 35 inches wide with an overall height of 45 inches.

The equipment has been designed to meet the constantly increasing use of larger electrode in welding, and the six cylinder performance gives a smooth, even flow of power so necessary for successful welding.

Arc-Welding Instruction Book

ONE of the most recent publications of the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., is a booklet on "Electric Arc Welding." This book is regularly used as a manual for training arc-welding operators and all student welders at the Westinghouse welding school at East Pittsburgh, Pa. It is arranged in a sequence of instruction and practice, designed to develop the understanding and application of principles as the student develops his skill in welding. Following the basic theory of welding, simple exercises are explained and gradually the more difficult exercises are taken up.

These instructions, which have proven their worth in the Westinghouse works, should be of value to welding training schools, to manufacturers who are developing welding organizations, to men who are now welders and are anxious to progress and improve their skill, and to those taking a course in the welding art.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

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.*

Fuel Burning in Oil-Country Locomotive-Type Boilers

Q.—In a locomotive type oil country firetube boiler, with a grate opening of 11.33 square feet, heating surface of 1,025 square feet, combustion chamber 50 inches wide, 52 inches high and 62 inches long, stack 25 inches inside diameter by 28 feet long, what is the equivalent grate area for oil or gas firing?—T. C. E.

A.—Your question would imply that you intend converting the boiler from coal burning to oil or gas burning.

For locomotive type boilers burning oil, it has been found satisfactory to use the same proportions of heating surface, grate, etc., as for bituminous coal. Many locomotive-type boilers have demonstrated themselves to be perfectly satisfactory for oil; the oil is burned under good conditions and the evaporation is high as oil has a greater heating value than coal.

The comparative heating values are as follows:

Bituminous coal	13,500 B.t.u. per pound.
Petroleum	18,500 B.t.u. per pound.

In burning oil, the following requirement should be met:

Its atomization must be thorough by the selection of a proper burner.

When atomized, it must be brought into contact with the requisite quantity of air for its combustion and this quantity must be at the same time a minimum to obviate loss in stack gases. This requirement is met by properly introducing the air into the furnace, either through checkerwork under the burners or through openings aound them and by controlling the quantity of air to meet variations in furnace conditions.

The mixture must be burned in a furnace where a refractory material radiates heat to assist in the combustion, and the furnace must stand up under the high temperature developed. This requirement is met by lining the firebox with a sufficient area of heated brickwork to radiate the heat required to maintain a proper furnace temperature.

The combustion must be completed before the gases come into contact with the heating surfaces or otherwise the flame will be extinguished, possibly to ignite later in the flues or in the stack. This requirement is fulfilled by providing ample space for the combustion of the mixture of atomized oil and air, and a gas travel of sufficient length to insure that this combustion be completed before the gases strike the heating surfaces.

There must be no localization of the heat on certain portions of the heating surfaces or trouble will result from overheating and blistering. This requirement is fulfilled by the adoption of a suitable burner in connection with the furnace meeting the other requirements. A burner must be used from which the flame will not impinge directly on the heating surface and must be located where such action cannot take place. If suitable burners properly located are not used, not only is the heat localized with disastrous results, but the efficiency is lowered by the cooling of the gases before combustion is completed.

Heating Surface of Boilers

Q.—I was interested in reading your answer as to the proper method of computing the heating surface of a firetube boiler in the July issue of THE BOILER MAKER.

Is this interpretation in accordance with paragraph 274 (last half) of the A. S. M. E. Boiler Code? I have always interpreted this paragraph to mean the internal area of the firebox and of the tubes. Will you kindly advise me the basis of your interpretation and oblige.—C. E.

A.—The usual rule is to consider as heating surface all the surfaces that are surrounded by water on one side and by flame or heated gases on the other, using the external instead of the internal diameter of tubes for greater convenience in calculation. External diameters of boiler tubes are usually given in even inches or half inches. This method is standard practice with practically all locomotive builders.

This method, however, is inaccurate for firetube boilers, for the true heating surface of a tube is the side exposed to the hot gases, the inner surface in a firetube boiler and the outer surface in a watertube boiler. The resistance to the passage of heat from the hot gases on one side of a tube or plate to the water on the other side consists almost entirely of the resistance to the passage of the heat from the gases into the metal, the resistance of the metal itself and that of the wetted surface being practically nothing.

The answer to the question in the July issue was given for a locomotive-type boiler and the method of computing the heating surface shown is used by locomotive builders, the answer being a general method and not intended as a strict interpretation of the A. S. M. E. Code.

In figuring heating surface to determine the minimum aggregate relieving capacity of all of the safety valves required on a boiler, the method called for in P.274 of the Code should be used.

Development of a Transition Piece

Q.—Show the development of a 90-degree transition piece, reducing from a square to a round base.—G. M.

A—To develop the 90-degree transition piece, as shown, it is necessary to draw a plan and elevation.

Space off the base circle in any number of equal spaces, sixteen spaces being used in this layout. Opposite the side A-F in the elevation develop A-C-D-F.

Draw the horizontal line M-N through the plan, thus dividing the object into two symmetrical halves. It will now be seen that if a development is made of the lower portion, as shown in the plan, a duplicate of the resultant figure will be a complete development.

The construction angles in Figs. 1 and 2 must now be formed. Draw a horizontal and perpendicular line at right angles, as in Fig. 1. On these lines the construction triangles are formed. With a pair of dividers, take the distance between the points *A-1*, in the plan view, and place this on the horizontal line of Fig. 1. This is the base line of the first construction triangle. Take the distance between A-G in the elevation and put this on the perpendicular line of Fig. 1. This is the height of the triangle and will be a common altitude for all the triangles taken from point A in the elevation. Draw a line diagonally across the two points. This line is the hypotenuse or the true length of the line *A-1*. In the same manner the true lengths of the lines *A-Z, A-3, A-4* and *A-5* are found.

In Fig. 2 the same method is repeated using the distance F-G of the elevation as a common altitude and thus finding the true lengths of *F-S, F-G, F-7, F-8* and *F-9*.

The next step will be to piece the triangles together to form the half pattern, as shown in Fig. 3.

Take the true length of line *B-1*, which is equal to the line *A-1* taken from the elevation, and at the point B strike an arc equal to the distance A-B in the plan and at the point *1* strike an arc equal to the distance *A-1* in Fig. 1, forming the triangle *1-B-A*.

Then taking the chord distances *1-2, 2-3, 3-4, 4-5* from the plan and the hypotenuse of the right-angle triangles in Fig. 1, as *A-2, A-3, A-4, A-5,* construct the angles in the development following the same procedure as for the triangle *1-B-A* until all the triangles are completed.

The development is now complete to the line *A-5*. The triangle *A-F-5* is formed by taking the distance A-F in the elevation and the *F-5* from Fig. 2 and proceeding with the development of the triangles using the hypotenuse of the right-angle triangles from Fig. 2. This completes the development.

Boiler Efficiency

Q.—A boiler test gave the following results: Weight of feedwater evaporated to saturated steam, 6200 pounds per hour; weight of coal used per hour, 750 pounds; feedwater temperature, 120 degrees Fahrenheit; steam temperature, 365 degrees Fahrenheit; calorific value of coal, 13,200 B.t.u. per pound. Find the efficiency of the boiler and the evaporation per pound of coal from and at 212 degrees Fahrenheit. C. H. K.

A.—The evaporation per pound of coal from and at 212 degrees Fahrenheit or the equivalent evaporation can be determined by the following formula:

$$W_1 = \frac{W(H - t + 32)}{970.4}$$

when,

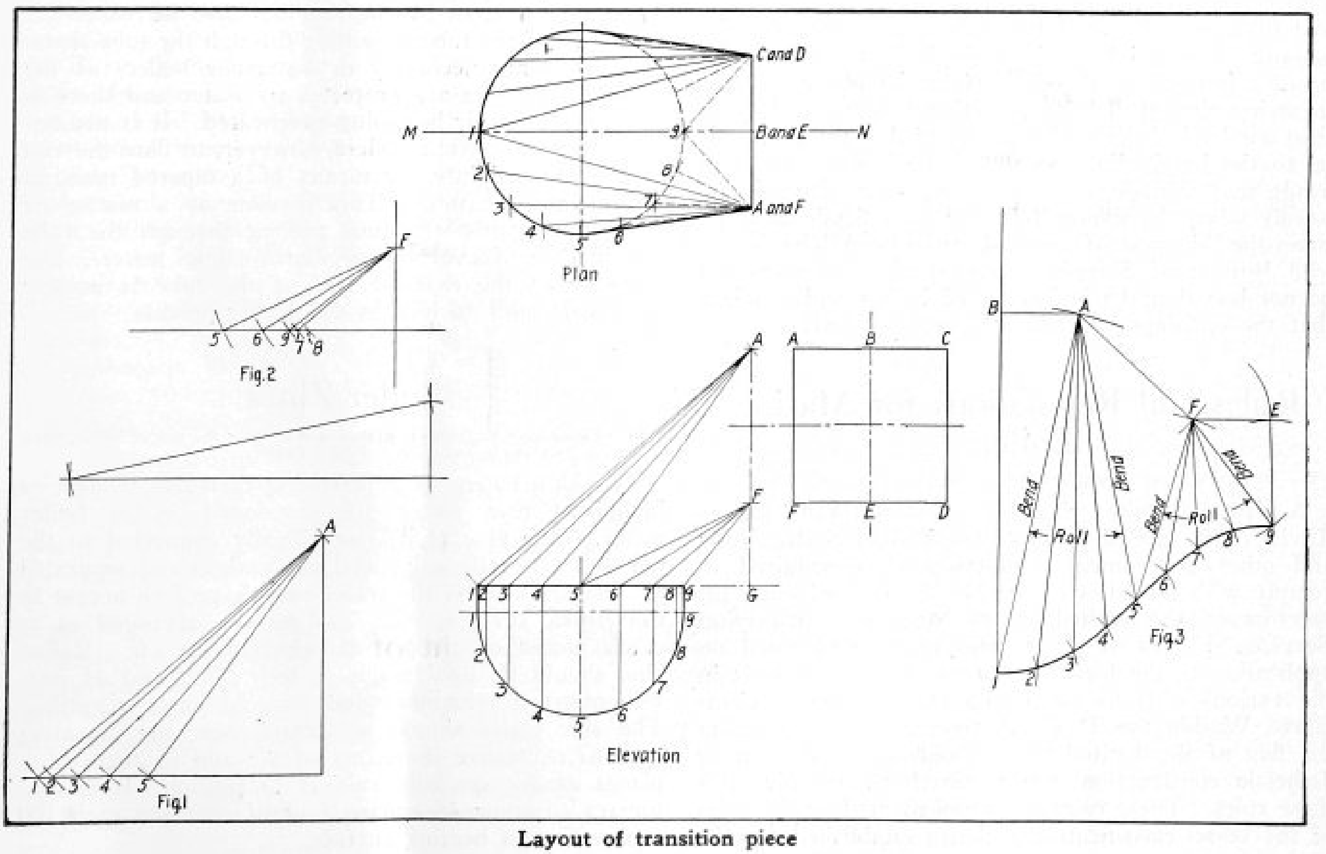
W = actual evaporation per pound of coal
H = total heat of steam above 32 degrees at observed pressure of evaporation
t = observed feedwater temperature
W_1 = equivalent evaporation from and at 212 degrees Fahrenheit.

Applying this formula to the problem, then,

$6200 \div 750 = 8.26$ pounds of water actually evaporated per pound of coal.

The heat units in steam at 365 degrees Fahrenheit taken from steam tables = 1194.78 B.t.u. Substituting in the formula, we have,

$$W_1 = \frac{8.26 \times (1194.78 - 120 + 32)}{970.4}$$



Layout of transition piece

W_1 = 9.42 pounds equivalent evaporation per pound of coal from and at 212 degrees Fahrenheit.

The equivalent evaporation per pound of coal can also be found by multiplying the actual evaporation per pound of coal by the factors of evaporation found in any standard engineering handbook.

The efficiency of the boiler expressed in percent equals:

$$E = \frac{100\,A}{B}$$

when,

E = efficiency of boiler in percent
A = heat absorbed per pound of combustible
B = heat value per pound of combustible

Applying this formula to the problem, then,

$A = 750 \times 9.42 \times 970.4 = 6,855,876$ B.t.u.
$B = 13,200 \times 750 = 9,900,000$ B.t.u.

$$E = \frac{100 \times 6,855,876}{9,900,000} = 69.2 \text{ percent, efficiency of boiler.}$$

The results would be slightly different and more correct had the test taken into consideration the quality of the steam and the percentage of ash in the coal.

Manholes

Q.—What size of manholes are used in marine boilers?

A.—The board of supervising inspectors of the United States Steamboat Inspection Service specifies that all marine boilers shall have a manhole opening above the flues or tubes not less than 10 inches by 16 inches or 11 inches by 15 inches or equal. The manhole openings shall be reinforced either on the inside or outside with reinforcing wrought iron or steel rings which shall be securely riveted or properly fastened to the boiler. These reinforcing rings must be of sufficient width and thickness of material to fully compensate for the amount of material cut from the boilers. Where the opening is made in the circumferential plates, the reinforcing ring shall have a sectional area equal to at least one-half of the sectional area of the opening parallel to the longitudinal seams of the boiler. Bumped heads may contain a manhole opening flanged inwardly when the flange is turned to a depth of three times the thickness of material in the head. The American Bureau of Shipping recommends that manholes be not less than 16 inches by 12 inches and requires that the openings be efficiently compensated.

Rules and Regulations for Marine Boilers

Q.—What rules and regulations govern marine boiler construction?

A.—In the United States the boilers for all steam-driven craft, except those of the United States Navy and other government departments, are required to comply with the rules of the board of supervising inspectors of the United States Steamboat Inspection Service. Copies of these rules may be obtained on application to the local inspectors of steam vessels in the various districts or to the Department of Commerce, Washington, D. C. All merchant vessels, flying the flag of the United States, whether of foreign or domestic construction, are required to comply with these rules. These rules are supplemented by the rules of the vessel classification societies established for the purpose of making surveys and issuing certificates of classification for vessels for standardizing and regulating marine insurance. The only American vessel classification society is the American Bureau of Shipping, 24 and 26 Old Slip, New York. The standards of this society are accepted by the United States government.

Dry Pipes

Q.—What is a dry pipe and how is it made?

A.—The main purpose of a dry pipe is to collect the steam over an extended area near the top of the shell farthest removed from the surface of the water, thus preventing a sudden local pull which would promote priming. The dry pipe should be of the same diameter as the steam outlet and is usually perforated with a series of 3/16-inch or ¼-inch holes on the upper half of the pipe or furnished with a series of narrow slots. The aggregate area of the perforations of the slots should equal 1.25 or 1.5 times the area of the pipe.

The rules prescribed by the United States Steamboat Inspection Service governing the construction of marine boilers state that safety valves when fitted either to the shell of the boiler or steam drum may be fitted with internal dry pipes when made of standard steam pipe or of riveted material equal in thickness and when the combined openings in the dry pipe equal in area at least 1.5 times the opening of the valve.

Beading and Flaring

Q.—Are the ends of tubes in marine boilers beaded over or flared?

A. In marine boilers of the firetube type, in which the tube ends project into the space occupied by the hot gases, they must be beaded over into close contact with the tube sheet. This not only protects the metal of the tube end from overheating but also increases the resistance of the tube to pulling through the tube sheet. Beading is not necessary in watertube boilers as the ends of the tubes are protected by water and there is no danger of their becoming overheated. It is not uncommon in watertube boilers, however, to flare the end of the tube slightly, by means of a tapered mandrel driven into the tube. This is done as a matter of protection against the tube pulling through the tube seat in case of overheating due to low water. The diameter of the extreme end of the tube is usually increased about ⅛ inch in the flaring process.

Boiler Zincs

Q.—Please give me some information regarding the use of boiler zincs. How are they made and how are they fitted?

A.—As a means of neutralizing corrosive tendencies in boilers, zinc plates are suspended in the boiler water. The zinc plates, metallically connected to the boiler, are usually suspended on brackets and separated by ferrules so that the water may have free access to the entire surface, with baskets so arranged as to catch pieces of zinc oxide which scale off. Rolled zinc should be used about ½-inch thick and of convenient size for handling and to avoid waste in cutting. The zinc plates should be located near the incoming feed to neutralize the effect of air and in such other places as are specially subject to pitting. It is customary to allow ¾ square foot of zinc for each 100 square feet of heating surface.

Associations

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

Steamboat Inspection Service of the Department of Commerce

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

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Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.

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Statistician—L. C. Peal, Nashville, Tenn.

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

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

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

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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.

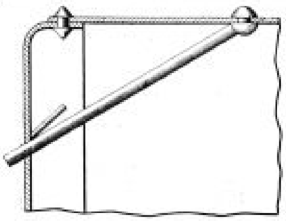
Selected Boiler Patents

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.

1,675,727. METHOD OF SECURING STAY RODS TO PLATES. JOHN PETTY, OF LEBANON, PENNSYLVANIA, ASSIGNOR TO JO PET, INC., OF LEBANON, PENNSYLVANIA, A CORPORATIO OF PENNSYLVANIA.

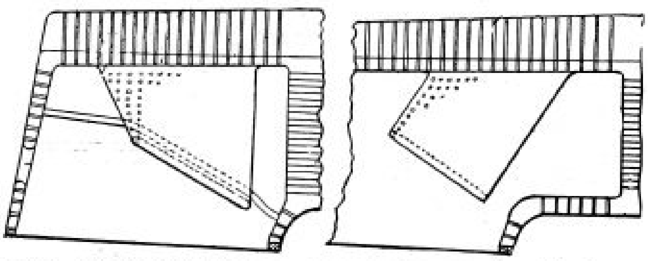
Claim.—The method of securing a stay rod to a sheet metal plate which consists in inserting the stay rod in a hole in the plate to a position in which its end will project beyond the outer surface of the plate to a sufficient



extent to be formed into a rivet head, then securing the rod to one side of the plate by a fused union, then heating the projecting end of the rod to forging temperature and forging it into a rivet head against the outer face of the plate. Two claims.

1,676,732. LOCOMOTIVE FIREBOX. CHARLES GILBERT HAWLEY, OF CHICAGO, ILLINOIS, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

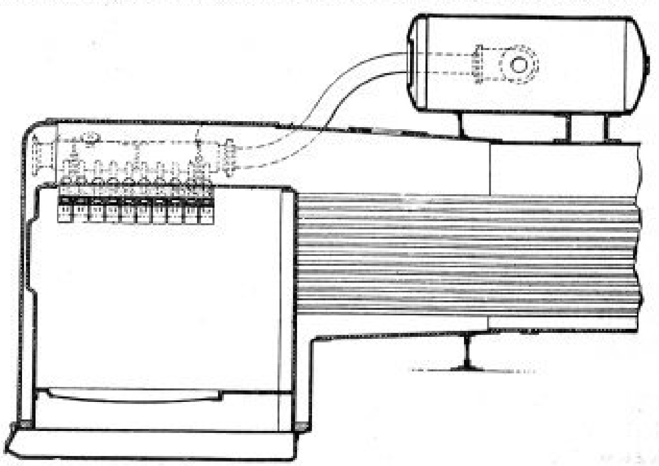
Claim.—A locomotive boiler and its stay bolted internal firebox, in combination with two longitudinally disposed and transversely opposed flat faced and stay bolted bracket-shaped water circulating walls within said



firebox, each said wall having a transverse lower portion that is rearwardly and upwardly inclined and, at its outer end, attached to its respective side of the firebox, each said wall having an upright upper portion which has its top attached to the top of the firebox, and, the upright portions of the two walls being separated by a passage which affords access to the front of the firebox. Four claims.

1,662,460. RADIANT-HEAT SUPERHEATER FOR BOILERS OF THE LOCOMOTIVE TYPE. WALTER F. KEENAN, JR., OF PELHAM, NEW YORK, ASSIGNOR TO FOSTER WHEELER CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

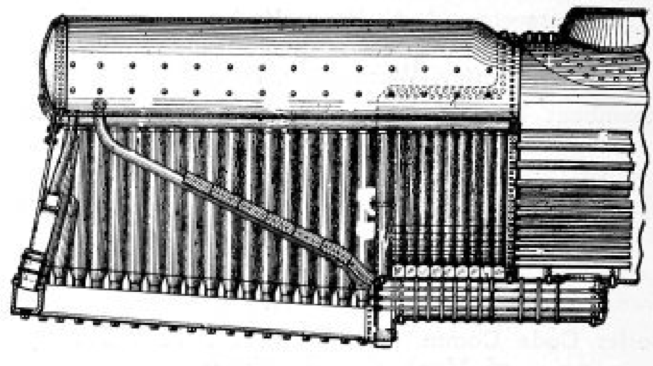
Claim.—In a boiler comprising an internal combustion chamber with a crown sheet roof and flues leading away from the combustion chamber,



the improvement which consists in a radiant heat superheater comprising a plurality of conduit elements arranged side by side in the combustion chamber immediately beneath the crown sheet. Six claims.

1,677,427. LOCOMOTIVE BOILER. WILLIAM L. BEAN, OF WEST HAVEN, CONNECTICUT, ASSIGNOR TO McCLELLON LOCOMOTIVE BOILER COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

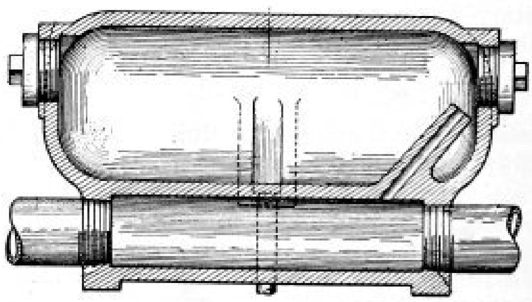
Claim.—A locomotive boiler comprising a barrel and a firebox comprising a crown chamber communicating at its forward end with said barrel and supported in part thereby, a foundation chamber also communicating at its



forward end with said barrel, water tubes extending between foundation and crown and providing the walls of the firebox and pillars exterior of the walls extending between foundation and crown at the rear of the latter and supporting the rear portion of the crown independently of said tubes. Five claims.

1,655,383. LOCOMOTIVE-FIREBOX STRUCTURE. GUY M. BEAN, OF LOS ANGELES, CALIFORNIA.

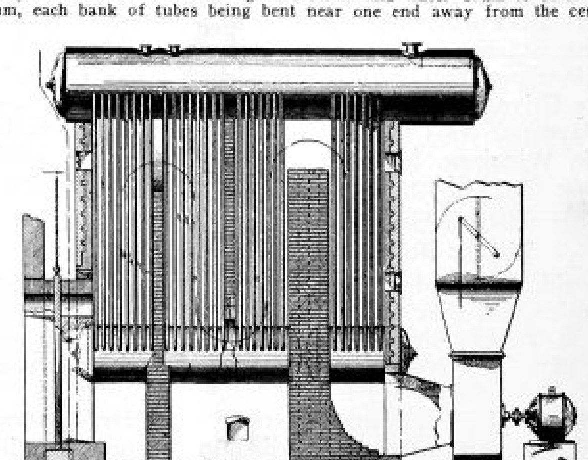
Claim.—A block provided on opposite faces with corrugations disposed at an angle of 45° to the longitudinal axis of the block, said corrugations



extending in one direction across the entire faces of the block. Three claims.

1,657,477. WASTE-HEAT BOILER. DAVID S. JACOBUS, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim.—In a steam boiler, an upper steam and water drum, a lower mud drum, banks of tubes connecting said steam and water drum to said mud drum, each bank of tubes being bent near one end away from the center



line through the two drums so that the two banks of tubes on either side of the center line are spaced apart, each bank being divided into a plurality of sections, and baffles located between adjacent sections of the tubes, alternate baffles being constructed and arranged to direct the gases over the tubes at their upper ends, and the other alternate baffles being provided with two openings opposite the lower ends of the tubes and on opposite sides of the center line whereby the gases are directed in series over the sections of each bank and longitudinally of the tubes. Four claims.

The Boiler Maker

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Contents

Value of a Bonus System

FOR nearly two years the Bangor & Aroostook Railroad has had a bonus system in successful operation at its Derby, Maine, shops, by which the men are guaranteed their hourly rate when they are unable to make the bonus price established for a job. This system is a modification of the Taylor and Emerson bonus systems and incorporates the best features of each. The accounting necessary to its operation has been simplified and the application of its principles has been made clear to the men.

Briefly, the principal features taken into account in the study on which the system as finally adopted was based include:

- Former cost of operation
- Cost figured from the time study
- Cost figured at a reduction of from 15 to 20 percent of the former cost, based on possible short cuts and modernizing the operation
- Final assignment of man-hours allowed for the operation
- Pro-rating the total bonus for an operation in proportion to the pay for the straight time worked where a standard operation is performed by a group working together

In planning the bonus schedule, the jobs to which the system could be applied were selected with great care and only after time studies had been made on them. The operations include many in the boiler shop; flue removal and installation; staybolt work; firebox welding and others. In making the studies in the boiler shop, as well as in the other departments, every possible assistance is given the men to arrive at a fair production average on which to base the bonus rates. Once these rates have been set, the men are permitted to earn as much as they are able to, the amounts of the pay checks depending upon the individual ability and resourcefulness in developing short cuts and time and labor-saving devices. No matter how much an individual or gang earns, the rates are never cut unless modern machine tools or more efficient shop tools are purchased to aid production. In such cases, after an investigation of their effect on the work, new studies are made and a new rate assigned with the assurance to the men, however, that such changes have been made solely to increase efficiency.

In practice, the system has resulted in a marked promotion in efficiency and a reduction in production costs. Above all, the men are given a real incentive to exert their best efforts in turning out the work. For example, on a boiler operation that formerly required five men and cost $288, when a bonus rate of $144 was assigned under the system, the five men were reduced by the leader to two with the exception that a third man was used for two days during the period instead of being employed continuously on the job. The bonuses on this work varied from $26 to $44 per locomotive depending on the general design. The regular hourly rate that the men earned on the job was in no way affected.

So much for the bonus system as applied by the Bangor & Aroostook in its Derby shops. In nearly 75 percent of the railroad shops in this country, general working conditions might be greatly improved if some definite plan similar in nature were developed so that men with ability and training might be given an opportunity to increase their earning capacity. This system is more than a piece-work scheme; for while it offers higher wages to the men and brings about closer co-operation in the shop, it also eliminates waste in the plant both in time and material. All this is accomplished without forcing the men in any way, as is done under the average piece-work method; for, in this case, the hourly rate is absolutely guaranteed, the reward coming in the form of a bonus when, by one means or another, the men have been able to increase production.

Boiler Orders

ACCORDING to the August report of the United States Department of Commerce, the number of boilers sold during the first eight months of the present year is practically the same as for the corresponding period in 1927. Up to and including the August figures in 1927, there were 11,075 power boilers of all types having 11,619,091 square feet of heating surface ordered, while in 1928 the new orders amounted to 11,046 boilers having 10,582,669 square feet of heating surface. Indications are that the remaining months of the present year will show a gain in production over that for a year ago. Bearing out this opinion is the fact that the total number of new boiler orders in August, 1928, amounting to 1649, is greater than at any time during the last quarter and compares with a total of 1517 boilers ordered in August, 1927.

These records of the Department of Commerce have proven to be a valuable asset to the industry even for the comparatively short time that they have been maintained in a comprehensive way. There are still some manufacturers who do not supply information regarding their output, but the figures available serve to indicate the trend of the industry.

If complete figures were available over the entire period since the war, it would be possible to foretell with some degree of accuracy whether or not the turn upward in the boiler market would continue. General conditions in the building and power fields would seem to indicate that boiler orders would increase over a considerable period at about the same rate they have for the past six months and that the next year will show a decided improvement over the present one.

The Manufacturer and the Inspector

IN this issue an official of one of the large boiler manufacturing concerns analyzes the relation existing between the inspectors in the shop and in the field with the boiler manufacturer. The attitude of each group has changed during recent years and now the spirit of co-operation developed between them reacts greatly to the benefit of the industry as a whole. Every effort should be made to foster this feeling and eliminate the suspicion of the manufacturer's motives in the minds of some inspectors and the manufacturer's idea, where it still prevails, that his work is being unfairly impeded by the inspector. The National Board of Boiler and Pressure Vessel Inspectors has been largely instrumental in clearing the situation and, it is hoped that further efforts along the same line will bring about a complete feeling of accord in the boiler field.

Communication

Belling and Beading Arch Tubes and Watertubes

TO THE EDITOR:

Watertubes in locomotive boilers known as arch tubes, and tubes in special type boilers, such as the Babcock & Wilcox Heine, Atlas, Duplex and Niclause, have to be rolled or expanded in place through an opening in the outside plate of the water space. Should one of these tubes become filled with scale, the tube will bend or buckle and pull out of place.

It is obvious that belling is an important part in the process of the application of a watertube. What is belling and beading and which is the better method? Belling consists of making the projecting end of the tube larger than the hole in the plate through which it is inserted, usually the thickness of the tube. To accomplish this the tube projects into the water space one ½ inch or more. Beading requires a shorter projecting end and this is calked with a suitable tool.

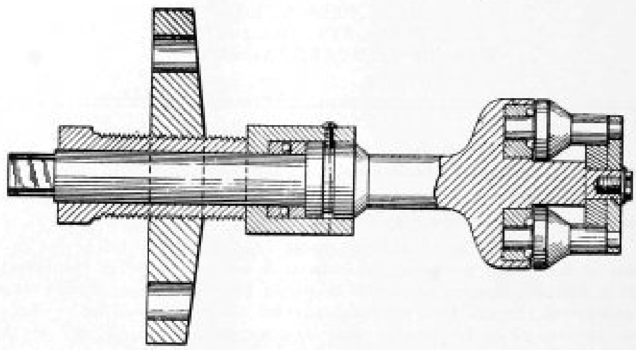


Fig. 1.—Sectional view of belling tool

Since beading a tube through a water space is a difficult process, the tube being very thick, the part calked over the plate to overlap the same is simply a burr hardened by repeated hammering. The belled end is as strong as the tube, while a bead may crack and break off. Beading is an operation necessary with firetubes to protect the ends from the flame. Belling only is required for watertubes as the ends project into the water.

Function of Arch Tubes

When a modern locomotive is in service, the arch tubes are the arteries through which the life blood of the power flows. Through them the water is rapidly circulated, keeping the boiler at an even temperature, thus equalizing the strains due to expansion and contraction. The brick arch which deflects the intense furnace heat to the crown sheet is also supported by these tubes. By being properly applied and kept free from scale, arch tubes contribute to the general efficiency of a locomotive.

Applying Arch Tubes

Let us now consider the method of applying arch tubes. The tube having been bent to fit the firebox plates at each end, perpendicular thereto, and annealed to relieve all strains due to bending, is set in place with the ends projecting ½ inch into the water space. The tube is then expanded or rolled in place by means of a flue roller. This operation requires a powerful leverage on a wrench or bar and repeated blows with a sledge hammer. Rolling should be done independently of belling since to combine both operations in one tool or process is impracticable.

Rolling the tube causes it to have a tension in the tube hole which is resisted by the elasticity of the surrounding plate. To bell the tube by striking a tapered bar with a sledge hammer relieves the tension, making it necessary to roll the tube a second time to obtain a steam-tight connection. There is also the danger of cracking the firebox plate by striking the end of the tube, since the plate around the tube hole is in contact with the rolled end of the tube.

A tool designed to bell the tube by thrusting tapered rolls against the projecting end and not using a hammer after the tube is set avoids these difficulties. Such a tool is shown in the illustration. The application of this tool eliminates the danger incident to striking a steel

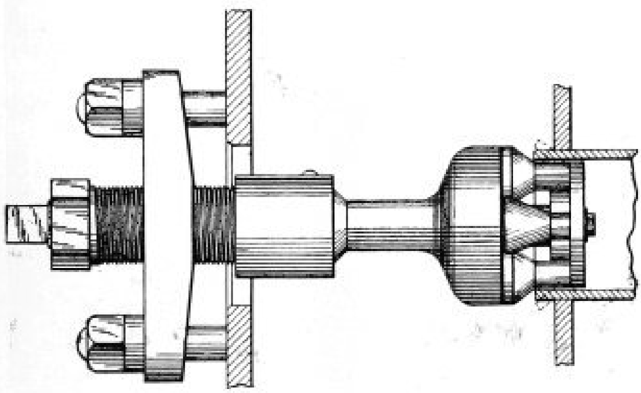


Fig. 2.—Tool in position for belling operation

bar with a heavy hammer in a confined space. Adjacent parts such as springs and equalizers do not have to be removed, and when conditions are favorable the tool can be operated by power means. Its use is therefore consistent with safety, economy and good workmanship.

Details of Belling Tool

The head of the tool, Fig. 1, is formed with eccentric recesses, in which are contained ball races and bearings. Cone-shaped rollers, reduced at one end, engage these ball bearings. At the outer end, the rollers of which there are four are supported by an end plate. The opposite end of the shank is shaped to receive a wrench for operating the rollers. The shank passes through a threaded sleeve on which a bearing plate operates. This bearing plate is adapted for engagement with the studs of the arch tube cap so that the tool is supported as shown in Fig. 2. At about the center of the shank, a thrust cap and bearing is located. The enlargement of the shank at this point contains an annular groove which receives the bearing pin shown in Fig. 1, on the thrust cap.

After the tool is placed in the operating position, Fig. 2, the thrust cap sleeve is rotated by means of a wrench until the rollers are brought firmly in contact with the tube end which has been expanded in the plate. The tool is then rotated by a hand wrench, or air motor, the cone-shaped rollers acting to bell out the tube. The thrust cap sleeve then comes in contact in the bearing to keep the rollers in firm contact with the tube until the belling is completed.

Ellensburg, Wash. R. L. Mason

Made Without a Pattern

A GOOD steel-working blacksmith, but with no boiler shop experience whatever, obtained a position in a boiler shop where he made tools to the satisfaction of the superintendent. The superintendent bragged about him to the shop owner, who, desiring to try out the blacksmith, appeared at his forge one day and said:

"I want a 7/16-inch patch, 6 inches wide, bent to a 30-inch radius, with a hole tapped for a 1-inch pipe in the center. There must be 4 other holes in each corner, threaded for screw rivets, which we use for patching."

The shop foreman was standing close by and heard the conversation, but said nothing. The blacksmith got a broom, swept a space on the floor, struck a 30-inch radius with dividers and a piece of chalk, had a bit of plate sheared, then made the required holes and bent the plate to fit the radius. He didn't thread the holes until after the plate had been bent to shape, however. Just as he was finishing the job, the shop foreman walked past and said:

"Bill, we have patterns for all such things."

"Then, why in **** didn't you tell me so!" replied Bill.

Local and Assistant Boiler Inspectors

The United States Civil Service Commission announces the following open competitive examinations:

Applications for local and assistant inspector of boilers, must be on file with the Civil Service Commission at Washington, D. C., not later than November 6.

The examinations are to fill vacancies in the Steamboat Inspection Service.

The entrance salaries are $3,200 a year for local inspectors, and $2,900 a year for assistant inspectors. Higher-salaried positions are filled through promotion.

Full information may be obtained from the United States Civil Service Commission, Washington, D. C., or from the secretary of the United States Civil Service Board of Examiners at the postoffice or customhouse in any city.

Working on a "Live" Steam Line

SOMETIMES, when a wisp of steam shows the presence of a small leak at a pipe joint or union, it is a great temptation for the engineer or pipe fitter to "take a chance" by tightening the joint while pressure is still on the line. Such a piece of carelessness sent two men to the hospital recently as the result of their attempt to put the finishing touches on an overhauling job at a Bridgeport, Conn., laundry. An extensive repair job had been completed and steam at a hundred pounds pressure had been turned into the line when the two pipe fitters found a leak which they thought could be fixed easily by means of a Stillson wrench. The union split while they were working on it and both men were badly scalded.—*The Locomotive.*

The Air Reduction Company, Inc., New York city, has recently purchased the business and property of the Ohio Oxygen Company, Niles, Ohio. This purchase adds one more oxygen plant to the facilities of this company, making thirty-seven oxygen plants located in the principal industrial centers.

Special Firebox Designed for Oil-Burning Locomotives

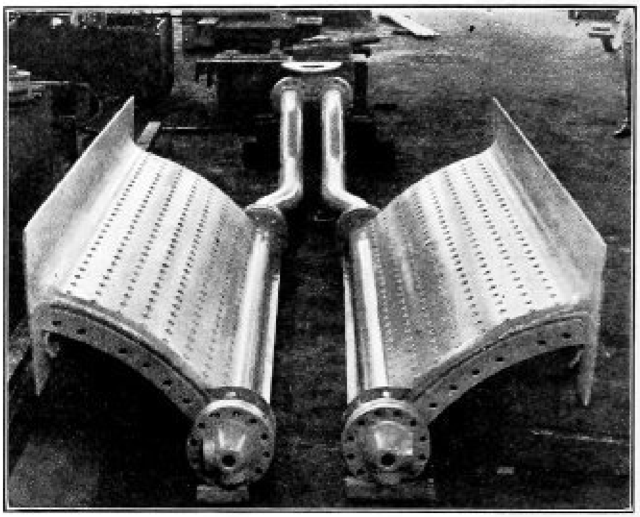
Texas & Pacific makes comparative tests with standard firebox—Nine percent fuel saving

THE Texas & Pacific conducted a series of four tests in January, 1928, with a locomotive equipped with Martin water-circulating and steam-generating tables, developed by the Locomotive Boiler Economizer Company, Roosevelt building, Los Angeles, Cal. At the same time these tests were run, a series of four similar tests with a locomotive equipped with a firebox of standard construction, was also made for purposes of comparison. Both locomotives were of the 2-10-2 type. The Martin tables were installed in September, 1927.

The 2-10-2 type locomotive, No. 541, which was equipped with the Martin tables, has been operated in pooled freight service over different divisions during that period to ascertain its performance with a variety of boiler feedwater. The comparative tests made last January for fuel performance with locomotive No. 534 of the same type and class, were made under adverse weather conditions, the temperature varying from 15 to 30 degrees F. during the tests with the Martin tables and from 55 to 70 degrees during the runs made with the locomotive equipped with the standard firebox. However, the railroad reports that a fuel saving of 11.2 percent per 1000 adjusted gross ton-miles was accomplished with locomotive No. 541, and it evaporated 14 per cent more water per pound of fuel oil than locomotive No. 534, which had the conventional firebox. The table gives a summary of the tests as reported by the mechanical department of the Texas & Pacific.

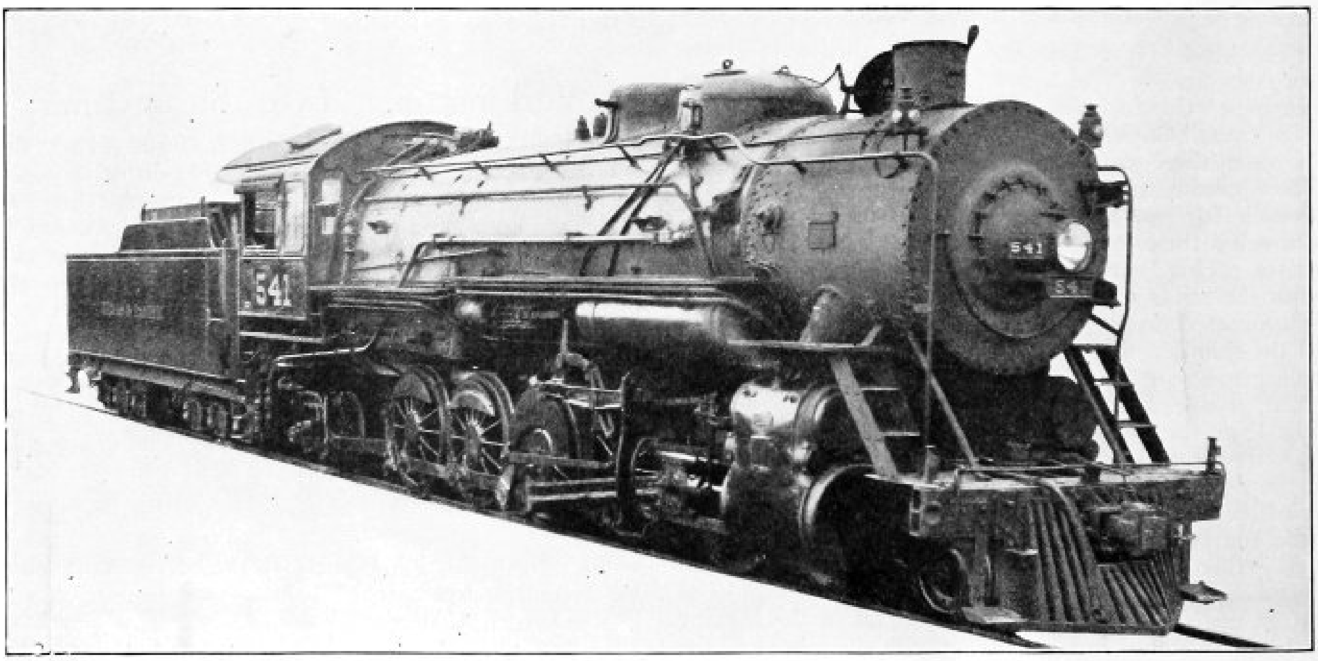
Results of tests comparing the Martin water-tables with a firebox of conventional construction

Description	Eng. 541 (Martin water-tables)	Eng. 534
Oil consumed per trip, gal.	1,946	2,180
Gals. oil per 1,000 g.t.m. (adjusted)	6.98	7.86
Gals. oil per 1,000 g.t.m. (adjusted)	6.98	7.86
Evaporation, lb. water per lb. of oil	11.89	10.42
Time on road	5 hr. 55 min.	6 hr. 20 min.
Actual running time	4 hr. 34 min.	4 hr. 24 min.
Per cent of rated tonnage handled entire trip.	97.35	97.05



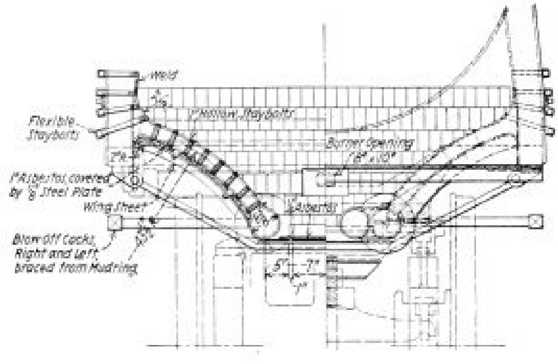
Martin water-circulating and steam-generating tables ready for application

From this table it will be noted that the fuel saving effected was substantial. In addition to the fuel saving



Texas & Pacific 2-10-2 type locomotive equipped with Martin water-circulating tables in road service, there is a material saving in fuel oil used at terminals in firing-up. A test at Big Spring, Texas, of locomotive No. 541 versus a standard equipped locomotive of the same class, showed that there was a saving of approximately 42 gallons of oil in bringing the two locomotives up to the same gage pressure, all conditions being equal. This is accounted for by the fact that the tables, in addition to the sides, crown sheet and combustion chamber, begin to absorb the heat from the flame of the oil burner as soon as the fire is lighted in the firebox. The circulation of the water from the shell of the boiler through the tables and water legs causes the water to absorb the heat at a more rapid rate than a boiler equipped with a firebox of standard construction. The table construction eliminates the dead end to the mud ring, and the objection to firing up oil-burning locomotives hurriedly, with the consequent strain to the firebox sheets, is eliminated.

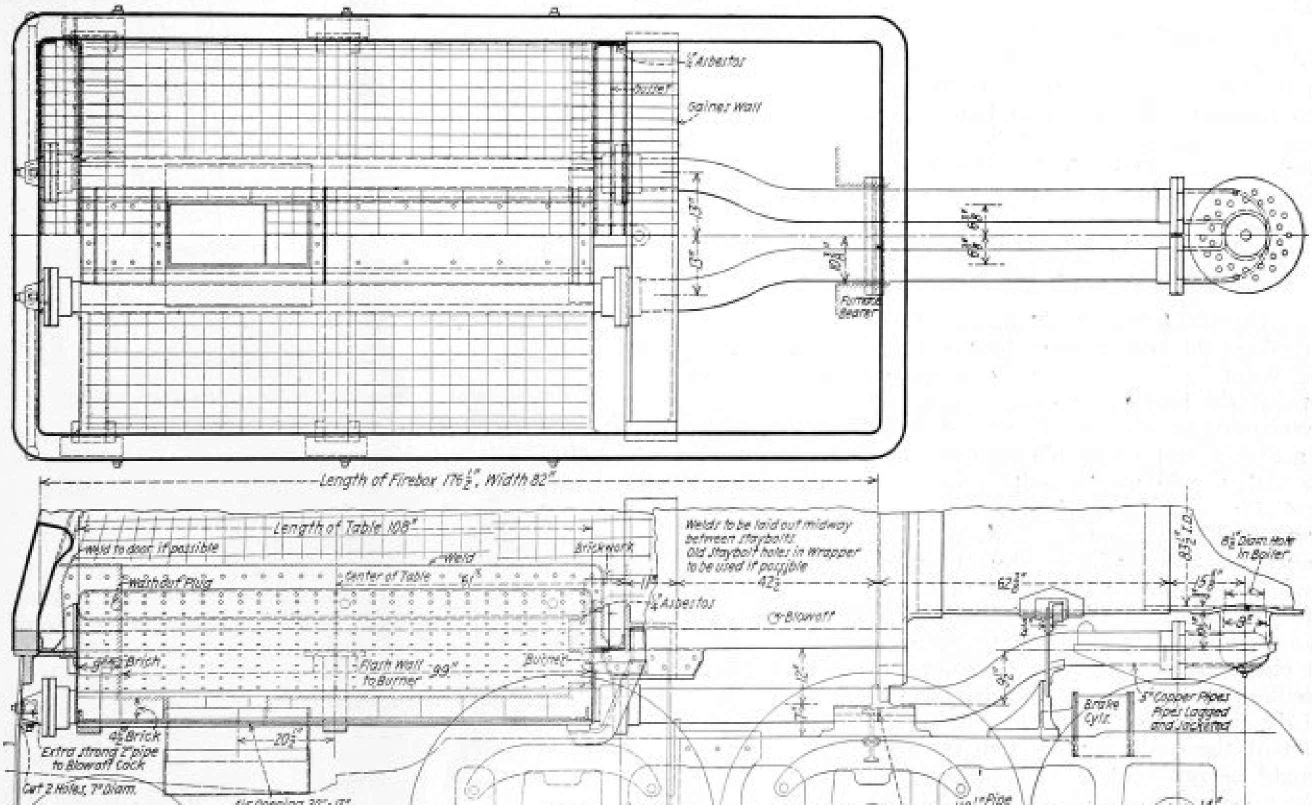
It will be noted from the drawings that the water tables present bare water-carrying surfaces to the fire, which surfaces were previously covered with fire brick. No fire brick are used on the side sheets of the firebox or on the tables, and it will also be noted that only a burner wall, flash wall and bottom floor between the bulbs or mud drums of the tables is used. An oil-burning locomotive firebox, equipped with these tables, eliminates the direct attachment of the side sheets of the firebox to the mud ring, substituting in lieu thereof a longitudinally running expansion joint occasioned by the juncture of the table with the side sheet. The tables, with the side sheets, form a loop which is brought around and secured by the bottom flange of the tables to the mud ring. In this manner, the strains incidental to the expansion of the side sheets are effectively compensated and bulging of the sheet under the heat of the firebox, causing it to move inwardly toward the fire and off the staybolts, is entirely done away with by the elimination of the direct attachment or anchorage of the side sheets to the mud ring.



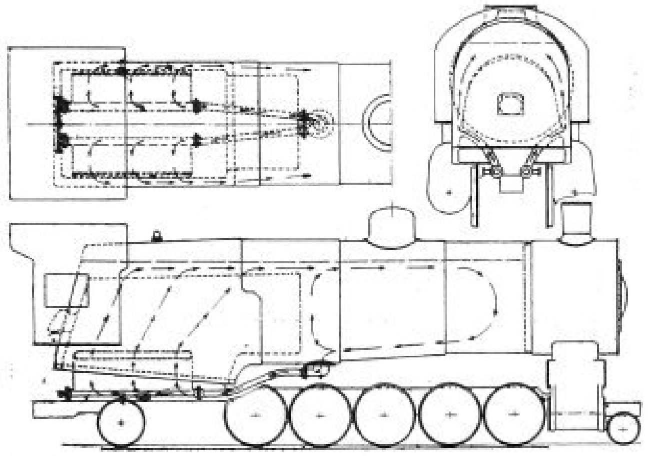
Cross section through the firebox

Installation Provides Additional Features

This means of compensating side sheet expansion reduces staybolt leakage and breakage to a minimum and affords relief in foaming water districts where staybolt trouble is greatly aggravated. The value of the water table construction in preserving the integrity of the firebox sheets was practically brought out in the operation of locomotive No. 541 between Big Spring and Toyah, Texas, in the foaming water district of the Rio Grande division where, owing to the shortage of rainfall and the highly concentrated condition of the water supply, it was necessary to brick the side sheets



General arrangement of the water circulating table installation on the Texas & Pacific 2-10-2 type locomotive of locomotives equipped with conventional fireboxes of the same class six rows of staybolts high, whereas locomotive No. 541 operated under the same conditions without any brick whatsoever covering the side sheets or water tables. The operation of the locomotive under the foaming water conditions referred to, showed a stabilization of the water in the glass, which is accounted for by the increased water-holding capacity of the tables in the bottom of the firebox, permitting the engineman to better control the water than in the standard equipped locomotive.



Water-circulation diagram with outside connection

The blowoff and wash-out arrangement also provides certain advantages. The construction of the tables at the bottom ends of the mud drums permits locating the blowoff cocks so as to blow off from the lowest point of the firebox and boiler. Adequate washout plugs are installed, which make the general system of removal of sedimentary matter from the boiler, washing out and changing water at terminals expeditious and practical.

The Table and Firebox Construction

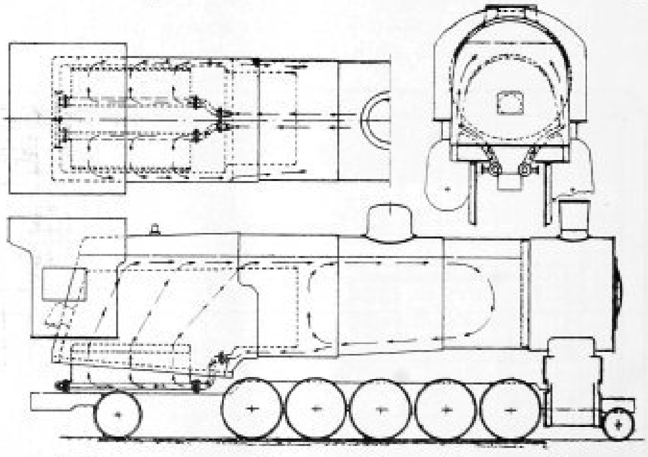
The problem of designing the Martin tables was one of taking the coal-burning mud ring firebox, and forming it into a firebox primarily adapted to burn fuel oil so that the heat of combustion could be utilized to the maximum; in other words, provide a construction without making any radical changes from existing standards so that, should the necessity arise at any time to convert the oil-burning locomotive to coal-burning, the complete change could be effected in a relatively few hours. To this end, the Martin oil-burning locomotive firebox was constructed on the principle that the bottom of the firebox could be utilized to advantage in the provision of water-circulating steam-generating tables or elements to serve as the bottom of the firebox, and feeding the tables or bottom with water from the barrel of the boiler in such a manner that a continuous circulation of the colder water from the barrel of the boiler would be provided by way of the tables into the side water legs of the firebox.

The effect of this is a dual one, in that the tables not only increase the active heating surface in the bottom of the firebox, but are the means of causing active circulation of the water in the side legs, which is ordinarily dormant a considerable distance over the mud ring and, because of being dormant, requires the protection of a refractory brick covering along the side sheets.

The circulatory movement of the water from the barrel of the boiler through the water tables into the water legs is occasioned by the difference in thermal head existing between the colder water in the shell of the boiler and the heating of this water in its passage through the tables. The result is that the water is lightened in the side legs by steam bubbles and is continually displaced by the colder water from the boiler barrel. The water tables act as generating surfaces not only to cause the active movement of the water through themselves but cause the steam line to be brought down the water legs from below the crown sheet, thereby materially increasing the capacity of the side sheet heating surfaces.

The object of this construction was to provide oil burning locomotives with a simple and efficient arrangement without any radical departure from the present standards, while taking advantage of all of the properties contained in the combustion of fuel oil. With this point in mind, the water tables are curved downward below the mud ring to form the deepest possible combustion chamber and to present convex surfaces to the fire. In this manner the firebox combustion volume, which is important in burning gaseous types of fuel such as fuel oil, is maintained at its maximum.

The illustrations show how the tables are constructed. They provide a continuation of the water legs of the firebox when attached by their flanges to the side sheets and mud ring, and are built in accordance with federal and state requirements. To install the tables, a strip of the side sheet is cut away approximately 18 inches above the mud ring, and the tables are substituted in place thereof, being welded along the upper flanged edges to the side sheets and riveted on the lower flanged faces, through existing ring rivet holes, to the mud ring. Should the occasion arise to change the fuel from oil to coal, the tables can be quickly removed with a cutting torch and a strip of sheet welded to the side sheets of the firebox. Two drawings show two forms of water passages. One is termed the outside connection, which is made from the shell of the boiler by a cast steel Y-header, while the other is designated as the inside connection, taken from the throat sheet of the firebox through a flanged steel nozzle connection. The pipes or conduits carrying the water are preferably made of copper and in accordance with the rules and regulations of the Department of Commerce for high-pressure pipes on ocean-going vessels. The copper pipes readily adapt themselves to all strains of expansion and contraction, and on this account are ideal water carriers. They carry cast steel flanges which are in turn secured to the cast steel flanges provided at the lower front ends of the tables. The cast steel flanges on the tables also carry cast steel blowoff headers, to which the right and left blowoff cocks are attached.



Water-circulation diagram with inside connection

Records of Combined Watertube and Firetube Locomotive Boilers*

Advantages of three types now in service as compared with stay-type boilers

THE question of boiler pressure has been a more or less important one since the inception of the steam locomotive, first limited probably by providing a boiler for carrying the stated pressure. As locomotives got larger without a corresponding increase in width limitation, it was necessary to keep cylinders within such limitations, and this in turn, required an increase in boiler pressure, the progress of the art being such that locomotive builders designed and built boilers to carry these higher pressures.

The railroads rested content for a number of years at the 200-pound mark, which was gradually exceeded for the reason mentioned above, that within the width limit the engines became slightly bigger and heavier. The range seemed to run along for a time between 200 and 220 pounds, and in building compound Mallets with large, low-pressure cylinders, the width limit again placed a corresponding limit on the side of the low-pressure cylinder, and in order to obtain the power desired, probably the biggest jump was made in going to 250 pounds boiler pressure.

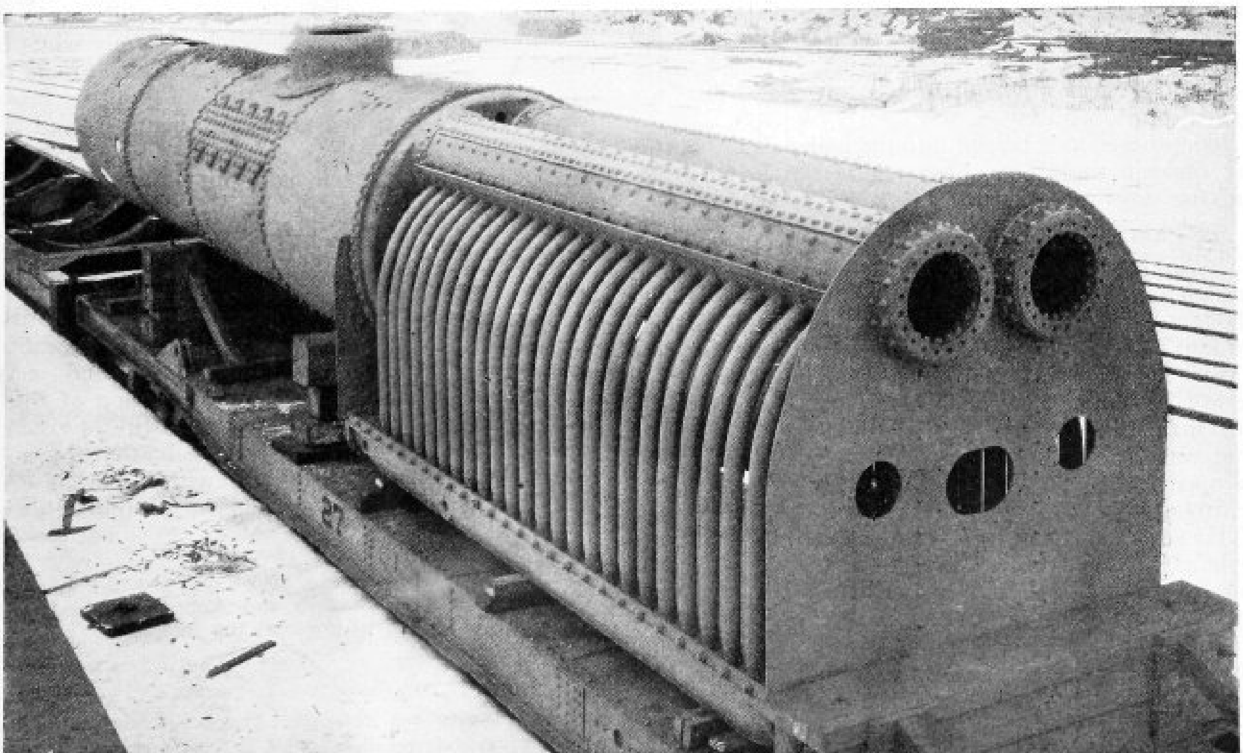
The 50 percent cut-off locomotive, with the high initial piston load, produced a mean effective pressure equal to that of an engine with a smaller initial piston load, working at longer cut-off, but with considerable saving in steam. Here again the width limitations of the railroad necessitated going to 250 pounds boiler pressure when the permissible limit of width over the cylinders had been reached.

In certain quarters there is some question as to whether a radial-stayed boiler can be built and successfully maintained for pressures much higher than 250 pounds. It was this thought that accounts for the efforts which have been exerted to bring out boilers with watertube fireboxes, making them not only sustain higher pressures, but providing the necessary increase in firebox heating surface and more rapid circulation.

Coupled with this thought was the desire to produce, if possible, a locomotive boiler without staybolts, it being apparent that the possible increase in initial cost would be more than offset by a reduced maintenance expense as compared with testing and replacing staybolts. This feature, irrespective of any thermic advantage, would justify this type of boiler.

The economy of a locomotive boiler in making steam can be measured practically by the difference in temperatures between the firebox and smokebox. The greater this difference, the greater is the efficiency obtained from the fuel burned; for it is logical to assume that the reduction in temperature between the firebox and smokebox is due to the heat absorbed in producing steam. In like manner, the efficiency of the cylinders

* Paper presented at the nineteenth annual convention of the Master Boiler Makers Association held in Cleveland, Ohio.



Baldwin Locomotive Works locomotive No. 60,000 is fitted with this boiler can be measured by the difference between the heat of the steam taken into the cylinders and the heat going out of the stack.

At the present time, three railroads in the United States, the Baltimore & Ohio, the Delaware & Hudson, and the New York, New Haven & Hartford, have in service locomotives of various types with combined watertube and firetube boilers. In addition, another watertube firebox locomotive, Baldwin Locomotive Works No. 60,000, has been in operation under regular service conditions on a number of more important roads throughout the country, since the latter part of 1926.

Baldwin Locomotive Works No. 60,000

This locomotive is the 60,000th constructed by the Baldwin Locomotive Works, and was built during the early part of 1926 as an experiment to determine the possible economies which can be effected by high steam pressure at a high ratio of expansion, with greater cylinder efficiency and greater horsepower per unit of weight.

The locomotive is of the 4-10-2 type, built for freight service with driving wheels 63½ inches in diameter, and three cylinders each 27 inches in diameter by 32 inches stroke. The total weight in working order is 457,500 pounds, of which 338,400 are on driving wheels.

Apart from the modifications necessary to the use of the watertube firebox and the high pressure, the boiler does not differ in principle from that of the conventional locomotive. The boiler barrel is of the usual firetube type having 206, 2¼-inch tubes, and a type *A* superheater carried in 50, 5½-inch flues.

The barrel consists of three courses, having plates respectively 1 5/16, 1⅜, and 1½ inches thick. The third course is sloped on top, increasing the shell diameter from 84 inches at the front end to 94 inches at the back. All circumferential seams are double-riveted, and the longitudinal seams are of the so-called "sawtooth," octuple-riveted design, which provides a short calking distance between the rivets. At the rear, the barrel is closed by a tube sheet, which is riveted to the shell in the usual way. The boiler tubes and flues are welded into this sheet.

None of the studs tapped into the boiler passes all the way through the sheets, hence there can be no leaky studs or stays.

Details of Firebox

The firebox is of the watertube type, each side wall consisting of 48 tubes 4 inches in diameter, connecting a hollow cast steel mud ring at the bottom to one of two longitudinal cylindrical drums at the top. Outside of these side tubes a firebrick shell is built, over which are applied removable cover plates which are covered with magnesia sectional lagging and jacketed. The front and back walls of the firebox are of firebrick and the opening between the drums, forming the crown of the firebox, is also closed with firebrick.

This construction provides a boiler entirely free from staybolts and from flat surfaces requiring staybolts. This feature of the design gives it an important advantage when high steam pressures are to be carried.

The depth of the firebox from the top of the mud ring to the center line of the drums is 6 feet 6 inches. The total volume, including combustion chamber, reaches the large figure of 683 cubic feet. This gives 8.3 cubic feet of volume for each of the 82.5 square feet of grate area, which is a high relative volume for a modern locomotive, and aids in securing effective and efficient combustion.

The two drums are each 26 inches in diameter, and the transverse distance between their centers is 31 inches. They have a total length of 23 feet 6 inches. and extend into the boiler barrel a distance of 5 feet 6 inches ahead of the back tube sheet. The openings in this sheet, through which the drums pass, have flanges 6⅝ inches in depth, to which the drums are double riveted. Each drum is closed, at the rear, by a cover plate which is secured to an internal ring by means of studs, and is fitted with a copper gasket to keep the joint tight. By removing these covers the drums can be entered for purposes of inspection, and the watertubes can be turbined during the washing out, to remove any scale. This can be done without removing any of the lower plugs, one of which is placed in the mud ring opposite each tube end.

The third course in the boiler barrel is sloped on top, and the two upper drums are so located that their forward extensions come in contact with this course, and are riveted to it. This acts as a support for the drums, and tends to counteract the cantilever effect of the long overhanging firebox. Furthermore, to balance the effect of the pressure on the covers at the back ends of the drums, three longitudinal stay rods are run from the forward end of each drum to the front tube sheet. These rods are anchored to internal braces which are riveted to the drum. This construction, together with a system of braces connecting the front end of the mud ring and the boiler barrel, relieves the back tube sheet of any tendency to distortion, due to the firebox overhang and the pressure on the drum heads.

The hollow cast steel mud ring is connected to each upper drum by 48 tubes each 4 inches in diameter; and there are also four tubes connecting the drums to the back section of the mud ring. All these tubes are swedged to a diameter of 3 inches at the mud ring end, where they are rolled and belled, while at the drum end they are rolled, belled, and welded. The tube holes in the mud ring have two depressions rolled into them, into which the tubes lock themselves firmly when being rolled in. Connection between the bottom of the boiler barrel and the front end of the mud ring is made by two elbow pipes, each 9 inches in diameter, and placed right and left.

The mud ring, which has a total length of 18 feet 2 inches and a width of 8 feet 5 inches, is cored throughout to permit water circulation. The rectangular outer frame is crossed by a central longitudinal member and also by a transverse member located about 6 feet back of the front end of the firebox. From this transverse member, which lies at the front end of the grate, five arch tubes extend to the upper drums, and serve as supports for the brick arch. That portion of the firebox which is forward of the arch constitutes a combustion chamber and is closed, at the bottom, by a horizontal steel plate, and floored with firebrick. A Y-shaped cinder pocket is applied for cleaning this combustion chamber.

Comparison of Baldwin No. 60,000 and a 2-10-2 Locomotive with Two Simple Cylinders and Approximately the Same Tractive Power as the B. L. W.

Number		Baldwin 60,000
Type	2-10-2	4-10-2
Tractive power	84,260	82,500
Factor of adhesion	4.12	4.1
Cylinders, diameter and stroke	30" x 32"	2—27" x 32" 1—27" x 32"
Drivers	64"	63½"
Boiler pressure, pounds	220	350
Weights—Drivers	347,230	338,400
Front truck	31,570	57,500
Trailer truck	57,710	61,600
Total locomotive	436,510	457,500
Locomotive and tender	734,910	700,900

Boiler—Diameter	90″	84″
Tubes, number and diameter	232—2¼″	206—2¼″
Flues, number and diameter	53—5½″	50—5½″
Flues, length	23′—0″	23′—6″
Firebox, size	132½″ x 96″	199½″ x 86″
Heating surface, square feet—Firebox	262	745
Combustion chamber	85	
Tubes and flues	4,881	4,420
Arch tubes	42	27
Total	5,270	5,192
Superheating	1,512	1,357
Grate area, square feet	88	82.5
Tender—Water, gallons	15,800	12,000
Coal, tons	23	16

The locomotive is at present arranged for burning coal, and is equipped with a duplex stoker. It can, however, subsequently be changed to burn oil, if necessary.

The dome is placed on the second barrel course, and is connected with the superheater header by an internal dry-pipe. The throttle is placed in the smokebox, between the superheater header and the cylinder; while there is a shut-off valve for the steam supply in the dome

The three cylinders, with their steam passages and steam chests, are formed in a single gray iron casting. The high pressure steam chest is placed in the saddle, on the right hand side, and is connected with the superheater by a single steam pipe. All the piston valves are 14 inches in diameter, that for the high-pressure cylinder being arranged for inside admission, while the valves for the low-pressure (outside) cylinders are arranged for outside admission. The high-pressure exhaust is conveyed to the low-pressure steam chests through passages cored in the cylinder casting; while the exhaust from the low-pressure cylinders passes to the smokebox through outside pipes which terminate in a single exhaust nozzle. A Worthington feedwater heater is applied to this locomotive, and a branch from each exhaust pipe conveys the steam to the heater.

Baltimore & Ohio Mikado Locomotive No. 4045 and Class Q-1x

This is the second watertube firebox locomotive constructed by this system, the first having been built in 1927, and applied to a modernized Consolidation locomotive.

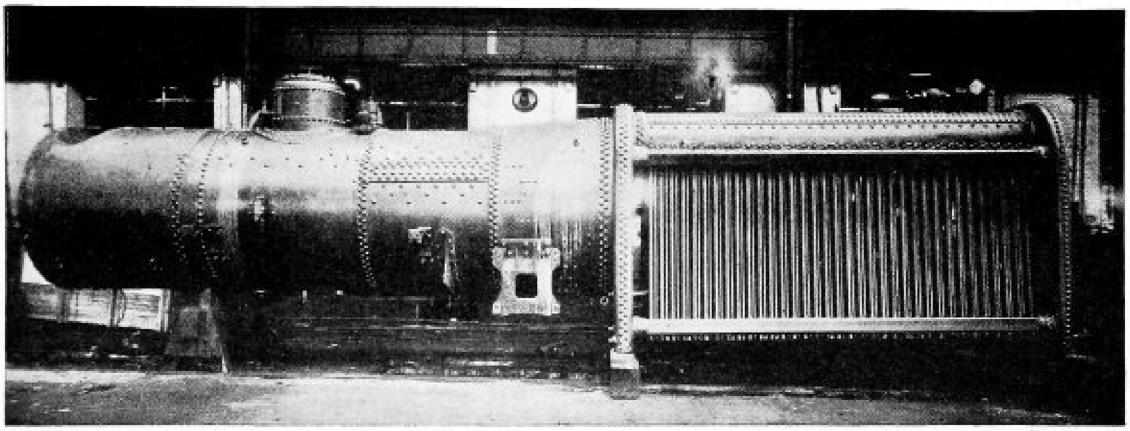
There is very little difference in the design of these two fireboxes, the principal difference being, the first one did not have the top watertube headers connected to the front and back water legs.

Locomotive No. 4045 was one of the most interesting exhibits at the Fair of the Iron Horse, held at Halethorpe, Md., in the fall of 1927. Half of the outside firebox covering was omitted at this exhibition, exposing the vertical watertubes and horizontal drums. This is a Mikado locomotive, 2-8-2 type, originally built in 1911, of 50,200 pounds tractive power, and in 1927, when the watertube firebox was applied, larger cylinders were put on and tractive power increased to 65,400 pounds, an increase of over 30 percent.

Comparison of Baltimore and Ohio Class Q-1 and Q-1x Mikado Type Locomotives

Class	Q-1	Q-1x
Type	2-8-2	2-8-2
Year built	1911	1927
Builder	B. L. W.	Baltimore & Ohio
Tractive power	50,200	*65,400
Factor of adhesion	4.35	*3.81
Cylinders, diameter and stroke	24″ x 32″	26½″ x 32″
Drivers, diameter	64″	64″
Boiler pressure, pounds	205	250
Weights, pounds—Drivers	218,740	249,000
Front truck	18,400	26,000
Trailer truck	38,910	59,000
Total locomotive	276,050	334,000
Locomotive and tender	457,550	535,000
Wheel base—Drivers	16′—9″	16′—9″
Locomotive	35′—0″	35′—0″
Locomotive and tender	71′—2 9/16″	71′—3 7/16″
Boiler—Diameter	78″	78″
Tubes, number and diameter	289—2¼″	205—2¼″
Flues, number and diameter	None	40—5½″
Flues, between sheets	20′—10¾″	16′—0″
Firebox size	84″ x 120″	84″ x 126″
Heating surface in square feet—		
Firebox and arch tubes	228	603.2
Tubes and flues	4,789	2,854
Total	5,017	3,457.2
Superheating	None	842
Grate area, square feet	70	73.5
Tender—Water, gallons	9,500	11,500
Coal, tons	16	17
Cylinders, horsepower	1,967	2,770

* Based on 60 percent cut-off. With 50 percent cut-off, tractive power 64,250, factor adhesion 3.88.



Boiler for Mikado-type locomotive of the Baltimore & Ohio Railroad

The table shown with this description gives a comparison between the original and present locomotives, and particular attention is called to the heating surface of the watertube firebox, this being 603 square feet as against 228 square feet for the original locomotive. The boiler shell itself is the general locomotive design with two cylindrical and one conical course, in which is applied regular boiler tubes and superheater flues, and the usual front and back tube sheets.

The dome is located on the first course, which is quite an advantage in having the throttle close to the cylinders and prevents excessive slipping of wheels on wet rail.

At the rear end of the shell is attached a watertube firebox having water legs both at front and rear, formed of outside and inside throat sheets, door sheet and back head. The front water-leg sheets are joined together at bottom sides and top with double row of rivets, and the back water-leg sheets with a single row of rivets at bottom, top and sides. At the upper portion of the rear tube sheet, two circular flanges extend toward the rear and are riveted to the front end of the steam drums and similar flanges extend toward the front from the door sheet, riveted to the rear end of the steam drum. These two steam drums, which are 28 inches in diameter, are in longitudinal position at the upper part of the firebox and normally are carried half full of water.

At the top and bottom of each side of the firebox are longitudinal headers, four in all, riveted to circular flanges projecting from the rear tube sheet and door sheet. The main portion of these watertube headers is 7¼ inches square, and provides communication between the front and back water legs. There are nine 4-inch circulating tubes connecting each of the top headers with the steam drums, and the top and bottom headers are connected together by two rows on each side of 2½-inch diameter watertubes, which form the sides of the firebox.

On the top of the top headers and on the bottom of the bottom headers are plugs used for applying and rolling in the watertubes, and by the removal of the top plugs the watertubes can be turbined or cleaned at washout periods.

The novel feature is that all tubes can be applied and rolled and the entire boiler cleaned without removing the dome cap for the workman to go inside the drums, and the entire cleaning operation can be performed in 4½ hours, the boiler being completely washed out, and watertubes turbined, which is the average time taken for washing out and testing a staybolt type boiler.

All crown stays, radials, and side water space staps are eliminated, the only staybolts being in the front and back water legs, and these being in sheets in which the ratio of expansion and contraction is uniform, it is not anticipated that any trouble will be experienced.

Five 3-inch arch tubes are used. These are secured to the inside, throat sheet at the front end in the regular way, and to the bottom of the top steam drums at the rear; three in one drum and two in the other. Standard arch brick rest on the arch tubes in the usual way.

At the center between the upper 28-inch diameter drums, also between the top side headers and drums, special design firebrick is used to close the openings. The outside of the watertubes are completely covered from front to rear by firebrick, the latter with heavy plate to which lagging and casing finish is applied.

Dynamometer tests conducted on this locomotive indicate that the overall efficiency is better than any yet operated on the Baltimore & Ohio Railroad, and due to elimination of practically all staybolts, and the good circulation obtained, the maintenance will be much less than with the conventional style of boiler. Since this type of firebox can be readily applied to existing boilers, it should be the means of greatly reducing operating expenses, at the same time increasing tractive power, because of the greater steaming capacity of the boiler.

The locomotive is duplex stoker fired and is also equipped with an exhaust steam injector and a closed type feedwater heater. The feed pump is located on the left side, under the cab.

This boiler was built at the company's shops, at Mt. Clare, Baltimore, Md.

A third watertube firebox locomotive, No. 2700, has been completed and recently placed in service, in which there is not a single staybolt; the design of this firebox is the same as locomotive 4045, except there are no water legs at the front and back; no outside throat sheet at the bottom, the rear tube sheet being flanged and riveted directly to the shell at the lower part and to hip sheet at the upper part. The longitudinal drums are connected to the boiler shell by riveting to flanges in the rear tube sheet and closed with heads at the rear end. The watertube top headers instead of being connected to the front and back water legs, are blanked off and the top headers are connected to the drums with the usual circulating tubes. The watertube headers at the bottom are connected to the front and back mud ring castings.

A fourth watertube firebox has been completed and applied to one of the President type locomotives No. 5320, "President Cleveland." This is a high speed passenger locomotive, having 27-inch by 28-inch cylinders, 80-inch drivers, and 230 pounds boiler pressure, and the following characteristics:

Total weight of locomotive	326,000 pounds
Tractive power	50,000 pounds
Firebox, inside	84¼ inches by 120⅝ inches
Grate area, square feet	70.30
Tubes and flues	70.30
Heating surface firebox	457
Total heating surface, square feet	4595
Superheating	1188

The Delaware & Hudson Company Locomotive Horatio Allen

The Horatio Allen, locomotive No. 1400, was designed to determine what could be accomplished in the better production and utilization of fuel heat and by means of higher steam pressure and the greater use of its expansion properties, in combination with the development of maximum hauling power in the most simplified form of a modern steam locomotive, consisting of two cylinders and four pairs of driving wheels.

There is another point in connection with the Horatio Allen type of boiler which is advantageous as compared with the conventional boiler. In the case of the later or modern design, the cylindrical shell ranges from 90 to over 100 inches in diameter. Where high pressure is used, in combination with such a large diameter of shell, it necessarily means a lot of additional weight to provide a factor of safety of 4. Furthermore, in the case of bad water conditions, where these shell plates are liable to be pitted, corroded and grooved, there is greater liability for explosion and greater necessity for sheet renewals from time to time.

With the Horatio Allen type of boiler, the largest cylindrical shell is relatively small, i.e., about 60 inches in diameter, and in addition, the boiler proper is made up of four much smaller cylindrical drums and a large number of self-sustained fire and watertubes. In other words, the flat-sheet or staybolt-stayed surfaces are reduced to the minimum consistent with keeping water surrounding the entire furnace so that the maximum heat generated can be absorbed by the water.

With respect to the substitution of watertubes for water legs at the sides and at the crown of the furnace, the breaking up of the water into these thin streams certainly does away with the sluggish circulation that obtains in water legs and therefore, not only increases the capacity of the boiler to generate steam on account of the increased circulation, but it also enables more of the heat generated in the firebox to be absorbed or picked up by the water and converted into steam.

As the steam locomotive is a combination pressure-heat machine, the importance of the foregoing mentioned feature in the boiler design and operation is obvious.

The New York, New Haven & Hartford Railroad Company McClellon Type Locomotive Boiler

The first experience which the N. Y. N. H. & H.

Railroad had with the McClellon boiler was in 1916, when two Mikado type locomotives were put in service, having a boiler pressure of 180 pounds. In 1920 several changes were made in the design of the fireboxes of these two locomotives because of weaknesses which had developed in service, but it was considered that fundamentally the McClellon boiler was sound in principle.

In 1924, one Mountain type locomotive was purchased, equipped with the McClellon boiler, in which was embodied desirable modifications developed from experience with the two Mikado locomotives. The boiler pressure was increased to 250 pounds.

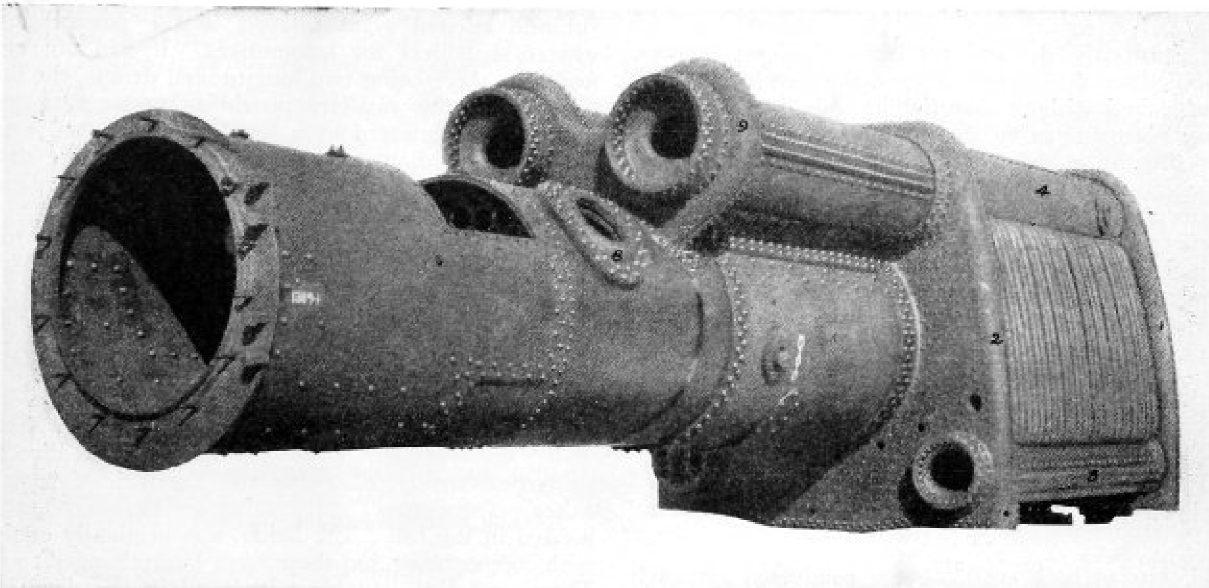
In 1926, ten additional Mountain type locomotive were purchased equipped with the McClellon boiler in which were embodied a few minor modifications, the boiler pressure being increased to 265 pounds.

a staybolt failure at this point. (Practically the only staybolts used in the McClellon boiler are in the throat sheet).

In raising steam in a standard type boiler everyone appreciates the unequal expansion taking place and the trouble and defects attendant thereto. Steam may be raised more quickly in the McClellon boiler and there is gradual and equal expansion in all parts of the boiler, with no dead line where there is slow circulation.

In general this boiler conforms, so far as the shell portion is concerned, to the usual practice, the dome being located on top of second course and the barrel contained 29 2¼-inch firetubes, 184 3½-inch diameter superheater flues, 14 of which do not contain any superheater units.

The firebox is made up of three steam drums at the top, the side and back mud rings being steel castings,



Boiler for the Delaware & Hudson Railroad locomotive Horatio Allen

There were recently built by the American Locomotive Company, ten more Mountain type locomotives with McClellon boilers which will contain modifications already made in part of the locomotives purchased in 1924 and 1926, consisting primarily of redesigned back flue sheets and center drums, making a total of 23 locomotives with this type of boiler.

In the discussion at our conventions from year to year, we have dwelt upon the best methods of eliminating firebox troubles. One item in prominence is the application, maintenance and inspection of staybolts, and regardless of what has been done we still have numerous failures irrespective of the type of bolt used, though some designs may last longer than others. There is also frequent application of part or full side sheets and in some locations early renewal of firebox, back ends and finally boilers complete. We have endeavored, without much success, to take care of unequal expansion as exists in radial-stayed boilers, to which we have decided a large percentage of boiler failures are due.

The throat sheet of the McClellon boiler, though similar in design to the standard boiler, may be considered practically a water container, from which the circular firebox ring and all vertical and arch tubes are fed. It is not subject to great variation in temperature, outer compared with inner, and these bolts are subject to strain in tension only, from which failure seldom occurs. This possibly is the reason we have never had

and the front of the mud ring is a water leg of the usual design.

There is a 12⅜-inch inside diameter circulating tube connecting the front water leg with the bottom of the third course of the boiler.

The sides of the firebox are made up of 4-inch diameter watertubes extending from the mud ring castings to the outer steam drum, and the back of the firebox is made up of 2-inch diameter watertubes extending from the back mud ring casting to the rear end on the bottom of all three steam drums.

The back tube sheet of the McClellon boiler is riveted to the boiler shell and drums, and is so shaped as to compensate for a variation of tube temperature compared with the shell. This produces an important advantage over the standard boiler in which the knuckle of the tube sheet at the top is a constant source of expense, repairs and renewals. We have experienced no such trouble with the McClellon type because the sheet maintains its original shape.

Designing engineers appreciate the evaporative efficiency of arch tubes and a similar advantage is obtained from the vertical tubes as applied in the McClellon firebox. The arch tubes in the McClellon firebox extend from throat sheet to crown (drums).

With the ordinary standard combustion chamber we do not get good circulation from the bottom, while in the McClellon this is taken care of by watertubes. There are eight circulating tubes connected at the bottom to the 12⅜-inch diameter connection under the shell, and at the top entering the outer steam drums.

This construction provides an increased firebox heating surface and rapid circulation of the water from the mud ring castings to the steam drums.

It has been noted that the vertical and combustion chamber watertubes retain very slight scale after years of service. Therefore, there is only one point aside from firetube area where sediment may accumulate, which is in the trough leading from the shell, through which water passes to the throat and firebox ring. This section is easily accessible for washing.

Maintenance is low at washout periods and the time required is reduced about 50 percent. In brief, there are the usual firetube troubles as experienced in standard boilers, but not staybolt and firebox sheet troubles.

Where the water is bad, naturally the time required is longer.

As regards the demand for higher boiler pressures, the McClellon watertube boiler makes such increases attainable and without material increase in weight.

After receipt from builders in 1924 of the locomotive equipped with the McClellon boiler, it was placed in regular freight service and later subjected to extensive road tests in comparison with a similar locomotive equipped with a standard boiler. A comparison of the principal characteristics of the two locomotives tested follows:

Comparison

	Engine 3324	Engine 3500
Type	4-8-2	4-8-2
Boiler	Firetube	Firetube
Firebox	Radial Stayed	McClellon*
Weight on drivers	230,500 lb.	243,500 lb.
Total weight, engine and tender	518,800 lb.	549,000 lb.
Boiler pressure	200 lb.	250 lb.
Cylinders	27 by 30 in.	27 by 30 in.
Maximum cut-off	85%	70%
Diameter of driving wheels	69 in.	69 in.
Tractive force	53.900 lb.	63,390 lb.
Factor of adhesion	4.28	3.81

* Watertube firebox.

The tests of both engines were conducted as nearly alike as possible and a summary of the test results follows:

Summary of the Test Results

	Eng. 3324	Eng. 3500	Percent Increase or Decrease for Eng. 3500
Test Conditions			
Av. running time, min.	254	254	
Av. delayed time, min.	88	106	20.0 inc.
Distance, miles	107	107	
Av. number of cars per train	90.5	87.0	3.9 dec.
Av. actual tons per train	4,360.6	4,556.0	4.48 inc.
Av. equated tons per train	4,486.5	4,640.0	3.2 inc.
Av. cut-off percent	44.8	38.5	16.5 dec.
Locomotive Output			
Av. drawbar pull (integrated), lb.	27,725	29,306	
Million ft.-lb. work at the drawbar	15,669	16,557	5.7 inc.
Dynamometer hp. (true average)	1,872	1,982	5.9 inc.
Fuel Performance			
Coal fired, average per trip	23,725	21,400	10.7 dec.
Coal fired, per dynamometer hp-hr. lb.	2.99	2.55	14.7 dec.
Coal fired, per 1,000 gross ton-miles, lb.	50.9	44.4	12.7 dec.
Coal fired, per sq. ft. grate per hr., lb.	79.1	71.6	9.5 dec.
Dry coal per dynamometer hp-hr. lb.	2.95	2.50	18.0 dec.
Dry coal per 1,000 gross ton-miles, lb.	49.96	43.41	13.1 dec.
Dry coal per sq. ft. grate per hr., lb.	77.6	70.0	9.8 dec.
Average thermal efficiency	6.46	7.47	15.6 inc.
Machine Performance			
Av. indicated hp. (reading intervals)	2,503.8	2,696.0	7.67 inc.
Av. dynamometer hp. (reading intervals)	2,203.4	2,347.0	6.52 inc.
Machine efficiency, percent	88.0	87.0	1.1 dec.
Boiler Performance			
Av. boiler pressure, lb.	194.8	241.1	24.0 inc.
Av. superheat, deg. F.	192.5	196.7	2.18 inc.
Water delivered to the boiler, average per trip, lb.	181,693	182,339	
Water losses, average per trip, lb.			
Through feedwater heater pump	3,428	3,880	
Through air pumps	7,364	7,367	
Through safety valves	2,303	1,496	
Through generator	423	423	
Through stoker	3,593	3,599	
Percent total evaporation delivered to cylinders	90.58	90.79	
Actual evaporation, lb. per hr.	42,963	43,189	0.5 inc.
Equivalent evaporation, lb. per hr.	56,750	56,821	0.1 inc.
Actual evaporation per lb. dry coal, lb.	7.81	8.75	12.0 inc.
Equivalent evaporation per lb. dry coal, lb.	10.32	11.50	11.4 inc.
Actual evaporation, lb. per sq. ft. evaporating surface, per hr.	10.40	10.64	2.3 inc.
Av. lb. water evaporated per dynamometer hp. hr.	22.95	21.8	5.0 dec.
Av. boiler efficiency, percent	74.59	81.53	9.3 inc.

The McClellon type boiler shows in these tests an increased efficiency of 9.4 percent over the standard boiler, and there was an increase in overall locomotive thermal efficiency of 15.5 percent.

It will be noted that the locomotive with the McClellon boiler hauled 4½ percent more tonnage with a 10 percent saving in fuel.

French Watertube Locomotive

Your committee also finds record of a watertube boiler on the Paris, Lyons, and Mediterranean Railway in Europe in February 1904. This boiler was successful and excited great interest in the possibilities of watertube boilers for locomotives. It had no regular firetubes, there being two longitudinal drums, the larger being over the smaller, providing water and steam space, and connected by a series of curved watertubes 2.6 inches in diameter and expanded into the drums. Three cylindrical necks also furnished communication between the drums at front, back, and center.

Headers below the grate level were connected to the upper drum by a series of tubes placed close together and forming the inside shell of the firebox, the tubes having an outside covering of steel plate. To facilitate cleaning the watertubes, two longitudinal blower pipes extended through the central space, piercing the two forward connecting necks between the upper and lower drums. These blower pipes had many openings through which jets of steam were blown in inclined directions against the watertubes for the removal of soot and ashes. The valves for operating the blower pipes were located in the cab. The boiler was originally equipped with copper tubes, but these were later changed to steel. There was little trouble with mud in the drums, but scale formed in the tubes requiring removal by brushes, hammers, and tube cleaners on flexible shafts. The boiler steamed freely and raised steam rapidly.

The Brotan Boiler

Another type of watertube firebox in Europe is the Brotan, extensively used by the Hungarian State Railways. This boiler has the ordinary shell with firetubes and superheater flues, while the firebox has two water and steam drums at the top connected to a mud drum casting at the bottom by watertubes.

Brotan was one of the pioneers in designing watertube fireboxes for locomotives and the boiler on the Baldwin No. 60,000 is frequently referred to as the modified Brotan type, though the locomotive itself differs greatly from its predecessor in mechanical construction and principle.

Difficulties had been experienced with the boilers on locomotives because of hard water and because of the highly satisfactory service which the Brotan boiler had rendered on some express locomotives, it was decided to embody it in the design of a new Mallet. Since this first locomotive was constructed, 59 more of the same design have been built and placed in service.

This particular design of the Brotan firebox boiler has a greater heating surface than is usually found in European locomotive boilers. The barrel of the boiler is in three sections: the middle section has a diameter of 68 29/32 inches and the plates ¾-inch thick, while the rear section is conical with a maximum diameter of 78¾ inches, the plates being ⅞-inch thick. The circumferential seams of the boiler are lapped and double riveted; the longitudinal seams have double straps of unequal width and are triple riveted. The copper tube sheet of the firebox is 1 3/16 inches thick, the front tube sheet is of iron 1 7/64 inches thick. The steam dome is 20 7/16 inches high and has a diameter of 35 7/16 inches; it consists of two parts: viz., the flanged shell which is 19/32-inch thick, and the dome which is ⅞-inch thick and which has a cover 25 9/16 inches in diameter.

The throttle valve on the steam dome is a double disk gate valve; two safety valves of 4 inches diameter, with a high lift, are fitted on a special pad back of the dome. On account of the size of the boiler two strainers, each with six cells of 21⅝ inches diameter, were fitted, the feedwater being led to these through a feedhead by means of a non-suction steam jet pump.

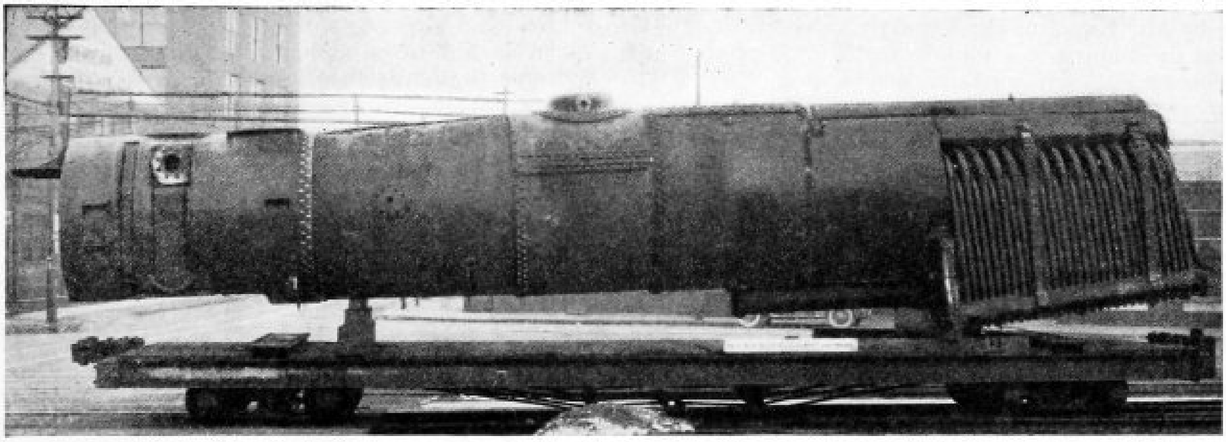
The Brotan type firebox, is 122 inches long between protecting plates and 79½ inches wide. The cast steel base frame is built up in four sections with flanged joints and its front end is connected to the boiler by three elbows. In later construction the base frame is in one piece. The side walls of the firebox are formed by seamless drawn wrought iron watertubes which end in two separate headers, and are connected with each other at the rear by a coupling piece. To insure tightness, the headers project into the boiler for a distance of 22 9/16 inches and are there supported by heavy angle bars. Furthermore, to better shut off the gases of combustion toward the top, two more horizontal watertubes were built in between the two headers, reaching from the rear coupling piece to the tube sheets.

The rear wall of the firebox is formed by six watertubes on each side, while forward a fireproof wall completes the enclosure. The fire door is a sliding door in halves, the opening being formed by a cast steel frame; combustion with but little smoke formation is attained by a long fire dome; a tilting grate serves readily to remove the slag formed by inferior coal.

The boiler barrel has a tapered section next to the firebox and the watertubes in the firebox, arranged in two vertical groups on each side, connect with horizontal drums which extend the entire length of the firebox. A hollow steel casting forms the under side of the firebox. A means of connection between this casting and the upper drums is provided by the watertubes. The upper drums are sometimes designated as the "primary" boiler. The lower hollow steel casting, or foundation ring, is connected to the under side of the boiler barrel by a series of elbows. This system is arranged to create a vigorous circulation of water through the firebox.

In the latest type of Brotan boiler used on the locomotive of the Hungarian State Railways, two flanged connections are formed on the upper portion of the copper firebox tube plate of the boiler. The longitudinal drums are inserted in the opening thus formed. At the extreme forward ends they are riveted to the boiler barrel stiffening plates about 2 feet ahead of the copper tube plate inside the tapered section. In this way, the support of the drums is largely taken by the stiffening plate within the boiler and not by the tube plate alone as was formerly the case.

The Brotan tubes which are placed close together form the side walls of the firebox and are, of course, directly exposed on the inner sides to the heat. The outer sides of the tubes are protected against heat losses by means of a cover of non-conducting material sheathed with a light gage metal.



New York, New Haven & Hartford Railroad locomotive boiler with watertube firebox

Table of Dimensions—Brotan Boiler

H. P. cylinders, diameter	20.47 in.
L. P. cylinders, diameter	33.46 in.
Stroke	25.98 in.
Rated tractive force, 75 percent	61,500 lb.
Weights in working order:	
On drivers	214,000 lb.
On front truck	27,000 lb.
Total engine	241,000 lb.
Tender	126,000 lb.
Wheels, diameter outside tires:	
Driving	56.69 in.
Front truck	37.40 in.
Boiler:	
Steam pressure	220 lb.
Diameter, first ring, inside	68.9 in.
Firebox, length and width	122 in. by 79½ in.
Tubes, number and diameter	180—2 1/16 in.
Flues, number and diameter	36—5¼ in.
Watertubes	70—3¾ in.
Length over tube sheets	16 ft.—6¾ in.
Heating surfaces:	
Grate area	54.7 sq. ft.
Firebox and watertubes	247 sq. ft.
Tubes and flues	2,671 sq. ft.
Total evaporative	2,918 sq. ft.
Superheating	857 sq. ft.
Comb. evaporative and superheating	3,775 sq. ft.
Boiler proportions:	
Tractive force ÷ comb. heating surface	16.3
Tractive force × dia. drivers ÷ comb. heating surface	9.45
Firebox heating surface, percent of evap. heating surface	9.3
Superheat. surface, percent of evap. heating surface	32.0

In addition to the boilers described in the foregoing, there have been many proposed designs worked up by sponsors of this type, which in the majority of cases while possessing features possible of accomplishing the desired increased pressure, circulation, and firebox heating surface, are of complicated construction, difficult to manufacture, and undoubtedly, very inconvenient to clean.

For simplicity of design and construction, the Baltimore & Ohio type presents no unusual problems in manufacture, accomplishes all the desired results, and is completely cleaned and turbined from the outside, so that it is suitable for any kind of water.

Higher Steam Pressure Possible

The stayed firebox is the weakest part of the locomotive boiler as ordinarily designed and with pressures of 250 pounds and above, a change in design is necessary to eliminate excessive trouble due to staybolt breakage. In boilers of conventional design, 240 to 250 pounds is probably the maximum pressure which can be successfully carried due to the fireboxes having flat sides braced by staybolts. With higher pressure, it is possible to build a locomotive of greater tractive effort without increasing the overall size of the unit. Higher pressure also permits taking advantage of working steam expansively by compounding, with economies in fuel and water; also with high initial pressure, locomotives can be worked "hooked up" to shorter cut-offs, which principle has been carried out to a much further degree by Mr. Kiesel of the Pennsylvania and Mr. Whitsitt of the Baltimore & Ohio with their 50 percent and 60 percent cut-off locomotives.

Increased Circulation

Under this heading, the advantages will immediately manifest themselves to all practical boiler makers. This is probably a greater factor tending to clean boilers than anything else. As between two locomotives with the same characteristics except that one has the usual type of firebox and the other a watertube type, the latter has shown a marked superiority. Careful inspection and comparison shows the watertube firebox boiler to have much less accumulation of solids or scale than the regular boiler. Clean tubes and flues mean more efficient heat conductivity with saving in fuel. The savings in increased life of tubes, flues, shell sheets, etc. are inestimable and naturally the more favorable the water, the greater the savings. The syphon firebox increases circulation and is really an intermediate design between the conventional type and the watertube firebox.

Elimination of Staybolts

Here the saving is not only in reduction of expenses due to no renewals or inspection, but also saving in time for which a locomotive is held out of service for such renewals and inspection. Surely boiler makers will welcome the omission of staybolts.

Comparison of Locomotives Having Combined Water and Firetube Boilers

Railroad	Delaware & Hudson	Baldwin Loco. Wks.	N. Y., N. H. & H.		Baltimore & Ohio	Baltimore & Ohio
Name or Number	John B. Jervis	60,000	3550 McClellon Firebox	2504, Class E-27x	*4045, Class Q-1x	2700, Class E-27y
Type of Locomotive	2-8-0	4-10-2	4-8-2	2-8-0	2-8-2	2-8-0
Year Built	1927	1926	1926	1927	1927	1928
Service	Freight	Freight	Freight	Freight	Freight	Freight
Boiler: Type	Comb. Water & Firetube	Comb. Water & Firetube	Comb. Water & Firetube	Comb. Water & Firetube	Comb. Water & Firetube	Comb. Water & Firetube
Boiler: Steam Pressure	400#	350#	265#	215#	250#	215#
Boiler: I. D. First Ring	61⅞"	81⅜"	79⅝"	73"	76⅜"	73"
Boiler: Fuel, Kind	Mixed Anthracite and Bituminous	Bituminous	Bituminous	Bituminous	Bituminous	Bituminous
Valve Gear, Type	Walschaert	Walschaert	Walschaert	Walschaert	Walschaert	Walschaert
Cylinders, Dia. & Stroke	1-22¼"x30" 1-38½"x30"	1-H.P. Inside 27" x 32" 2-L.P. Outside 27" x 32"	3-22" x 30"	2-25" x 30"	2-26½" x 32"	2-25"x30"
Tractive Power: Cylinder, Simple	85,000#		71,000#	55,300#	*64,250# e65,400#	55,300#
Tractive Power: Cylinder, Compound	70,800#	82,500#		—	—	—
Tractive Power: Auxiliary Loco.	18,000#			—	—	—
Factor of Adhesion	3.5 Simple 4.17 Comp	4.1	3.6	3.91	*3.88 e3.81	3.68
Valves, Piston Type, Size	12" and 14"	14"		12"	14"	12"
Weight on Drivers	295,000#	338,400#		216,500#	249,000#	208,000#
Weight on Front Truck	41,500#	57,500#	256,000#	25,000#	26,000#	32,000#
Weight on Trailer Truck	—	61,600#	59,000#	—	59,000#	—
Weight, Total Engine	336,500#	457,500#	59,000#	241,500#	334,000#	240,000#
Weight, Total Engine and Trailer	639,500#	700,900#	374,000#	423,000#	535,000#	440,000#
Dia. Drivers	57"	63½"	659,400#	62"	64"	62"
Dia. Front Truck	36"	33"	69"	33"	33"	33"
Dia. Trailer Truck	—	45½"		—	46"	—
Journals Dia. & Length: Driving, Main	12" x 14"	12" x 13"		10½" x 13"	12" x 13"	10½" x 13"
Journals Dia. & Length: Driving, Others	11" x 14"	11" x 13"		9½" x 13", Rear 10" x 13"	10" x 13"	9½" x 13"
Journals Dia. & Length: Front Truck	7" x 15"	7" x 12"		6" x 10"	6" x 10"	6" x 10"
Journals Dia. & Length: Trailer Truck	—	9" x 14"		—	9" x 14"	—
Wheel Base: Drivers	18'-0"	22'-10"	19'-9"	16'-8"	16'-9"	16'-8"
Wheel Base: Rigid	18'-0"	22'-10"	19'-9"	16'-8"	16'-9"	16'-8"
Wheel Base: Total Engine	29'-0"	45'-2"	42'-3"	25'-7"	35'-0"	25'-7"
Wheel Base: Total Engine and Tender	74'-11½"	86'-11¼"	85'4"	64'-2"	71'3 5/16"	64'-2"
Firebox, Length and Width	152" x 77⅝"	199½" x 96"	120" x 85"	111 5/16" x 75⅜"	126" x 84"	109" x 75¼"
Arch Tubes, Number and Diameter	6-3½"	5-3"		5-3"	5-3"	5-3"
Watertubes, Number and Diameter		100-4"		110-2½"	138-2½"	118-2½"
Tubes, Number and Diameter	101-2"	206-2¼"	33-3½"	230-2"	205-2¼"	224-2"
Flues, Number and Diameter	52-5½"	50-5½"	172-3½"	25-5½"	40-5½"	27-5½"
Length Over Tube Sheets	15'-0"	23'-0"	19'-8"	13'-4½"	16'-1¼"	16'-2¾"
Average Length, Water Tubes				4'9⅜"	5'-7"	5'2½"
Grate Area	82 Sq. Ft.	82.5 Sq. Ft.	70.8 Sq. Ft.	58.26 Sq. Ft.	73.5 Sq. Ft.	56.96 Sq. Ft.
Heating Surface Sq. Ft.: Firebox, Arch Tubes	67 Sq. Ft.	27 Sq. Ft.	27 Sq. Ft.	43 Sq. Ft.	48.6 Sq. Ft.	24 Sq. Ft.
Heating Surface Sq. Ft.: Firebox, Water Tubes	1150 Sq. Ft.	745 Sq. Ft.	431 Sq. Ft.	283 Sq. Ft.	329.2 Sq. Ft.	300.1 Sq. Ft.
Heating Surface Sq. Ft.: Firebox, Firebox				153 Sq. Ft.	175.4 Sq. Ft.	67.2 Sq. Ft.
Heating Surface Sq. Ft.: Total Firebox	1217 Sq. Ft.	772 Sq. Ft.	458 Sq. Ft.	479 Sq. Ft.	603.2 Sq. Ft.	391.3 Sq. Ft.
Heating Surface Sq. Ft.: Tubes	788 Sq. Ft	2775 Sq. Ft.	592 Sq. Ft.	1597 Sq. Ft.	1932 Sq. Ft.	1891.45 Sq. Ft.
Heating Surface Sq. Ft.: Flues	1116 Sq. Ft.	1645 Sq. Ft.	3085 Sq. Ft.	475 Sq. Ft.	922 Sq. Ft.	626.88 Sq. Ft.
Heating Surface Sq. Ft.: Total Flues and Tubes	1904 Sq. Ft.	4420 Sq. Ft.	3677 Sq. Ft.	2072 Sq. Ft.	2853.5 Sq. Ft.	2518.33 Sq. Ft.
Heating Surface Sq. Ft.: Total Evaporative	3121 Sq. Ft.	5192 Sq. Ft.	4135 Sq. Ft.	2551 Sq. Ft.	3457.2 Sq. Ft.	2909.63 Sq. Ft.
Superheating	700 Sq. Ft.	1357 Sq. Ft	1758 Sq. Ft.	367 Sq. Ft.	842 Sq. Ft.	459 Sq. Ft.
Tender, Water Capacity	16,000 Gal.	12,000 Gal.	16,000 Gal.	9,500 Gal.	12,000 Gal.	10,000 Gal.
Tender, Fuel Capacity	20 Tons	16 Tons	18 Tons	16 Tons	16 Tons	18 Tons
Cylinder Horse Power			3462	2421	*2718 e2770	2421
Boiler Capacity			83.5%	97.7%	*111% e109.6%	92.6%

* 50% Cut Off .731 of B. P. e 60% Cut Off. .745 B. P.

Increased Firebox Heating Surface

Greater evaporation can be obtained due to increased firebox heating surface, this being five times as effective as firetube heating surface, and is one of the greatest features of the watertube firebox boiler. It is an advantage to put a watertube firebox on a locomotive even though the pressure is not increased.

There are practically no washout plugs or handholds in the cab and thus no danger from leaks and blowouts. In case of water getting below the normal level, the circulation will keep water over the bottom portion of the steam drums, preventing overheating. The cylindrical steam drum will stand up longer in case of heating than the comparatively flat stayed crown sheet.

Watertube fireboxes with side headers at the top can have watertubes cleaned without entering the boiler. On those types having watertubes entering steam drums, cleaning is more difficult and takes much longer.

A direct comparison or test between two boilers, one of conventional design and the other with watertube firebox, indicated that the latter will raise 200 pounds steam pressure from water at 70 degrees F. in 85 minutes when fired with an oil burner in the shop as against three hours for the present style boiler.

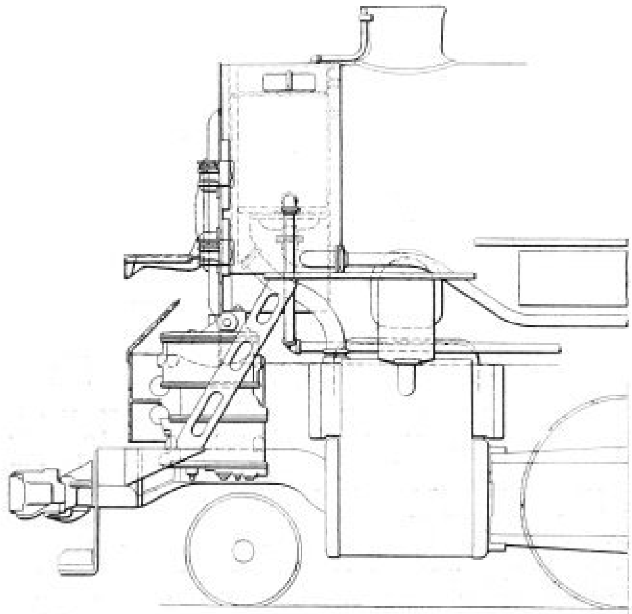
The evaporation in a watertube firebox is much higher than in the ordinary type on account of the increased firebox heating surface and more rapid circulation.

This report was prepared by a committee composed of Walter R. Hedeman, chairman; M. A. Foss and John A. Clas.

Circulating System in the Coffin Feedwater Heater

THE J. S. Coffin, Jr., Company, 36 Grand avenue Englewood, N. J., has developed a feedwater heater which combines advantages of both the open and closed types. In the illustration showing the piping arrangement, the feedwater flows into the auxiliary heater compartment *D*, either of the integral type or built-in manifold type, between the auxiliary heater casting and the tender floor. While passing through this space, it is mixed with the condensate and excess steam from the main heater on the front end.

Whether of the integral or manifold type, the auxiliary heater compartment acts as a settling tank and allows the liberated oxygen and lubricating oil to rise to the surface of the water in the vent pipe (1), where the oil remains until the tender is refilled. The oil then floats to the top of the pipe where it overflows into the

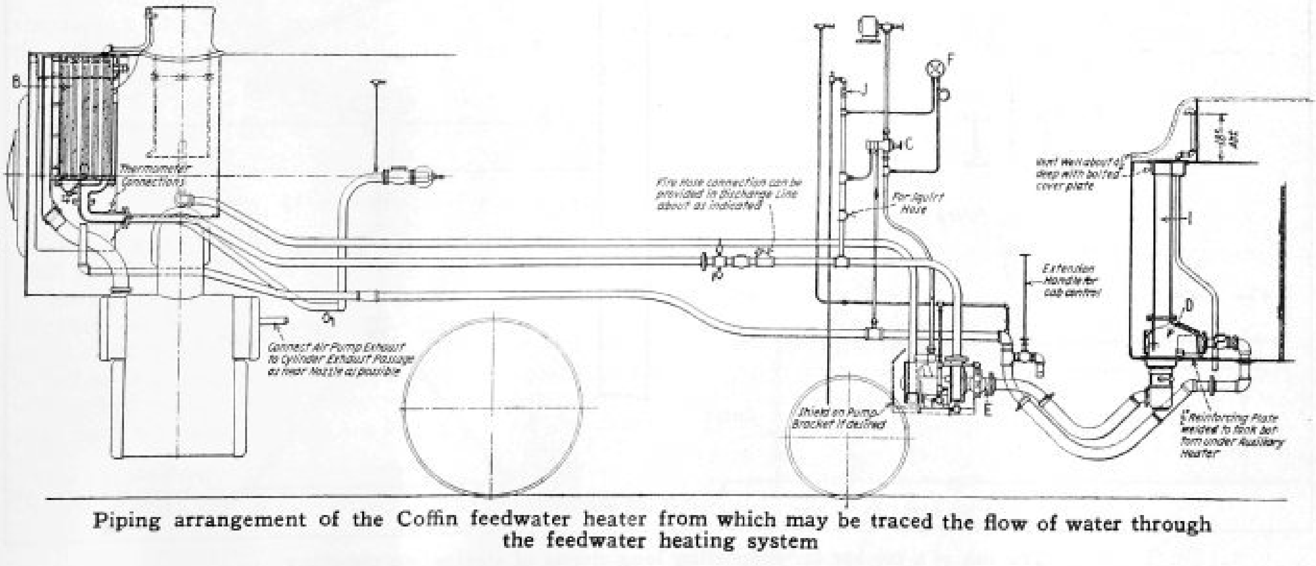


Showing the feedwater heater recessed into the smokebox

vent well, secured to the top of the tender, and then to the track through the overflow pipe. The ¾-inch vent at the top is applied to prevent syphoning. The water then flows by gravity to the pump through the suction strainer *E* and is then pumped through the main heater *B* into the boiler of the locomotive.

Just above the pump, the feed-line branch is taken off. This supplies the squirt hose and leads to the water end of the control valve *C*, the water connection of the duplex gage *F*, and the ¾-inch vertical ball check *J*. The vertical ball check is merely an inverted check which stands open when the pump is not in operation, insuring that the pump is primed at all times.

The heads of the heater *B* are arranged to cause the feedwater to pass through five groups of tubes, each group or pass having tubes approximately 10 ft. in length, making a total water travel within the heater of about 50 feet.



Piping arrangement of the Coffin feedwater heater from which may be traced the flow of water through the feedwater heating system

The first pass is farthest from the steam inlet, the second pass is toward the front, etc., and the fifth or final pass is directly adjacent to the baffle. Thus the water heats progressively toward the front and the steam flows toward the rear. The hottest water passes through the tubes surrounded by the hottest steam.

The 1¼-inch open vent pipe extending from the top of the heater up in front of the stack is to insure a positive circulation of exhaust steam toward the rear of the heater and to prevent formation of air pockets in the steam space of the heater—exactly comparable to an air valve on a household radiator.

The condensate flows by gravity down the outside walls of the tubes to the condensate connections on each side of the heater; thence back to the auxiliary heater *D* in the tender, with a certain amount of excess exhaust steam.

The steam conduits to the main heater are now integral with the heater. Since this feature has been incorporated, it is only necessary to apply a short pipe connecting the exhaust cavity of the cylinders with the heater, as the connection on the heater is considerably below the boiler center line.

A new method of mounting the heater recessed into the smokebox is shown in one of the illustrations. The heater is now made to suit any capacity and also to conform with the outside diameter of any smokebox. It can be recessed so that no part of the heater extends beyond the smokebox.

A Plate-Punching Kink

By C. G. Meyer

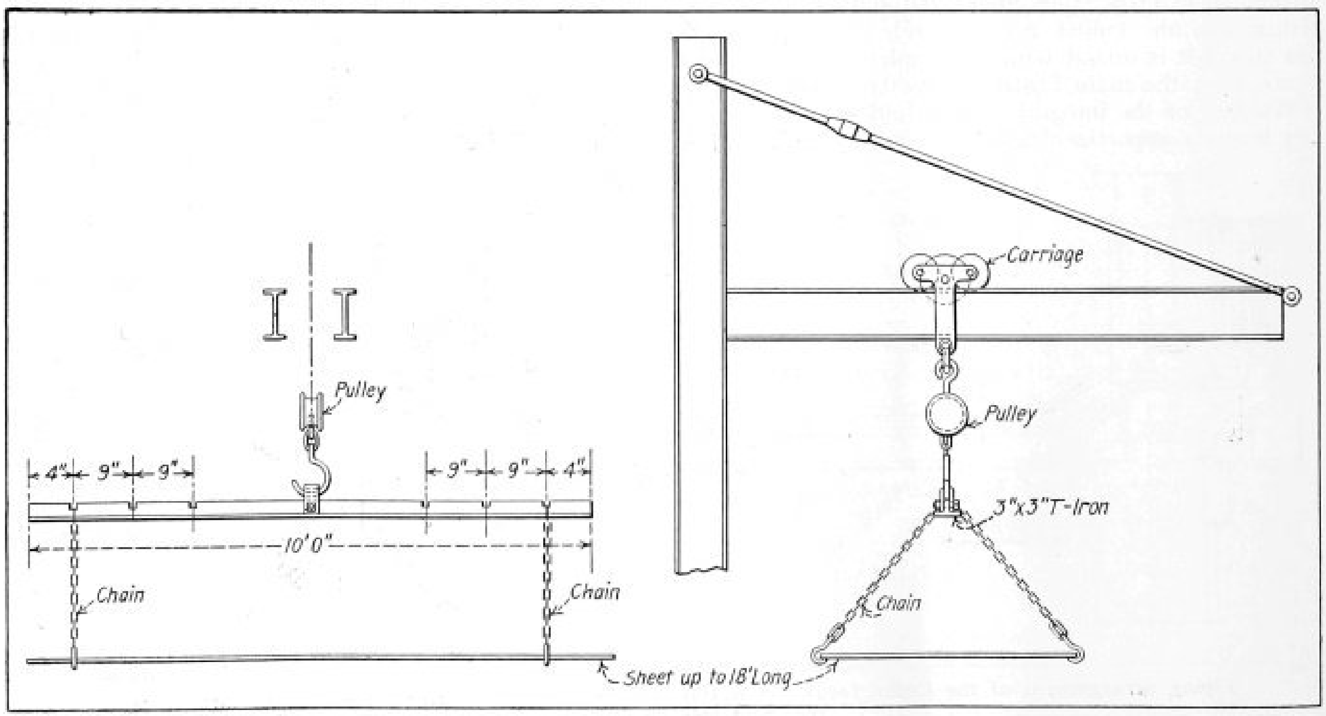
THE shop kink shown in the illustration is a device used in punching long sheets of steel. It consists of an ordinary piece of 3-inch by 3-inch by ⅜-inch tee bar with a ring attached at the center to hook on an ordinary block and tackle located above the punching machine. The tee bar is about 10 feet long and has slots cut about 4 inches from each end with two or more slots 9 inches apart to accommodate different lengths of sheets to be punched. Chains are then fastened at each end of the sheet to hold it in place on a level with the punch. By this means, it is a simple matter to locate the correct center-punch mark and assure accurate punching of material.

This kink has been in use at the Chicago, Burlington & Quincy Railroad shops at West Burlington, Ia., for several years. At these shops, prior to the adoption of this kink, it was noticed that the operation of punching long sheets, was awkward with one chain located at the center of the sheet, due to the sagging of the plates. In most cases where one chain is used, it is necessary to have an extra helper to obtain good results. With the shop kink as described, one man can punch long sheets quicker and better than before. Less material is rejected because of bad punching. The time saved by the use of this device has been as high as 50 percent in this shop alone.

Special Purpose Welding Rod

THE Fusion Welding Corporation, Chicago, Ill., has announced the development of a special-purpose welding rod, known as "Weldite Yellow Jacket." This new product is a mild-steel electrode of high quality. Compared to the ordinary bare mild-steel rod, it is said to give 25 to 50 percent more penetration, 15 to 30 percent more tensile strength and 10 to 20 percent more ductility.

The International Oxygen Company, Newark, N. J., has taken over the business of the Tariffville Oxygen & Chemical Company, Tariffville, Conn. This plant will be conducted by a newly-formed company, the Tariffville Oxygen Company, as the New England division of the International Oxygen Company. The Tariffville Oxygen Company will manufacture oxygen, hydrogen and acetylene and handle, in addition, the other products of the International Oxygen Company.



The use of a tee-bar for supporting long sheets of steel when punching

Locomotive Boiler Construction—III *

Assembling and riveting the first ring and smokebox—Laying out the remaining rings

By W. E. Joynes†

TO form and assemble the welt strips, the inside-welt strips are rolled to the correct radius for bolting firmly to the boiler shell. Outside-welt strips are too narrow to run through a plate-rolling machine; they are pressed to fit the shell, in a die, by means of a hydraulic flanging press.

When the rolling of a cylinder course with non-welded ends has been completed, the inside and outside-welt strips are bolted in place before the ring is removed from the rolls. If the ring is to be welded, on one or both ends, it is removed from the rolls to the floor for the welding operation, after which the welt strips are bolted in place for re-drilling the seam rivet holes.

Assembling and Riveting the First Ring and Smokebox Course

With the ring lying in a horizontal position, the longitudinal-seam rivet holes are re-drilled with radial type drilling machines to the correct diameter for driving the rivets. The machines are high in design, for reaching the seam rivet holes at the top of the ring. Two of these machines are usually mounted along one side of a floor pit. The bottom of the pit has adjustable saddle supports fitted with two or more sizes of removable rollers. These are used for turning a ring to the correct radial drilling position when re-drilling the various rows of rivet holes along the seam.

All of the seam rivet holes having been re-drilled, the ring is removed to the assembling floor.

The welt strips are removed from the ring for grinding the burrs from the contact surfaces of the shell and the welts, after which the welt strips are again applied to the ring and bolted firmly for riveting. The edges of all rivet holes under the rivet heads should be chamfered to 1/16-inch radius. This removes the burrs and assures a tight rivet when driven.

The waist sheet and guide-yoke angle irons are bent in a former having the same or approximately the same radius as the boiler-shell or outside-shell liner.

The rivet holes are located in the angles by marking them on a thin metal template from the rivet holes in the shell and then center punching the location from the template onto the angle iron. The holes are then punched; the angle is heated to a good red bending heat, applied to the shell with bolts and hammered to fit the shell closely when the bolts are tightened.

Angle Irons Riveted to Liner Only

One edge of the liner is bolted to the end of the shell to which it is to be riveted. This allows the liner to project beyond and conform to the same radius as the shell for fitting the angle closely to the liner. The angle rivet holes are reamed. The liner with the angle bolted to it is then removed from the shell and riveted with a hydraulic riveter. The rivet holes are countersunk and the heads calked on the inside of the liner.

Angles, liners, longitudinal brace feet, dry-pipe support angles, and any other details or attachments that are to be riveted to the shell, are now bolted to the shell and reamed to the correct diameter for riveting.

Riveting the First or Front Ring

The longitudinal-seam welt strips, brace feet, liners, angles, etc., having been bolted firmly in place, the shell is raised by the crane to the top of the hydraulic bull riveter and then lowered and turned, as required, between the riveting dies for each rivet location. In riveting longitudinal or circumferential seams, domes, liners, angles, etc., the rivets are not driven in consecutive order. Several holes or rivet spaces are skipped and followed up later when the seam, dome or attachment has been tack-riveted for removing the holding bolts. This procedure will assure a good riveted job by distributing the strain of the rivet-driving pressure and holding power of the rivets. The outside-welt strip, dome base and all calking edges are "laid up" with a flat die after the tack riveting has been done. The term "laid up" means to press the edge of the welt strip, dome base, etc., against the shell with the pressure of the riveter.

When all the rivets have been driven, the shell is ready for applying the front tube sheet and the smokebox shell. If the smokebox circumferential seam has a joint ring between the two shells, it is more practicable in providing for riveter die clearance to assemble the smokebox after the front tube sheet has been riveted in place.

The ring is placed in an upright position on its back end; the tube sheet is raised with the crane and lowered at an angle far enough for a rivet hole in the tube sheet flange to come in line with the corresponding rivet hole in the shell. A drift pin is then driven in to hold the position of the parts. The tube sheet is rammed evenly into place and lined up with a number of drift pins and bolted. The fit should be snug. Little difficulty is experienced, as a rule, in this application.

The smokebox course is usually designed with a longitudinal seam at the top center. It is easily applied over the first ring by loosening the bolts at the back end of the seam until the ring is fitted in place.

The first course and the smokebox are now assembled for reaming and riveting the tube-sheet and circumferential-seam connection. The smokebox longitudinal seam at the top, the solid iron stiffening and front connection ring at the front end, and the smokebox liner at the bottom of the smokebox shell are riveted. This completes the assembly and all the riveting required for these two courses.

Layout of Remaining Rings

In order to maintain the scheduled boiler output, the second, third and additional rings should be ready at this time for assembling and riveting together. Also, the plates comprising the back or firebox end of the boiler should have been laid out, rolled or flanged, fitted up, and otherwise made ready for assembling and riveting the front end to the back end.

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* The first instalment of this series appeared on page 218 of the August issue, and the second on page 253 of the September issue.

† Boiler designing department, American Locomotive Company, Schenectady, N. Y.

The instructions for laying out, machining, etc., of the remaining rings of the boiler and also other rings, which differ materially in design from these, will follow. The laying out, flanging and machine work for all the back-end plates will be described before the boiler assembly, riveting and the like are continued.

make the front diameter of the boiler barrel considerably smaller than the diameter at the firebox end. A conical-shaped course therefore is necessary for joining a larger shell.

The frustum-of-a-cone course is commonly referred to as a "gusset" or a "conical connection." A descrip-

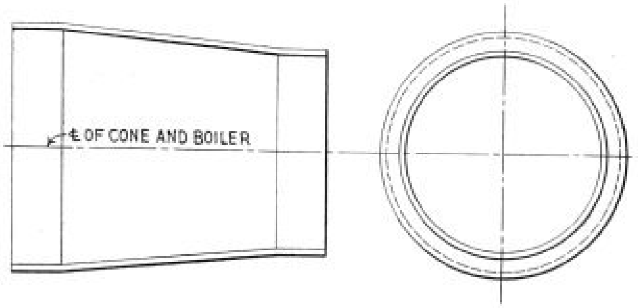


Fig. 8.—True or right cone

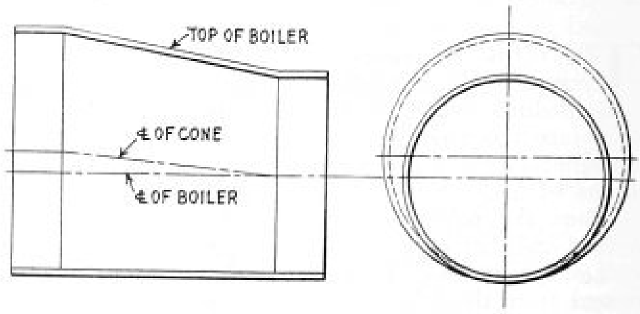


Fig. 9.—Oblique cone—horizontal bottom

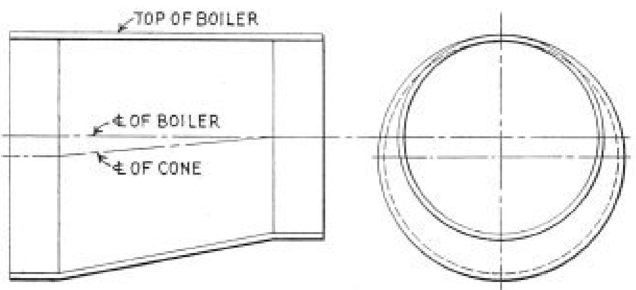


Fig. 10.—Oblique cone—horizontal top

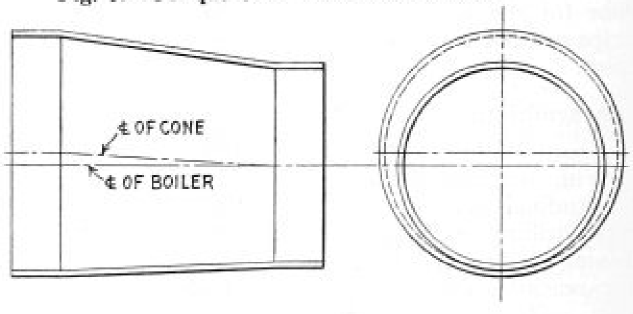


Fig. 11.—Oblique or irregular cone

In the laying out and manufacturing operations for the plates and details that are to follow, only such instructions that differ materially from the information already given will be presented. It is not the writer's intention to eliminate any essential information, but rather to avoid repeating the instructions except where they seems necessary to refresh the reader's memory or to make the subject, as a whole, more clear and understandable.

Laying Out Cone-Shaped Courses

The application of a conical course, instead of a cylindrical course, as part of the boiler barrel, is usually brought about by the necessity of distributing the engine weight. This distribution often requires the reduction of the front-end weight of the boiler.

This weight reduction often causes the front tube sheet to be of such diameter as required for the tubes and dry pipe only. The foregoing features usually

tion, with outline sketches, of the several types of conical courses used in locomotive boiler construction is given in the following paragraphs.

A true or right cone is a cone having a straight horizontal center line and concentric diameters, as shown in Fig. 8.

An oblique cone with a horizontal bottom or top having a sloping center line with the two extreme diameters in a horizontal plane at the top or bottom of the boiler, is shown in Figs. 9 and 10.

An oblique or irregular cone, with a sloping center line and the surface between bend line tapering all around is shown in Fig. 11.

The second ring of the boiler is often of a cone design. The type of cone most commonly used is the oblique cone with a horizontal bottom. The instructions and drawings, for laying out this and other types of cones from the development plate drawings, follow.

Fig. 12 shows the plate layout for the horizontal bottom "gusset" course shown in Fig. 9, with the seam

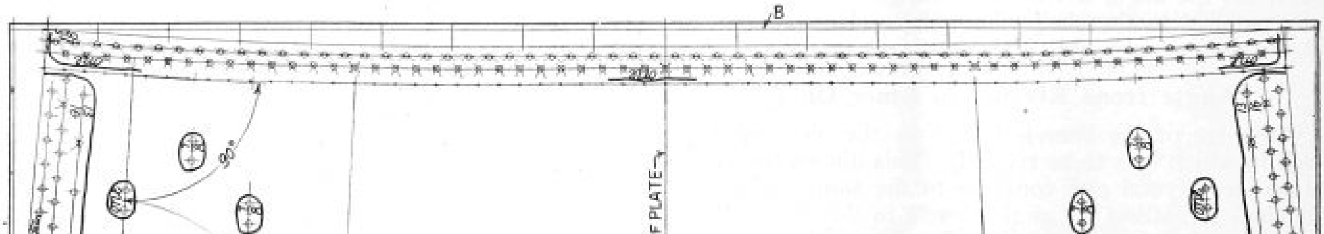


Fig. 12.—Cone course layout—horizontal bottom type. Pattern plate

on the top center. Fig. 13 is the developed plate drawing.

Draw a straight line *A* at the back end of the plate. The distance from the edge of the plate to the line should equal the largest set dimension plus 1/4 inch for shearing.

The outline set with the largest dimension is at the center line of the plate for a horizontal bottom cone, with the longitudinal seam on the *top* center, and at the plate center for any radial location of the seam for a right cone. When the seam is not on the top center of a horizontal bottom cone, the largest set dimension will *not* be at the center of the plate.

Erect a right-angle line at the plate center and then draw the line *B* at the front end of the plate. Line *B* is parallel with line *A* when the longitudinal seam is on the *top* center of a horizontal bottom cone. When the seam is not on the top center, line *B* will *not* be parrallel with line *A*. However, the difference found is usually so small that the two lines *A* and *B* are made parallel to simplify the layout work. In extreme cases (which seldom occur), the circumferential length of the plate at the front end, at either side of the plate center, is unequal to such an extent that the triangles formed by the sloping ends of the plate will amount to 1/16 inch difference in the two longitudinal end lengths. Then the set base line *B* should *not* be made parallel to base line *A* but should be of such distance apart at the incorrect-length end as to make the longitudinal length of the seam *equal* at both end of the plate. Fig. 14 is the development of a horizontal bottom cone, with the seam off center and with the base lines *A* and *B* *not* parallel.

The outline sets, front and back ends, are next measured on the 12-inch ordinate spaces as shown. A batten (wooden strip) is bent to touch the measured set points and held in place while the outline is drawn in.

The circumferential seam rivet lines and the bend lines are then measured and drawn in with the batten.

The dimensions shown on the bend or developing lines should now be checked with a measuring wheel. Lines for the right and left center lines and the ends of the plate should be drawn. If the measured points, wheeled on the bend lines, intersect the plate end line, which has been drawn in from the outline dimensions intersecting at the base lines *A* and *B* the plate development drawing dimensions check and the layout of the plate is correct.

Following the same method of manufacture as a cylindrical course, the rivet holes of circumferential seams and all other rivet holes, plug holes, etc., are

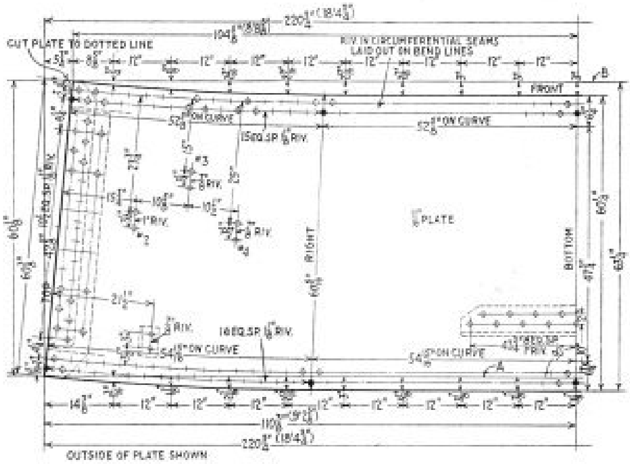


Fig. 13.—Cone course development—horizontal bottom type. Longitudinal seam on the top center

drilled in the flat plate before it is rolled into shape. However, the circumferential-seam rivet holes are not spaced off on the rivet lines as shown on the plate development drawing, but are spaced on the bend line and bisected from these spaces onto the rivet lines as shown on the plate layout, Fig. 12.

Waist-sheet and guide-yoke-angle rivets and reinforcing-liner rivet holes are laid out parallel to the seam-rivet lines, when they are shown on the boiler drawing at right angles to the boiler center line or parallel with the circumferential seam. This is the regular practice in applying these angles and liners to the boiler.

Dimensions locating the longitudinal brace-feet rivet holes, from the top or side center lines of the ring, should be measured central between the holes. The longitudinal center line for the holes should be drawn from points squared from and onto the front and back bend lines, from a central point between the rivet holes as shown.

The rivet holes for the longitudinal seam are laid out by the same method as given for a cylindrical

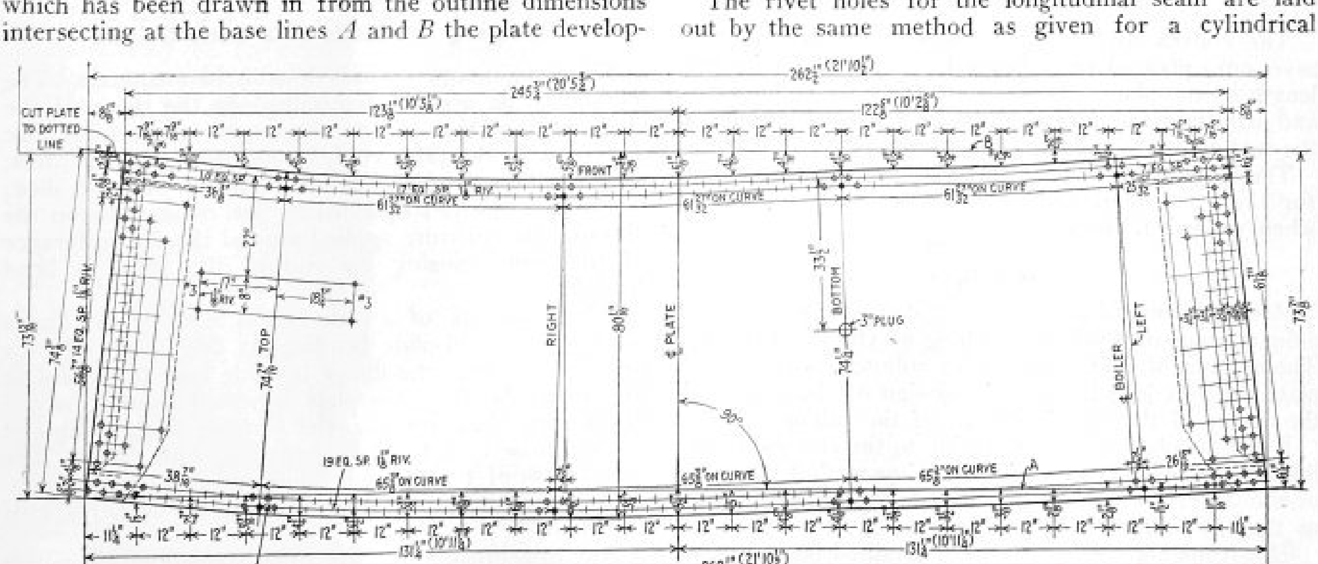


Fig. 14.—Cone course development—horizontal bottom type—Longitudinal seam off center and base lines A and B not parallel

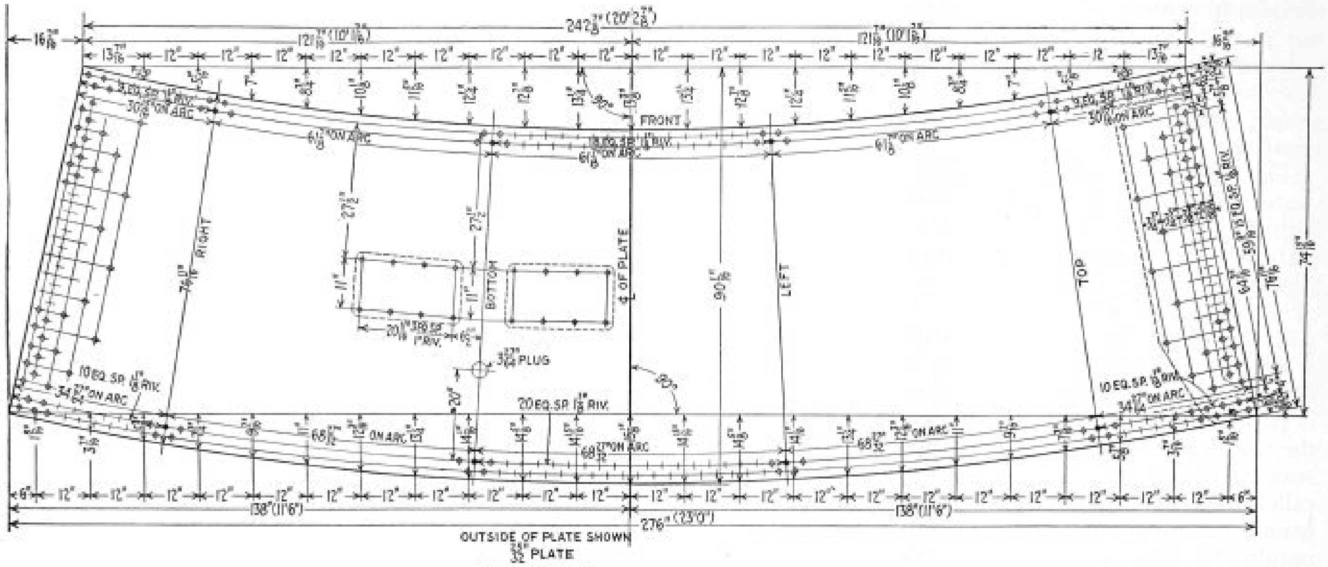


Fig. 15.—True cone development

course. This is done by divider spacing, bisecting, and transferring the spacings with a metal strip. When duplicate plates are required, this plate is used as a pattern plate. Tack holes are punched in the pattern plate and the duplicate plates; these are bolted together and drilled. The finish outline of the cone pattern plate is prick punched all around the plate. The plate is then trimmed for marking off the outline of duplicate plates.

Trimming the Plate Edges

The back or convex edge of the plate is sheared off. The concave or front edge is removed with a cutting-off punch. Enough stock should be retained for planing a finished edge.

A cutting-off punch has parallel sides with semi-circular ends and is used for cutting off the concave edges of plates having a thickness not exceeding ¾ inch. To prevent overstressing the punching capacity of the machine a round punch is used for plates exceeding ¾ inch in thickness.

Planing

The convex and concave edges are planed with a bevel on a plate planer. Several cuts are made for the length of the plate. This is done by shifting the plate and adjusting the cutting tool to the curved outline as the tool moves along the edge of the plate.

The longitudinal edges of the plate are planed straight for the seam joint and beveled for the weld length, when welded at the ends.

Rolling

Rolling a cone of any type is, of course, a much more difficult piece of work than rolling a cylindrical course. The amount of time required for rolling a cone-shaped plate depends largely upon the design of the cone and the ability of the man in charge of the rolling.

It will be observed, by referring to the elevation outline of the several types of cones shown, that the ends of the cones are flanged cylindrical for the application of the adjoining courses.

The triangular pieces of plate, retained between the bend line and the front end of the plate, fills in what would be an open space on a horizontal bottom cone, after the cylindrical end had been flanged. Similar triangular pieces are removed from the edges at the back end of the plate, to allow the ends to butt together for the seam joint.

The opening or spreading apart of the seam joint at the front, and the closing together of the seam joint at the back end of the plate is caused by flanging the ends of the plate straight and cylindrical. This has a greater spreading and closing effect in the horizontal bottom type of cone. The nearer a cone design approaches a true cone shape, the more the spreading and closing effect of the longitudinal seam joint will diminish. In actual practice the triangular end pieces at the front, are retained for the horizontal bottom type of cone only. In other types of cones, the spreading apart of the front end of the plate serves partly as a groove for adding the welding material, if the end of the seam is to be welded.

When the plate has been rolled, the ends are butted together by lapping one triangular piece above the other. Tie straps bolted through the seam rivet holes keep the seam joint closed for flanging the ends. The welt strips are then bolted in place.

Flanging the Ends of a Cone Course

This flanging operation is done by two methods. The method to be used is determined by the taper of the cone. Cones that do not have too much taper are flanged with the plate cold, by means of the hydraulic riveter. The riveting dies are replaced with flat dies; the rolled cone is suspended by the crane between the dies and the pressure applied around the circumference of the cone, causing the end of the plate to bend straight.

When the tape of a cone is too steep or the flange too long for cold-plate bending, as the front end of a first course where the flange is made long for receiving the front tube sheet, the plate is heated around the end in an open blast fire to a red bending heat. The end is then made cylindrical by pounding with mauls. The correctness of the flanged diameter is checked by running a measuring wheel around the inside surface of the plate.

Any attachments that are to be riveted to the course can now be fitted and assembled for riveting.

Fig. 15 is the developed plate drawing of a true cone. The circumferential-seam rivet holes are laid out on the rivet lines as shown and not on the development or bend line as is done for oblique cones. Also, note that the triangular end pieces are omitted.

The base lines *A* and *B* are always parallel and the plate center line at right angles to both base lines. The largest set dimension is at the plate center. Notice that the longitudinal seam is not on a center line. The longitudinal seam location for right cones does not affect the outline dimensions unless the direction of the seam center line is *not* radial to the cone development.

(To be continued)

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, 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 and published.

Below are given records of the interpretations of the committee in Cases Nos. 576, 595, 598 (Reopened), and 599-602, inclusive, as formulated at the meeting on June 15, 1928, all having been approved by the council. In accordance with established practice, names of inquirers have been omitted.

CASE No. 576—*Inquiry*: Will the electric-resistance butt-welding method be acceptable under the provisions of the Boiler Code?

Reply: It is the opinion of the committee that welding done by the electric-resistance butt method under pressure may be considered the equivalent of forge welding, as provided for in Par. P-186.

Note: It was the opinion of the committee that a higher working stress may be allowable than that specified for forge welding, and a special committee was therefore appointed to submit recommendations for a revision of the code in this respect.

CASE No. 595—*Inquiry*: Will it meet the requirements of the Code for Low-Pressure Heating Boilers to insert staybolts in welded steel heating boilers that consist of ¾-inch button-head rivets, the head end of the rivet to be on the outer surface of the water leg and welded around the periphery of the head, while the inner end of the rivet is welded to the furnace sheet as provided for in Par. H-83?

Reply: If the button-head end of the rivet which is attached by welding is welded in accordance with the requirements of the code, the construction will conform to the requirements of the code.

CASE No. 598 (REOPENED)—*Inquiry*: Will it be permissible, under the rules of the Power Boiler Section of the code, to use for cleanout openings a special type of plug which fits into a thimble or nipple threaded into the water leg, instead of the usual form of threaded opening with pipe plug as referred to in Pars. P-266 and P-267? It is pointed out that with this construction there is no danger of crossing threads in inserting the plugs and that the tightness is dependent upon seating surfaces rather than tapering threads.

Reply: There is nothing in the code to prevent the use of the type of plug described, provided it will meet the requirements of the code where reference is made therein to such plugs.

CASE No. 599—*Inquiry*: Does the requirement in Par. P-328 for safety latches or fastening devices apply to the firing doors of watertube boilers which are equipped with down-draft furnaces of the water-grate type?

Reply: While Par. P-328 of the code is specific in regard to firing doors for watertube boilers, in this case the boiler would be inoperative unless the firing door were open. The committee recommends, therefore, that some form of door be used that is capable of being retained with a substantial and effective latching or fastening device, or that a type of door be used which will admit air yet will prevent the gases from the furnace from being blown directly outward in case of pressure within.

CASE No. 600—*Inquiry*: Is Par. P-301 of the code intended to prohibit the use of a shut-off valve between the outlet of a boiler and its superheater when the latter is used on a boiler of the portable type? It is pointed out that on a steam-shovel installation, without such a shut-off valve, it will be necessary to shut down the boiler in case of a gasket leak between the superheater and the throttle valve.

Reply: It is the intent of Par. P-301 to allow the superheater connection to be operated without a stop valve, but it was not intended to prevent the application of the stop valve in this connection if so desired. It is allowable to use a stop valve in this connection provided the full safety-valve capacity required is installed on the boiler and no credit is taken for the capacity of the required safety valve or valves on the superheater.

CASE No. 601—*Inquiry*: Is it the intent of Par. U-3 of the code that lifting devices must be attached to all safety or relief valves? Attention is called to the fact that it is not customary to equip water-relief valves with lifting devices and Pars. H-50 and H-103 of the Heating Boiler Code state specifically that such lifting devices are not required for hot-water relief valves.

Reply: Par. U-3 was formulated with special reference to requirements for relieving pressure of air or other gases that are not noxious, and it is the opinion of the committee that it need not be applied to relief valves for use on connections to water-pressure vessels. A revision of the code in this respect is contemplated.

CASE No. 602—*Inquiry*: Is it permissible to use a constant of 135 in the formula given in Par. H-21 of the code for ordinary staybolts welded into plates forming the water leg of a boiler? It is pointed out that these staybolts do not exceed 6 feet in length.

Reply: In the recent revision of the definition of the constant 135 in Par. H-21, it was the intent that welded stays computed with this constant should be of a length between supports in excess of 120 diameters. A further revision of this paragraph to incorporate this limit is under consideration.

Relationship of the Boiler Manufacturer with the National Board*

By George W. Bach†

THE relationship of the manufacturer to the inspector is one that can be defined in many ways, and in order to get the proper slant on this matter, I put the question before the American Boiler Manufacturers' Association in convention recently, and have the reaction of most of the members, so what I am about to tell you is not only my own view, but a composite view of most of the boiler manufacturers of the country.

Inspection Conditions in the Old Days

We all recall, and not so long ago, when manufacturers in general looked on inspectors coming into their shops with some fear and apprehension, because the inspector was supposed to come for the purpose of finding fault, causing a lot of trouble, and finally rejecting certain work. For that reason the inspector was not at all welcome and in some shops no doubt certain preparations were made for his coming.

On the other hand, the average inspector went into a shop for the specific purpose of finding as much trouble as possible, justly or unjustly, as he felt that this was necessary to hold his job. Many inspectors in those days and some today are laboring under the erroneous impression that their jobs depend on their finding defects in workmanship and material and in violation of design codes, in order to hold their jobs. In some instances, no doubt, the shop tried to put something over on the inspector, but more often the inspector tried to put something over on the shop, with the result that both parties suffered.

This state of affairs was due largely to a lack of understanding between the inspection departments of the various insurance companies, the state inspectors and the manufacturer. This misunderstanding has happily been eliminated by getting together with the people in charge of the inspection departments in private conferences and in meetings of this kind.

As Shakespeare once said, "You cannot hate a man you know," and we have a lot of misunderstandings between the human elements that are all wiped out on closer contact and better social communication between the men in charge.

Inspectors Welcome Today

Today we not only welcome the shop inspector or the man who inspects our boilers in the field, but most manufacturers have a qualified shop inspector from one of the reputable insurance companies in their shops, who is not dependent on either the superintendent or the manager for his job. It is his duty to pass on the material and workmanship, as well as on the adherence to the various laws governing boiler construction. Many manufacturers pay considerable money every year for shop inspection, and their instructions to the inspector are usually to the effect that they expect him to adhere rigidly and without fear or favor to certain standards of workmanship and material as prescribed under the laws, and in keeping with good shop practices. Under no circumstances shall he pass any work that is not up to standard.

We ourselves frequently instruct our shop inspector that the symbol of his company on the boiler does not mean much to us, but the reason for his presence in our shop is to give us qualified neutral shop inspection. His job is not dependent on the superintendent or on the management, and he is responsible for the defects that may develop in the field after the boiler is put in service. For that reason we want rigid inspection without fear or favor. His stamp of approval is not particularly a stamp of quality but it merely holds him responsible for any inspection which, if it is wrong, may mean his job with his company.

In many shops the service rendered by these men is so satisfactory that the inspector stays in one shop for many years, in spite of other changes that may occur in the shop management. That is advantageous, because once an inspector gets familiar with your shop practices and routine, it is desirable to keep the same man on the job if he is fair and all parties are satisfied. Frequent changes in shop inspectors tend to upset certain standards of inspection and react unfavorably on those in the shop and possibly on those in the field.

Co-operation in Shop Inspections

Shop inspection of this kind with proper co-operation between the shop management and the inspector cannot help but be constructive in its results and productive of good, not only to the manufacturer but also to the user. In addition the public is protected by the elimination of explosion hazards, since these men understand from long years of field experience what to look for in the way of shop or workmanship defects that lead to trouble with boilers in service in the field.

A boiler built in a shop today with proper facilities to do the work right, and with an organization trained on a conscientious quality policy, inspected in the aforementioned manner, is as nearly perfect as it is humanly possible to make any piece of equipment today. No doubt we are all benefited by having better and safer boilers and pressure vessels on that account.

State Inspection Departments

Supplementing this inspection service further, the various state inspection departments, who in a measure check on the private inspection service and who gets copies of all data reports showing the material, design, and testing of boilers and pressure vessels, have their records, which enable them to check on the data furnished, any violation of the code or state laws or rules governing in their particular section or city. This affords a double protection to the manufacturer, the user and the public.

Taking up specifically the functions of the National Board of Boiler and Pressure Vessel Inspectors, I must go into the history of the formation of your organization. We all recall the difficulties we had in stamping boilers for the various states and municipalities, which required a separate stamp in addition to the A. S. M. E. stamp, where the code symbol was not sufficient under

* Address before the sixth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.
† General manager, Union Iron Works, Erie, Pa.

their laws. Many boilers had a profusion of stamps and data affixed to them, which caused errors and were difficult to find in the field. This was particularly true of boilers of the portable type that were frequently taken from one state to another, and many boilers in this service were rejected for one reason or another, causing a hardship and unnecessary expense to the owners of such boilers.

I recall at some of the meetings of the American Boiler Manufacturers' Association, about eight or ten years ago, discussions on this point with a view of finding a remedy, and it was suggested that if we could get all of the states and municipalities to accept the A. S. M. E. symbol without reservation that would be the ideal ararngement. However, in view of the fact that most states had accepted the code and its amendments with certain reservations of their own, this was not possible, and the logical solution was to have a National Board of Boiler and Pressure Vessel Inspectors with one stamp or a unified control, so that any boiler accepted by such an inspector would pass any other state or district where such an inspector was in authority.

I believe your present secretary Mr. Myers, who has attended many of our boiler manufacturers' meetings, and whose wise counsel and advice we always welcome, took part in this discussion of simplifying stamping. It is my opinion that this was the inception of your organization, as Mr. Myers got busy and by a lot of hard work and effort, with co-operation from others, was able to found your splendid organization.

Work of National Board

The work done by the boiler and pressure vessel inspectors has been of tremendous importance and good both to the boiler manufacturer and to the user, simplifying as it does, certain shop standards and methods of stamping boilers.

Suggestions for Improving Inspections

Occasionally there seems to be in the minds of certain inspectors a tendency to feel that their work is the more important. We notice this particularly in field inspections by competing insurance companies' field inspectors or assistant state inspectors or city inspectors going over boilers that have been inspected in the shop by an insurance inspector. This leads to the point where certain over-zealous inspectors feel it necessary to find something wrong with a boiler in order to get something on the shop inspector. This frequently causes misinterpretation of rules and differences of opinion. This is one phase of inspection work where you men as chief inspectors can further improve matters by having your field inspectors or assistants understand that they are not holding their jobs for the sole purpose of finding fault, and that their work should be of a constructive character rather than destructive.

It is obvious that it is not necessary to discredit the work of the state inspector or the insurance inspector by either of the other inspectors to justify their respective positions. Any inspection department laboring under the impression that its position or very existence depends on finding fault with the other inspection service is of course based on the wrong premises, and proper corrections should be made in such a department.

The speaker makes this statement from actual experience, having in a number of cases been, with other manufacturers, the innocent victim of this practice, which reacted unfavorably to both inspection departments and created an element of doubt in the minds of boiler users, who become a party to such a controversy, and usually form their own opinions as to the merits of the case. The speaker recalls an instance where a certain young, ambitious assistant state inspector told the writer that he had found 190 violations on one boiler that had been inspected and passed in shop test by a qualified insurance inspector, and while this boiler was not of the speaker's company's manufacture, I am sure this over-zealous young inspector was wrong, as it seems impossible to get that many violations on one boiler.

Rigid Examination Requirements

We must bear in mind the fact that the inspectors for both the state and the insurance companies are usually well-trained men, who have to pass rigid examinations with their companies and later on with respective states and municipalities, further proving their qualifications. When you issue a certificate of competency to such a man it is accepted as such by boiler users.

The members of the National Board are given a great deal of authority, which of course carries with it large responsibilities to their department and the public, as well as to the boiler manufacturer. This should be carried on down to their assistants, who should be made to realize that their duties are not to find fault but to work along constructive lines. If errors or defects are found, they should be taken up in the proper manner for correction or rejection, in such a way as to cause the user and the manufacturer as little hardship as possible. There is no getting away from the fact that in spite of the most rigid shop inspection and the best efforts on the part of the manufacturer to produce a strictly first-class job, occasionally something gets by that is not up to standard, and is caught in the field. In such a case there should be a co-operative spirit between the inspection department and the manufacturer that will avoid making a mountain out of a mole hill, as is frequently the case.

The speaker cannot refrain from taking this opportunity to also plead for better co-operation between the various state inspection departments direct. I do not know the politics of the situation, but occasionally the manufacturer finds a certain state inspector that seems to be looking for something on another fellow in his organization. This of course leads to the destruction of the morale in your own organization and is bound to react unfavorably on your work and the efficient results you should get.

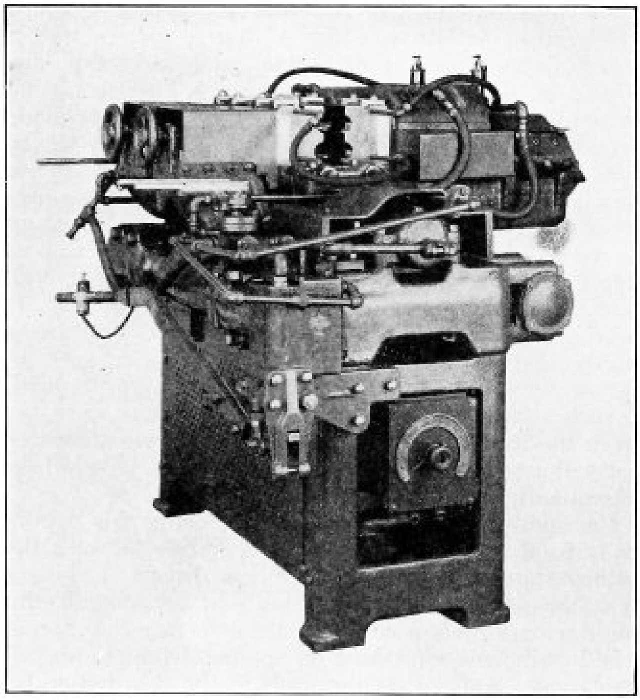
Conclusion

In concluding, allow me to say on behalf of the American Boiler Manufacturers' Association, whom it is my privilege to represent at your convention by authority given me through our president's office and at your invitation, that we as manufacturers are fully in accord with the objects and motives of the National Board of Boiler and Pressure Vessel Inspectors. We realize that the Board's stamp has greatly simplified matters and effected a real saving to the boiler users. The cordial relationship that exists between the manufacturer and your association as a whole is greatly appreciated by the manufacturers, and you may rest assured that we welcome your authority and constructive criticism at all times, and feel that the proper co-operation between your organization and the manufacturer will lead to better and safer boilers and pressure vessels, and will enable us to render a greater service to the public and the boiler users in general.

Redesigned Electric Flue Welder

THE Thomson Electric Welding Company, Lynn, Mass., has placed on the market an electric welder equipped to weld flues from 2 inches up to 6 inches in diameter. The frame is of a new design of the side-rail type, having the sliding or moving plates bolted directly to the side rails. The side rails are circular in section and have their bearings at the extreme right and left ends of the frame, thus removing them from the danger of becoming pitted or burned by flash or dirt. The bearings are also amply protected by sheet metal guards, wipers, etc. They are bushed with a standard bronze bushing which may be easily replaced when necessary.

The transformer of 150 kilovolt-ampere capacity is wound for operation on any standard voltage 60-cycle, single-phase, alternating current. The operating control of the primary circuit is obtained through a push button conveniently mounted and connected to the operating coil



The Thomson Model 55 electric flue welder

of the power line solenoid switch. The secondary of this transformer is of cast copper and water-cooled, the water being conducted through seamless steel tubing cast integral with the secondary coil. The core of the transformer is of the double window shell type. The inherent design of such a transformer, together with the application of a special protection, is such as to give maximum protection against flash or dirt occurring from the making of the weld.

The clamps are air operated and of the horizontal type. The clamp bracket itself is made of a high-grade malleable iron or cast steel. The clamp sides are also made of cast steel. There is no sliding surface electrical contact. The current is carried from the terminal blocks of the transformer to the die blocks of the clamp directly by a patented flexible lead construction. This feature does away with loss of power. All of the steel-to-iron, or steel-to-steel sliding surfaces on the clamps are amply protected from flash or dirt by suitable guards. The Alemite oiling system is used throughout. The valves for controlling the air supply to the clamp cylinders are conveniently located for the operator at the front of the welder. The die blocks are adjustable in and out for obtaining accurate alinement of the flues, and the clamp is so designed as to obtain, under all normal conditions, ample clamping pressure for preventing the slipping of the flues in the clamps.

The dies are made of cast copper and water-cooled. They are 9 inches long by 3¾ inches thick by 7 inches high. This length insures sufficient support for maintaining the flues in accurate alinement. The dies are also relieved in their center portion to obtain a higher unit clamping pressure on the flues, which is an aid in preventing slipping between the flues and dies.

The pressure device is of the hand-operated, oil-jack type consisting of a pressure cylinder actuated by a hand-operated oil pump. The complete unit is mounted on the frame of the welder. This unit will produce a total pressure of approximately nine tons on the ram of the pressure cylinder. This type of device does away with the necessity of accumulator service and also permits very fine and accurate control on the part of the operator in the flashing speed and unsetting pressure of the machine.

The following current consumption readings are an average obtained from several railroads using this flue welding equipment: On 2-inch diameter flues, the maximum demand showed 60 kilovolt-amperes with a power factor of 75 percent; on 5½-inch diameter flues, the maximum demand was 144 kilovolt-amperes with a power factor varying from 65 percent to 75 percent.

Suggested Improvement in Boiler Designs

By G. P. Blackall

IN his annual report for 1927, C. E. Stromeyer, the chief engineer of the Manchester Steam Users' Association in England, has thought it desirable, in view of his retirement from that office after 30 years' service, to summarize his views on possible improvements in boiler design which, though he has not recorded them, have been the mainspring of the researches with which he has been associated.

Mr. Stromeyer presents his views as being extreme possibilities and therefore to be handled with caution, but he is convinced that if looked upon as possibilities they will step by step effect an improvement in boiler design. They may also, he says, help the inspectors to a broader view than exists about boilers by formulating the views held by some engineers which he strongly endorses, that increased thickness may in some cases mean decreased strength. The explanation of this apparent paradox is that, whereas stresses due directly to pressure are decreased by increasing thicknesses, stresses due to deformations increase rapidly as thicknesses are increased. The tendency to remedy defects by increasing thicknesses may therefore do harm, especially when now, owing to increased pressures, excessive thicknesses are resorted to.

Fatigue of Metals

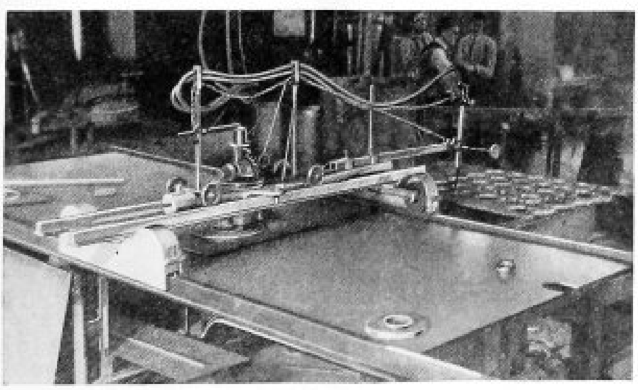
Mr. Stromeyer's leading idea is that the experimental study of the fatigue of metals is in effect a study of their plastic properties or toughness, and that toughness, which till recently was looked upon merely as a valuable safeguarding property of mild steel, can, thanks to fatigue research, be treated as the principal resisting quality of mild steel. He hopes that insistence on the fact that boilers are subjected to plastic stresses and that these are not dangerous will lead to mathematicians taking in hand the long delayed study of such stresses. He also hopes that long before such a study is completed boiler makers will have the courage and initiative to design their boilers with the deliberate intention of relying on plastic stresses for the necessary strength.

All parts of a boiler cannot be reduced equally in thickness and it would certainly not be desirable merely to work boilers at double or three times their present pressure and watch the result. However, Mr. Stromeyer suggests that it would be a public benefit if a boiler were designed on what might be called plastic lines, placed within thick walls or in a pit, as has been done with large volume boilers in France, and fed and fired automatically under the most exacting conditions, except that the water would have to be pure. Twelve months' trial, perhaps under occasional increased pressure conditions until failures occurred, would be of incalculable value both to boiler makers and boiler users. An explosion need not be feared if the pressures are increased step by step and inspections are frequent, since with plastic stresses minor troubles are sure to give warning of danger.

Mr. Stromeyer's suggestions, coming from one of the most experienced boiler engineers in Europe, have aroused the greatest interest throughout the United Kingdom, and it is hoped that they may have some important practical result.

Oxweld Shape-Cutting Machine

An automatic oxy-acetylene shape-cutting machine, designed to cut shapes of any sort from steel plate, sheet, forgings, billets or ingots, is being introduced by The Linde Air Products Company, New York city. In this machine the cutting blowpipe is mounted on a carriage which is moved in any direction by means of an electric motor. For routine production it will operate automatically from templates. In cases where only a few parts are to be cut out a hand tracing device can be attached and used to follow the outline of a sketch or blueprint.



Oxy-acetylene machine developed for special plate work

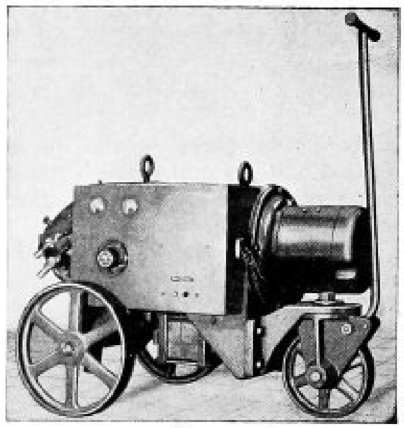
The parts of the machine are sturdily built without impairing the delicacy of adjustment necessary in a precision instrument of this sort. The rigid construction and special design prevent lost motion and make the cutting accurate in every case.

The Oxweld shape-cutting machine requires but one operator. Little machining is necessary in most cases after cutting, because the parts are produced with straight corners and smooth faces. The speed of cutting is high and ranges from 3 to 20 inches per minute, depending on the thickness of the metal. Accurate and smooth cuts can be made in stock up to 1 foot and more in thickness. It is claimed that production costs are reduced materially owing to economies in labor, time and material.

Westinghouse 200-Ampere Arc Welder

A new Westinghouse, 200-ampere, single-operator welding set has been designed to meet requirements in both the shop and field and to serve all applications, within its rating, with speed and economy.

The set is started by connecting directly across the line by means of a *Linestarter* and *Linestart* motor. Starting and stopping are accomplished by the simple operation of a pushbutton. A single rheostat varies the arc current over the entire welding range. Accurate adjustment over the welding range, from 60 amperes to 300 amperes, is afforded by steps of 5 amperes.



New 200-ampere arc welder

The motor-generator and control equipment are assembled in a totally enclosed frame. The exciter, which is overhung from the motor end, is securely fastened to the unit frame. This type of construction guards the operator against injury, and protects the set from dirt and falling objects. In performance tests welding operations have been carried on while the sets were suspended at every angle that could possibly be required in any application. Operation is as satisfactory when the set is placed on end, as when it is in the normal position.

The unit is rated at 200 amperes, 1 hour, 50 degrees rise on a resistance load at 25 volts which conforms to the standard rating of the National Electrical Manufacturers Association. The motor is wound for 220 or 440 volts and is assembled with the necessary connections made for operation from a 3-phase 60 cycle circuit. If it is desired to operate the unit from a 440 volt, 3-phase, 60 cycle circuit, it is only necessary to replace the operating coil on the magnetic starter and to reconnect the motor leads.

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

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.*

Water Capacity of Heating System

Q.—In connection with our heating system which is hot water, I would like to know how many gallons of water (Standard or Imperial) it holds. It takes 14 minutes to fill with water passing through ½-inch hose at 80 pounds per square inch pressure on the main. When the water is turned on it drops down to 20 pounds per square inch. The system when full registers 4¾ pounds on the gage at the boiler. Trusting you will supply the information at an early date. G. I. C.

A.—The information given in the question is not complete, as the conditions under which the water is obtained from the main and delivered to the boiler are not given, also the distance and type of hose used. However, a theoretical result may be obtained by the use of the following formulae:

$$Q = AV$$

when,

A = area of cross section of pipe in square feet

Q = quantity in cubic feet, flowing past any section in one second

V = mean velocity of flow in feet per second

$V = \sqrt{2g\ (h + h_1) - h_2}$

when,

$g = 32.16$

h = head in feet

h_1 = head in feet due to pressure

h_2 = head in feet due to pressure against the flow

h_1 and $h_2 = \dfrac{P}{0.434}$ where P = pressure in pounds per square inch. Substituting in these equations, taking the 20 pounds pressure as the pressure in the hose:

$$V = \sqrt{2 \times 32.16\ \left(O + \frac{20}{0.434}\right) - \frac{4.75}{0.434}}$$

$$V = \sqrt{64.32 \times 46.08 - 10.92}$$

$$V = \sqrt{2261.491}$$

$V = 47.55$ feet per second

$$Q = AV$$

$$Q = \frac{0.19635 \times 47.55}{144}$$

$Q = 0.06483$ cubic feet per second

$0.06483 \times 7.481 \times 60 = 29$ gallons per minute

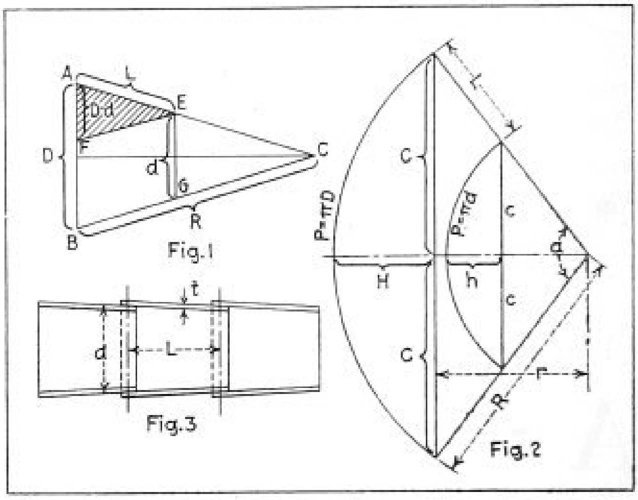
$29 \times 14 = 406$ gallons of water.

Formula for Finding Camber

Q.—Will you give me a formula showing the application of the versed sine in finding camber when the conical shape of the course is only due to the thickness of the plate. In other words, consider the thickness of the plate, the diameter and length of the course only. N. T.

A. The versed sine of an arc is that part of the diameter intercepted between the extremity of the arc and the foot of the sine, which corresponds to the distance H as shown in Fig. 2 for ½ the angle a.

In order to develop a formula for the versed sine under the conditions outlined in the question, it will



Development of formula for camber, using versed sine

be necessary to lay out and develop the formula from a simple conical course.

Referring to Fig. 1.

D=diameter of large end of conical course

d=diameter of small end of same

L=length of course

R=generating radius of whole cone.

Then we have from the similar triangles CAB and EAF.

$$R : L :: D : D - d$$

$$R = \frac{LD}{D - d}$$

This formula gives the radius R for the development of the whole cone.

Fig. 2 shows the development of the conical course. Referring to Fig. 2, we have,

$$H = R - r$$

$$r^2 = R^2 - C^2$$

$$r = \sqrt{R^2 - C^2}$$

or,

$$H = R - \sqrt{R^2 - C^2}$$

This formula gives the versed sine of ½ angle a fo a simple conical development.

Now,

$$C^2 = R^2 - r^2$$
$$C^2 = R^2 - (R - H)^2$$
$$C^2 = R^2 - (R^2 - 2RH + H^2)$$
$$C^2 = R^2 - R^2 + 2RH - H^2$$
$$C^2 = 2RH - H^2$$
$$C^2 = (2R - H)\,H.$$

or,

$$C = \sqrt{(2R - H)\,H}$$

which gives the length of half the cord in Fig. 2.

If the arc belonging to this half cord C is very flat, which is the case when the radius R is very large, $\frac{\pi D}{2}$ can be substituted for C. Substituting this value in the above formula and considering the first formula, we have.

$$\left(\frac{\pi D}{2}\right)^2 = \left(\frac{2LD}{D-d} - H\right) H$$

Now H as a rule is very small compared with the value of $\frac{2LD}{D-d}$ and, therefore, it can be neglected.

We then have,

$$\frac{D^2\pi^2}{4} = \frac{2LD}{D-d} \times H$$

or,

$$\frac{D\pi^2}{4} = \frac{2L}{D-d} \times H$$

or,

$$H = \frac{D\pi^2}{4} \times \frac{D-d}{2L}$$

$$H = \frac{D\pi^2\,(D-d)}{4 \times 2 \times L} = 1.235 \times \frac{D\,(D-d)}{L}$$

Fig. 3 shows a conical course in which the taper is due only to the thickness of the plate, as requested in the question; then by substituting $d + t$ for D and $d - t$ for d in the above formula, we have,

$$H = 1.235\,\frac{(d+t)\,[\,(d+t) - (d-t)\,]}{L}$$

$$H = 1.235\,\frac{2t\,(d+t)}{L}$$

$$H = 2.47\,\frac{t\,(d+t)}{L}$$

when,

t = thickness of plate
d = inside diameter at largest end
L = length of course
H = versed sine of ½ the angle a, as shown in Fig. 2.

Tank Construction

Q.—Please publish in your Questions and Answers department a formula for determining the dimensions of hoops, or bands, for a wooden tank as shown in the illustration. G. E. L.

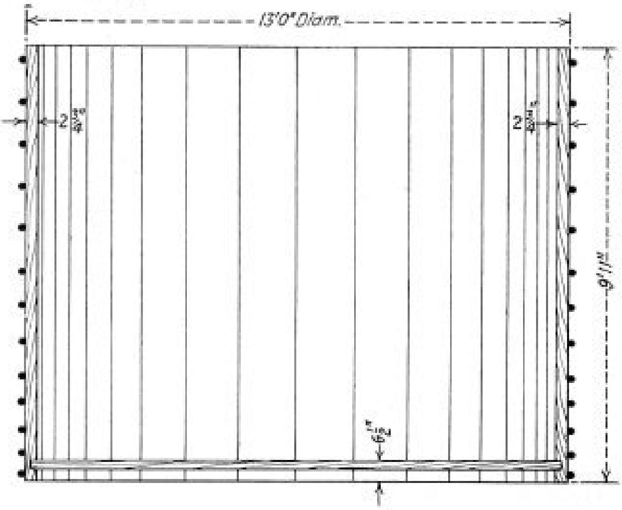
A.—The pressure on the sides tending to break the hoops, or bands, by tension due to the weight of the water (I assume the tank is to be used to hold water) increases in direct ratio to the height, and also to the diameter. The strain upon a section one inch in height at any point is the total strain at that point divided by two; for each side is supposed to bear the strain equally. The total pressure on any band, or hoop, is equal to the diameter of the tank in inches multiplied by the pressure per square inch due to the height or head of the water at the point where the hoop, or band, circles the tank, multiplied by the vertical distance between the hoops, or bands, in inches.

It may be expressed as follows:

$$A = \frac{0.434\;W'HDX}{2S}$$

where,

H = distance from top of tank down to the center line of hoop, to be calculated, in feet.
x = factor of safety = 5
D = diameter of tank in inches
S = tensile strength of material in pounds per square inch
W = vertical distance between center lines of hoops in inches
A = cross-sectional area of hoop, or band, in square inches.



Section of wooden tank showing method of construction

Applying this formula to the problem, it is necessary to assume the tensile strength of the material and also to determine an approximate spacing of the hoops.

Placing the first hoop aproximately 4 inches above the inside bottom of the tank and spacing the hoops 8 inches apart, the net cross-sectional area of this hoop is then found by substituting in the formula.

Assume 50,000 pounds tensile strength of the material:

then,

$$A = \frac{0.434\;WHDX}{2S}$$

$$A = \frac{0.434 \times 8 \times 9 \times 156 \times 5}{2 \times 50{,}000}$$

$$A = \frac{24{,}373.44}{100{,}000}$$

$$A = 0.24373 \text{ square inches}$$

The result, as shown, would be for the bottom hoop upon which the greatest load is found.

The nearest commercial diameter of hoop having a cross-sectional area of over 0.24373 square inches would be ⅝-inch diameter.

The hoops should be kept a uniform diameter for a tank of this height, the spacing of the hoops being increased towards the top of the tank, but not exceeding 12 inches.

It is also necessary to place additional hoops around the bottom of the tank to take up the stresses due to the swelling of the tank bottom when wet. These hoops should be so located around the bottom of the tank as to protect the sides where the tank bottom is set in.

Flat hoops are often used, but, due to their unprotected condition on the inside, they rapidly rust and become weakened. A round hoop can more readily be protected with paint.

Lugs for these hoops should be of malleable iron, drop forged. Cast iron is likely to crack and is, therefore, unsafe. The lugs should not be in a vertical line when placed on the tank.

Diameter of Rivet

Q.—How is the diameter of a rivet selected?

A.—The diameter of rivet used in the calculation of the strength of riveted joints is the diameter of the driven rivet and is the same as the diameter of the rivet hole, as it is assumed that after being driven the rivet will occupy the full volume of the rivet hole. This result is practically assured by proper hydraulic riveting. The diameter of the rivet selected before riveting is usually about 1/16 inch less than the diameter of the drilled hole. With accurate alinement of rivet holes and particularly with plates not over 3/4 inch or 1 inch in thickness, the clearance allowance between the diameter of the rivet and the diameter of the rivet hole may be reduced to 1/32 inch.

Area of Safety Valves

Q.—Please explain how the size (either area or diameter) of a safety valve may be obtained (without resorting to a table of constants), considering, either, heating surface, grate area, evaporation in pounds of water and boiler pressure. W. T.

A.—The following formulas may be used in determining the area of the safety valves for boilers:

The area for the safety valve of a boiler may be determined from the grate area by the formulae:

$$a = \frac{A \times 4}{\sqrt{P}}$$

when,

a = area of valve in square inches

P = working pressure in pounds per square inch

A = area grate surface in square feet.

Also by the formulae:

$$a = \frac{37.5 \times A}{Gp}$$

when,

a = area of valve in square inches

Gp = absolute pressure = boiler pressure plus 14.7 pounds

A = area grate surface in square feet.

From the evaporating power of the boiler, the area of the safety valve may be found approximately by the formulae:

$$a = \frac{E}{40 \times \sqrt{P}}$$

when,

a = area of valve in square inches

P = working pressure in pounds per square inch

E = evaporating capacity of the boiler in pounds per hour.

The area of the safety valve can also be determined by the following formula based on the water evaporated per square foot of grate area:

$$a = 0.2074 \times \frac{W}{P}$$

when,

a = area of valve in square inches

P = absolute pressure per square inch = boiler pressure plus 14.7 pounds

W = pounds of water evaporated per square foot of grate surface per hour.

Crowfoot Design

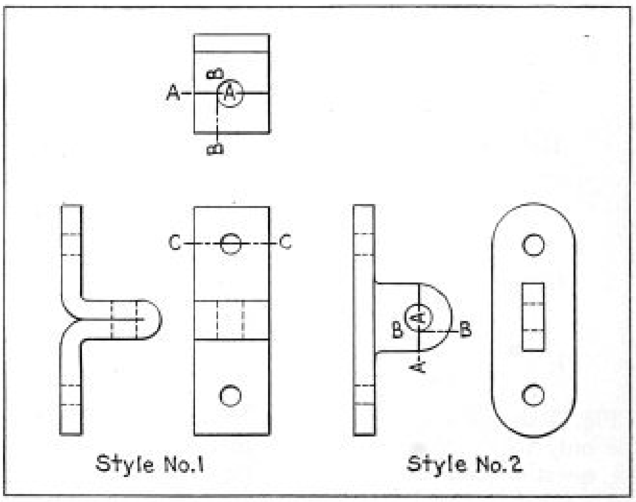
Q.—Will you please give me an explanation of paragraph P-223-6 on page 37 of the 1927 edition of the A. S. M. E. Boiler Construction Code which reads:

"Design each branch of a crowfoot to carry two-thirds the total load on the brace."

I would especially like to know how you would apply this paragraph to the two styles of crowfeet illustrated.

Thanking you for any information you can give me on this question and hoping that you will publish a reply at your early convenience. L. M. L.

A.—Applying P-223-6 of the A. S. M. E. Code to the styles of crowfeet shown in the illustration, I have



Two designs of crowfeet

designated with the sections *A-A*, *B-B* and *C-C* the weakest sections of the crowfeet and, therefore, the sections to be considered.

At *A-A* crowfeet will be in tension and the cross-sectional area at this section should be calculated in tension for a load of two-thirds the total load on the brace.

At *B-B*, both crowfeet will be in shear and the cross-sectional area at this section should be calculated in shear for a load of two-thirds the total load on the brace.

At *C-C*, both crowfeet will have to meet the conditions required by P-223-7 of the Code, which reads:

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.

The Globe Steel Tubes Company, Milwaukee, Wis., is making improvements in its plant at that city. These improvements consist in replacing one tube-rolling mill and installing modern machinery for piercing, rolling and reducing. All machinery will be driven by electricity; this involves a considerable addition to the electric power plant and some changes in buildings.

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

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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—C. D. Thomas, Salem, Oregon.

Secretary Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.

Vice-Chairman—William H. Furman, Albany, N. Y.

Statistician—L. C. Peal, Nashville, Tenn.

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

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

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

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

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

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

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.	St. Louis, Mo.	Nashville, Tenn.
Erie, Pa.	Scranton, Pa.	Omaha, Nebr.
Kansas City, Mo.	Seattle, Wash.	Parkersburg, W. Va.
Memphis, Tenn.	Tampa, Fla.	Philadelphia, Pa.

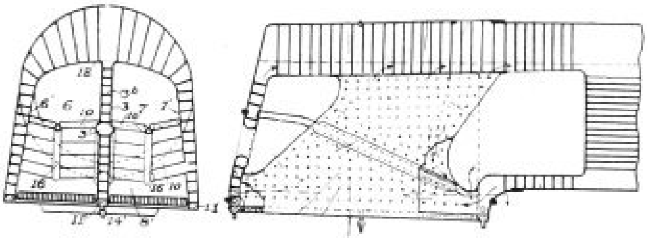
Selected Boiler Patents

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.

1,669,414. LOCOMOTIVE BOILER. CHARLES GILBERT HAWLEY, OF CHICAGO, ILLINOIS, ASSIGNOR TO LOCOMOTIVE FIREBOX COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

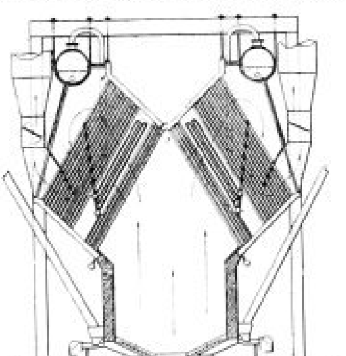
Claim.—A locomotive boiler and fire box embodying therein, a crown sheet, side sheets and front and rear sheets, an upright flat tubular water wall extending longitudinally of the fire box between said side sheets and connected at its ends with the bottom portions only of the front and rear



water legs of the boiler and opening at its top through the crown sheet, said water wall, substantially dividing the fire box into a plurality of fire chambers connected together only at the ends of the water wall above its points of connection with said front and rear water legs, whereby temperature conditions in said fire chambers are substantially equalized. Three claims.

1,671,144. WATERTUBE BOILER. ALFRED COTTON, OF ST. LOUIS, MISSOURI, ASSIGNOR TO HEINE BOILER COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

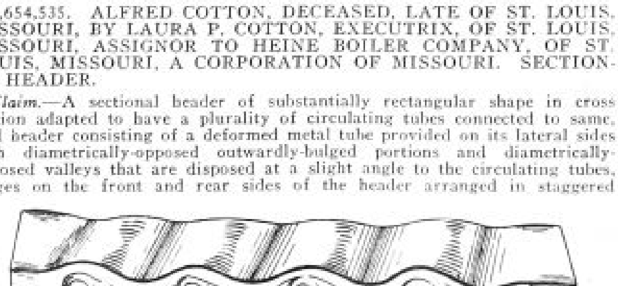
Claim.—A boiler, comprising oppositely-inclined banks of superimposed water tubes arranged at opposite sides of a substantially A-shaped combustion chamber, each of said banks having radiant heat tubes, a steam-



and-water drum associated with each of said banks, and a header structure at the upper end of each of said banks, disposed at an angle to the tubes of same and having its lower end portion communicating with some of the radiant heat tubes of the other bank and arranged in substantially longitudinal alignment therewith so as to virtually form a continuation in a straight line of said radiant heat tubes. Eleven claims.

1,654,535. ALFRED COTTON, DECEASED, LATE OF ST. LOUIS, MISSOURI, BY LAURA P. COTTON, EXECUTRIX, OF ST. LOUIS, MISSOURI, ASSIGNOR TO HEINE BOILER COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI. SECTIONAL HEADER.

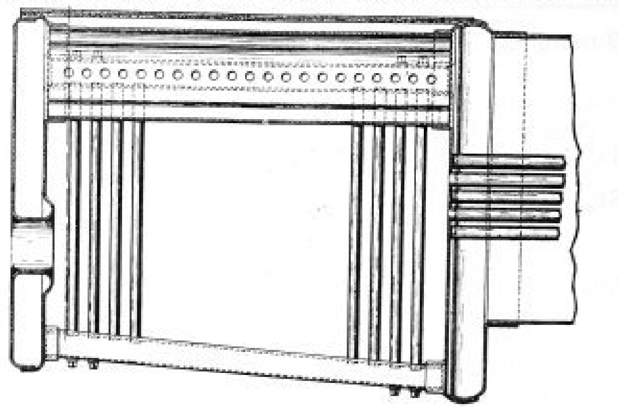
Claim.—A sectional header of substantially rectangular shape in cross section adapted to have a plurality of circulating tubes connected to same, said header consisting of a deformed metal tube provided on its lateral sides with diametrically-opposed outwardly-bulged portions and diametrically-opposed valleys that are disposed at a slight angle to the circulating tubes, bulges on the front and rear sides of the header arranged in staggered



relation to the outwardly-bulged portions on the lateral sides of the header, and tube holes and hand holes in the front and rear sides of the header. Six claims.

1,656,475. GEORGE H. EMERSON AND OLIVER C. CROMWELL, OF BALTIMORE, MARYLAND. FIREBOX FOR LOCOMOTIVE BOILERS.

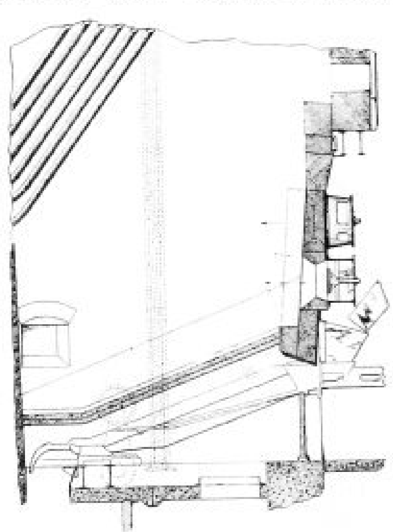
Claim.—In a firebox for a boiler, the combination with the tube sheet and back water leg, of upper and lower headers connecting said tube sheet and leg to form passages between said sheet and said leg, each of said upper



headers comprising side extensions formed by a continuation of the header shell and having holes in the bottoms and tops thereof, water tubes, each having one end secured in a hole in the bottom of one of said extensions and the other end connected to one of said lower headers, and removable plugs mounted in the holes in the tops of said extensions. Nineteen claims.

1,672,532. FURNACE. DAVID S. JACOBUS, OF JERSEY CITY, NEW JERSEY, AND WILLIAM A. JONES, OF WEST NEW BRIGHTON, NEW YORK, ASSIGNORS TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

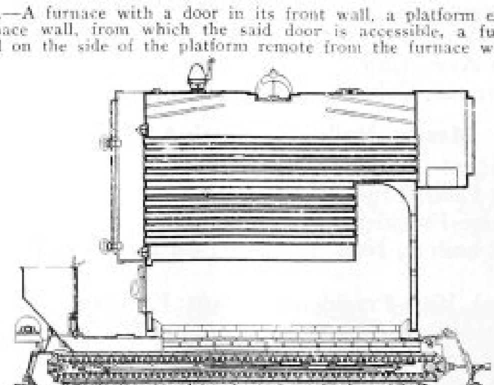
Claim.—An oil-burning furnace comprising an inclined furnace wall



composed of tile and an oil burner set in said wall, at substantially right angles thereto. Seven claims.

1,672,413. FURNACE GRATE. HARRIS B. HOLT, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO ROSEDALE FOUNDRY & MACHINE COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

Claim.—A furnace with a door in its front wall, a platform external to the furnace wall, from which the said door is accessible, a fuel hopper arranged on the side of the platform remote from the furnace wall, and a



grate of endless chain type whose upper horizontal reach is continued from beneath the hopper, beneath the said platform, and through the furnace wall to the chamber within. Two claims.

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Contents

Safety Campaigns

In MANY states where manufacturing industries predominate, special departments of labor and industry have over the past few weeks accomplished great reductions in injuries and loss of life to the men employed in factories and plants of all kinds.

The State of Pennsylvania, Department of Labor and Industry has been conspicuous for the care exercised in developing its safety code and the excellent results obtained from its enforcement. Industrial accidents of all kinds have been curtailed to a remarkable degree since the department has been functioning, but the authorities believe that still further reductions are possible. For the purpose of attacking the problem from a different angle, the department in this state has instituted a new plan of factory inspection in the form of a state-wide industrial safety campaign for the year 1929.

In outlining the scope of the plan, Harry D. Immel, director of the Bureau of Inspection, states that the campaign will cover every industry in the State of Pennsylvania, except agriculture and coal mining. The general aim will be to close the present decade with so substantial a reduction in the annual industrial-accident record as to give every agency for the promotion of safety a new inspiration and a new obligation for the years to come. "The original conception and the chief object of the Department of Labor and Industry," states Mr. Immel, "has always been very much a matter of routine, the application of mechanical safeguards being the principal means of accident prevention.

"Under the new inspection plan there will be placed monthly in the hands of each of the nine supervising inspectors of the Bureau of Inspection, a complete list of lost-time accidents of each industrial association in his division as reported to the Bureau during the previous month. Inspectors will visit the establishment, make personal observation and discuss safety needs with employers or their representatives. The new inspection plan aims to make each concern a safety factor in itself and to develop a study and solution of the individual accident problems. Every organization and every agency in the state interested in labor or industry, every civic and every safety organization will be invited and urged to participate. Local labor units and local manufacturers' associations can do much to advance its success."

The foregoing is an outline of the method of attacking the general safety problem as employed by one state. The same constructive thought and effort should be applied to the reduction of accidents in every plant —including boiler shops—in the country. The boiler makers' occupation is a hazardous one at best and carelessness and lack of adequate safety measures and proper plant inspection aggravate the condition. As in Pennsylvania, let every shop make the year 1929 a safe year for the men employed.

Trend in Marine Boilers

THE fuel economies resulting from the use of high pressures and high degrees of superheat have caused a marked trend toward the use of watertube boilers instead of Scotch boilers in the marine field. While about 80 percent of the steam-propelled vessels afloat employ Scotch boilers, the orders for new tonnage and the plans for contemplated construction indicate that the Scotch boiler is no longer considered economical from a marine standpoint.

In Scotch boilers, the highest feasible pressure is about 200 pounds per square inch, whereas watertube boilers may be operated at 300 to 400 pounds per square inch and, in some cases, even higher pressures have been utilized. Attempts have been made to increase the strength of Scotch boilers to meet the pressures desired for maximum fuel economy. The resulting boilers have proved to be far too heavy for employment in marine work; a boiler operating at 300 pounds per square inch, for example, requires a shell-plate thickness of over 2 inches.

High-pressure watertube boilers have been successfully employed in the British steamship *King George V*. In this vessel, two Yarrow boilers operate at a pressure of 465 pounds per square inch with valves set for a blow-off pressure of 575 pounds per square inch. A superheat of 750 to 800 degrees Fahrenheit is maintained.

The weight of a Scotch boiler operating under conditions similar to those on the *King George V* would be prohibitive. On the other hand watertube boilers may be utilized without excessive increase in weight. With these factors determining the type of boiler employed, the preference of the watertube boiler is but the logical outcome of a desire for high fuel economy through the use of high pressures and high superheat.

Boiler Practice

METHODS of building and repairing boilers do not readily lend themselves to radical changes. Nevertheless, from time to time developments in equipment and machinery for carrying out boiler operations make possible more efficient plant layout and the substitution of modern production principles for those that have become obsolete. One outstanding example of this in the United States is the entirely new locomotive building plant of the Baldwin Locomotive Works at Eddystone, Pa. A complete description of the boiler department of this plant and details of the machinery and methods employed will appear in future issues of The Boiler Maker.

An example of the same development in England appears in this issue under the title "Work at Crewe Locomotive Shops." This plant, which was completely reorganized last year and put into operation early in 1928, offers many new ideas in the building and repairing of locomotive boilers. Some of these could be adopted in this country to advantage, while others do not conform to the requirements of American motive power. While the present article is devoted mainly to a description of plant and equipment at the Crewe Works, a future article will deal with the production methods employed with great success in both the construction and repair of British locomotive boilers.

Communications

Shop Inspectors

To the Editor:

The article on "Relationship of the Boiler Manufacturer with the National Board" which was published in the October issue of The Boilermaker, is very timely, and quite constructive, although I cannot quite agree with its entire contents.

In the first place, the fact that insurance company inspectors, or state inspectors hold certificates of competency as National Board, or state inspectors, is no sign that they are fully qualified to make shop inspections, although they may be fully qualified, to make field inspections in service.

It is the writer's opinion that there should be two examinations given, one for field inspectors and one for shop inspectors. Under present conditions, this is not required, and every Tom, Dick and Harry who is considered wise enough to read out of a Boiler Code during the examination is classed as a qualified inspector and presented with a certificate of competency. Some may doubt this assertion, but I know it is true; for at one time I took the examination before a State Board, and was permitted to make the examination easier for myself by the use of the Boiler Code.

The above, however, does not apply to state inspectors who take the examination under competitive civil service requirements, in which case, the applicant is only allowed to bring into the examination room a pen, pencil, eraser and ink. He must rely upon what he has in his head, and not what is in a book.

Qualifications of a Shop Inspector

The shop inspector should be a boiler maker, and he should be well trained and informed in his trade. Surely, the inspector who has not had actual shop experience in the construction and repair of boilers is not at all qualified to pass upon the new construction. How does he know when the rivets have been properly heated and driven, the plates flanged, or when the proper heat has been made? Does the inexperienced inspector of construction know when tubes have been properly rolled, braces properly heated and fitted, and numerous other details, which can only be acquired by long periods of shop experience?

Coming back to the subject, I would like to comment on the paragraph, "Suggestions for Improving Inspections." The writer of that paragraph infers that it seems to be the opinion of certain inspectors, that they only hold their positions as long as they find fault; furthermore, that they are over-zealous. I do not agree with this assertion, and will take the stand that more of the state and chief inspectors should be a little more particular and exacting on boilers coming into their districts.

Certainly some of the boilers coming through today are far from meeting the requirements of the A. S. M. E. and National Board, and it is a wonder to me that the A. S. M. E. and the state symbol are allowed to be stamped upon such boilers.

I had the opportunity of examining a watertube boiler that lasted less than a year and which cost the owners, over $14,000. It was cut up into scrap because it could not be repaired or kept tight. This boiler was shop-inspected and passed by an inspector, yet he still holds a commission; surely the buyer was not protected in this instance.

I assume that I am classed as one of the over-zealous inspectors; in fact, I know I am considered that by different organizations and have been advised that my objections have been brought up at different meetings of these organizations. Yet, in order to defend the position of the strict and conscientious inspector, I will still take the stand that we are not too strict; in fact, we are not strict enough and only find fault with the boilers where the fault is due, not only protecting the interests of the buyers but of the manufacturer who is building code boilers.

It is possible to find 190 violations on one boiler; that is, the inspector referred to may have taken into account that all poorly driven staybolts and rivets, also poorly installed tubes, were a different violation of the code.

Massachusetts' Requirements Not Too Strict

I admire the attitude of Massachusetts in her stand for strict and exacting adherence to the requirements of her Boiler Code. If more states would follow her example and be as exacting and as strict as she is, there would not be so many manufacturers getting by with improperly constructed boilers.

I have been in shops where boilers were under construction; have seen the so-called shop inspector come in, take the plate melt numbers and leave again; come back a little later, apply the hydrostatic test and O. K. the boilers. Yet he has never followed up the construction or workmanship as required by the codes. I have had the opportunity of checking up these boilers later. Was the work right; far from it, yet we are to be condemned and criticized as being too exacting and over-zealous.

Credit to the Boiler Manufacturers

I will admit that several boiler manufacturers who strive to do their work well, and do it well, should be given credit for it; and again, there are several who should not be given credit. Their work does not warrant it. In all justice to the maker who is turning out a real code boiler, I will say that he should be protected from unfair competition which his brother boiler maker, of a poorer product, is turning out. He cannot compete against such odds successfully, although the purchasers are now commencing to see that the cheaper product is not always the most economical in the end.

There is a gradual trend of the purchasers in requiring and insisting upon new boilers being inspected by state inspectors after the boilers have reached their destination. The purchaser has realized that he has been "stung" enough and is now seeking protection which only comes through conscientious, careful and exacting inspections.

Shop Inspections

The time is coming, and I do not believe it is far off, when state inspectors will inspect boilers during construction, and at the place of installation as well. The view now taken by many is this: The Jones Insurance Company has a shop inspector at the plant; when the boilers are tested and completed, he stamps his company's mark upon the boilers. The boiler is installed in the field, and the same insurance company gets the risk; their field inspector makes an inspection, he notes his own company's mark upon the boiler and he will not register a kick even though the work is not right, but, let the boiler be field-inspected by a different insurance company inspector, or state inspector, and, if there are any defects, they will be reported.

The conscientious inspector can successfully defend his stand where he objects to poor workmanship, and I dare say that the average state inspector is not thinking that he holds his position only so long as he finds fault, but, that he holds his position because he is fully qualified and capable of performing the duties of his office, and because of his strict adherence to the Boiler Code requirements.

It is unfortunate that any boiler manufacturer should suffer if he is an innocent victim of an inspector when he is not entitled to be; and again, it is unfortunate that any inspector should be condemned when he is protecting the symbols of the A. S. M. E. National Board, and state codes.

Rigid Inspections in New York State

There is no politics connected with the state boiler inspection department in this state (New York). We are trying to enforce our boiler code rules without fear or favor, and are not trying to get something on any inspector unless he deserves it by his lax inspections.

The shop inspectors who are passing boilers for this state had better watch the boilers that are coming into this state; we are looking them all over, and we intend to keep it up. Our rigid supervision is now showing results in that the boilers are of a better quality of workmanship and construction.

There are still a few manufacturers that can show improvement, and several shop inspectors, who should familiarize themselves more thoroughly with the boiler codes and proper inspection methods.

The National Board is doing a splendid work. The members have improved and simplified matters very much. I trust they may continue these improvements and also look into the complaints registered by inspectors concerning poor workmanship and inspections, always bearing in mind that there are always two sides to every story. Therefore, not only giving the manufacturer a chance to be heard but the field inspector as well.

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

Neutral Center of Heavy Plate

To the Editor:

Referring to the discussion in recent issues of The Boiler Maker, regarding, adding three times the plate thickness to the length of a sheet for take-up in bending; it is evident that working to the neutral diameter of a proposed shell is all right, so long as it is known what the neutral diameter or the neutral center of boiler plate really is.

There is a lot of theory "on tap" regarding that matter, and while theory is first class and we cannot get along without it, any more than we can without practical experience, let us work the two along together.

A Practical Method of Finding the Neutral Diameter

Steel plate 1¼ inches thick will serve admirably to experiment with, since it is sufficiently heavy to prove the neutral diameter theory by the following practical method. If it be assumed that the 1¼-inch shell to be considered is to be 4 feet in diameter between the inner and outer courses, then the supposed neutral diameters of the shell courses will be 3 feet 10½ inches and 4 feet 1½ inches respectively. The neutral circumferences may then be worked out by multiplying by *pi* or by 3 1/7.

Procure two 1¼-inch bars of steel, cheap "black" steel will answer the purpose, and let the length of the bars be at least 3 feet longer than the supposed neutral circumferences of the inner and outer courses. Measure off as accurately as possible the neutral circumference of each course, laying off the lengths on separate 1¼-inch bars. Mark the ends of each circumference with a small center-punch mark, then square entirely around the bar and scratch deeply into the bar so that the marking will not be lost in bending.

Lay off the calculated distance in the middle of each bar, leaving the ends of about equal length beyond the markings, and not less than 14 to 18 inches from the marks to the ends of the bar.

Procure a good "runner" or traverse wheel, such as is used by blacksmiths for measuring the size of wagon wheels and tires. There should be one of these convenient appliances around the boiler shop, but, if you do not have such a tool, make one up by dressing out a smooth circular disk or wheel, 6 to 10 inches in diameter and mounted on one end of a handle by means of which the wheel may be run around a wheel, a tire, or along any piece of wood or metal. There should be a permanent radial mark deeply scratched into the rim of the little wheel.

Using the Measuring Wheel

Place this mark fair with one end of a neutral circumference mark, then roll the wheel along the 1¼-inch bar until the other end of the neutral circumference has been reached at this cross-mark. Make a mark even therewith on the traverse wheel with your soapstone slip, but do not make the mark permanent. You may count the revolutions of the traverse wheel if you wish, but it is not necessary to do so unless you know the exact circumference of the traverse wheel and wish to use it in checking up the neutral circumference in feet and inches. "Run" both the bars and record their respective marks on the traverse wheel in a manner which will not lead to confusion or mistakes later. Having "run" or traversed both bars, pass them through the bending roll; let their long ends, beyond the marks, pass each other and roll until the squared-around circumference marks come fair with each other. If you wish, the rolled-up bars may be carefully cut off, after rolling, at the squared-around marks, but it is best to wait awhile before doing so.

With the traverse wheel, "run" the outside of the smaller or inner course bar and mark its ending upon the other side of the traverse wheel, taking care to do all running in the same direction, so that the several marks may all be read upon the same side of the starting mark on the traverse wheel. Having "run" the smaller bar on both inside and outside, and marked the result, run the bar along its side or edge and see how much, if any, the result differs from results obtained when the straight bar was run between circumference marks. Be very careful in making the edge-running to keep the wheel exactly in the middle of the bar all the time; otherwise, the results obtained will be misleading and worthless.

Should the edge-run distance be found greater or less than the distance run between the squared-around marks, then you have evidence that the neutral center is not in the middle of the bar's thickness and you should proceed to locate that bit of neutrality by comparing its traverse-wheel length with the recorded prebending center-bar length and with the length of the inside and outside edges of the bent bar.

Locating the Neutral Center

Having located the probable location of the neutral center to your satisfaction, proceed to treat the other and larger ring in the same manner. The traverse-wheel readings from the outer edge of the smaller ring, and the inside of the larger circumference, will tell you whether or not using the middle of plate thickness as the neutral center can be trusted with calculations for lengths of inner and outer courses.

It may be noted that the squared-around circumference marks are still radial and do not stand at a more or less oblique angle, as does the end of a heavy plate after it has been rolled up. The reason for this is obvious; in the excess-length bars, rolling was done at the squared-around marks, as well as anywhere else, but the ends of a heavy plate cannot be bent in the rolls, hence their oblique position instead of being radial. Should the long ends of the two bars be cut off, the resulting rings may be tried together, but better not do any cutting until after you have satisfactorily located the neutral center of the thick bars or plates.

Indianapolis, Ind. JAMES HOBART.

The Hollow-Staybolt Calking Tool

TO THE EDITOR:

In the August issue of THE BOILER MAKER, the description and illustration of a calking tool for hollow flexible staybolts is given, and, according to claims made for this tool, we have a solution to the leaky staybolt problem. Now, not wishing to criticize, I fail to see where the use of this tool would have any effect upon the bolt farther than the first thread or firebox edge of the sheet. To ensure a tight bolt, we must have a good fitting bolt for the entire thickness of side sheet, and the only help that can be given for hollow staybolts, is to devise some means of expanding the bolt in the sheet until such time as they can be renewed. Bobbing helps for a short time, but incessant bobbing brings on trouble with the surrounding bolts, due to the tendency of the sheet being drawn in. Where we have a 7/32-inch tell-tale hole in the bolt, and where Federal and company rules would allow it, why not plug with a 9/32-inch taper plug and help expand the bolt in the hole and then bob.

Faulty Staybolt Driving

No boiler maker can deny that the flexible staybolt is the savior of the modern boiler, so far as safety and economy of upkeep are concerned; then why so much complaint about leaky staybolts? Can you expect bolts to stay tight that are run in with the fingers, and again, run in so tight that the thread is virtually crushed? Can you expect bolts to stay tight that are carelessly held on and driven? Give us staybolt holes tapped out carefully and the bolts cut to a thread that is snug, and other conditions being normal, and we shall not have so much trouble.

A little experience of a friend of mine, who is a practical boilermaker, may be enlightening. While taking in the sights of the boiler shop of a large repair plant, he watched the driving of the staybolts in a new firebox and made the casual remark to the "holder-on," "Why don't you hold on all of the bolts?" The answer came back, "What the H—l's that to you?"

A great deal depends upon the care given to leaking staybolts at washout periods. No good is obtained by bobbing the bolts with all the power of the air hammer. Experience has shown that a light bobbing gives best results. Where you have bolts that will not stay tight, take off the cap, chip off the head, if any, on the firebox side and nine times out of ten one blow with the hammer will drive the bolt out of the sheet and no thread on sheet or bolt is disclosed. Expansion and contraction are not altogether to be blamed for this condition; the manner of application tells the story and no bobbing tool made can overcome that.

Lorain, Ohio. Joseph Smith.

Rating Steam Boilers

To the Editor:

I have read with interest the article on "A Suggestion for Rating Steam Boilers" in the September issue of The Boiler Maker, and must admit that I was rather impressed by the way in which the problem is tackled therein. I quite agree that the old-fashioned method of expressing boiler capacity in terms of horsepower was a mistake, but, at the present time how many boilers are rated in these terms? Very few, I think, at least in England, although the writer is not conversant with American practice, but can only credit America with using the term where the American accepted standard of one horsepower being equivalent to the evaporation of 34.5 pounds of water from and at 212 degrees F. is understood. In fact, the term "horsepower" as applied to boilers has practically died a natural death; it was impossible for it to survive.

At the same time, I am of the opinion that the authors of the above-mentioned article confuse matters rather than simplify them. In the first place, they suggest the term "steam generator" to include all the steam-raising plant. Now overall efficiency of the plant is a thing altogether different from "boiler efficiency." In nine cases out of ten, the boiler makers do not supply the economizer, and very often not the furnace, although the furnace conditions must be known before the boiler can be designed.

In my opinion, therefore, the boiler performance should be reckoned from the water entering the boiler (not the economizer) to the steam leaving the stop valve or valves. The authors recognize the fact that the term "boiler efficiency" is very loosely used, but if it be laid down and officially accepted to imply what I have just suggested, one difficulty would be solved as far as the boiler maker is concerned. The suggested term "gross steam generating efficiency" would be quite suitable no doubt for use by the chief engineer or boiler house superintendent, they being the men who have specified and ordered all the different items which go to make the plant, but is really not of much use as regards the rating of "boilers."

Then again, the suggested term "kilotherms" is rather confusing, as it is intended to have a different meaning when applied to the furnace and when used in connection with the heat absorbed by the water. In the latter case it is defined simply as "1000 British thermal units," but in the former as "one pound of gas containing 1000 British thermal units" and is qualified by the furnace factor.

I think it is a mistake to regard the boiler as separate from the furnace. Whether the makers of the boiler supply the furnace or not, the two go to make one unit and cannot possibly be regarded as separate items. One is incomplete and useless without the other. I also fail to see why, as the article suggests, if the boiler does not come up to specification, the furnace builders should blame the boiler makers or vice versa.

Testing Flue Gases

Surely it is a simple enough matter to test the flue gases and make sure whether the furnace is doing its work properly or not. If it is, then the fault lies with the boiler makers. The boiler designer *must* know the type of furnace to be installed and the conditions under which it is to work (for instance, the quality of fuel used, whether or not under forced draft, etc.) before he can get out a suitable design of boiler. To say that the fuel analysis, carbon loss, and excess air are all *assumed*, is a mistake. They are not assumed in any plant nowadays where good results are expected, and it would be an impossibility to design an efficient boiler on these assumptions.

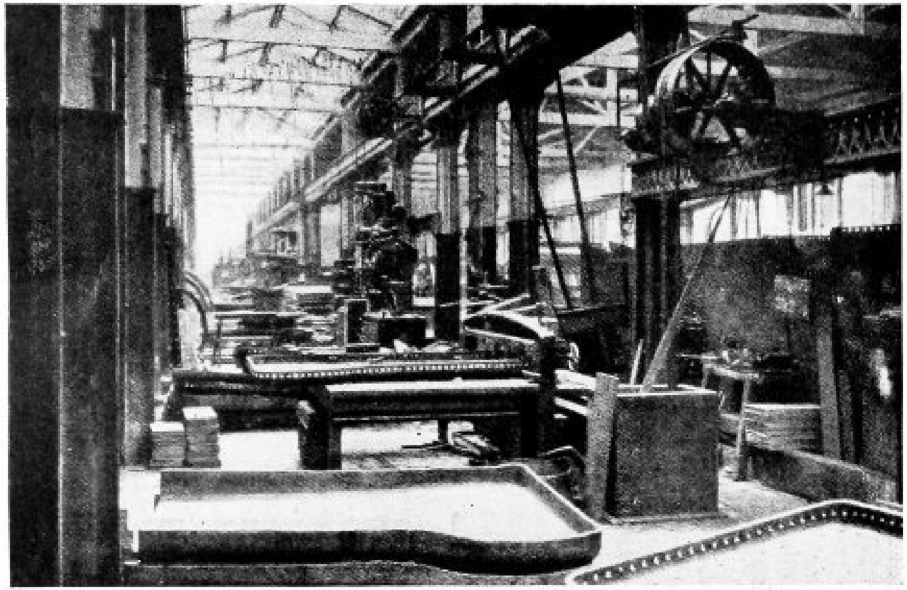
British Thermal Units as a Measure of Evaporative Capacity

I am aware that it is very easy to criticize and all credit is due to the people who give their time and experience to the solving of problems for the benefit of the world at large. I have no desire to appear presumptuous, but am looking on the matter from the point of view of the boiler maker. To my mind there is but one way of reckoning boiler capacity, and that is the one which is almost universally adopted today. It all boils down to British thermal units, as the article under consideration states, but, why make a new term for a multiple of these units? Everybody knows that the evaporation of one pound of water under atmospheric pressure from and at 212 degrees F. requires 970.4 British thermal units, and this should be the standard method of rating. If the evaporation of a boiler (which must include the furnace) is given as so many pounds of water per hour from and at 212 degrees F., it is quite definite and simple. Now if in the specification it be stated that the boiler must be capable of a certain duty, *working at a given thermal efficiency*, the whole matter is covered. Of course in a complete specification, one would expect to find the conditions accurately given. The more accurately these conditions are given (and it need be no guess work) the nearer the finished boiler will be to the specification, and if they cannot be given then nobody can be blamed for a poor final performance, if the makers have been working to an incomplete specification.

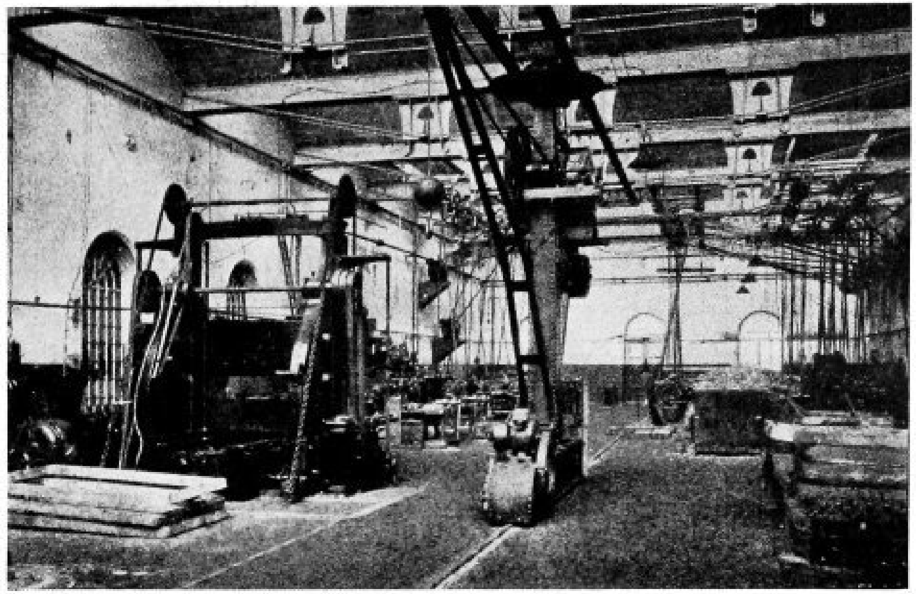
New Terms Unnecessary

To conclude, I think the most satisfactory method of tackling the question is not to bring out *new* terms—we already have enough to think of—but to come to a firm understanding on the old ones. Let the term "boiler" *mean* boiler, and not boiler plus economizer, plus superheater, etc. The only things which cannot be separated are the boiler proper and the furnace, and the furnace is a definite part of the boiler. If it was settled once and for all what was meant by the terms we already use, by far the most difficult part of the business would be solved. One cannot tell at present when the word "boilers" is used whether or not entire steam raising plants are implied. I should be very pleased to see other comments on the matter.

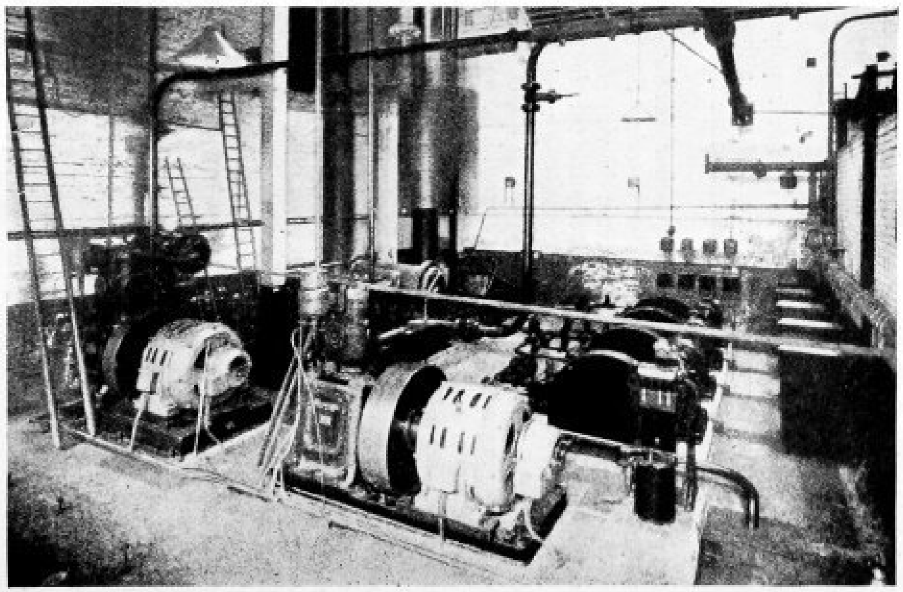
Halifax, England. Norman Wignall.



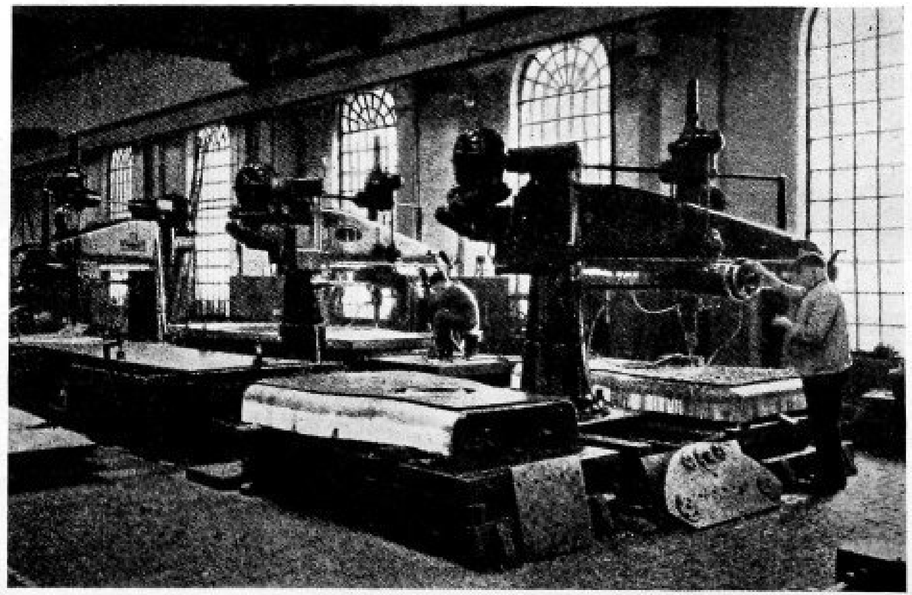
General view of center machine bay



General view of light machine shop



Hydraulic pump and compressor house



Battery of drills with duplex tables

General view of machine bay in boiler shop

Work at Crewe Locomotive Shops

Improved plant facilities make possible rapid and efficient production in locomotive boiler construction and repair work

EARLY in the present year a complete reorganization of the plant arrangement and equipment of the Crewe Locomotive Works at Crewe, England, was undertaken. Although the methods employed in building and repairing locomotive boilers in British shops are somewhat different than those practised in this country, nevertheless they offer much that is of general interest. In fact the description of the plant, equipment and outline of the work at the Crewe shops which follows will undoubtedly indicate to many of our readers certain methods that might well be adopted in their own shops. The publication of this information has been made possible through the courtesy and co-operation of *The Railway Engineer*.

The reorganized Crewe Locomotive Works in England has utilized many advanced machines and methods for the construction and repair of locomotive boilers. The accompanying article outlines the general layout of the new boiler and firebox-building section of the plant and the system employed in promoting production. In a later issue, details of what is known as the "belt" or conveyor system of assembling boilers will be published, as well as an outline of plant, facilities and methods employed for boiler repair work.

Reorganization of Crewe Works

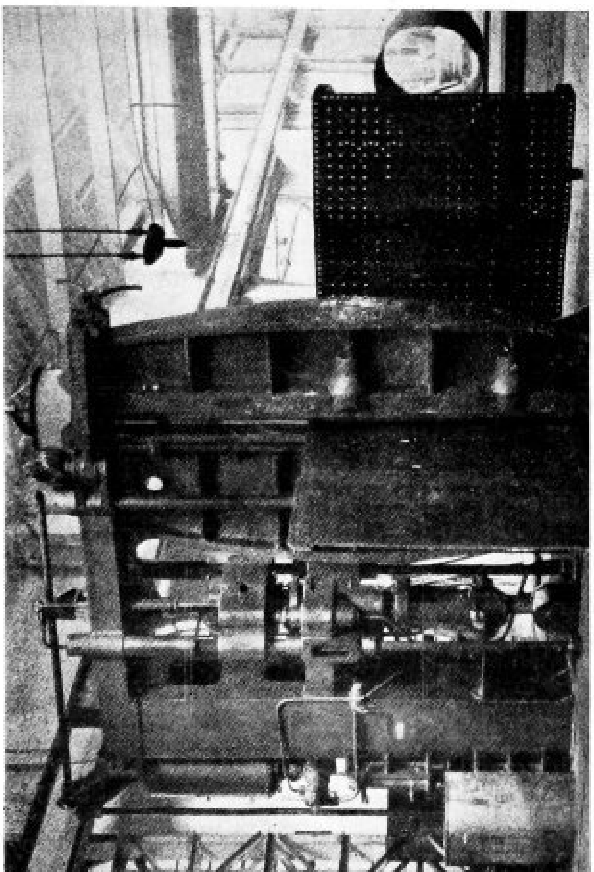
When the plans for reorganization were first formulated, it was realized that the boiler department would be an important factor in the future operation of the plant. In replanning the equipment and arrangement of the shops, considerable attention was given to the methods that would be employed in building and repairing boilers. The new boiler department incorporates the former erecting shops, the layout being indicated in one of the illustrations. Special attention was also given to the section in which boiler tubes are repaired, and new methods and appliances were installed with the object of speeding up the work and saving time and labor.

The general scheme on which production is based is similar to that employed in the erecting shop, although in the case of boiler work the "belt processing" principle, as it is called, is more difficult of accomplishment. The scheduling system employed is similar to that utilized in many shops in this country, where all component parts of the boiler are brought along through production at about the same rate so that the complete assembly is made simultaneously, all fittings and parts from other departments having been made available at the time required. The system is applied both to the construction of new boilers and to repair work.

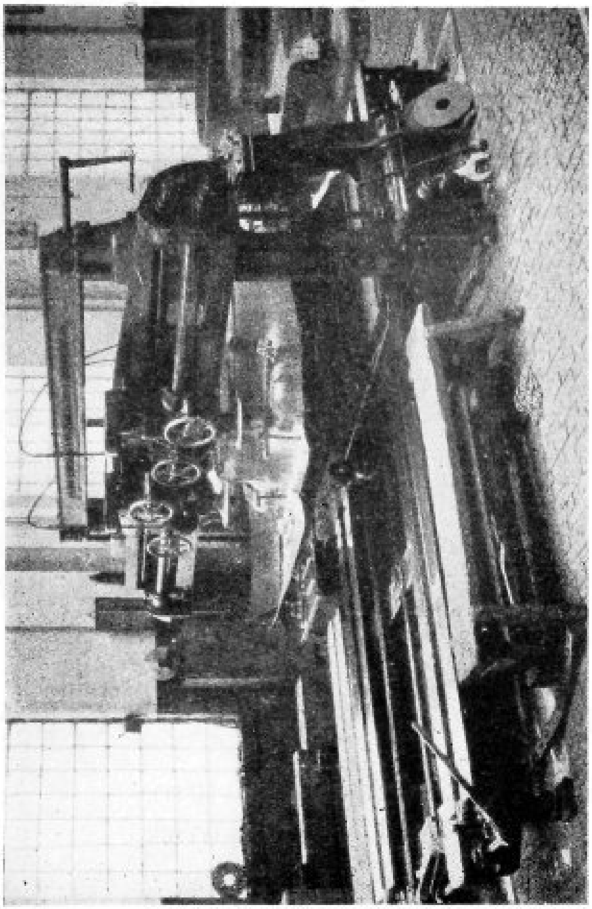
Material Storage

The first building in the boiler department, which was formerly No. 1 erecting shop, has been utilized as a receiving department and for material storage. Plate and other materials used for building or repairing boilers are received from the manufacturers, stored, and supplied on shop orders as required. Fabricated material, flanged plates and other repair parts are also kept in stock to be utilized when needed. This building is in two bays and has a length of 196 feet and a width of 80 feet 9 inches. The bays are served by overhead cranes, each of 3 tons capacity. Safety devices for handling the plates and other materials are used to protect the men. A card system is employed for checking material in and out of the stores.

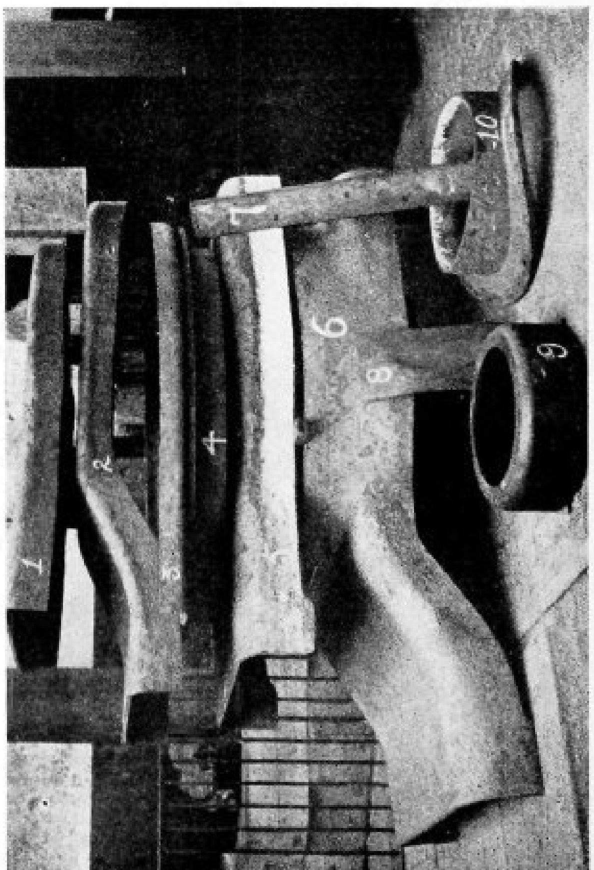
A section of this shop is divided from the storage



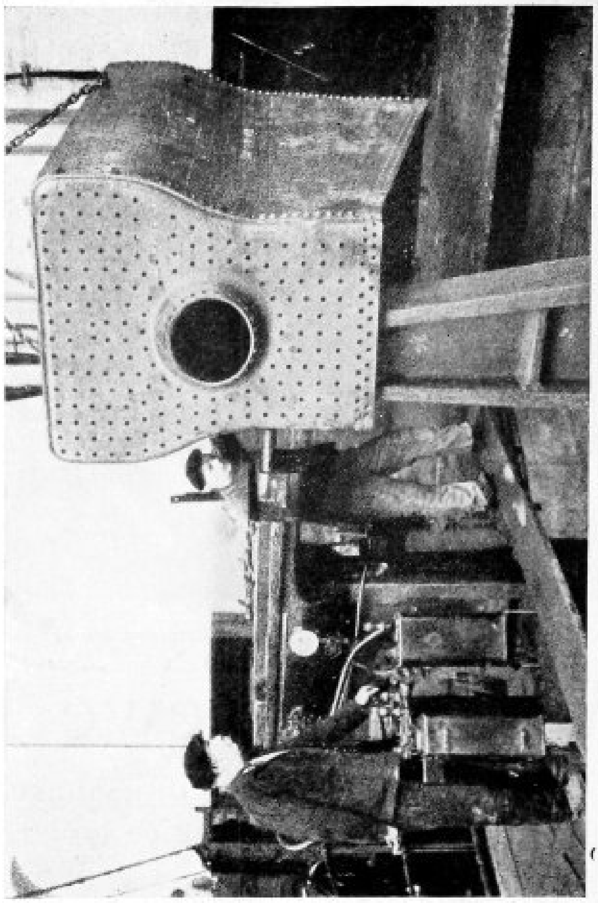
Firebox sheet in vertical, hydraulic bending machine



Throat sheet in duplex sawing machine



Flanged plates for boiler and firebox

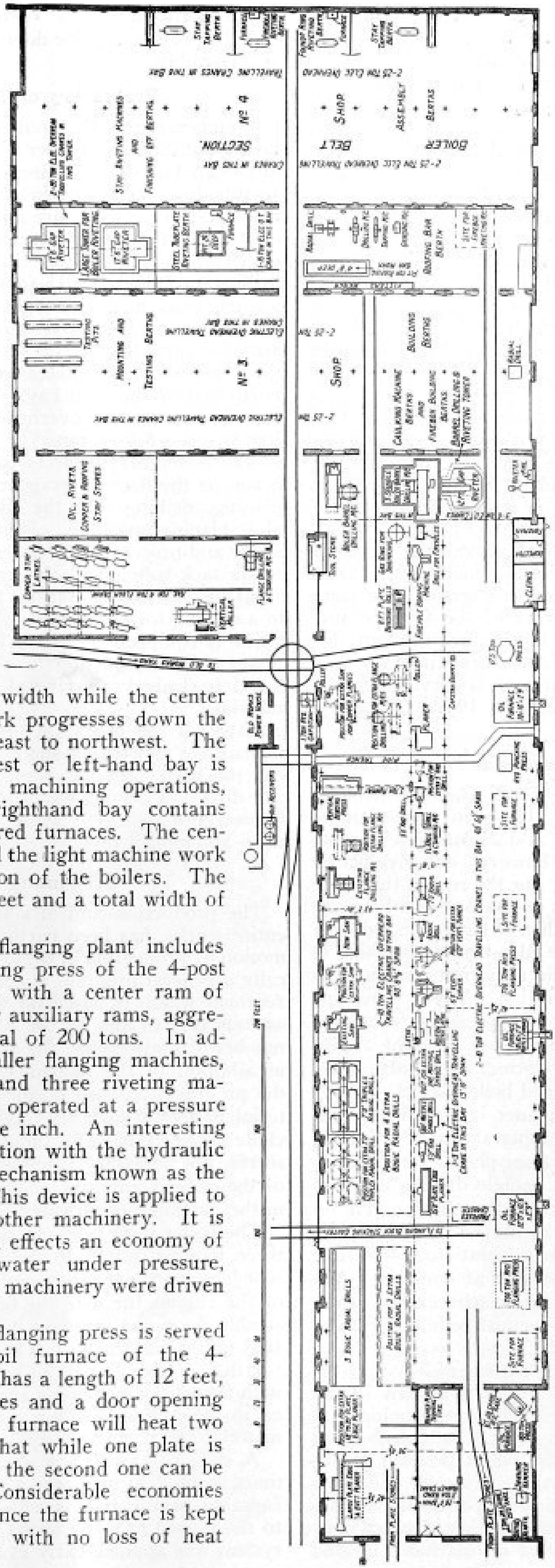


Firebox being riveted on 12-foot gap hydraulic machine department and is used for shaping and preparing material before entering the boiler shop flanging and machine sections. The equipment in this department includes a large punch and shearing machine capable of punching and shearing plates up to 1⅛ inches in thickness. Plates that are to be flanged in the boiler shop proper are shaped or punched and sheared to the required form by means of templates. Material after going through this operation is delivered to either the flanging or machine shop.

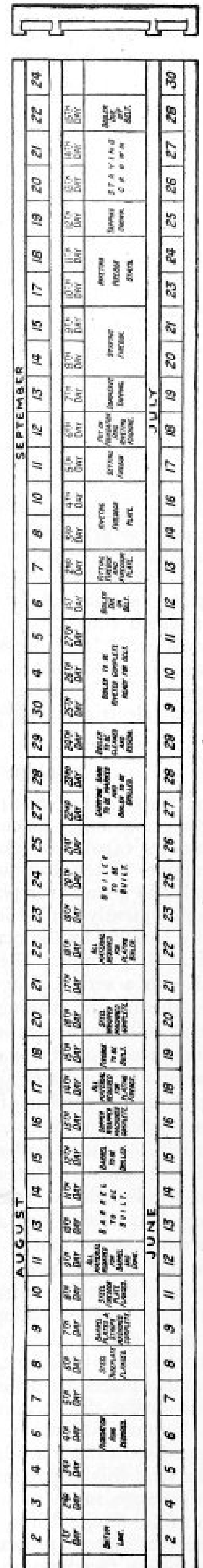
The machine section, which includes a complete installation of machine tools, furnaces, presses and the like, grouped in the proper order for the prescribed sequence of operations, is in three bays, two of which are approximately 43 feet in width while the center bay is 16 feet wide. Work progresses down the length of this shop from east to northwest. The equipment in the southwest or left-hand bay is grouped to accommodate machining operations, while the northeast or righthand bay contains flanging presses with oil-fired furnaces. The center bay is equipped to do all the light machine work required by the construction of the boilers. The shop has a length of 509 feet and a total width of 102 feet.

The equipment of the flanging plant includes a 700-ton hydraulic flanging press of the 4-post type. This press is fitted with a center ram of 200 tons capacity and four auxiliary rams, aggregating between them a total of 200 tons. In addition, there are four smaller flanging machines, a vertical bending press and three riveting machines. These presses are operated at a pressure of 2000 pounds per square inch. An interesting device employed in connection with the hydraulic pressure machinery is a mechanism known as the "power saving device." This device is applied to the flanging presses and other machinery. It is stated, that the mechanism effects an economy of 55 to 70 percent in the water under pressure, which would be used if the machinery were driven without it.

The 700-ton hydraulic flanging press is served by a large plate-heating oil furnace of the 4-burner type. This furnace has a length of 12 feet, a width of 10 feet 6 inches and a door opening of 2 feet 9 inches. This furnace will heat two plates simultaneously so that while one plate is coming to the proper heat the second one can be removed for flanging. Considerable economies are effected in this way since the furnace is kept continuously at work and with no loss of heat value.



General arrangement of boiler shops and machinery at the Crewe Locomotive Works



Slide rule for checking boiler operations with the time schedules

Flanging is required in the case of eight plates for each boiler, the principal plates being the smokebox, tube sheet, the back end, the throat sheet and the boiler barrel ring, the last-named part being recently adapted to the flanging press, having previously been made up of angle iron. Flanged plates from this department are marked off on a nearby table, the necessary center lines being drawn on them for the drilling jigs used in the machine operations. After this, the plates are ready for delivery to the respective machines where the next operation is carried out.

The flanging department is also equipped with a four-column hydraulic press operating at 680 tons pressure. This press is served by an oil-fired furnace of the semi-muffled type having six burners. This furnace is smaller than the first one mentioned, measuring 10 feet in length, 10 feet in depth with a 2-foot 9-inch door opening. This furnace and flanging press combination is mainly used for flanging copper tube sheets and similar parts. The remaining flange presses in this shop include a 630-ton hydraulic punching press for flanging smokebox door liners, smokebox fronts, dome base plates, and the like; a 175-ton press of the four-column type used for general flanging work and two other small presses for light work of a general character. A single furnace, located between the first two machines, is used for plate heating. A feature of this section is a conveyor which runs across the front of the furnace and connects with both presses. Plates drawn from the furnace move toward each press as required on this conveyor. The flanging department is served by two overhead electric traveling cranes of 10 tons capacity each.

Machine Operations

The machine bay is equipped with planing, drilling, punching and other machines. The plate edge-planing machine is capable of planing a stack of plates up to the number of ten. In practice, however, only five plates are piled in a stack for planing, for the reason that they are subsequently drilled in sets of five and can be more readily handled by the cranes than if larger stacks were fabricated as a unit. The plate edge-planing machine is fitted with a series of hydraulic rams for gripping the plates during the planing operation. These rams operate at 700 pounds per square inch pressure. The two planing heads of the machine are set at right angles to one another and a profile, or former bar, is also fitted for planing the camber of a coned boiler barrel. In addition to this equipment, the planer is also fitted with a former for outer firebox wrapper sheets.

After a stack of plates has been planed on this machine, the bundle is lifted to a mobile drilling machine arranged to move along a track laid in the concrete on the shop floor so that it may be moved as required to carry out the necessary drilling operations. The five plates are drilled by means of jigs at one time. On completion of the drilling operation, the outer firebox wrapper sheet is taken to the vertical bending press at the north end of the bay.

Flanged plates are drilled by a battery of 7-foot radial triplex drills, the location of which is shown in the shop layout illustration. Each of these machines is equipped with three heads with two tables to each head. On leaving this department, the plates proceed to adjoining flange saws, of which there are two, and from there to the flange drilling machine. The steel and copper firebox plates are next fitted together, the fire door flange being faced up and drilled on machines located at the north end of the center bay. On completion of these processes, the fire door and front sheets are ready for assembly.

Processing of Boiler Plates

Commencing at the south end of the shop with the laying out table; a number of light fabricating machines are located along the center or narrow bay of the shop. In this department, smokebox tube sheets, boiler barrel rings and dome bases are laid out and afterwards proceed along the center bay for the machine operations, which include work on the multi-spindle tube plate drilling machine, the 15-foot plate edge-planer having a single head, and other light machine operations. Upon completion of these operations, the various parts are sent forward through a series of assembly stages in the same shop, the boiler barrels being riveted at the north end of the west bay. This bay is equipped with two 10-ton electric overhead cranes while the center bay has one 3-ton crane.

The boiler barrel sheets pass through the same processes as the firebox wrapper sheets, namely, shearing, planing, drilling and the like, and finally reach the plate-planing machine. Here the sheets are bent to shape and proceed to the assembly stage, where the barrel is tack-bolted and the barrel ring and dome base fitted. From this operation, the boiler barrel proceeds to a drilling tower situated at the end of the shop. This tower is equipped with two large vertical drilling machines. On completion of the drilling operation, the barrel is cleaned and riveted on a 12-foot gap-riveting machine.

Although the operations follow along in a manner comparable to work in shops in this country, nevertheless the basic idea has been to keep work moving in one direction, saving lost motion and promoting production, the machines being grouped in such a manner as to accomplish this.

Scheduling System

The production-control system, which applies to the entire works, has been particularly adapted to the promotion of production in the boiler department. Periodically a general program is drawn up by the boiler shop foreman which is based on the erecting shop schedule as indicated to him by the works manager. A certain number of spare boilers for existing power is maintained in addition to the demands for new engines. After the program has been decided upon, the necessary material is set through the preliminary stages which include the assurance of a sufficient supply of material and stores, the necessary machine work in the preparation of the material, and its availability in a completed form in the assembly department when required.

The boiler shop foreman submits a schedule covering three months output to the works manager. On this schedule are shown the number of the boiler, the class of the engine, the date the boiler will arrive on the assembly floor and the date it is due in completed form. It is found that the largest boilers require about 15 days for their assembly on the belt. If the program meets with the works manager's approval, copies are forwarded to the foremen of the respective shops from which material and parts are required.

A slide rule, which is shown in one of the illustrations, is used to maintain a check on production. The function of the rule is self-evident since it is similar to those used in many shops in this country. Since the system was applied, early in the present year, consider- . . .

ably over 100 new boilers have come through production absolutely in conformity with the schedule arrangements which indicates that the system functions satisfactorily.

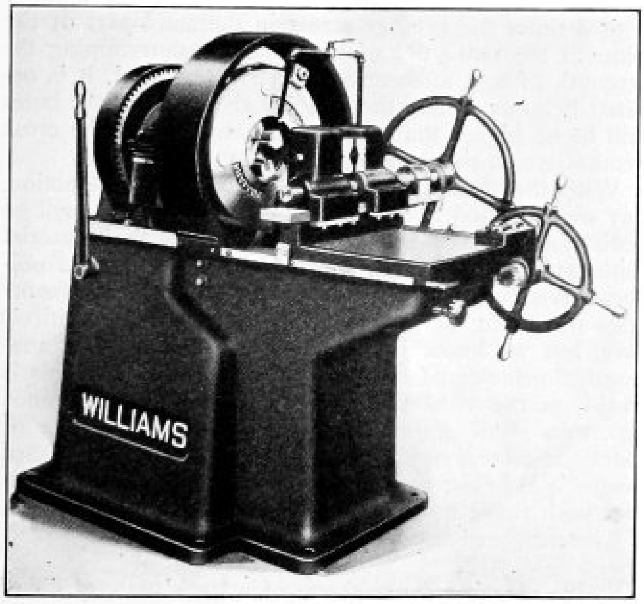
Assembling Boilers

The third shop employed for new boiler work, which is immediately north of the flanging and machine section, is utilized for assembling boilers. In this department, the boiler barrel is joined to the outer firebox, the boiler being trued up to lines and gages and checked for size. After drilling, the boiler is riveted on a 17-foot 6-inch gap riveting machine, located in a tower between the plate shop and finishing shop. After the riveting is completed, the boiler is placed on what is called the "belt," which is located in the fourth shop in this department.

(To be continued)

Rapid Rotary Pipe Threader

THE Williams Tool Corporation of Erie, Pa., has recently placed on the market a new "rapid rotary" threading machine especially designed for increasing threading production on bent pipe and nipples. This machine, as shown in the illustration, has a range of spindle speeds that gives an average cutting



The Williams Rapid Rotary bent-pipe and nipple threader

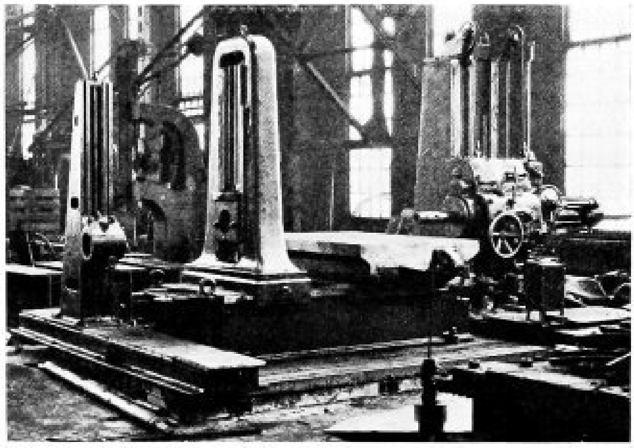
speed of 19 surface feet per minute which is said to have increased threading production as high as 60 percent over methods now in use in railroad shops and industrial plants.

The Williams "rapid rotory" reams the burr from the pipe as the threads are being cut. An automatic cam and lever trip releases the dies from the pipe the instant the thread is finished. Chucking and releasing of the pipe are made quicker and easier as a result of this automatic trip. The automatic opening and closing of the rotary die head on this new pipe threader permits a saving on set-up time.

Four sets of dies cover the entire range of the machine. The "rapid rotary" threads 1-inch to 4-inch pipe in its regular ranges and can also be used to good advantage on ½-inch to ¾-inch pipe.

Horizontal Drilling, Boring and Milling Machine

IN many metal-working shops the problem of milling or boring small pieces as well as machining very large and bulky jobs often presents itself. The situation is always troublesome where the amount



Ryerson, combination drilling, boring and milling machine

of both kinds of work does not warrant buying a floor-type and also a table-type horizontal drill.

The Canadian Bridge Company of Walkersville, Ont., Canada, had this problem to deal with until a special machine was developed by Joseph T. Ryerson & Son Inc., Chicago, Ill., which as shown in the illustration, is a combination of the two machines.

This is a standard floor type horizontal boring and milling machine having a spindle saddle with a vertical movement on its column; a column with a horizontal movement on its runway; a bed plate fastened to the runway; and an outer boring bar support which has a hand movement on the bed plate parallel to the spindle travel. It is direct-motor driven, and all speeds, feeds, and power traverse to spindle, spindlehead and column are controlled from the head. The outer boring bar support as well as the main post is fitted with vernier and scales reading to 0.001 inch.

A special self-contained portable table, used when machining small pieces, is mounted on the bed plate and can be removed when the machine is used for large work. The table has movements in two directions, parallel with the spindle travel and parallel with the column travel. It is operated by hand, but is so arranged that an electric motor can be supplied, giving the table milling feeds and rapid traverse.

For small work this combination gives practically all of the advantages found on the modern table-type machine, and with the table unit removed, the great range of the floor-type machine is available for bulky pieces.

The Brunswick-Kroeschell Company, Chicago, Ill., has transferred its boiler business to the Kroeschell Boiler Company, Chicago, Ill. The boiler works of the Brunswick-Kroeschell Company have been leased to the Kroeschell Boiler Company, which has purchased the complete business, including the inventories, machinery, good-will, etc., so that Kroeschell boilers will continue to be made in the same premises as heretofore and under the direction of the same active management.

Calculating Dished Heads*

Proposed changes to the A.S.M.E. Boiler Code rules for thicknesses of boiler and tank heads

By D. S. Jacobus

IN preparing the first Boiler Code of the American Society of Mechanical Engineers, the rules for dished heads called for thicker heads than had been used in many installations. This was particularly true in the case of small heads. It was considered advisable at the time to increase the thickness of the thinner heads, as corrosion near the circumferential seams had in some cases resulted in failure. However, it was not thought to be necessary to change the current practice for thicker heads. With the advent of higher steam pressures it became desirable to modify the rules to make them more consistent than the older rules.

New Rule Requirements

The old rules call for an added thickness of 1/8 inch for heads having manholes over the required thickness for blank heads. As the thickness of the heads increased on account of increases in the working pressures it can readily be appreciated that this led to illogical results. The new rules call for an added thickness of 15 percent for heads with manholes over the required thickness for blank heads to a minimum of 1/8 inch.

The new rules also call for somewhat thicker blank heads, the thickness for blank heads being made the same as in the Massachusetts Code. They also call for a longer corner radius than that specified in the old rules. Rules are also given for semi-elliptical blank heads in which the minor axis is at least one-half the diameter of the shell. There is also a modification in the requirements for the depth of the flange in a manhead, which is made the same as in the old rules up to a plate thickness of 1½ inches, above which the depth of the flange is made the thickness of the plate plus 3 inches. A formula for flat heads will also be included after there is an agreement of the Boiler Code Committee in regard to one that will be the best for the purpose. Rules will also be given for the strength of heads which are pierced with holes.

Further Revisions

The rules have also been revised to give credit for the strength of the stays in stayed dished heads with through stays attached by outside and inside nuts, where the heads have a minimum thickness of 7/8 inch and are at least two-thirds as thick as called for by the rules for unstayed dished heads. In preparing the first code much thought was given to the question of whether there should be any credit for the holding power of stays used in connection with boiler heads. It was decided that there should be no credit. This was due to the fact that there was no exact way of determining the strength of an overbraced structure of the sort. To be safe, the heads should be strong enough to withstand the pressure irrespective of the additional strength due to the stays.

Later on this principle was departed from in the case of wrapper sheets of locomotive boilers, where the additional strength due to the stays which run between the wrapper sheet and the crown sheet was credited. The rules which give credit to stays used in connection with heads are along the same general lines as those which give credit to the stays used in connection with wrapper sheets, and, as had been pointed out, they are limited to a specific construction and to thick heads.

Factor of Safety of Boiler Shells

It is difficult to develop consistent rules for boiler construction. The feature that stands out prominently in the minds of most of those designing boilers is the factor of safety of the shells, which, it would seem, is something that can be readily computed. A close analysis, however, shows that where a factor of safety such as 5 is called for by the rules, there is not a factor of safety of 5 for the fibers in the steel which are the most highly strained on the initial application of pressure to the boiler. To illustrate, experiments have shown that if a circular hole is made in a plate, the stress at the edges of the hole on pulling the plate is 2 or 3 times the average stress in the solid part of the plate at the two sides of the hole. In determining the strength of a tube sheet or of a riveted joint, it is ordinarily assumed that the stress at the edges of the holes will be no higher than throughout the rest of the cross section which resists the strain.

With the ductile steel used in boiler construction, any overstrained fiber will yield and the strain will be redistributed over the cross section of the material withstanding the strain, so as to be more or less uniform. We know very well through using certain formulas over long periods of time that they are entirely safe, but we know just as well that if correctly analyzed, the factor of safety will be less than 5 if this is based on the yield point of the most highly strained ligament. Rather than endeavor to say what factor of safety has been used in the new formulas for dished heads, it is better to say that they will be more consistent with those used for the shells.

The proposed revised rules are as follows:

P—195. Heads.—The thickness of a blank unstayed dished head with the pressure on the concave side, when it is a segment of a sphere, shall be calculated by the following formula:

$$t = \frac{8.33 \times P \times L}{2 \times TS}$$

where

t is the thickness of plate in inches.
P is the maximum allowable working pressure in pounds per square inch.
TS is the tensile strength in pounds per square inch.
L is the radius to which the head is dished, measured on the concave side of the head in inches.

Where two radii are used, the longer shall be taken as the value of L in the formula.

When a dished head has a manhole opening, the thickness shall be increased by not less than 15 percent of the required thickness for a blank head computed by the above formula, but in no case less than 1/8 inch additional thickness over a blank head. Where a dished head has a flanged opening supported by an attached flue, an increase in thickness over that

* Abstract of a paper presented at the sixth annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.

for a blank head is not required. If more than one manhole is inserted in a head, the thickness of which is calculated by this rule, the minimum distance between the openings shall be not less than one-fourth of the outside diameter of the head.

The radius to which the head is dished shall not be greater than the diameter of the shell to which the head is attached.

Where the radius *L* to which the head is dished is less than 80 percent of the diameter of the shell the thickness of a head with a manhole opening shall be at least that found by making *L* equal to 80 percent of the diameter of the shell. This thickness shall be the minimum thickness of a head with a manhole opening for any form of head.

A blank head of a semi-elliptical form in which the minor axis of the ellipse is at least one-half the diameter of the shell shall be made at least as thick as the required thickness of a seamless shell of the same diameter. If a manhole is placed in an elliptical head the thickness shall be the same as for an ordinary dished head.

The diameter of the shell to be used in applying these rules shall be the inner diameter of the shell for a head fitted to the inside of the shell and the outer diameter of the shell for a head fitted to the outside of the shell.

Unstayed dished heads with the pressure on the convex side shall have a maximum allowable working pressure equal to 60 percent of that for heads of the same dimensions with the pressure on the concave side.

P-196. When dished heads are of a less thickness than called for by Par. P-195, they shall be stayed as flat surfaces, no allowance being made in such staying for the holding power due to the spherical form unless all of the following conditions are met:

(1).—That they be at least two-thirds as thick as called for by the rules for unstayed dished heads.
(2).—That they be at least 7/8 inch thick.
(3).—That through stays be used, attached to the dished head by outside and inside nuts.
(4).—That the maximum allowable working pressure shall not exceed that calculated by the rules for an unstayed dished head plus the pressure corresponding to the strength of the stays or braces secured by the formula for braced or stayed surfaces given in Par. P-199 using 70 for the value of *C*.

If a dished head is formed with a flattened spot or surface, the diameter of the flat spot shall not exceed that allowable for flat heads as given by the formula in Par. P-195 (the formula for flat heads to be published later on).

P-197. The corner radius of an unstayed dished head measured on the concave side of the head shall not be less than 3 times the thickness of the material in the head; but in no case less than 6 percent of the diameter of the shell.

P-198. A flanged manhole opening in a dished head shall be flanged to a depth measured from the outside of the head at the minor axis of not less than 3 times the thickness of the head for plate up to 1½ inches in thickness. For plate exceeding 1½ inches in thickness the depth shall be the thickness of the plate plus 3 inches. A manhole opening may be reinforced by a riveted manhole frame or other attachment in place of flanging.

Australian Progress With Boiler Standardization

By G. P. Blackall

GOOD progress is being made by the sectional committee appointed by the Australian Commonwealth Engineering Standards Association to draw up uniform regulations for boilers. Under the direction of this committee, of which J. A. Gibson, of Sydney, is chairman, the work has now been taken in hand by the various panels and sub-committees throughout the different states of the commonwealth.

The work has been subdivided under various headings, sub-committee No. 1 for example, being concerned with power boilers, while sub-committee No. 2 is concerned only with locomotive boilers. Similarly other panels have been formed to consider the problem in all its relationships to miniature boilers, cast-iron boilers, gas cylinders, and pressure vessels, the organization throughout Australia being now almost complete.

The objects of the boiler sectional committee are the preparation and promotion of uniform rules in connection with the design, construction and inspection of boilers and unfired pressure vessels, materials, etc., and periodically to review them with a view to amendment in order to bring them into line with modern requirements. The promotion of cordial relations between the Australian Commonwealth Engineering Standards Association and persons interested in the objects of the committee, and the coordination of the efforts of boiler makers and boiler users for the improvement of boiler and pressure vessels, materials, processes and methods, is a further very important function of the sectional committee.

Co-operation With Other Boiler Groups

Constant touch is maintained with boiler code organizations in other countries, in order that the work in Australia may be thoroughly up-to-date, and in accordance with the best practice adopted throughout the world. The state panels under the respective chief inspectors of machinery are at present chiefly concerned with the preparation of draft rules for power boilers. Later they will also consider the question of pressure vessels, but up to the present attention has only been given to the larger question of power boilers as it affects each state.

In formulating the draft regulations which will be reviewed by panels working in each of the states, the sectional committee has made an exhaustive study of boiler codes in use elsewhere, and, although, as far as possible, the British Board of Trade rules have been adopted as a basis for the Australian rules, a departure from this particular code is being made wherever the requirements of Australian conditions seem to justify it. The second section of the work is the preparation of general conditions governing design, workmanship and hydraulic test, and this involves the consideration of conditions which vary to some extent in accordance with the requirements of the conditions under which boilers are to be used.

Apart from the great saving that will be effected by the adoption of uniform requirements in regard to boiler construction, the question of the safety of those employed in their operation is of great importance. The supervision which is exercised in regard to the construction, maintenance and operation of boilers throughout Australia is such that a very enviable freedom from accident is enjoyed there as compared with many other countries.

It is with the idea of tightening up the regulations so that the uniform code for Australia may enable the greatest safety factor possible to be attained that the boiler sectional committee has been set up by the Australian Commonwealth Engineering Standards Association. When its work is completed and a uniform boiler code issued, it is anticipated that the immediate results obtained from its adoption will be sufficient reward for the painstaking work which is going into the preparation of the rules, all of which is being done voluntarily by the expert members of the various panels and committees.

Apprentice Training on the U. P.*

A frank discussion of the underlying principles and philosophy of the plan

By R. H. Beauchamp

Special representative of vice-president of operation, Union Pacific System Lines

EDUCATION for a long time held disdainfully aloof from trade contamination with a tenacity singularly remarkable, and industrial progress was painfully slow. Our progress of the past few years has been markedly rapid, but this was not occasioned by smarter men being born, it came with the putting of overalls on education.

Vocational education is not something mysterious and difficult to comprehend; for to do a thing accurately and efficiently, and understand the purpose and technique, and to learn to properly explain and repeat the performance, is education plus training, which means vocational education. However, it means a little more in the mechanical trades, in that the ability to sketch, make technical computations, and reproduce from sketches is involved.

We have vocational training under many aliases, such as apprentice training, foremanship training, safety first measures, courtesy campaigns, shop councils, round-table discussions, and meetings of various sorts. It is the aim to reach all departments, for there is just as much need for vocational training among the various other industrial occupations as there is with the mechanical trades.

Who is to Pay?

The need of industrial education is apparent and recognized, but the big question is: "Who is going to pay for it," Industry has been paying practically the entire cost, but now and then there are indications that workers are becoming conscious of the fact that mental development is principally their responsibility. However, I occasionally hear the plaintive cry that industry gets all the benefits of increased efficiency that workers are able to show through mental and manual training. The greatest wage-fixing influence of labor is wholesome intelligence, and the only way in which labor can hope to successfully attain its ends is to properly develop that most powerful influence the world has ever known, the human mind.

Industrial executives should also realize that we are fast approaching the age when the standing of each industry on the industrial chart will be measured, not alone by the intelligence of a few executives, but by the collective intelligence of the entire industrial concern. Honest capital is the victim of ignorant labor, and ignorant labor is the victim of dishonest capital. Industrial education will promote co-operative effort, the fundamental of democracy, and operate to remove ignorance, dishonesty and drudgery. It is the surest road to industrial peace, and both industry and labor are benefited in the same measure.

A Democratic Procedure

An industrial educational program must have a sympathetic understanding and the sincere interest of those for whom it is intended, yet some do not seem to comprehend the necessity of discarding the cloak of pedagogy and getting on common ground with the worker and industry, in order to build that confidence and faith so necessary to the proper commencement of educational development. Industrial training is, essentially, a democratic procedure, and must be carried to industry and become an integral part of industry; you can't take industry out of its environment to put it "in school." Furthermore, education must be sold to the worker, and if a demand is to be created, then it must be attractive and profitable.

Some have leaned toward vocational education by correspondence; but to my way of thinking this method with the industrial trades just about approaches zero in educational endeavor. I do not mean to condemn correspondence courses, as a whole, but I am firm in the belief that insofar as the mechanical trades are concerned, most courses, so far, have proved of little practical value to the apprentice. Furthermore, I am fearful that the reaction in too many instances has seriously retarded industrial education; for subscribers to a vocational correspondence course frequently give up in despair, and having lost faith, they seem to lose spirit.

The classroom work of technical instruction should be in close contact and interwoven with the practical work, and the instructor should have both under his immediate observation, because the apprentice needs guidance while he is doing the work rather than after the work has been done. When a correspondence course is of value, it will, as a rule, prove materially beneficial only to those with advanced education; and most workers do not belong to this class. Therefore, vocational education, being intended for workers with a primary or retarded education, a correspondence course can be of value only when dove-tailed with personal contact by instructors, to see that the ideas are being absorbed and properly understood. We desire that our apprentices have constant contact with instructors and supervisors, so that information will be immediately available, to the end that errors may be avoided and production not retarded.

Every Supervisor an Educator

Every supervisor should be an educator, and industry is learning that one of the principal requisites of the supervisor is the ability and will to educate and train those under his supervision. No training plan will ever be successful unless it has the sympathetic interest and active co-operation of the supervisor. And to create and secure this interest and co-operation, he must be made to feel that he is not only responsible for discipline of apprentices, but is, in fact, one of the most important members of the teacher faculty. From this statement I believe you will understand why we have been sold to the idea of foremanship training, which I consider the outstanding contribution of federal and state vocational men to industrial education.

In developing our apprentice training plan we readily admit that the little word "economy," which means so much to successful business, was the principal of the composite which influenced our action. We carried the

*From an address before the American Vocational Education Association at Los Angeles, Cal., December 17, 1927.

conviction that to train men to our standards and develop their creative and productive powers by teaching the technical side, as well as the practical, and thus build up an organization of efficient men and good citizens, eager to make the most of their attributes and thus command respect and merit promotion, was a big step in the interest of economy; and we have found it so. The men we train develop a sort of ownership feeling toward our company, which has a subtle retaining and stabilizing influence, and now, happily we find that our mechanical labor turnover (labor turnover is the curse of industry and workmen) has been reduced to a reasonable minimum.

A Broad Influence

Our plan embraces more than education and training. We go so far as to be interested in the social and home life of our boys; but our activities in this respect are so guarded that it may not properly be said that instructors or supervisors assume an unseemly inquisitiveness or meddlesome attitude. Good character is a valuable asset to the man and the institution for which he works, and it is good business to develop high class men. We also encourage thrift.

We do not pretend to be an institution of learning; but an industrial concern that has for its objective safe, efficient, and reliable service. We do not give degrees or awards—except in a manner appropriately fitting, we do give a certificate at the end of the journey—but turn out a finished product fully qualified as a journeyman, who will prove a valuable asset to the institution that employs him. It is also our aim to develop honorable, upright, loyal citizens.

We provide well equipped school rooms at all our larger shops, and class room attendance, four hours per week, not to exceed 40 weeks per year, is compulsory. We also encourage attendance at part time classes and special study of subjects in which they appear deficient, and our instructors and supervisors are eager to lend assistance. Materials and supplies, including text data and class room equipment, are furnished by the company. Apprentices must take proper care of the instruments loaned to them.

We have apprentice instructors at all main shops. These are fortified by the valuable assistance and cooperation of the vocational education departments of various states and the federal government, and vocational education departments of some of the city schools. State, federal and municipal representatives also cooperate in vocational extension work with other employees.

Most of our apprentice instructors have gone through college, and have also served time as apprentices. Our requirements are that they be men of good character, so that they may teach character building in the simple way so well understood by the boy, namely, by example. They must be instructors of ability, peculiarly adapted to the work of handling boys; natural leaders. But in addition to the apprentice instructors, each foreman is also a leader and responsible for the boys under his supervision. Questions of boys must never be ignored and their discrepancies must not be overlooked. Cursing or other improper treatment of apprentices is unheard of on the Union Pacific System.

Selection of Apprentices

Next to the selection of instructors, is the selection of the apprentices, to which we are now directing special attention. The efficiency of a mechanical product is largely dependent on the quality of the material used; and the same principle applies to the apprentice. Railroad mechanical work is important, and a mechanic should be efficient, accurate and reliable; for the transportation of commodities and human life with safety and dispatch depends on the quality of his product and the accuracy of his work. Therefore, to select a boy who is lazy, careless, unresponsive to responsibility, and physically or otherwise incompetent, is not only a liability insofar as economy is concerned, but his employment would be unjust to the public. We require the equivalent of an eighth grade education as one of the entrance requirements, and the minimum age limit is 17 years.

Favoritism is frowned upon, and, so far as it is possible to do so, not only the apprentice instructor, the foreman, the master mechanic or the shop superintendent have a hand in the selection and employment of apprentices, but as a follow-up measure I try to find time to have an early personal interview with each new apprentice taken into the service. He is told about many things he can do and of just a few things that will not be tolerated. We tell him that great opportunities may be found in the mechanical field, and that his progress and future achievements depend on his application to work and study as well as on his character, ability and endeavor.

Mental Standards

We have a minimum mental standard in accepting applicants, which is determined by written examination and personal interviews. I have little faith in fancy schemes like the so-called intelligence tests, or psychological tests. I do not know much about them, but I do know that when it comes to the creative arts and the handling of men, certain men possess that undefinable something which makes them outstanding. No one knows what that undefinable something is, and no intelligence tests will reveal it; only actual contact with the work and men will indicate to any degree of certainty whether or not a man has it.

Most of our supervisors and instructors would not recognize psychology dressed up in "fancy togs." But whether they realize it or not, all are applied psychologists and teachers (if not, it is a reflection on the management), and as proof outstanding of their ability in these respects, they are selecting and placing boys who are developing into just the sort of men we need; men who learn the technical as well as the practical side of their trades, and who graduate as applied psychologists and tradesmen. And if they show that undefinable something which qualifies them for leaders or specialists, they are assigned to the positions they will best fit.

Apprentice Boards

The boy is taught not to be afraid, but that he must respect his superiors in rank and age. He soon learns we have apprentice boards that keep a careful check of his conduct and his work in the school room, as well as of his practical work in the shop. Each apprentice board is comprised of the master machanic (or shop superintendent in charge), general foreman and three departmental foremen, and one mechanic each from the seven mechanical crafts. The board must meet at least once every three months, and the master mechanic or the shop superintendent, as the case may be, is the chairman. It is the duty of the board to note the progress of each apprentice, analyze the progress made in the examinations held by apprentice instructors, and examine all other reports that have to do with the deportment, schooling and training of apprentices. It is the duty of the apprentice board to take such action on all matters affecting the apprentice as will reflect a decided interest in their welfare and above all in their progress.

The board, by majority vote, may remove an apprentice from the service or change his occupation. In case of a tie vote, the apprentice is given another trial for such period as may be agreed upon by the board, and during the trial period he is paroled to the chairman of the board, who has sole authority as to disposition during that period. It should be understood, however, that authority of the board does not abrogate agreement rules with respect to investigation and right of appeal. Apprentices consider it a severe reflection if called before the board for discipline, and, happily, we are reaching the point where such instances seldom occur. In order to insure the efficiency of the apprentice boards, all details of each meeting must be spread in the minutes, showing the action taken in each case. The minutes are reviewed by the proper mechanical officers, and are held available for inspection by other officers authorized to review this intimately human side of our training plan.

Our apprentice training program does not, therefore, resolve itself into a one-man proposition; every mechanic on the job with whom an apprentice works, and every supervisor on up to the general manager of the property, and up to the vice-president of operation, has an interest and responsibility. Even the president of the company thoroughly understands our plan and takes a personal interest.

A Definite Schedule

We have a definite schedule for practical work in the shop, which may be varied at the discretion of the apprentice instructor. In our school rooms we teach blue print reading, railroad shop drawing, which includes freehand sketching (the importance of which I wish to emphasize), shop arithmetic, and other subjects closely related to actual shop work, such as operation of air equipment, automatic train control and radio. Instruction on the latter subjects, however, is restricted to certain trades and to such details as will prove of practical value to the apprentice.

We are now devising a plan having for its purpose the requirement that each apprentice make a detailed analysis of important jobs, which I much prefer to so-called intelligence tests. We have shop classes on the more important work such as valve setting. Apprentices are sometimes permitted to rebuild freight cars and locomotives as exclusive apprentice productions. We have lectures on safety first, and a definite plan for boys to preside at safety first meetings, shop councils, and other meetings, for which they are frequently required to prepare articles which they know are subject to constructive criticism. We encourage apprentice clubs, but the boys must promote, finance and conduct them on their own responsibility.

We have a system of grading and some standard reports showing characteristics, progress, etc., but I think it is a mistake to burden apprentice instructors or supervisors in this respect. Progressive examinations do not impress me nearly so much as occasional conferences with apprentice boards, supervisors, and instructors, to learn from them their knowledge of each boy in the shop; for if they are able to tell us all we want to know regarding each boy, then we feel there is no occasion for apprehension in respect to the sort of boys we are going to graduate. If progressive examinations will help the boy, then it will be very well to continue them, but if they are intended to tell the supervision something they already should know, they represent time wasted.

Does It Pay?

The mechanical trades demand trained men and railroads have always trained men and paid the cost of training. Just now we happen to have the cost localized and it stands out like a "sore thumb." The cost, however, has always been with us, and the objections I hear remind me of the old expense account gag, involving the overcoat which was included but could not be seen. Industrial executives who believe they are getting trained men without paying for the training are either wholly unfamiliar with what takes place, or content with the "covering up" process; that is, they know the cost of training is in the expense account, but are content so long as lack of exposure does not invite criticism. The difficulty now is that the champions of a prescribed program, who boldly put the "overcoat" in the expense account where it can be seen, are obliged to defend and justify this item of expense; and their chief difficulty lies in the inability to compare a visible expense with a hidden expense.

For example, say we have 1,000 apprentices attending school on company time four hours per day, 40 weeks per year, and the average rate of pay is 50 cents an hour. A few simple computations and we find that the cost of class room attendance is $80,000 per year. Those on the negative side gleefully throw the spotlight on that outstanding figure, and promptly tell you that it is an additional expense, and that the training given is not responsible for the present state of efficiency in shop operations; that tightening up of supervision, speeding up of production, etc., are the responsible factors. This is not an additional expense; it is an exposed expense.

While I do not say that our training program is responsible for every improvement made in the mechanical department, I do say that it has made a healthy contribution to the improvement, and that every venture to improve service is a training process, call it what you may, and industry pays the bill. There are no tangible assets which can be fished out to show that our training program is costing a lesser amount than previously expended, for previous expenditures were hidden. One may support ones argument with generalities, but it takes an unusually clever person to be convincing when dealing with generalities. However, I am firm in my conviction in comparing the results obtained, that we are expending far less to train men than the old method would now cost us.

I do not believe that industry should be required to pay the entire cost of class room attendance. Some think this cost should be on a 50-50 basis; and that would help considerably. I like the 50-50 idea, but I really think that in teaching a man the practical side, safeguarding his person and health, and paying to him a decent wage, is the 50 per cent side of industry, and that a free contribution of time necessary for study and mental development, and a manifestation of willingness and eagerness to render safe and efficient service within reasonable limits of mental and physical endurance, ought to be the 50 per cent side of the worker.

P. E. Terroy, formerly directing inspector of the Hartford Steam Boiler Inspection and Insurance Company at Atlanta, Ga., has been appointed chief inspector of that company at Baltimore, Md.

Hal F. Wright has been appointed assistant to the general manager of sales of the American Chain Company, Inc., and associate companies, with headquarters at Bridgeport, Conn.

Locomotive Boiler Construction-IV*

Layout of dome course, combustion chamber ring, liners and rivet holes for small flanges

By W. E. Joynes†

THE developed plate drawing of a cylindrical dome course is shown in Fig. 16. The steam dome is always located on a cylinder course unless the design of the boiler is such that the proper location for the dome brings it on a gusset course. Locating the dome on a gusset course is avoided when possible.

When the dome is applied to a cylinder course, the plate outline and details can of course be laid out similar to the instructions that have been given for cylindrical rings.

The instructions as given for laying out the various types of cone courses are also applicable to these courses when a dome is located on them.

The layout of the dome opening, dome rivet holes and the dome-opening-reinforcing-liner rivet holes is as follows:

The dome opening or the hole in the shell for steam passage to the dome, and the two rows of rivet holes, in circles around the same for the reinforcing liner connection, are laid out and the rivet holes spaced as shown.

The rivets securing the dome to the shell are located between the two circles of liner rivets. These dome rivets are not laid out and drilled in the plate in its flat form, but are drilled first in the base of the dome. The dome is then clamp bolted to the rolled shell and the holes drilled through the shell, directly from the holes in the base of the dome.

When duplicate plates are required, the dome steam opening is burnt out of the pattern plate before the plate is rolled into shape. The location of the opening can then be center punched on the duplicate plates from the pattern plate

The opening is not burnt out of duplicate plates until after the plates are rolled into shape. Retaining

* The first instalment of this series appeared on page 218 of the August issue, the second on page 253 of the September issue, and the third on page 291 of the October issue.

† Boiler designing department, American Locomotive Company, Schenectady, N. Y.

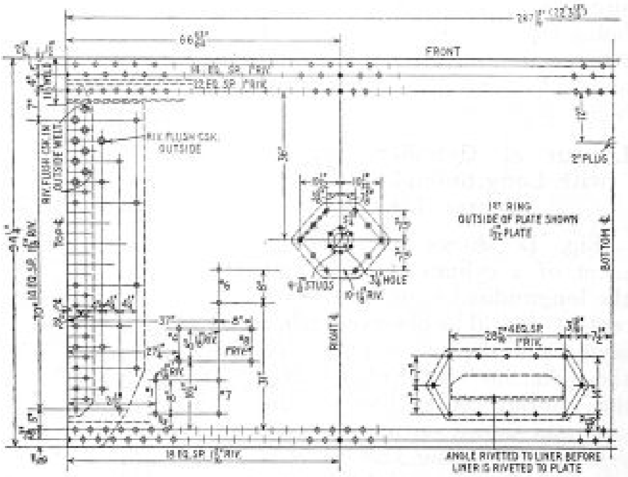


Fig. 17.—Cylinder course development with longitudinal seam on top center

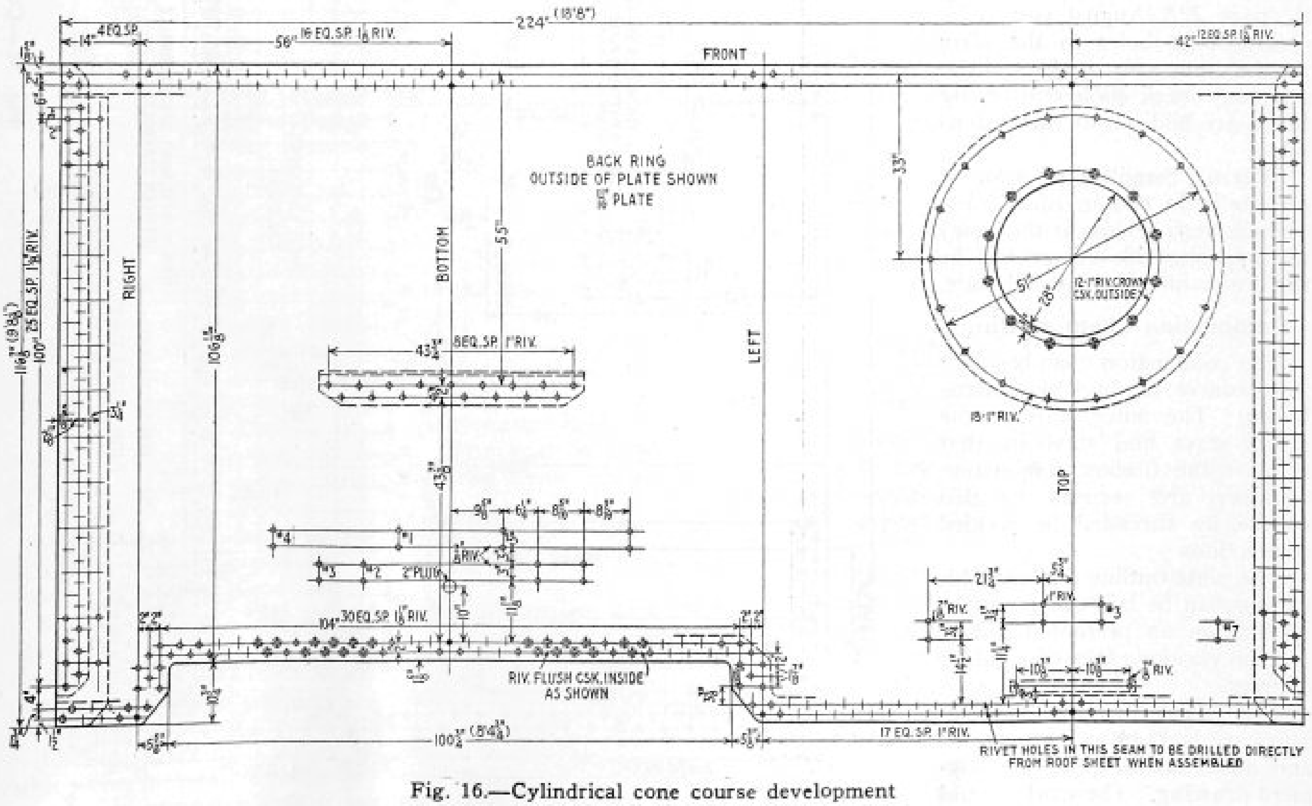


Fig. 16.—Cylindrical cone course development

the full plate metal, greatly facilitates the rolling of the plate. Removing a large piece of metal from a flat plate makes it more difficult to obtain a true radius, about the opening, when rolling the plate.

The plate shown in Fig. 16, being the last or back ring of the boiler, the bottom half of it is riveted to the throat sheet; and the top half (except in a boiler with a continuous throat design) is riveted to the roof sheet. The cutout at the back end is laid out as dimensioned and the rivet holes spaced off as shown for the throat sheet connection.

True rivet holes and better results are obtained when the rivet holes for the roof sheet connection, to the top half of the ring, are drilled directly from the rivet holes of the roof sheet seam.

Layout of Cylinder Courses with Longitudinal Seam on Center Line

Fig. 17 shows the development of a cylinder course with the longitudinal seam on the top center. It will be observed, when laying out the metal plate that the center line of the plate is also the bottom center line of the wing, as shown on the plate development drawing, and that it is not necessary to establish new center lines, as is done when the seam is off the center, as in Fig. 2 (page 222, August issue).

The rivet holes in the plate for the guide-yoke angles and the injector - check - hole reinforcing liners are laid out as dimensioned.

When a longitudinal seam is on the side center of a ring, (which very seldom is the case) the opposite side center will be the center line of the metal plate.

Combustion Chamber Ring

The combustion chamber ring is, of course, the back ring of the boiler. The outer ends of the radial stays and staybolts that support the firebox combustion chamber are secured to this course by threaded or welded connections.

The plate outline and rivet locations can be laid out from the instruction as presented above, for the various types of clyinder courses.

The radial stay and staybolt holes are laid out as dimensioned and noted on the plate development drawing. The work should

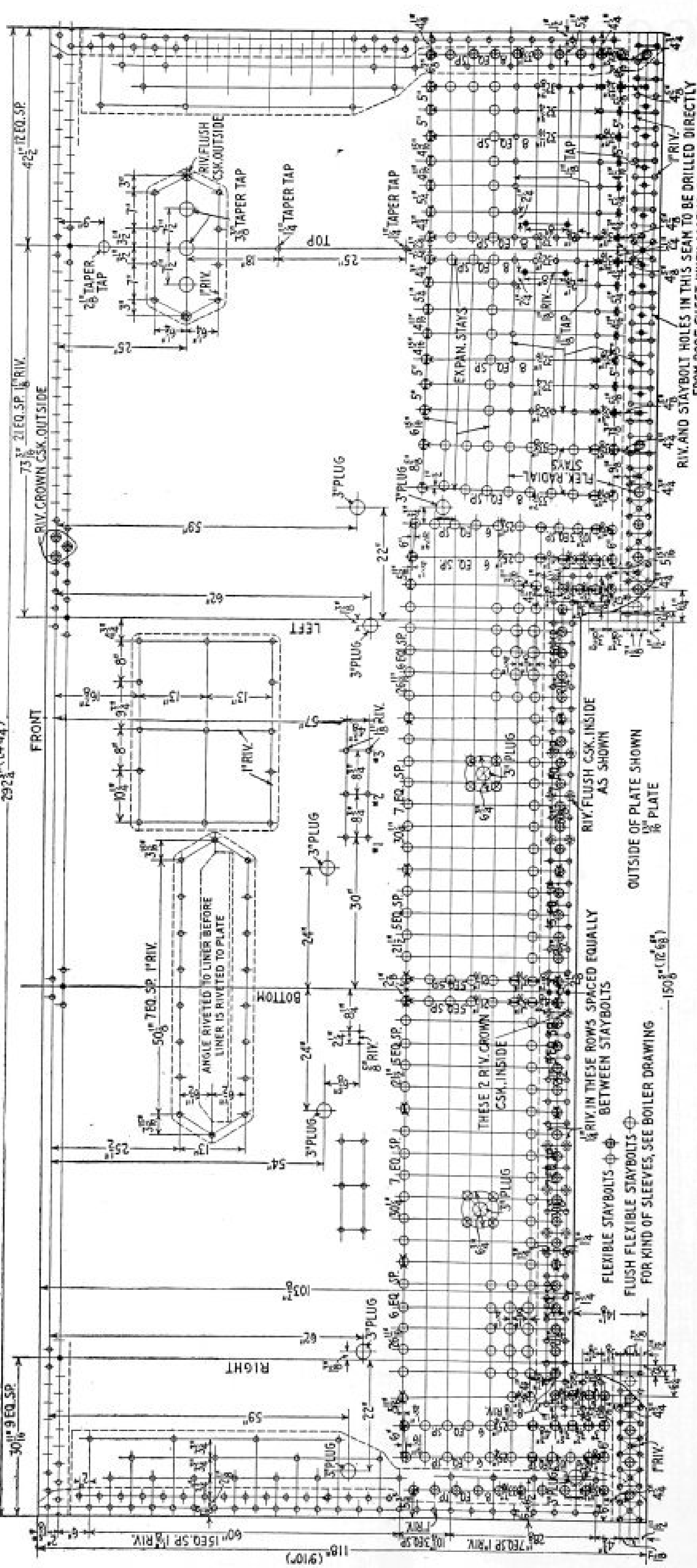


Fig. 18.—Combustion chamber ring development

be done with care to avoid mistakes in the location of staybolt holes and other details.

Fig. 19 is the pattern-plate layout for the round dome liner as shown on the dome course (Fig. 16). Find the center line of the liner in the longitudinal direction and draw a line the full length of the plate. Find the center of the plate in the other direction on this line and draw a short line.

The liner being applied on the inside of the boiler shell, the 28-inch diameter steam opening shown on Fig. 16, draws away from the shell opening, at the sides, when the liner is rolled to fit the shell. Therefore, the liner opening should be made smaller transversely to retain the rivet lap, around the opening. This is accomplished by centering the 14-inch opening radius, a proportional amount off the center line to allow for the difference of the rolled neutral axis of the shell and liner. This makes the liner opening smaller transversely in the flat plate, but conformable to the shell opening, when applied to the rolled shell.

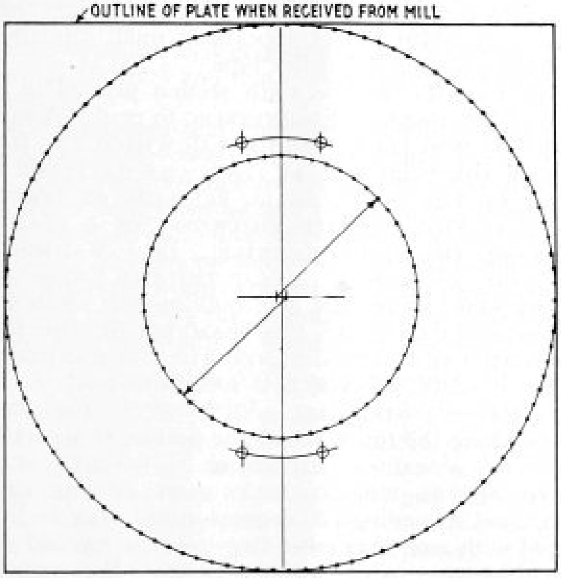


Fig. 19.—Layout of pattern dome liner—showing tack holes —ready for rolling and then bolting to the boiler for marking off the remaining rivet holes

Scribe (soapstone line) part of the inner rivet circle at the front and back of the opening and locate the two top rivet holes, front and back. Measure (from the center line) the location of these holes as laid out on the ring and then make a proportional allowance for the location of the same in the liner.

Scribe a circle for the diameter of the liner as dimensioned on the boiler drawing. Marker punch all around the outline and the opening.

The four top holes, as proportionately laid out should be punched for tack holes. The liner is now rolled to a radius slightly larger than the inside radius of the boiler shell.

Using the tack holes, bolt the liner to the shell. With a marker-punch, locate the holes in the two rivet circles of the shell, on the liner.

Re-roll the liner flat and burn off the outline and opening. Return the liner to the laying out section; center punch the location of the tack holes and marker punch (air hammer operated) around the opening and the outline of the duplicate liners.

The liners are next bolted together and drilled, after which the material outside the outline and inside the opening is removed with a burning torch. The liners are then rolled to shape for application to the shell boiler.

Waist-Sheet and Guide-Yoke Angle Liners

With the exception of small boilers designed for low pressure, the present practice of waist-sheet angle-iron application is not to rivet the angles directly to the boiler shell. A bearing plate is riveted on the outside of the shell. The boiler may slide back and forth on the angle irons supported by the waist sheet, with the bearing plate as a protection for the shell, or the angles can be riveted directly to the liner plate, but, *not* through both the liner and the shell.

The guide-yoke angle liners are similar in design to waist-sheet angle liners or bearing plates, with the exception that the angles must be riveted or made secure to the liners. Liners and angles of this design are shown on either side of the bottom center line of Fig. 17.

The liner rivet holes for the shell connection and the angle-iron rivet holes can be laid out; the liner drilled, planed and rolled ready for application to the boiler. The circumferential locations of the rivet holes are, of course, proportional to the neutral diameter of the boiler shell and the liner. The necessary dimensions for the location of the rivet holes in the shell and the liner should be given on the boiler drawing. With careful laying out, to avoid mistakes, this method of liner layout is less expensive than the more practical method of rolling a liner up for marking the rivet holes directly from the shell.

The rolled-up liner, marking-off method is as follows:

An outline a little larger than the finished outline of the liner is marked on the boiler shell. This is quickly done by bending a thin metal strip against the shell, in line with the edge of the rivet holes, then marking a line along the opposite edge of the strip.

The course is turned on the floor, to place the liner rivet holes at the top. The liner plate is laid on the shell equally within the outline that has been marked around the rivet holes. Long beam bars, extending the full length of the shell, are laid over the liner. Draw the bars tightly against the liner by bolting through the circumferential seam rivet holes, or other holes that may be nearer. Now, center the holes in the liner with a marking punch.

Re-roll the liner flat and mark off the outline from the center of the rivets, as dimensioned on the boiler drawing. Shear the outline for planing and punch for tack holes. Center punch tack hole locations and marker punch the outline of duplicate liners before drilling.

All liners, on cylinder courses, whether on the outside or inside of the boiler shell can be laid out by either of the foregoing methods.

Liners on Cone Courses

The outline of liners on cone courses being curved to the cone development, the liner rivet holes cannot be laid out independently of the shell, in a practical way.

A practical method for locating rivet holes in a liner that is to be riveted to a cone course, without rolling up the liner for marking the holes directly from the boiler shell, is as follows: Bend a thin metal sheet over the liner rivet holes, of the rolled shell. Mark the hole locations on the sheet with a soapstone pencil.

Lay the sheet on the layout table and draw a straight line between the centers of the extreme end holes, front and back. Layout the cross section of the shell and liner; space hole locations on the shell as dimensioned on the plate development drawing. Extend the radial line from two of these space points through the liner and then gage, with dividers, the distance between the rivet hole centers of the liner. This distance may also be proportionately calculated.

Draw a straight line at the front and back of the liner plate. The lines are to be far enough from the liner edge to allow for the rivet lap and the curve of the rivet line as marked on the thin metal template.

Transfer the rivet space as gaged with the dividers to the liner and scribe a short arc. Measure or gage with the dividers, from the template, the distance between the straight line and the center of the second rivet hole from the end. Transfer this measurement from the template to the liner and make a point to intersect the short arc, which has been scribed for the rivet space. Continue this operation for all of the liner rivet holes. Mark off the outline lap from the rivet holes as given on the boiler drawing. Center punch hole centers and marker punch the outline. This completes the liner layout.

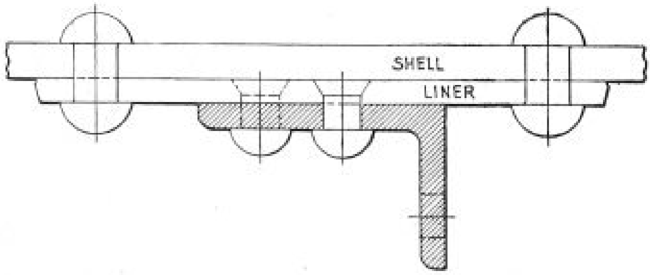


Fig. 20.—Detail of guide yoke angle and liner riveting

Layout of Rivet Holes for Small Flanges Riveted to Boiler Shell

It is more efficient in production to layout all the holes possible in the shell before rolling the shell to shape. The rivet holes for small flanges, such as wash-out-plug and injector-check flanges, that are riveted to the shell, should be laid out in the flat plate.

The rivet holes in these flanges are marked off from the shell. A short line for the diameter or width and breadth of the flange is marked symmetrical with the hole center, top and bottom and front and back, on the rolled shell. The flange is then placed on the shell, between the guide marks, and the rivet holes marked on the flange.

Fig. 20 shows the detail of the riveting of the guide-yoke angle to the reinforcing liner and the riveting of the liner to the shell.

(To be continued)

Revisions and Addenda to the Boiler Construction Code

It is the policy of the Boiler Code Committee of the American Society of Mechanical Engineers to receive and consider as promptly as possible any desired revision of the Rules and 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 the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the committee for consideration.

After a reasonable time has 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.

Par. P—195. Revise sixth section printed in July issue of MECHANICAL ENGINEERING to read: A BLANK HEAD OF A SEMI-ELLIPTICAL FORM IN WHICH THE MINOR AXIS OF THE ELLIPSE IS AT LEAST ONE-HALF THE DIAMETER OF THE SHELL SHALL BE MADE AT LEAST AS THICK AS THE REQUIRED THICKNESS OF A SEAMLESS SHELL OF THE SAME DIAMETER. IF A MANHOLE IS PLACED IN AN ELLIPTICAL HEAD THE THICKNESS SHALL BE THE SAME AS FOR AN ORDINARY DISHED HEAD WITH A RADIUS EQUAL TO 0.8 THE DIAMETER OF THE SHELL AND WITH THE ADDED THICKNESS FOR THE MANHOLE.

Par. P—230*b*. Revise first section to read: *b* In a form on CONSTRUCTION [reinforcement] for crown sheets where the top sheet of the firebox is a part of a circle OF A RADIUS EXCEEDING 55 PERCENT OF THE WIDTH OF THE FIREBOX, THAT PART OF THE CROWN SHEET, not exceeding 120 degrees in arc, MAY BE [and is] braced with arch bars extending over the top and down below the top row of staybolts [at the sides] CONNECTING THE FIREBOX SHEET AND WRAPPER SHEET WHERE THESE SHEETS BECOME PARALLEL, these arch bars being riveted to the water side of the crown sheet through thimbles and the maximum allowable working pressure should be determined by adding to the maximum allowable working pressure for a plain circular furnace of the same thickness, diameter, and length determined by the formula in Pars. P.-239 and P-240, the pressure P_1 determined from the following formula, which is a modification of that in Par. P-241 *a*: IF THE TOP OF THE FURNACE IS SEMI-CIRCULAR, IN WHICH CASE THE RADIUS IS EQUAL TO 50 PERCENT OF THE WIDTH OF THE FIREBOX, THE ARCH BAR NEED NOT EXTEND DOWN INTO THE WATERLEG BEYOND THE THREE ROWS OF STAYBOLTS AT EACH END.

A new Prest-O-Lite Gas plant located at 3155-27th Avenue, N., Birmingham, Ala., commenced operations October 16. This plant will supply the local demand for dissolved acetylene used in oxy-acetylene welding and cutting. With this addition, the Prest-O-Lite chain now numbers 34 acetylene-producing plants situated in industrial centers throughout the country. A. J. Topham is plant superintendent and G. A. Andrews, with headquarters at the same plant, is district superintendent.

Recommended Safe Practices*

A summary of safety measures that have been developed to eliminate shop accidents

THE Department of Labor and Industry of the State of Pennsylvania has developed and promulgated a list of seventy-four recommendations for safe practices for circulation among employers and workers in that state. However, these recommendations are applicable to all plants and particularly to the boiler shop, machine shop, or locomotive shop where the hazards of industry are evident.

While most of the recommendations set forth are merely common sense, nevertheless, the accident records throughout the country indicate that it is only through the constant exercise of common sense that a material reduction of industrial accidents will be secured. With this end in view, the following suggestions have been made with the idea that the worker and the employer together must see that general safe conditions are maintained at all times and that common sense governs daily operation.

"All employers and employes should recognize and contribute to the observance of safe practices in industry. The recommendations hereinafter set forth represent those recognized as safe practices in industry and should be observed. The rules hereinafter set forth are repetitions of rules previously adopted and included in other regulations but are included because they are similar in nature to the recommendations and because of the wide distribution given them."

General Precautions

1. No person or persons shall remove or make ineffective any safeguard, safety appliance, or device attached to machinery or guarding a hazardous condition except for the purpose of immediately making repairs or adjustments; and any person or persons who remove or make ineffective any such safeguard, safety appliance or device, for repairs or adjustments, shall replace the same or its equal immediately upon the completion of such repairs or adjustments.

2. The cleaning and oiling of machinery while in motion shall be prohibited in all cases of exposure to hazardous contact.

3. Extra hazardous operations should have guards stationed to warn all persons who may become endangered, especially where overhead operations are being carried on.

Yard and Internal Housekeeping

4. All roadways, walkways, aisles or other foot, crane, or vehicular travelways should be clearly marked or otherwise well defined. They should be kept in good repair, free from all debris and all obstacles. All walkways above the level of the ground shall be equipped with railings and toe boards.

5. Puddles or drippings of oil, grease, water or other liquids should be rendered harmless by mopping up and strewing sand or sawdust until dry. Oil-soaked sawdust should be disposed of promptly to prevent spontaneous ignition. The formation or drippings on floors should be prevented by eliminating the cause or by placing drip pans in position until the cause has been eliminated.

6. Workmen working at elevated levels should not strew their tools about promiscuously. They should be carried in tool belts or kept in tool boxes when not in actual use. The practice of throwing tools from one level to another should be discouraged. They should be raised or lowered with light ropes or passed from hand to hand. The practice of working over other unsheltered workmen should be actively discouraged at all times.

7. Piling. (a) All material needing to be piled should be carefully piled to prevent falling. When piling material near travelways, special care should be exercised to eliminate any possible hazard from piles being knocked over.

(b) Piles of material should not interfere with the adequate distribution of natural or artificial light.

(c) Material should not be piled to a height which renders the pile unstable or which interferes with the operation of a sprinkler system. Piles should not be placed so close to equipment as to hinder operators or expose the operator to hazard from slides or falls of material if the piles are knocked over.

(d) Wherever possible the stability of piles should be increased by piling alternate layers crosswise or, in the case of long piles, by cris-crossing at the ends or using binder strips.

(e) Piles of barrels, rolls of paper, pipe, or other cylindrical material should be carefully blocked at the ends to prevent spreading.

(f) In piling heavy bagged material the first four end bags of each pile should be cross-tied and a step-back of one bag should be made at every fifth bag in height. All bags in the outer tiers should have the mouths facing the center of the pile so that if any bags break open at the neck the pile will sag toward the center. In unpiling, the piles should be kept at an approximately even height and the necessary step-back maintained.

(g) Walls or partitions should not be used to brace piled materials unless of sufficient known strength to withstand the pressure.

(h) Substantial retaining walls or partitions should be provided for the storage of loose coal, sand, gravel, stone or similar materials in restricted areas. Wherever possible such loose materials and scrap should be kept in storage bins.

(i) Persons working about banks and piles of coal, sand, gravel, stone, or similar materials should avoid undermining to start slides. They should insure that no person is in danger from any slides of material. All overhanging ledges should be knocked down as soon as formed, especially in winter when the upper crusts are likely to become frozen.

(j) Material piled on vehicles for transportation should be limited to an amount which constitutes a safe load based on the distance it is to be transported, the strength of the individual person or equipment, and the character of the surface over which it is to be transported. Material should be so piled and secured that it cannot be jarred loose by ordinary vibration. The load should not project to an extent which renders it liable to catch on buildings or projecting piles or which would cause the load to topple over.

*Published by the Secretary of Labor and Industry, Commonwealth of Pennsylvania.

(k) All highway motor vehicles should have all load projections extending beyond the body of the vehicle to the front or rear conspicuously marked by a piece of red material attached at the farthest points of projection in front and rear.

(l) When loaded trucks are moved on or off an elevator, the elevator should be brought level with the floor and plates should be used to bridge the space between the elevator and the floor if such space creates a tipping hazard.

8. Loose board material and other objects or materials should not be permitted to remain strewn haphazardly on the floor or ground in places where persons have to walk or work, but should be piled up neatly. No loose material of any description should be permitted to remain unsecured in any overhead position.

9. Nails.

(a) Loose nails should not be permitted to remain strewn promiscuously on any floor, scaffold, working platform, or other place where persons walk.

(b) All upturned or protruding nails should be withdrawn or clinched into the wood.

(c) After the head of a barrel has been removed, all exposed or protruding nails around the top should be withdrawn.

(d) Pointless nails should be used for core room and foundry work.

10. All objects with sharp edges, such as scraps of glass, tin, sheet metal and the like should not be thrown into the waste baskets or other containers ordinarily used for other debris, but should be placed in separate containers. Neither should such material be permitted to remain on floors except in operations normally resulting in its creation. In the latter case, containers should be provided to catch such waste material as it drops from machines or benches and the floors should be frequently cleaned up each day to prevent undue accumulations.

11. All rags, waste paper, bits of broken lumber, excelsior, packing materials and other imflammable debris should be cleaned up daily from under work benches, from behind machines and from all other spaces. Such materials should be kept in suitable covered containers which would tend to reduce the amount to be cleaned up each day.

12. Surfaces that have become gummed or caked with accumulated dirt, paint, grease or other material creating a slipping hazard should be scraped or otherwise cleaned and then should be kept clean.

13. Snow and ice should be promptly removed from all walkways and work places. Icicles hanging over walkways and work places should be knocked down.

14. Dry sweeping in work rooms should only be permitted where there is no dust hazard or where the nature of the work performed precludes the use of other methods. Otherwise all floors should be sprinkled with water before sweeping. The use of disinfecting solutions in the water is recommended. The practice of using damp sawdust or other wetted materials is acceptable in lieu of sprinkling water, especially around electric equipment where the use of water would tend to create a hazard.

15. The practice of promiscuously spitting on the floor, on piles of material, in waste products or in corners should not be permitted. Neither should spitting in reservoirs of machine cutting oils or compounds be permitted. All machine cutting oils or compounds should be frequently sterilized by boiling or by the addition of some germ killing solution.

16. Covered refuse cans or boxes should be provided at convenient points and workmen required to deposit all refuse therein. Such cans or boxes should be emptied frequently enough to prevent overflow or the creation of obnoxious odors. Separate containers equipped with gravity closing lids should be provided for oily waste. Oily waste should be burned only by an authorized person equipped with a long handled tool or shovel for handling the waste.

Hand Tools

17. Wooden handles of hand tools should be of the best straight-grained material.

18. Wooden handles which have become excessively burned or worn, or which are cracked or badly splintered should be removed from service.

19. When repaired in the shop where used, the heads of all hand tools requiring handles except blacksmith tools should be substantially fastened to the handles by experienced persons to eliminate the hazard of improperly fastened heads flying off.

20. No tools or stencils with mushroomed heads should be permitted in service. This applies to tools owned by the workmen themselves as well as company tools.

21. Hand tools should always be struck with wooden, soft metal, rawhide, or rubber hammers or mallets if the part receiving the blow is case hardened or tempered. Such hammers or mallets should also be used in the presence of inflammable or explosive gases or vapors. Sheets of brass or other soft metal may be used to receive blows but should not be battered to an extent which will create a hazard of flying particles. Hand striking tools which show any signs of cracking should be immediately removed from service.

22. Hammers and hatchets with corrugated driving faces for driving flat headed nails should not be used for driving brads or nails with rounded heads, because of the increased hazard of flying nails.

23. Wrenches.

(a) All wrenches should properly fit the nuts, bolts, or other objects they are used to turn. Except when closed wrenches are used, the practice of using thin pieces of material as shims to make an oversize wrench fit should not be permitted.

(b) Wrenches should not be used as hammers.

(c) The use of wrenches which have excessively worn threads, nuts, or pawls, or battered or defective jaws or handles should be prohibited.

(d) The practice of tightening bolts, nuts, clamps, or other fixtures on moving machine parts with wrenches while the machine is in motion should be prohibited.

(e) Monkey wrenches should always be placed on the objects to be turned so that the wrench faces forward in the same direction that the handle is to turn.

(f) Safety release or ratchet type wrenches only should be used in opening drop bottom cars or wagons.

24. Keen edged or pointed tools.

(a) Care should be exercised in the use of adzes or draw knives to insure that no part of the body is close enough to the point being worked on to be endangered by a slip of the tool. When cutting with a hand knife, the direction of the cut should always be away from body.

(b) Keen edged or pointed tools, such as axes, hatchets, adzes, saws, knives, chisles, bits, lineman climbers, or similar tools should not be carried in a manner which endangers the bearer or persons passing him.

25. Handles.

(a) All hand files should be provided with handles.

(b) Wood chisels should be provided with substantial handles. If struck with mallets, a metal or leather band should be placed at the end of the handle to prevent spreading.

26. Proper sizes of screw drivers should be used at all times by all workmen requiring them. Screw drivers should not be used for purposes for which they were not intended. Screw drivers which are bent, or which have rounded corners or splintered handles should be removed from service.

27. No hand tools should be permitted to lie on the floor, ground or working platform when not in use for any length of time. They should be kept in the proper receptacles or storage places. Axes, hatchets, adzes or knives should be placed in receptacles provided for the purpose. For temporary purposes only, the cutting edge of the tool should be driven into a timber far enough to hold the tool in an upright position.

28. Picks, shovels, forks, bars, rakes and hoes.

(a) Picks and shovels should always be stacked or stuck into the ground so that the handles stand upright. Horizontal storing should only be permitted where it creates no tripping hazard.

(b) Forks should be stacked or stuck into the ground so that the handles stand upright. They may also be hung, handle down, in pegs on walls.

(c) Rakes and hoes should always be stood or hung with the head off the ground and the handle pointing down.

(d) Crowbars should always be laid flat in places where persons will not trip over them or else lodged vertically in corners or racks where they cannot fall over. Ordinary crowbars should not be used to move cars, specially adapted bars should be provided for this purpose. All dull or broken ended crowbars should be removed from service. When using a crow or pinch bar to move weights, the hands should be so placed that they cannot strike other objects as the bar moves under pressure.

29. Compressed air tools.

(a) In the use of compressed air tools, care should be used to prevent the tool from being shot from the gun.

(b) When momentarily out of use, the gun should be laid in such position that the tool cannot fly out if the pressure is accidentally released. When not in use, all tools should be removed from the gun.

(c) In disconnecting a compressed air tool from the air line, care should be exercised first to shut off the pressure and then to operate the tool to exhaust the pressure remaining in the hose.

(d) Compressed air hose or guns shall not be pointed at nor brought into contact with the body of any person.

Shop Apparel

30. Superfluous material and loose fitting clothing should be avoided in the presence of a hazard from moving machine parts. Excessively wide or long aprons should not be worn around moving machinery. Aprons should never be tied on with wire and should be but lightly secured so that they can be easily torn loose by hand. In the presence of a fire hazard aprons of non-flammable material should be used.

31. Head covering.

(a) Persons working in shops around machinery which presents a hair catching hazard should wear caps or other types of head covering. Caps should also be worn where there is danger of the hair catching fire. Caps with metal buttons or metal visors should not be worn around electrical hazards.

32. Footwear.

(a) For normal shop wear shoes with unbroken soles and low or medium height broad heels should be used. Where there is a possibility of heavy objects dropping on the feet, the toes should be boxed or reinforced.

(b) For hazardous occupations such as the handling of hot metal, acids, caustics, electric current, and hot substances, or other objects offering a burning hazard to the feet, specially adapted types of footwear are available and should be worn.

33. Leg protection.

(a) Protective leg covering (clothing or devices) should be worn when handling hot metal, acids, caustics, or other hot or cold substances offering a burning or scalding hazard. The material of which they are made should be determined by the nature of the product being handled. Full length leg protection should be used if the nature of the operation presents a full length leg hazard.

(b) The method of fastening all protective leg covering should permit of instantaneous removal.

34. Hand and wrist protection.

(a) *Except where the hands come close to rotating or otherwise moving machine parts,* gloves, mits or hand pads or other hand or arm protection should be worn when handling objects with sharp edges or which contain splinters, fins, slivers or other similar dangerous projecting parts.

(b) The material used and the shape and style of the gloves, mits or hand pads should be determined by the nature of the operation and the hazard against which it is desired to protect.

(c) Gloves or other hand or arm protection against heat or fire, hot or corrosive substances, or electricity, or similar hazards, such as the handling of plates of glass, should be long enough to cover the space between the wrist and the end of the shirt or coat sleeve.

35. Flammable apparel.

(a) Articles of wearing apparel or personal adornment, include spectacle rims, collars, eye shades, or cap visors, composed principally of some form of cellulose should not be worn in the presence of a spark or fire hazard.

(b) Clothing rendered quickly flammable by grease or other substances should not be worn by persons exposed to a fire hazard.

36. Goggles or other forms of head and eye protection shall be worn during the performance of all operations involving hazard to the head or eyes.

37. The interchange of personal protective devices among employes without first having been sterilized should be avoided.

38. All persons working aloft should be required to wear life belts properly secured when exposed to a falling hazard.

Electrical Hazards

39. Where static electricity exists, belts and rapidly moving parts of machines should be grounded. In the presence of explosive or flammable gases or dust, no metal lacings nor metal plates for fastening belts should be used.

40. In gaseous or dusty locations, the hazard from sparking commutators should be eliminated by using an induction type of motor, or a type approved by the U. S. Bureau of Mines as explosion proof.

41. Drop and portable installations.

(a) Heavy, reinforced cords only, known in the trade as packing house or brewery cord, should be used in connection with portable lamps or tools. They should be kept well insulated and should be laid or strung so as not to create a tripping or catching hazard.

(b) All electrical hand tools and other drop or portable installations should be well insulated. They should be frequently inspected and tested for current leaks. All frayed cords or other unserviceable and hazardous parts should be immediately removed from service. Portable extension light should be equipped with guards for the bulbs and sockets.

42. Electrically connected equipment should not be installed, repaired or removed except by trained electricians or workmen under their immediate personal supervision. When electrical hazards are encountered in the course of other work, such work should be immediately stopped until a trained electrician is available to supervise such work until the electrical hazards are removed.

43. Electricians working on poles or other places where a falling hazard exists should always wear safety belts. On high tension work rubber gloves should be worn. Such gloves should be tested to detect the presence of holes each time before being used.

44. Wherever possible, no work should be performed on high voltage electrical equipment until the current has been turned off. Switches which have been opened for that purpose should be locked or blocked open and a suitable warning device placed thereon.

45. No stream of water used for extinguishing a fire, or for cleaning or other purposes should be permitted to come in contact with electrical equipment at any time. This should not be construed to apply to water-cooled bearings or similar equipment.

46. The dangerous practice of playing "electrical" jokes on fellow workers shall be prohibited.

47. Material of long length, such as pipe, lumber or ladders, when carried by one man should be carried so that front end is high enough to avoid striking persons who may be approaching from around corners or other projections.

48. The carrying of very heavy objects by a gang of men should be personally supervised by the foreman or gang leader. He should be prepared at all times to assist, to instruct, and to prevent injury to new or inexperienced men in his gang. He should be responsible for developing distinct and separate signals for simultaneously lifting or dropping heavy objects by his gang.

49. Heavy objects should not be handled on an incline without the use of ropes or other tackle in addition to the necessary chocks or wedges.

Conveyors and Hand and Automotive Vehicles

50. Vehicles with wheels or other parts that are broken, cracked or otherwise defective should be removed from service until the defective parts have been repaired or replaced with parts free from defects.

51. Wherever practicable, the wheels of vehicles should be mounted on axles inside the frame of the vehicle or inside the bearing which attaches them to the vehicle.

52. Two wheeled hand trucks should always be parked in a vertical position at racks which will prevent them from falling over or in a horizontal position at location not used for travelways. Truck handles should not be left extended on the floor. Wherever the construction will permit, they should be secured in an upright position by means of springs, weights or retaining hooks or latches.

53. The practice of working under suspended vehicles supported only by a light chain, or rope, or single block should not be permitted. Working or walking under any suspended load should not be permitted.

54. Working or walking under a load suspended by an electric magnet is prohibited.

55. Where the possibility of contact with persons exists, all counterweights shall be enclosed sufficiently to prevent fouling or striking persons.

56. Trucks or other vehicles being loaded should be properly chocked or blocked in all cases where there is a possibility of the vehicle moving away by gravity or from jars.

57. All loads which are not fully contained or supported by the vehicle carrying them should be secured to the vehicle by means of chains, cables, ropes, blocks, chocks, or other effective devices.

58. Runways or ramps on which wheelbarrows and hand trucks are operated should be so constructed that the wheels run on solid boards and not on cracks between boards. Workmen should not be permitted or required to operate wheelbarrows or hand trucks over runways or ramps which have the entire surface cleated to prevent slipping. Sufficient smooth space should be left for the passage of the wheels.

59. Gasoline motors should not be started or permitted to run in spaces which are not thoroughly ventilated unless the exhaust is piped to the outside air.

60. When filling the tank of any gasoline motor, the nozzle of the hose should always be kept in direct contact with the tank being filled. The engine should be stopped and any open flame lights of the vehicle turned off.

61. All persons should be forbidden to ride or walk on mechanical or gravity conveyors at any time except that workmen engaged in repairing such conveyors should be permitted to mount thereon in performance of their work if such conveyors have been stopped. Separate oiling platforms should be required at all points requiring lubrication.

Dusts, Gases and Volatile Liquids

62. The striking of matches, the smoking of cigars, cigarettes or pipes, or the use of open flames, open fire, open lights, or arc-forming electrical equipment in the presence of explosive or inflammable gases or explosive organic or metallic dusts should not be permitted. The use of materials creating such dust around electrical equipment should not be permitted except where such equipment has been properly protected.

63. All electric light globes shall be protected by a vapor-proof globe and guard in the presence of an inflammable or explosive dust hazard.

64. Extreme care should be exercised by all persons to prevent the introduction of metal parts into conveyor or disposal systems wherein an explosive dust hazard exists.

65. Explosive metallic or organic dust should not be allowed to accumulate on floors, rafters, beams, machinery, or other lodging places from which it can be blown by vibration or air currents.

66. Gas leaks should not be sought with matches, candles or other open flame lights. Soapy water is an excellent detector of gas leaks.

67. Where oxygen, acetylene and similar gases piped from a central point are used in quantity at permanent work places, they should be piped to the point of usage in permanent tubing or piping.

68. Grease or oil should not be used to lubricate the valves or joints of compressed gas containers. Acetylene should not be used at more than 15 pounds pressure per square inch. The valves of all containers

should be tightly closed at all times when not actually in use, especially when connected with torches or other apparatus, at the end of the day's work and on all supposedly empty containers.

69. Containers of compressed gas should not be subjected to dropping, bumping, rough handling, or temperatures in excess of normal atmosphere. Such containers should always be maintained in a horizontal position unless cribs or racks are provided to prevent them from falling if maintained in an upright position.

70. Compressed gas containers should not be permitted to remain in direct contact with sunlight during warm weather.

71. The use of matches, cigars, cigarettes, pipes, or other open flame or fire producing equipment should be prohibited in all places where flammable or explosive volatile liquids or oils are stored, handled or used. Leaky gasoline containers should not be soldered until all traces of gasoline vapor have been removed.

72. Tanks, pipes, or drums used in the storage, handling or use of flammable or explosive volatile liquids or oils should be properly grounded to carry off any static electricity that may be generated.

Report of Accidents

73. All injuries should be reported at once to the dispensary or hospital for treatment.

74. All accidents incurred in course of employment and causing 2 or more days' loss of time shall be promptly reported by the employer to the Department of Labor and Industry.

Merger of Boiler Concerns

THE International Combustion Engineering Corporation, New York city, has recently purchased the Hedges-Walsh-Weidener Company of Chattanooga, Tenn. This company is a recent combination of the Casey-Hedges Company and the Walsh & Weidener Boiler Company of that city. These are two of the oldest and most widely-known boiler manufacturing companies in the United States.

With the addition of these new companies, the International Combustion Engineering Corporation acquires a large and general boiler business which augments its present extensive manufacturing facilities. One of the plants is an outstanding factor in the sectional heating-boiler field and the other has facilities for the manufacture of larger drums than any plant in the United States. Installations made by this company include the plant of the New York Steam Corporation at Kip's Bay and the proposed New York Edison plant at 14th Street, New York city. This latter plant, which will deliver 1,000,000 pounds of steam per hour, will be the largest steam generating installation in the world.

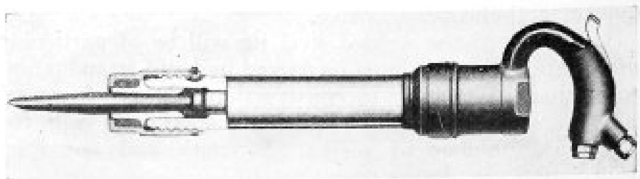
This new acquisition will function in all phases of its activity through the Combustion Engineering Corporation, the American operating subsidiary of the International Combustion Engineering Corporation.

W. S. Stewart, of the Lincoln Electric Company, Cleveland, O., has been appointed manager of a new office of that concern opened at 533 Market street, San Francisco, Cal. L. P. Henderson, formerly of the Chicago office, has been transferred and put in charge of the Minneapolis district. Mr. Robert Notvest has been transferred from Kansas City to Indianapolis where he will have charge of the Indianapolis district.

Rivet Buster

A NEW rivet buster, has been developed by the Ingersoll Rand Company, 11 Broadway, New York city, for cutting or busting off of rivet heads up to ¾ inch and for knocking the rivets out. This pneumatic hammer is sufficiently light to be readily handled by one man. It is easy to hold and is fast cutting.

The nozzle end is finished with a heavy square-section thread, over which a retainer nut is fitted. This



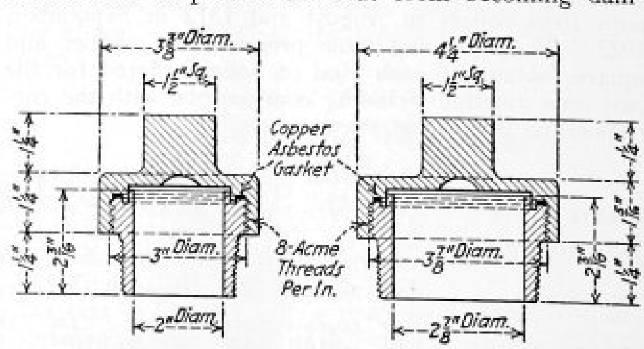
Rivet buster showing special chisel and retainer

nut takes the blow of the hammer through a rubber buffer if the hammer is operated without the cutting tool being held against the work. The success of the retainer device is due to a heavy, strong knob on the upper end of the taper-shank tools used. This knob permits the use of light-weight tools. It provides a shoulder for transmitting the blow through a split nozzle to the rubber buffer and on to the retainer nut. The chisel cannot be shot out of the tool.

Three different tools are furnished for use in the rivet buster: a cutting chisel, a shearing chisel, and a knockout punch.

Boiler Washout and Arch-Tube Plugs

THE T-Z Railway Equipment Company, Chicago, Ill., is now manufacturing washout and arch-tube plugs made of drop forgings. The bodies of these plugs are designed with projecting lips to absorb all the abuse from cleaning rods and washout nozzles and to protect the seat from becoming dam-



Two sizes of the T-Z boiler washout and arch-tube plugs

aged. The joint between the nipple and cap is sealed by a special copper-asbestos gasket. The nipples and caps have Acme threads (eight per inch) which eliminates the possibility of the threads crowding and permits of quick and easy removal of the caps. The caps are also provided with 1½-inch square heads to facilitate their removal. The plugs are made in three sizes, namely, 2-inch, 2⅞-inch and 3¼-inch.

Welded Jigs and Fixtures

A PHASE of oxy-acetylene welding which is coming to be of considerable value to the management of manufacturing plants is fabrication of welded jigs and fixtures. These are traditionally made from cast iron, but in a great many instances can be made to better advantage from stock steel pieces, cut to shape with the blowpipe, and joined by welding.

The welded fixture, if properly designed, will have structural rigidity equal to that of its cast iron prototype, and in addition will be lighter and stronger, as well as quicker and cheaper to make.

Lightness of the welded steel jig will be of particular importance where it must be moved by hand from station to station. Economy in construction cost is of special interest where the order requiring a special jig calls for a limited number of pieces. Strength and speed of fabrication are always desirable.

Whenever a new jig or fixture is contemplated, consider fabricating it from steel by oxwelding. This may solve for you important problems of construction, time, and cost, and will give you a decidedly superior product—*Oxy-Acetylene Tips.*

Power Show to Be Held in December

THE seventh National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace, New York city, from December 3 to 8 inclusive. The features of this exposition, which is held at the same time as the annual meeting of the American Society of Mechanical Engineers, are the exhibits of equipment of all types which apply to the power field and a complete motion picture program running throughout the week and covering a wide field of industrial progress.

Steel Boiler Orders

NEW orders for 1420 steel boilers were placed in September, as reported to the Department of Commerce by 72 manufacturers, comprising most of the leading firms in the industry, as compared with 1649 boilers in August and 1312 in September, 1927. The following table presents the number and square footage of each kind of boiler ordered for the past nine months, including comparisons with the corresponding period last year.

Prest-O-Lite Flood-Light Attachment

THE Prest-O-Lite Company, Inc., 30 East 42nd street, New York, announces a flood-light attachment of new design for use with the familiar small tanks of dissolved acetylene, the same as are used for truck and tractor lighting and similar purposes.

Flood-light attachment

Prest-O-Lite gas tanks are available from service stations throughout the country. By the connection of the attachment a convenient, portable, powerful flood-lighting unit is obtained which can be used for illumination in dark places and for facilitating night work of all kinds.

The improved attachment is of simple, strong, rigid and compact construction. Universal adjustment is obtained with only one swing joint, thus minimizing the possibility of leakage occurring.

J. P. Pelletier, formerly boiler foreman of the Chicago, Burlington & Quincy Railroad, at Beardstown, Ill., has been appointed boiler foreman of the company's shops at St. Joseph, Mo.

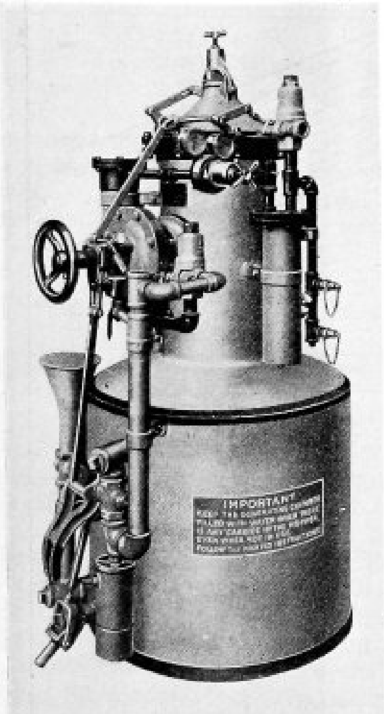
Joseph T. Ryerson & Son, Inc., Chicago, Ill., has acquired the plant, merchandise and good will of the E. P. Sanderson Company, Kendall Square, Cambridge, Mass. The Ryerson Company, a pioneer steel-service organization, has plants in Boston, New York, Buffalo, Detroit, Cincinnati, Cleveland, Chicago and St. Louis.

	Total 9 mos., 1928		Total 9 mos., 1927		June, 1928		July, 1928		August, 1928		September, 1928		September, 1927	
	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. ft.
GRAND TOTAL....	12,466	11,833,937	12,387	12,771,356	1,611	1,469,617	1,615	1,528,053	1,649	1,459,652	1,420	1,251,268	1,312	1,152,265
STATIONARY														
Total	12,299	11,429,355	12,211	12,169,047	1,591	1,449,893	1,597	1,478,034	1,639	1,454,622	1,402	1,215,677	1,294	1,136,984
Watertube	1,009	5,024,448	1,048	5,774,302	133	627,877	133	563,404	115	535,286	88	409,529	72	432,365
Horizontal return tubular	987	1,264,004	1,237	1,503,124	136	159,389	129	185,064	169	205,196	110	131,731	144	185,238
Vertical fire tube..	1,221	364,911	1,426	379,666	133	45,555	109	41,616	131	35,165	93	27,571	162	46,942
Locomotive (not railway)	231	125,589	213	93,295	24	12,416	17	8,708	22	9,662	14	8,559	13	6,060
Steel heating [1]......	7,806	3,815,571	6,955	3,380,960	1,036	488,194	1,084	567,462	997	484,221	929	499,473	808	387,256
Oil country	463	447,143	749	649,222	64	66,362	64	62,722	132	137,831	78	77,020	21	19,124
Self contained portable [2]	466	328,878	497	347,413	56	45,323	54	45,191	55	39,522	73	53,403	63	50,738
Miscellaneous	116	58,811	86	41,065	9	4,777	7	3,867	18	7,739	17	8,391	11	9,261
MARINE														
Total	167	404,582	176	602,309	20	19,724	18	50,019	10	5,030	18	35,591	18	15,281
Watertube	67	357,835	63	501,901	4	12,482	9	47,668	2	3,182	12	34,416	2	5,620
Pipe	1	1,881	2	3,127	...	......	...	......	...	......	...	......	...	......
Scotch	85	36,896	101	90,005	13	4,624	4	982	6	1,098	6	1,175	13	4,765
2 and 3 flue........	11	4,347	5	1,990	2	1,378	5	1,369	2	750	...	......	...	......
Miscellaneous	3	3,623	5	5,286	1	1,240	...	......	...	......	...	......	3	4,896

[1] As differentiated from power. [2] Not including types listed above.

Large-Capacity Acetylene Generator

THE Oxweld Acetylene Company, New York city, has developed a new type of medium-pressure acetylene generator, designated as Type MP-3. This new piece of equipment is designed to carry 300 pounds of carbide together with a large supply of gas with a minimum-pressure fluctuation and with a minimum expense for maintenance.



Oxweld large-capacity acetylene generator

The same principle of carbide feed that has been employed in the popular Oxweld balance seal generator is used in the Type MP-3. The feed is driven by a motor actuated by a weight. A diaphragm pressure control is used in connection with the motor to regulate the feed and maintain proper pressure in the generator. The feed-shaft bearing is protected by a dust-proof cover which protects it from carbide dust. Two changing doors facilitate filling the hopper. For maximum durability some gears are made of bronze and monel metal and certain shafts are of special alloys. The brake control on the motor is positive in action and does not require frequent adjustment once it is set.

A clean-out door is provided which permits cleaning the carbide feed disk without removing the generator top. The filter can be repacked, if necessary, without breaking any adjustment of interference or relief valves. This operation is performed by removal of the top plate.

Back-Pressure Valve

The hydraulic back-pressure valve is so arranged that it is always filled with water before the generator itself is entirely filled. An overflow-level check plug has been provided in order that the operator may check the water level at any time.

When recharging is necessary, the interference, which is of simple and sturdy construction, operates the relief valves, locks the feed motor so it cannot operate, and permits the carbide doors and water filling cock to be opened.

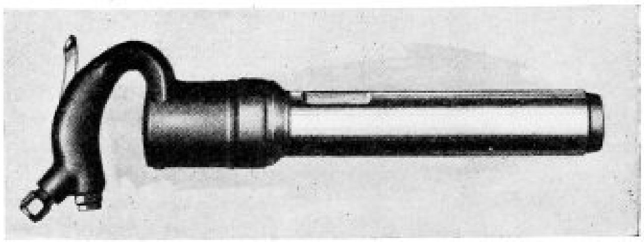
The operating pressure can be changed by turning the adjusting nut on the feed control. During normal operation, the set pressure will not vary more than about 1 pound.

The Type MP-3 generator consists essentially of two sections, the lower being a cylindrical shell, the upper a shell in the shape of a truncated cone. The bottom is dished for maximum strength. All seams are bronze welded, both inside and out.

This generator uses 1¼ by ⅜-inch carbide. The overall height is slightly over 120 inches and the height to the top of the generator shell is 104 inches. The diameter of the shell is 42½ inches and the shipping weight is 2300 pounds.

New Style Riveting Hammers

A NEW line of riveting hammers in four sizes, having strokes of 5 inches, 6 inches, 8 inches, and 9 inches, has been developed by the Ingersoll-Rand Company, 11 Broadway, New York city.



New Ingersoll-Rand riveting hammer

The new hammers have several improved features of construction which insure reliable and economical service.

An important feature is the manner in which the handle is fastened to the barrel and kept tightly in place by a spring-locking device. The handle is threaded on to the barrel and the spring lock not only prevents the handle from unscrewing but applies tension to tighten it automatically.

The valve operates in a hardened and ground valve box located at the head of the barrel and clamped in place by the handle. The valve box has a solid upper end which provides a positive compression chamber for the piston on its up-stroke. It acts to prevent the piston from striking the handle end as this air cushion is not dependent upon an air-tight joint between the handle and the barrel.

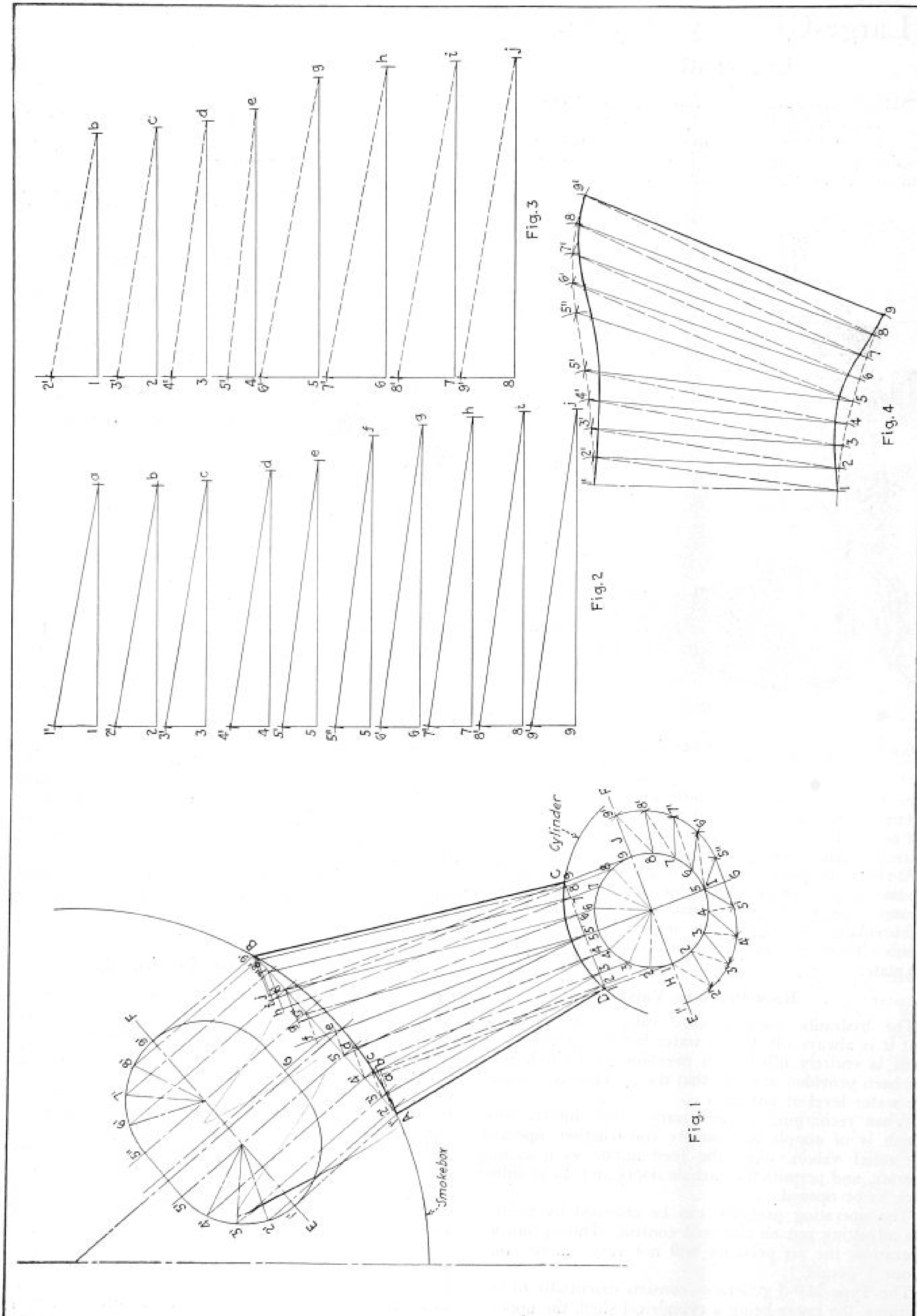
An open-type outside trigger handle is furnished, but closed or inverted type handles can also be supplied.

Arc-Welding Textbook

THE Lincoln Electric Company, Cleveland, O., has recently published a supplement to the textbook, "Arc Welding—The New Age in Iron and Steel." This book is entitled "How to Begin the Application of Arc Welding in Production Manufacturing." The bulk of the text is devoted to the redesign of machinery. In developing the theory of arc-welded design many line drawings have been used which show clearly how standard steel shapes are utilized to build up structures which formerly would be cast.

Along with these theoretical designs, however, are shown photographs of similar designs which are in actual use.

The supplement is a convincing proof of the rapid strides which are being made in the substitution of arc-welded steel for cast iron as many of the forecasts made in the original text are seen as proven facts in the supplement.



Details of locomotive steam-pipe casing layout

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

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.*

Development of a Locomotive Steam-Pipe Casing

Q.—Show the development of a locomotive outside steam-pipe casing. G. M.

A.—Fig. 1 shows a typical steam-pipe casing. The elevation is shown by *A-B-C-D*. In the plan, *E-G-F* represents one-half of the top and *H-I-J* represents one-half of the circular base. From the plan view, it can be seen that the top is symmetrical about the line *E-F* and that the base is symmetrical about the line *H-J* and therefore a development of a half of the plan, as shown, would represent one-half of the pattern.

For the present, it will be necessary to disregard the contour of the smokebox and consider *A-B* as a straight line; also the contour of the cylinder casing and consider *C-D* as a straight line.

In working out the pattern by triangulation, it will be necessary to divide the base *H-I-J* into a number of equal parts, as shown by the small figures *1-9* on *H-I-J*; also divide the *radii* of the top into the same number of parts, as represented by the small figures *1'-5'* and *5"-9'*. Connect the points with solid and dotted lines as shown.

As the next step, preparatory to obtaining the lines of the pattern, construct triangles whose bases are equal to the length of the lines drawn between the points on *H-I-J* and *E-G-F* and whose altitudes are equal to the perpendiculars to the base line *D-C*, as *1-a*, *2-b*, *3-c*, as shown in the elevation.

The diagram of triangles represented by the solid lines is shown in Fig. 2. To obtain these triangles, draw a horizontal line any convenient place and from *1* erect a perpendicular equal to the distance *1-1'* in the plan and measure off on the horizontal line the distance *1-a* in the elevation; connect the points *1'-a*, completing the triangle. Repeat this process using for the altitudes the distances *2-2'*, *3-3'*, *4-4'*, *5-5'*, *5-5"*, *6-6'*, *7-7'*, *8-8'*, *9-9'* using their corresponding base lines equal to the distances *2-b*, *3-c*, *4-d*, *5-e*, *5-f*, *6-g*, *7-h*, *8-i*, *9-j*, in the elevation.

The hypotenuses of these triangles are the true distances between the points on *H-I-J* of the base and the points on *E-G-F* of the top, as indicated by the solid lines in the plan.

The triangles shown in Fig. 3 are constructed in the same manner, and are derived from the dotted lines in the plan view, as *1-2'*, *2-3'*, *3-4'*, *4-5'*, *5-6'*, *6-7'*, *7-8'*, *8-9'*, which are the altitudes, and in the elevation *1-b*, *2-c*, *3-d*, *4-c*, *5-g*, *6-h*, *7-i*, *8-j* the corresponding bases.

The hypotenuses of the various triangles in Fig. 3 are equal to the true distances measured on the finished article between the points on *H-I-J* and *E-G-F* of the plan, as indicated by the dotted lines.

Constructing the Pattern

To construct the pattern, first set one pair of dividers for the small spaces on the base *H-I-J* and also another pair for the larger spaces on *E-G-F*.

Begin by drawing a line as *1-1*, Fig. 4, on which set off a distance equal to *1'-a* in Fig. 2, which equals *A-D* in the elevation. Then with the dividers set to the large spacing, scribe an arc using point *1'* as a center, then using point *1* as a center with the trams set equal to *2'-b*, Fig. 3, scribe an arc cutting the arc just made, which establishes the point *2'* at the top. Now set the trams equal to *2'-b*, Fig. 2, and using *2'* as a center, scribe an arc at the bottom. Then using the dividers set to the small spacing and using *1* as a center, scribe an arc, cutting the arc just made with the trams and establish the point *2* on the bottom.

Then using the dividers set to the large spacing, scribe an arc from the point *2'*. Then set the trams from *c-3'* in Fig. 3, and with *2* as the center scribe an arc cutting the arc just made and establish the point *3'*. Now, using the dividers, set to the small spacing and with *2* as a center scribe an arc. Then set the trams equal to *c-3'* in Fig. 2 and with *3'* as a center scribe an arc cutting the arc just made and establish the point *3*.

Continue in this manner until point *5'* at the top is located, and then in locating point *5"*, use the distance *5'-5"* in the plan view instead of the dividers set to the larger spacing when making this arc. Continue from *5"* in the same manner as before until all the hypotenuses in Figs. 2 and 3 have been located. Connect the points with a dotted line and the pattern as shown in Fig. 4 will be completed.

The pattern, as now completed, would be for the casing as shown in the elevation, not providing for the radii of the smokebox or the cylinder casing.

It will, therefore, be necessary to step off on the solid lines at the points *1* to *9*, Fig. 4, distances equal to the vertical distances from the base line *D-c* in the elevation to the arc caused by the cylinder casing, and also at the points *1'*, *9'*, Fig 4, distances equal to the vertical distances from the line *A-B* in the elevation to the arc caused by the radius of the smokebox. For convenience, these lines can be measured along the solid lines in the elevation and also on the pattern. The distance measured from the point *2* in the elevation being stepped off from the point *2* in the pattern, and so on, with points *3*, *4*, *5*, etc. By connecting these points in the pattern the development is then complete.

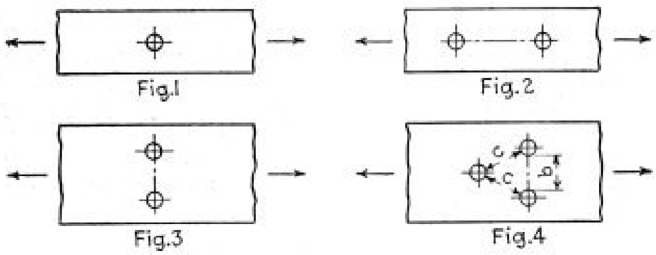
Strength of Materials

Q.—If possible, please publish a formula from which the strength of material may be calculated taking into account deductions for holes or other openings in the plate. W. T.

A.—The question is too general to attempt to develop a formula to cover all cases that might come under it.

The following rules, however, will apply to this subject:

The strength of a bar or plate is that of its weakest section. Therefore, in considering any area through which a force acts, the minimum effective section must be taken.



Calculating plate strength, deducting allowance for holes

If a hole be bored in a bar, this reduces its effective sectional area by the diameter of the hole as in Fig. 1.

If two or more holes be made in line with each other, as in Fig. 2, only one need be deducted.

If two holes are side by side, as in Fig 3, two must be deducted.

If there are three holes, as in Fig 4, breaking joint experiments prove that the distance *c—c* must be greater than *b* and in that case only two holes need be deducted from the cross section.

Tube Holes

Q.—How are the tube holes cut in marine boilers?

A.—Tube holes in marine boilers may be drilled full size from the solid plate or, if guide holes are used, the United States Steamboat Inspection Service specifies that guide holes for drills and cutters may be punched not to exceed 75 percent of the diameter of the full-sized finished hole. The remainder shall be cleanly cut, drilled or reamed full size. Holes not to exceed 4 inches in diameter in plates 5/8-inch thick and over may be punched within 1/2-inch full diameter, the remainder to be cleanly cut, drilled or reamed to full size. All burrs on both sides of the tube should be removed and the edges of the finished hole slightly chamfered to receive the tube.

Combustion Chamber Layout

Q.—With reference to a series of articles written by W. E. Joynes of the American Locomotive Company on "Laying Out Locomotive Boilers," and published in The Boiler Maker, I would like to refer you to page number 130 of the May, 1925, issue, which shows a cross section of the boiler at the combustion chamber. I would appreciate it if you would advise why it is necessary to have two different dimensions (28 1/2 inches and 29 inches) from the center line of the boiler to the point where the 14-inch corner radii are struck; also, how the two dimensions are determined, which of course, determines the two different radii at the bottom of the combustion chamber, which are, 42 1/2 inches at the back of the combustion chamber and 43 inches at the front. R. W. D.

A.—It is customary on locomotive boiler drawings to dimension each of the sections completely so that the same can be readily laid out in checking over the staybolt layout.

The dimensions necessary for laying out the firebox crown sheet would be the dimensions shown in the rear view and the section taken at the firebox tube sheet.

These dimensions determine the contour of the firebox crown sheet at the front and back. The crown sheet tapers from front to back as shown in Fig 1.

In Fig. 1 it will be noticed that all the dimensions are constant with the exception of the spread between the 14-inch radii. The spread of the radii is tapered from 58 inches at the front to 53 inches at the back or 5

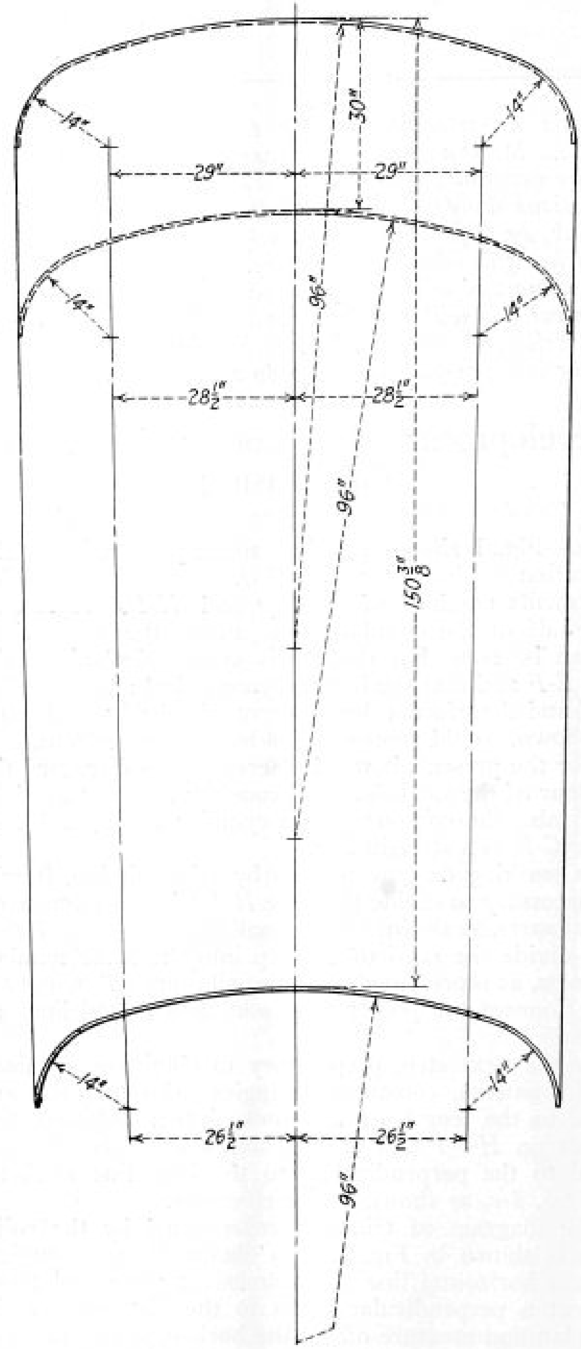


Fig. 1.—Method of determining contour of crown sheet

inches in a total distance of 150 3/8 inches, which would be 30.075 inches of length for each 1-inch of spread.

The section of the combustion chamber in question is taken directly ahead of the inside throat sheet which is approximately 30 inches back from the front of the crown sheet, which would reduce the spread of the 14-inch radii 1 inch or from 58 inches to 57 inches; dividing by two would give 28 1/2 inches on either side of the center line at this section.

Associations

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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.

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Chairman—Fred R. Low.
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Assistant International President—William Atkinson, suite 522, Brotherhood Block, Kansas City, Kansas.
International Secretary-Treasurer—Joseph Flynn, suite 504, Brotherhood Block, Kansas City, Kansas.
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International Vice-President—H. J. Norton, Alcazar Hotel, San Francisco, Cal.
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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.	St. Joseph, Mo.	Memphis, Tenn.
Detroit, Mich.	St. Louis, Mo.	Nashville, Tenn.
Erie, Pa.	Scranton, Pa.	Omaha, Neb.
Kansas City, Mo.	Seattle, Wash.	Parkersburg, W. Va.
Los Angeles, Cal.	Tampa, Fla.	Philadelphia, Pa.

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.	St. Louis, Mo.	Nashville, Tenn.
Erie, Pa.	Scranton, Pa.	Omaha, Nebr.
Kansas City, Mo.	Seattle, Wash.	Parkersburg, W. Va.
Memphis, Tenn.	Tampa, Fla.	Philadelphia, Pa.

Selected Boiler Patents

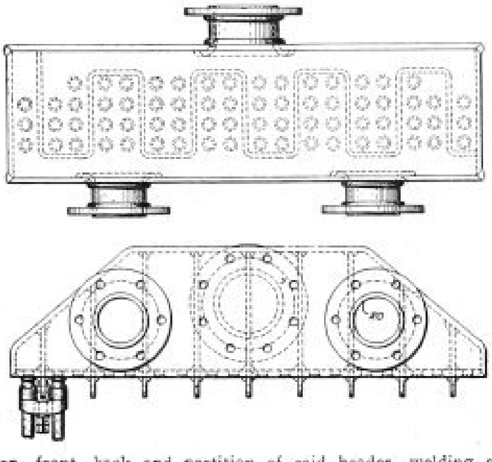
Compiled by
DWIGHT B. GALT, Patent Attorney,

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.

1,651,653. SUPERHEATER HEADER FOR LOCOMOTIVES. WILLIAM B. WHITSETT AND WALTER R. HEDEMAN, OF BALTIMORE, MARYLAND.

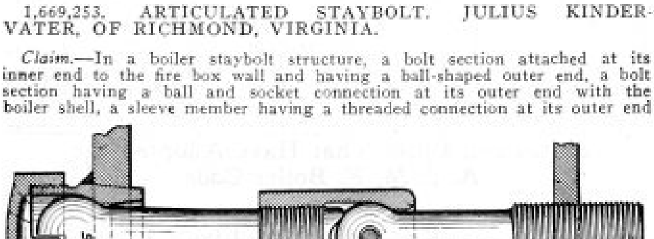
Claim.—The herein described method of forming a superheater header of sheet metal which consists in shaping sheets of metal to form the



bottom, top, front, back and partition of said header, welding said partition to said bottom and top, welding said bottom to said top and welding said front and back to said bottom and top. Fifteen claims.

1,669,253. ARTICULATED STAYBOLT. JULIUS KINDERVATER, OF RICHMOND, VIRGINIA.

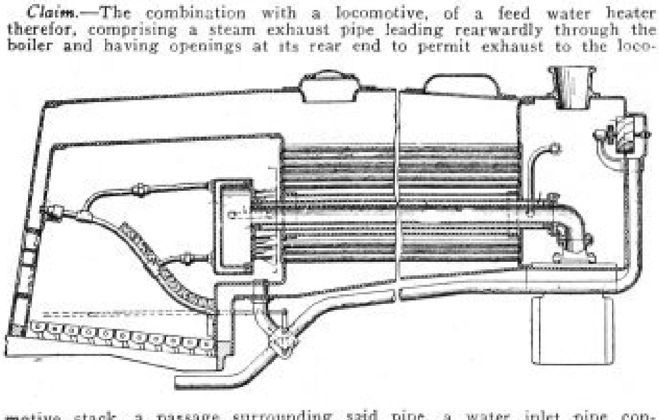
Claim.—In a boiler staybolt structure, a bolt section attached at its inner end to the fire box wall and having a ball-shaped outer end, a bolt section having a ball and socket connection at its outer end with the boiler shell, a sleeve member having a threaded connection at its outer end



with the inner end of the upper bolt section, said sleeve member being provided with a socket formation in which to receive said ball-shaped outer end of the inner bolt section, and a pin extending transversely through the walls of the socket and the ball-shaped end of the inner bolt section. Three claims.

1,674,219. STEAM LOCOMOTIVE. MICHAEL PEKICH, OF PITTSBURGH, PENNSYLVANIA.

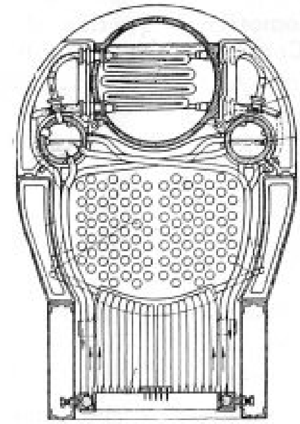
Claim.—The combination with a locomotive, of a feed water heater therefor, comprising a steam exhaust pipe leading rearwardly through the boiler and having openings at its rear end to permit exhaust to the loco-



motive stack, a passage surrounding said pipe, a water inlet pipe connected to said passage at one end, and a connection between said passage and the water space in the boiler at its other end. Six claims.

1,663,910. WATER-TUBE BOILER. OTTO H. HARTMANN, OF CASSEL-WILHELMSHOHE, GERMANY, ASSIGNOR TO SCHMIDTSCHE HEISSDAMPF G.M.B.H., OF CASSEL-WILHELMSHOHE, GERMANY, A GERMAN CORPORATION.

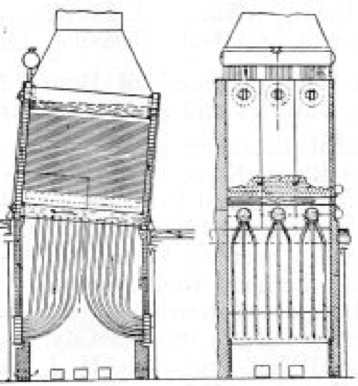
Claim.—In a locomotive having a water-tube firebox, said firebox comprising lower water collectors, upper headers, positioned above said collectors, an upper boiler drum located at a higher level than said upper



headers, water-tubes connecting said collectors, upper headers and upper boiler drum with each other and forming a firebox, brackets supporting said upper boiler drum from the locomotive frame, means for suspending the upper headers from said brackets, the lower collectors and the fire box being thereby suspended as a unit from said brackets through the medium of the upper headers. Six claims.

1,666,532. STEEPLED RADIANT-HEAT STEAM BOILER. CHARLES GILBERT HAWLEY, OF CHICAGO, ILLINOIS.

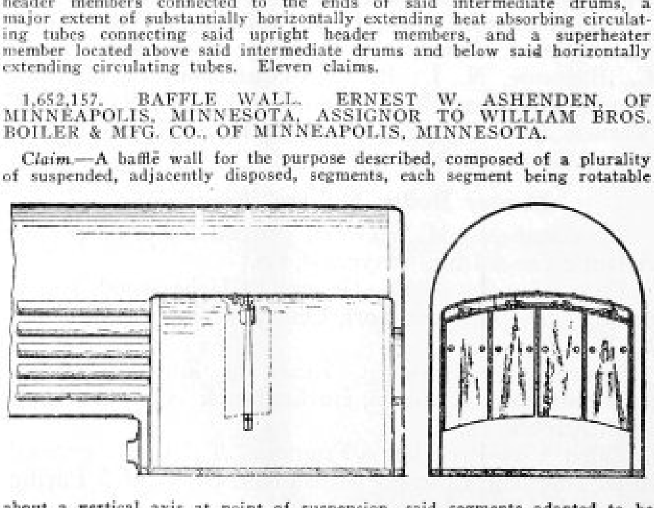
Claim.—A casing or setting containing a tall combustion chamber admitting of the substantially natural maturity therein of the flame of a body of long flaming fire, in combination with a steam boiler comprising a radiant heat absorbing portion in said chamber and a convected heat absorbing portion positioned above said chamber to receive the hot gases therefrom, said radiant heat absorbing portion including opposed parallel header members near the bottom of said chamber, parallel horizontally



extending intermediate drums in the upper portion of said chamber and a minor extent of heat absorbing circulating tubes rising from said header members to said drums and widely spaced in and across said chamber, and said convected heat absorbing portion including upright wall forming header members connected to the ends of said intermediate drums, a major extent of substantially horizontally extending heat absorbing circulating tubes connecting said upright header members, and a superheater member located above said intermediate drums and below said horizontally extending circulating tubes. Eleven claims.

1,652,157. BAFFLE WALL. ERNEST W. ASHENDEN, OF MINNEAPOLIS, MINNESOTA, ASSIGNOR TO WILLIAM BROS. BOILER & MFG. CO., OF MINNEAPOLIS, MINNESOTA.

Claim.—A bafflē wall for the purpose described, composed of a plurality of suspended, adjacently disposed, segments, each segment being rotatable



about a vertical axis at point of suspension, said segments adapted to be aligned in co-planer relation, to form a substantially imperforate wall. Twelve claims.

The Boiler Maker

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Contents

Annual Index

THE annual index of THE BOILER MAKER for the year 1928 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, 1929.

Locomotive Boiler Construction

DEVELOPMENTS in steam locomotive engineering during the past few years have been more or less confined to improvements in mechanical detail, as evidenced by the adoption of the three cylinder locomotive, limited cut-off, wider application of the booster and of the feedwater heater. Several notable experiments have also been carried out by a number of roads on boilers of the combined firetube and watertube type carrying higher pressures than usually employed. The results of metallurgical developments have also been tried out in isolated cases, as for example, the use of nickel steel in the construction of locomotives for the Canadian Pacific Railways, which permitted an increase in boiler pressure of 75 pounds.

It remained for the Northern Pacific Railway to authorize the construction of a locomotive at the American Locomotive Works, that, while designed along conventional lines, incorporates features that may well place it in the front rank of modern motive power. This locomotive has only recently been completed, so that any prediction of its operating characteristics would be premature at this time. However, if the success of its first tests is measure of its future efficiency, the experiment will have been more than justified.

The special feature of this 2-8-8-4 simple, articulated, Mallet-type locomotive is the boiler, which is the largest ever built for any locomotive. Since only a single locomotive of this type was included on the railroad company's original order, the construction of the boiler entailed an unusual amount of hand work, and special methods had to be developed in carrying out the details. The description of the boiler, which appears in this issue, indicates the lines along which the work was carried out.

The problem of the railroad, which led to the development of the locomotive under consideration, was one of capacity. The district over which it will operate covers a 216-mile run between Mandan, N. D., and Glendive, Mont. Large booster-type Mikado engines, with a tractive effort of 63,000 pounds have been unable to haul more than 2225 tons between these points over the prevailing grades, which have a maximum of 1.1 percent. Consequently, freight trains arriving at

Glendive from the west, with 4000 tons have had to be split into two trains before continuing to Mandan. Mechanical engineers of the Northern Pacific and the American Locomotive Company have sought a solution to the difficulty by designing this 2-8-8-4 Mallet locomotive, having a tractive effort of 139,900 pounds, which should prove capable of hauling loads of 4000 tons or more, over the grades in this district.

This locomotive and others, more or less experimental in character, indicate progress in the field of boiler design and construction. The steam locomotive is undergoing a transition from older types to modern high-power machines that will continue to maintain this form of motive power in the front rank. This change is slow, to be sure, but none of the experiments conducted in recent years has resulted in failure. Wherever unusual conditions and physical demands of the railroads require locomotives having special characteristics, it may safely be predicted that the mechanical engineers of the railroads and of the builders will solve the design problems involved, and the boiler makers of the country will execute the work successfully.

Keeping Posted

THE future development of boilers, whether for use in locomotives, ships or for power plants, is to a great extent dependent upon the ability of the men who constitute the boiler-making fraternity of this country. The trade has in some directions become one of specialists, the all-around men of former days having largely been replaced by those who are required to carry out a limited number of operations only. While this specialization has aided in speeding up production and maintenance, it has, at the same time, lessened the scope of the experience of those engaged in this work.

Apprentice courses in boiler work are designed to train young men in such a way that they will have a broad knowledge of every phase of the trade; but for the older men who are ambitious to improve their positions, some other system of study and training is essential. The first requirement for such students is for them to learn thoroughly all phases of the construction and repair operations in their own shop. The next essential is to familiarize themselves with the elements of production, equipment arrangement, materials and their characteristics, management, and, above all, to develop the ability to get along with every one in the plant, to be congenial, willing and helpful. Finally, one of the major requirements to success in the future boiler-making industry is a knowledge and understanding of the rapid developments being made in all forms of steam-power generation, which necessitate the construction of modern types of boilers.

The Boiler Maker has endeavored to impress on its readers the necessity for keeping in touch with these developments, and to this end thoroughly covers all phases of this work, both here and abroad. Whenever special information is required in connection with details of new boilers or equipment, or when an explanation of any practical layout, shop, design or other problem is needed, a request to the Editor of the Questions and Answers department, with an outline of the problem, will be promptly answered and the necessary data will be supplied. Moreover a careful study of the answers to problems of other readers will add materially to the fund of information on boiler and plate work which is so essential to individual progress.

Communication

Boiler Shell Sag

To the Editor:

The readers of the Boiler Maker may be interested in a method for determining the degree of hogging and sagging of a boiler shell, which has been used by the writer with some success. This method has lead to the solution of many problems of which the following are a few:

It became necessary to move a riveted shell a distance of about 50 feet, and turn it at right angles to its former position. The shell was 6 feet 6 inches in diameter, 64 feet long, built of 9/16-inch plate, and designed to carry a gage pressure of 100 pounds per square inch. The writer was uncertain how carefully this big shell should be handled, and particularly wished to know if there was any danger of "hogging" in the shell if it were supported at only its mid-length during the moving operations.

In order to determine whether hogging existed, three small holes were drilled partially through the shell plates; one ⅛-inch hole at each end and the third hole at the mid-length of the shell, in line with the two end holes. The three holes were tapped and a bit of wire screwed snugly into each hole so that the pieces of wire would remain as placed, but firm enough so that they could be screwed in or out with the fingers.

The wire in the first hole was cut off about an inch from the shell and its outer end flared to about 1/32-inch thick, then a small hole, not over 1/32-inch in diameter was punched in the flattened portion of the wire, about ⅛-inch from the outer end of the wire.

The wire in the hole at the far end of the big cylinder was cut off about ⅞-inch from the shell, its end flattened to a thin edge, and screwed into the shell until the wire projected as far from the tube shell as the small hole in the wire at the near end of the shell. The sights, thus arranged by the two wires were similar to a pair of rifle sights, the wire with the hole in it, forming the "peep" sight, the other flattened wire acting as a "bead" sight. Another wire was screwed into the third hole at the mid-length of the 64-foot shell. The end of the middle wire was cut off and flattened in a manner similar to the end wire, and when screwed into the middle hole, was made to stand exactly in line with the two end sights.

The big cylinder, by the way, was a "hardening cylinder" inside of which sand-lime bricks were treated under high pressure steam. This shell was freed from its continuous foundation and rolled to its new location, special care being taken not to bend either of the three "gun sights." At frequent intervals during the moving of the shell, a "squint" would be taken through and over the three sights, but at no time during the moving of the shell, was any one of the pins out of exact alinement with the others. This indicated that there was no appreciable sagging of the big shell, not even when, at one time, the shell rested entirely upon a single mid-length block while the shell was swung by rope tackle, through an arc of 90 degrees to its new location.

The sights were allowed to remain in position after the big cylinder was put back to work, hardening bricks again, to observe the action of the shell while in service.

Action Under Steam Pressure

Sights taken along the big cylinder while it was taking steam, showed that distortion began before the pressure had risen very high. The sights were forced out of line and remained so until the cylinder was blown off at completion of a 10-hour run, when the three pins returned to a straight line.

Further experimenting was effected by placing another row of three more wire sights about 90 degrees from the first row. The next time the cylinder was placed under pressure, both lines of sights were watched and from the manner in which the wires went out of alinement, it was deduced that the several shell courses were forced into more perfectly circular form by the heavy pressure.

Portable Boiler Experiment

A set of sight-points was drilled into the boiler of a semi-portable combined engine and boiler of the locomotive type, the engine of which was riveted direct to the boiler. This engine had always been troublesome on account of its almost continual misalinement and wearing out of the wrist and cross-head bearings. The application of a set of pins from the boiler of this machine, showed that the boiler changed shape a good deal while under pressure, and while it did not actually sag, it pulled the connecting rod mechanism so far out of alinement that it was impossible to keep the connecting rod in adjustment.

A set of sight-points was drilled into the upper shell of a certain watertube boiler which had given trouble by some of the tubes persistently coming loose where they entered the upper shell. The points showed considerable movement of that shell while under pressure, and this movement was blamed for causing the tubes to become leaky with such great frequency. This experiment, together with that of the locomotive boiler engine, pointed out the great necessity for forming boiler shell courses into more perfectly cylindrical form than is evidently the case in many boiler shells as now constructed. While such change of form does not cause appreciable sag in a boiler shell, it is evident that the life of the steam vessel is impaired to a greater or less degree by such continual change of form each time the internal pressure is increased and diminished.

Indianapolis, Ind. JAMES F. HOBART.

Working Model of Stevens Locomotive on Exhibition

A FULL size working model of the original locomotive built by Colonel John Stevens who has been called the "Father of American Railroading" has been built by the Pennsylvania Railroad Company at its shops in Altoona, Pa. This engine with a replica of the original circular wooden track was exhibited in operation at the Stevens Institute of Technology in Hoboken, New Jersey, during the week of November 18. This exhibition was held in connection with the inauguration of Dr. Harvey N. Davis as president of the institute.

The construction of this replica was made possible by data given in original manuscripts now in possession of the Stevens family, and from original parts and the model in the Smithsonian Institute at Washington, D. C.

The Smithsonian Institute shipped to the Stevens Institute of Technology the original boiler and safety valve of the John Stevens locomotive. The boiler is of the vertical tubular design with a grate beneath into which lengths of wood were fed through a hole in the casing. The boiler consisted of a top and bottom header, each header being made in halves and bolted together and containing twenty 1 3/16-inch tubes.

The original engine consisted of one cylinder 5 inches in diameter and having a 12-inch stroke. It was a rack-driven locomotive and power was transmitted to the rack through two gears attached to the frame. Records in the government archives indicate that the Stevens locomotive attained a speed of 12 miles an hour carrying 6 persons on seats at one end of the locomotive frame.

Colonel Stevens first operated the locomotive in 1825 on his estate at Castle Point, Hoboken, N. J., to demonstrate the practicability of the railroad project which he had previously incorporated as the Pennsylvania Railroad Company. He also proved that steam locomotives could be operated on rails over ground with grades as well as on level ground.

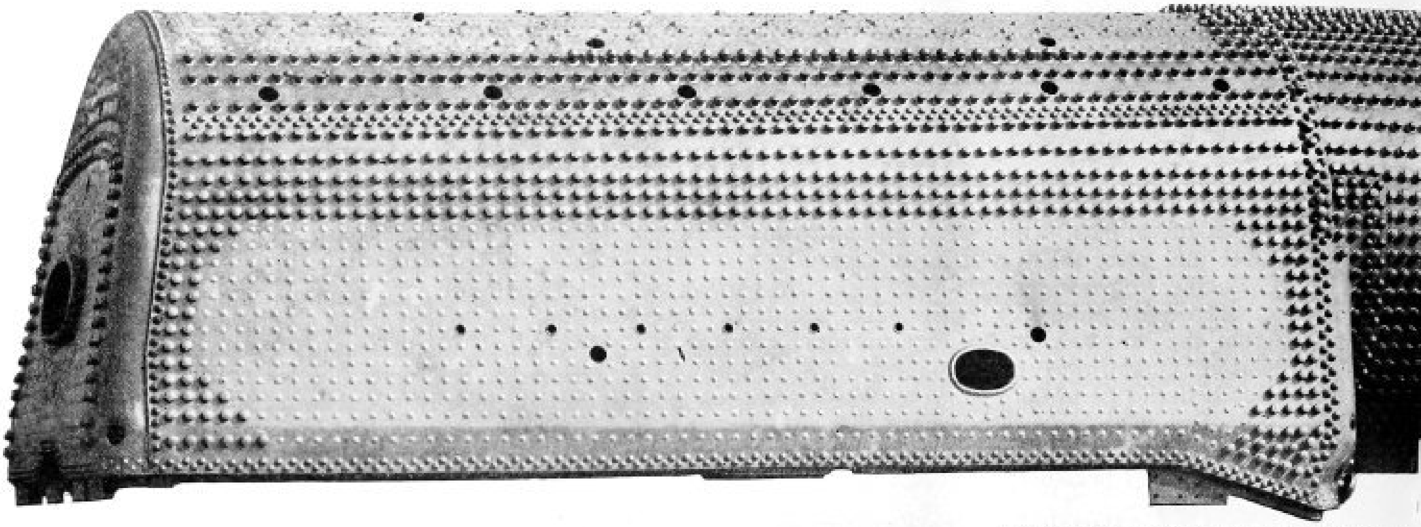
Production of Hollow Forged Drums Developed in England

By G. P. Blackall

IMPORTANT pioneer work in the production of hollow steel forgings for high-pressure boilers is being carried out in Sheffield, England, by John Brown & Company. The hollow rolling mill installed at the firm's Atlas Works is the only one of its kind in the United Kingdom. For medium pressures, up to about 500 pounds per square inch, it is considered satisfactory to employ a hollow forged cylindrical drum of suitable thickness, in which separate dished ends are riveted. In cases where the stress and temperature are high, however, the boiler drums are forged in one piece, the ends being closed so as to leave only a manhole at each end or such openings as may be required by the designers.

In special cases these may be supplied with one end completely closed, a manhole being left at the other. In the process of manufacture the ingots are cut to length, and a hole trepanned through them to enable a careful examination to be made. In the subsequent forging process the ingot is both expanded and drawn. The steel is worked both circumferentially and longitudinally, thus ensuring that the grain lies in the direction most suitable for dealing with the stresses set up in the steel during service. All boiler drums are machined, because steel, when properly finish-machined is far less liable to corrosion and gives greater general efficiency than when left in the forged condition. A large number of these hollow-forged drums of varying sizes up to a length of 50 feet have been supplied by this concern to boiler works both in the United Kingdom and abroad.

Petty & Wherry, Inc., 50 Church Street, New York city, have been appointed metropolitan distributors for the Buckwall Engineering Company of Brooklyn, New York—manufacturers of the Buckwall Sprocket Wheel.



More than 20,000 holes were drilled in

World's Largest Locomotive Boiler

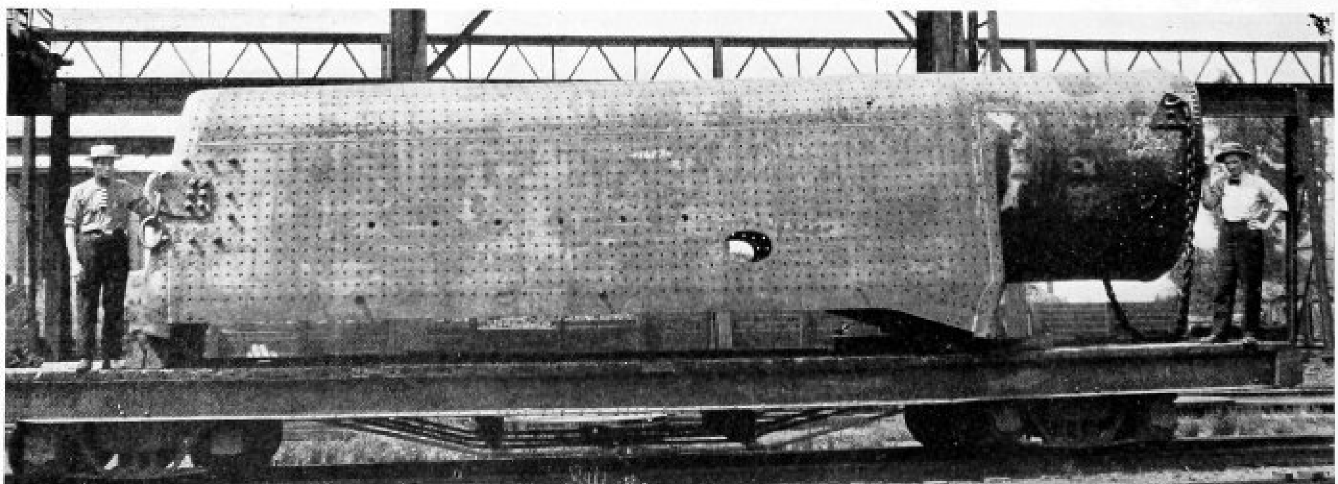
Northern Pacific locomotive boiler is nearly 64 feet in length and weighs 165,000 pounds

WHAT is said to be the largest locomotive in the world, has recently been completed by the American Locomotive Company, Schenectady, N. Y., for the Northern Pacific Railway. This locomotive is of the simple articulated 2-8-8-4 type and is equipped with a conical boiler built for a working pressure of 250 pounds per square inch. The estimated weight of the boiler alone is 165,000 pounds. More than 20,000 holes were drilled in the boiler during its construction, and it is equipped with five Nicholson Thermic syphons. There are 5153 Alco staybolts and 2527 Alco welded sleeves used in the firebox assembly. The grate area is 182 square feet, the total heating surface is 7673 square feet and the total superheating surface is 3219 square feet.

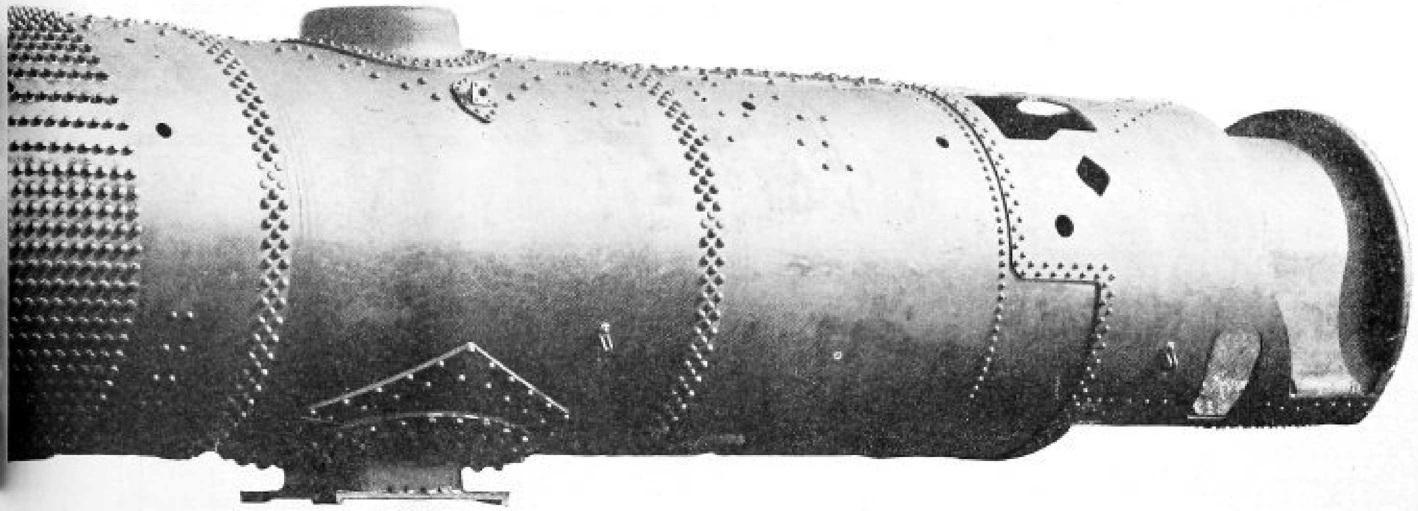
The size of this boiler is so great that its fabrication entailed an unusually extensive amount of hand work. This, combined with the fact that the work was of a more or less experimental character, makes the details of the construction of considerable interest.

General Details of Boiler

The boiler is built with a factor of safety of 4.5. Flange steel, having a tensile strength of 55,000 to 65,000 pounds per square inch and firebox steel with a tensile strength of 52,000 to 62,000 pounds per square inch were used throughout. These plates, having a total weight of 111,440 pounds, were supplied by the Lukens Steel Company, Coatesville, Pa. The total length of the boiler is 63 feet 8¾ inches, while the firebox and



Completed firebox for Northern Pacific boiler



this Northern Pacific locomotive boiler

combustion chamber combined are 28 feet 6⅝ inches long. At the front end, the boiler has an inside diameter of 103¼ inches and at the throat connection an outside diameter of 110¼ inches.

The firebox has a length inside the sheets of 229¼ inches and a width of 114¼ inches with a water space at the front of 7 inches, at the back 6 inches and at the sides 6 inches. The combustion chamber has a length of 72½ inches. The water space under the combustion chamber is $6\frac{1}{16}$ inches. In the firebox construction, the crown sheet, side sheets and fire door sheet are all of ⅜-inch thick firebox steel. The tube sheet has a thickness of ⅝ inch and the inside throat sheet a thickness of ½ inch.

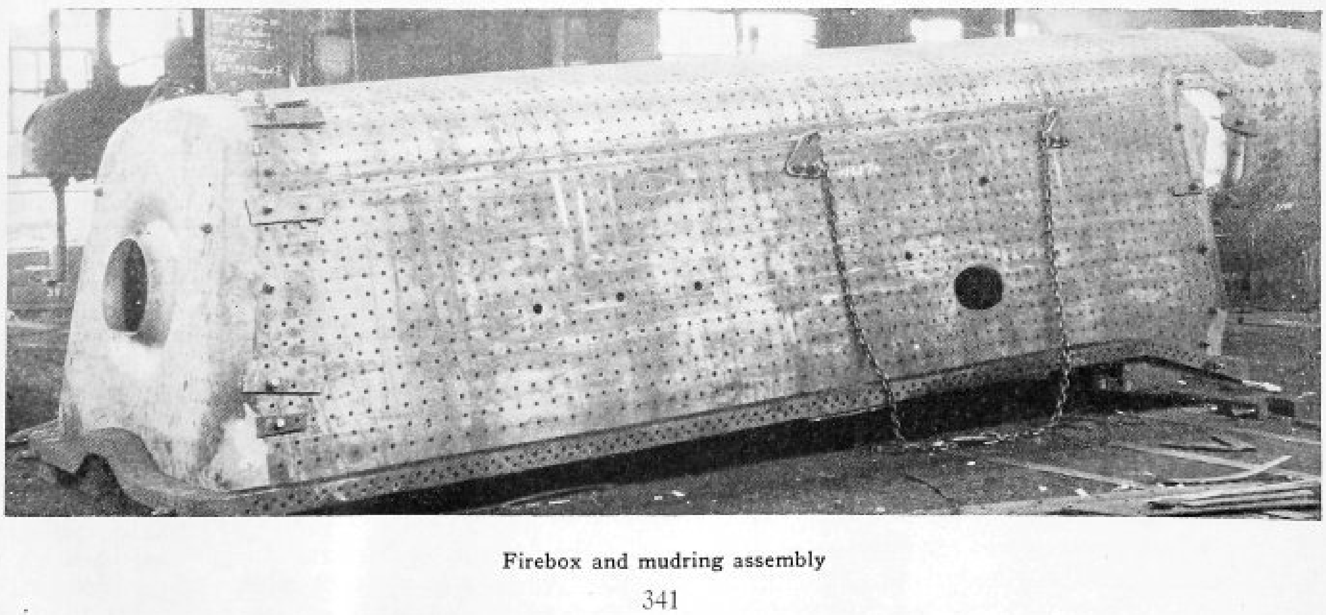
Firebox Construction

The firebox ring, which is horizontal back of the brick wall, has a total length of 23 feet 4 inches and a total width of 10 feet 7 inches. Because of the great size, it was not possible to make the entire ring of cast steel, so an assembly with forged steel sides and cast steel ends was used. It was necessary to drill all holes in the various parts of the mud ring before they were assembled as the completed ring would have been too large to be accommodated on the drill press in the shop.

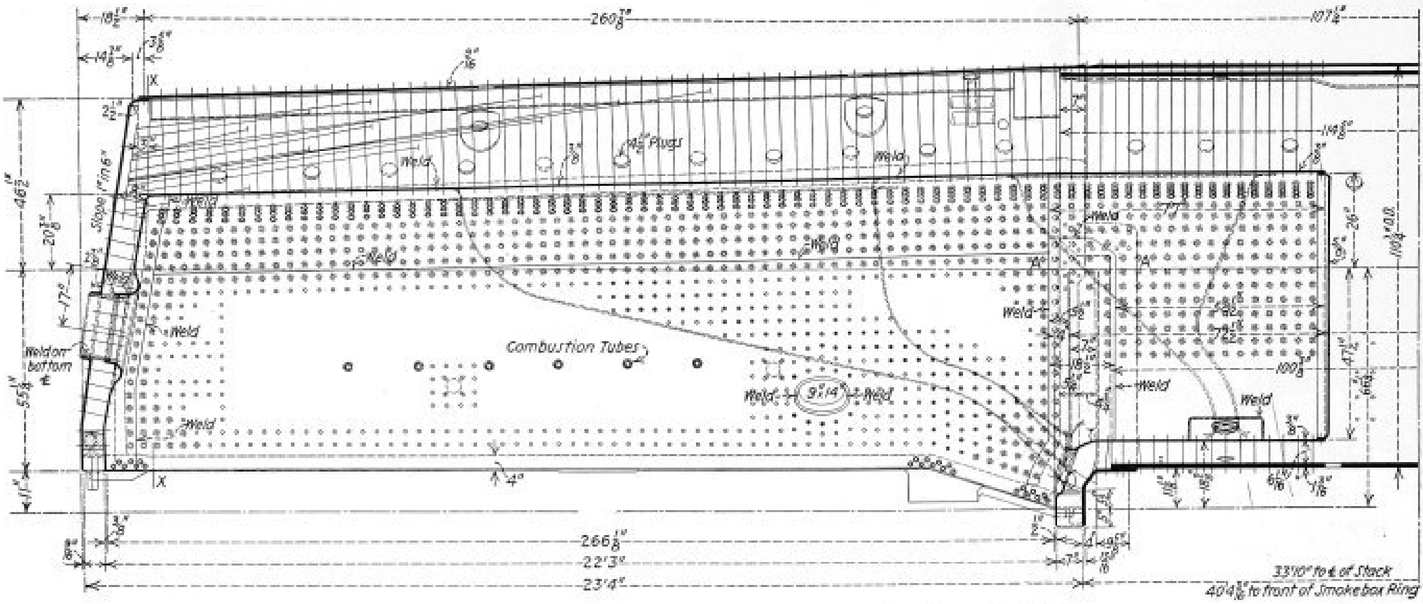
The firebox is in three sheets, the crown and side sheets being joined by arc welding. These sheets are also welded to the inside throat while the one piece combustion chamber is welded to the crown and inside throat sheet. The sheets used for the sides of the firebox were ordered with the grain of the metal running lengthwise. The firebox sheets are welded to the mudring for a distance of about 10 inches on each side of the corners. This applies to both inside and outside sheets. The door sheet is welded to the crown and side sheets, the welding being located centrally between the two back rows of staybolts. The inside throat sheet is butt-welded to the crown and side sheets, with the welding located between two rows of staybolts. Again in the case of the firebox flue sheet, care was taken in ordering and laying out the plate that the grain should run vertically, in order that the flange at the top would be across the grain instead of parallel with it.

The backhead as well as the door sheet are flanged out at the fire hole, which is an opening 16¼ inches wide by 30¼ inches long. A sleeve is applied between the backhead sheet and the door sheet which is lap welded to the flanges with welding ½-inch wide on both sides. The fire door flange is of the O'Connor type.

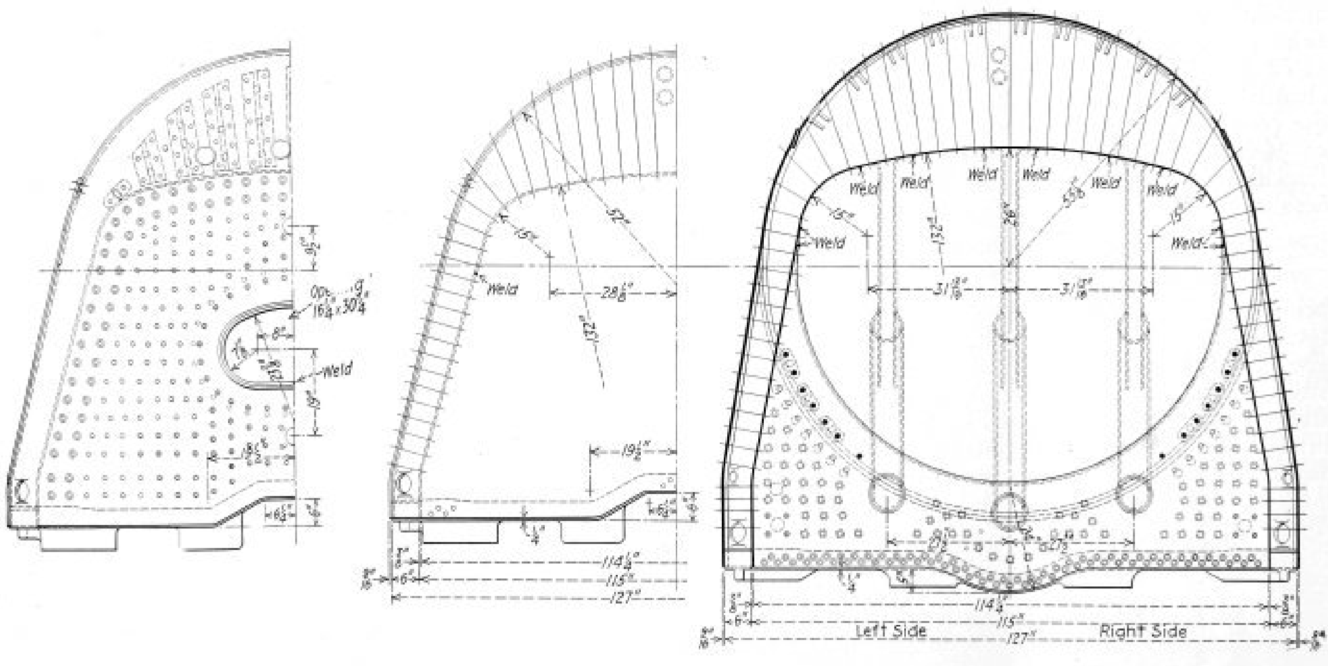
A detail that has been carefully observed is the slight flattening of the corners of the firebox sheet at the curve of the throat and backhead where washout plugs



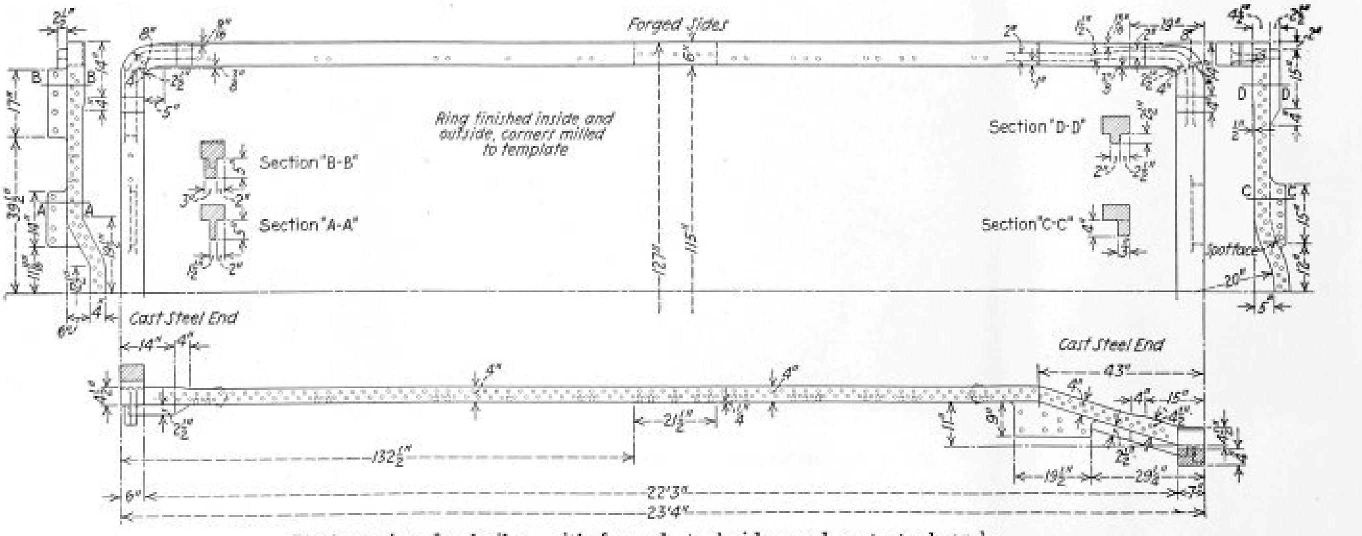
Firebox and mudring assembly



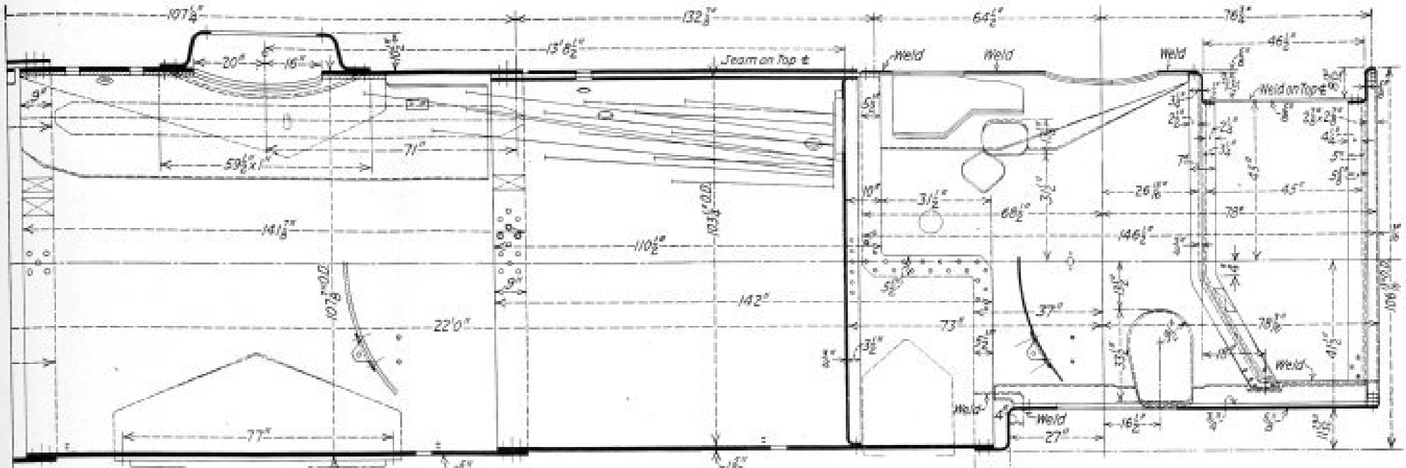
Longitudinal section through firebox and combustion chamber



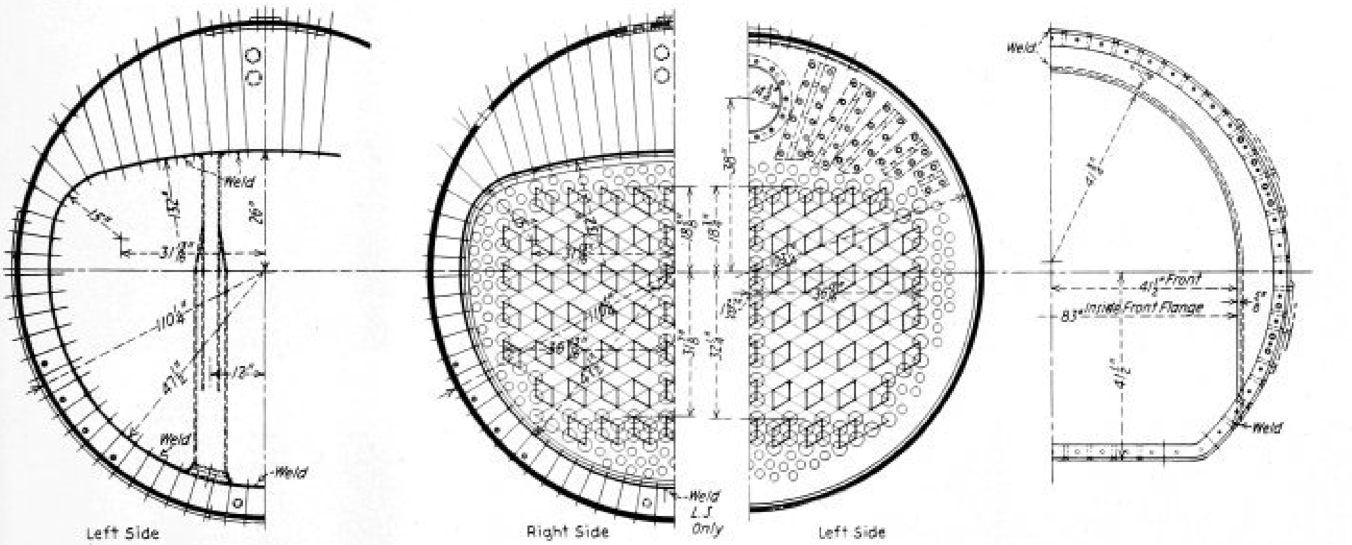
Sections through firebox of boiler



Firebox ring for boiler, with forged steel sides and cast steel ends



Longitudinal section through boiler barrel and smokebox



Section through boiler at combustion chamber, tube sheets and smokebox

are located, so as to give the plugs full threads in the sheets. The outside throat seam was sealed on the water side by welding after the seam was calked.

Boiler Barrel

The first course of the boiler barrel has a length of 142 inches and is made of 1 5/32-inch plate; the second course has a length of 141⅞ inches and is also of 1-5/32-inch plate; the third course at the throat has a length of 114⅝ inches and is made of 1 3/16-inch plate. The shell is thoroughly re-inforced at all openings. All plates used were carefully planed at the edges and circumferential seams were calked inside and outside. Special welding was performed at the longitudinal seams as will be noted later. Rivet holes were reamed after the plates had been assembled to insure uniform holes. They were also countersunk on each side and no drifting was permitted. Such precautions as these observed throughout the construction of the boiler resulted in a remarkably well-finished job and one in which no leaks developed under the tests.

All circumferential seams were triple riveted. Burden iron rivets were used throughout the boiler. Rivets 1 inch in diameter were used to connect the smokebox ring and the first course; 1-inch diameter rivets to secure the front tube sheet in the shell; 1 7/16-inch rivets the first and second and second and third course; and 1⅛-inch rivets to connect the last course to the firebox wrapper sheet.

Smokebox Construction

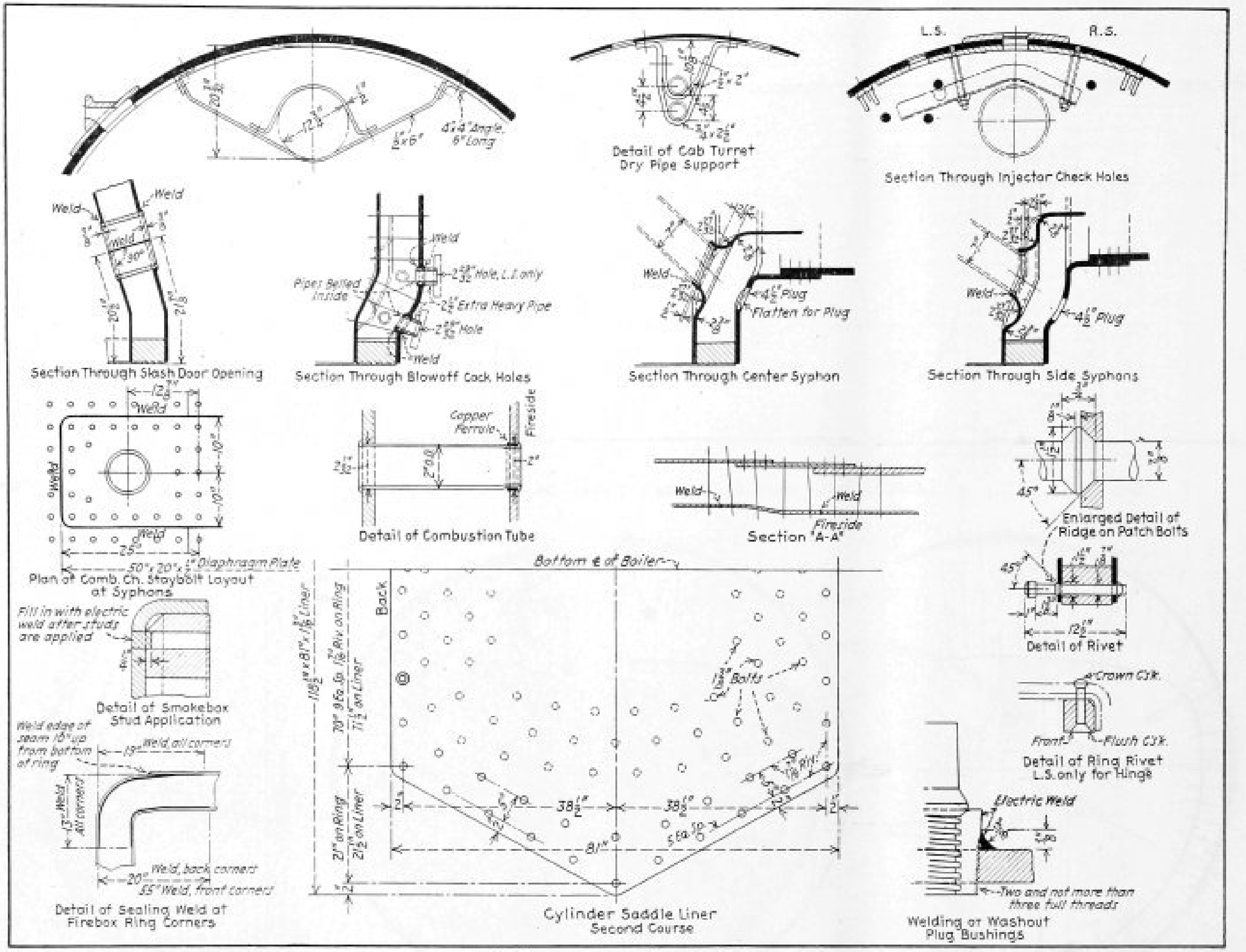
The construction of the smokebox for this boiler was an extremely difficult operation as it entailed the formation of cutouts in the plate at the front end to accommodate the Coffin feedwater heater (also the largest in the world), which was applied. In building this part of the boiler, accuracy had to be maintained so that when the heater was dropped into place it fitted perfectly and with ⅛-inch clearance to allow for expansion of gases. The smokebox has a length of 146½ inches and a diameter of 106 13/16 inches and is made of ⅝-inch plate.

A great deal of welding was used around the top and bottom liners which have a thickness of ¾ inch. Details of these liners are shown in the illustrations.

Staybolts used in the boiler are of Ulster special iron. The total number of Alco flexible bolts amounts to 5153.

Tubes and Flues

There are 92 open-end, hot-rolled seamless-steel 2¼-inch outside diameter tubes, 22 feet in length over the sheets; 280 hot-rolled, seamless-steel superheater flues 3½ inches outside diameter, 22 feet in length. These



Boiler construction details

tubes were supplied by the Globe Steel Tubes Company. In addition, there are six 2-inch combustion tubes in each side of the firebox, set with No. 18 B. W. G. copper ferrules in the firebox end.

A type E superheater supplied by the Superheater Company is installed. This superheater is composed of 140 units of cold-drawn, seamless-steel tubing, 1 3/16 inches outside diameter.

A Gaines arch is applied in the firebox, while the firebrick arch which is installed was supplied by the American Arch Company.

Because of the length of the grates it was necessary to provide openings above them on each side of the firebox so that access might be obtained to the front end of the grates for cleaning.

The remaining accessories of the boiler include: Frankling Railway Supply Company fire door; Hancock injector and injector checks; Standard Stoker Company type B stoker; Q. & C. Company grate bars; "Edna" water column; Cleveland low-water alarm; Everlasting blow-off cock; Huron washout plugs.

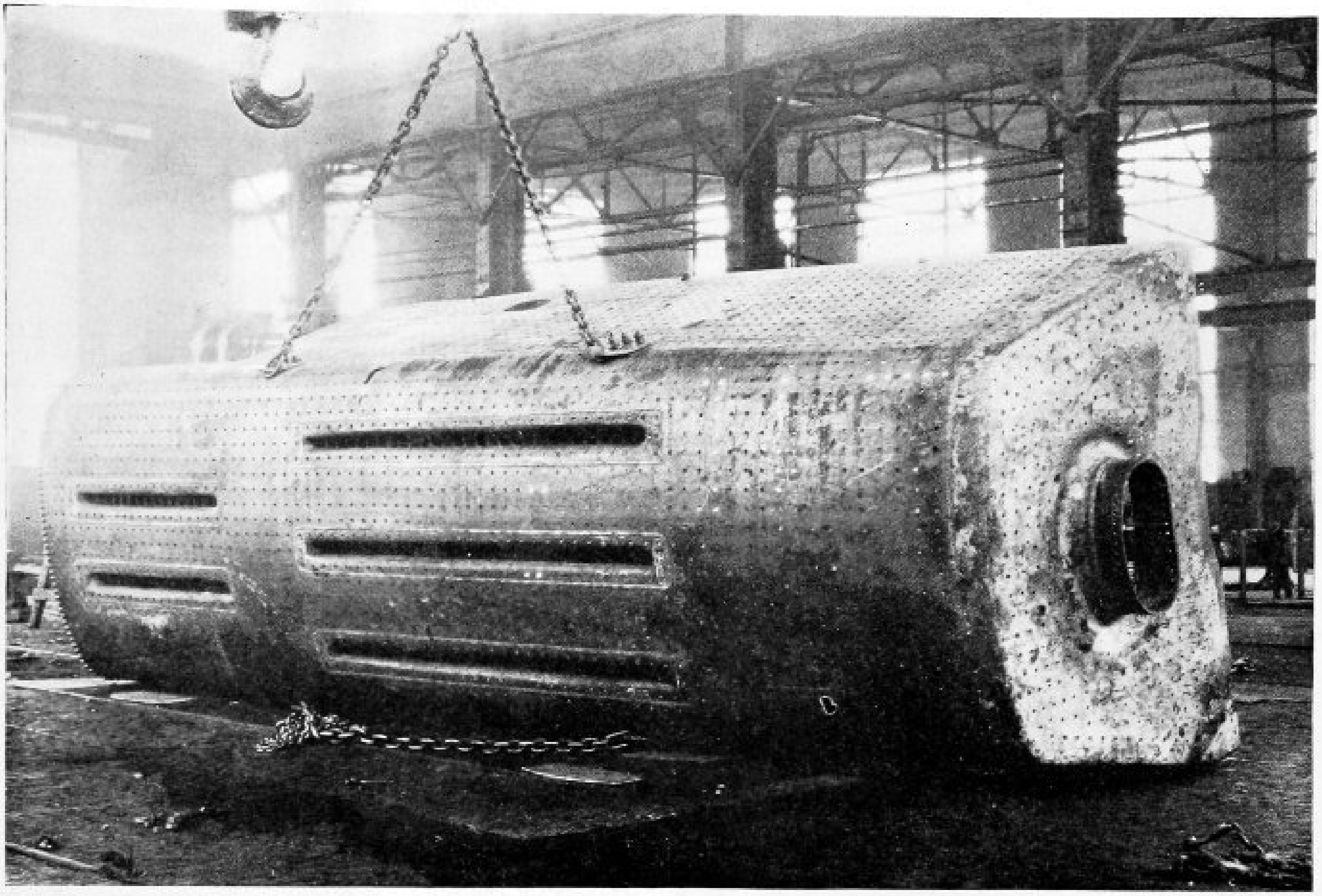
The number of Huron washout plugs with which the boiler is equipped is unusually great, there being forty 4½-inch plugs and four 3⅞-inch. Details of the welding in of these plugs are given in the illustration.

Shop Work on Boiler

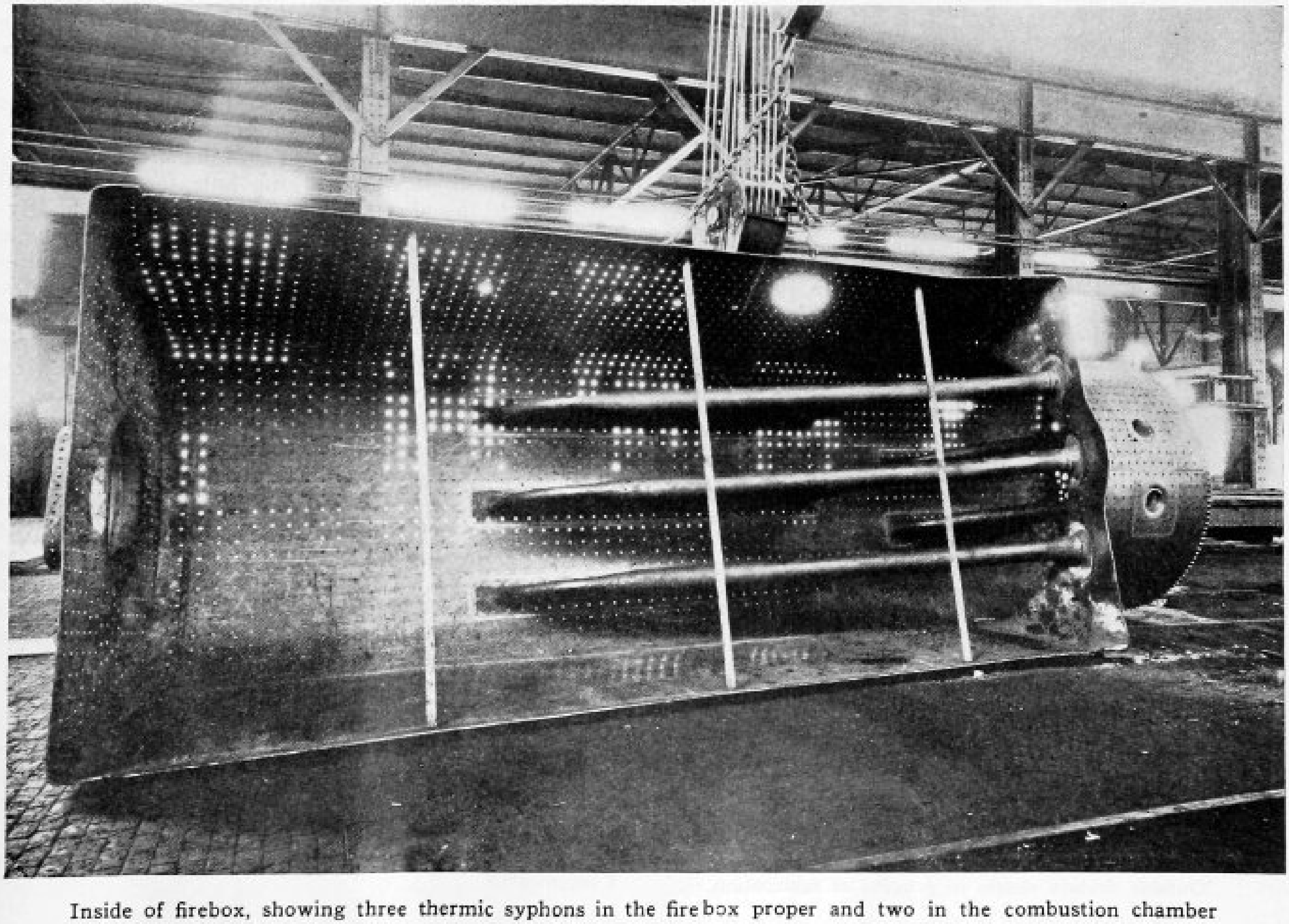
In executing the work in the shop, the fact that the boiler was so large and that it was the only one on the order, made the development of special procedure necessary in carrying out many of the details. The back end, for example, was so long that there was not clearance enough from the floor to the stake of the bull riveter, which is 17 feet from the floor, to drive the connection on this machine. It was, therefore, necessary to drive the rivets by hand. For this purpose, a No. 90 Ingersoll-Rand double-plunger air hammer, operating at 100 pounds pressure, was used to drive the 1⅛-inch rivets which were held on by means of an Ingersoll-Rand air jamb.

The only rivets used in the firebox were in the back tube sheet connection and these were driven on the 150-ton bull riveter, each rivet being held for 18 seconds.

The great amount of welding employed in the construction of this boiler, both to join major sheets and to increase the tightness of seams, adds to the general interest of the job. In the firebox, the crown sheet, side sheets, combustion chamber, inside throat sheet and door sheet are all assembled by welding. The five syphons are welded in the crown sheet. The welding of the syphons had a tendency to set up strains in the crown sheet and to distort it. This naturally added to the difficulty of the work. The problem was finally solved by the use of strong backs made up of arched plates and angle irons, the curve in the bottom of the strong backs conforming to the curvature of the crown. In using these devices preparatory to welding, spacers were inserted between them and the crown sheet and they were then bolted solidly in place. With the strong backs in



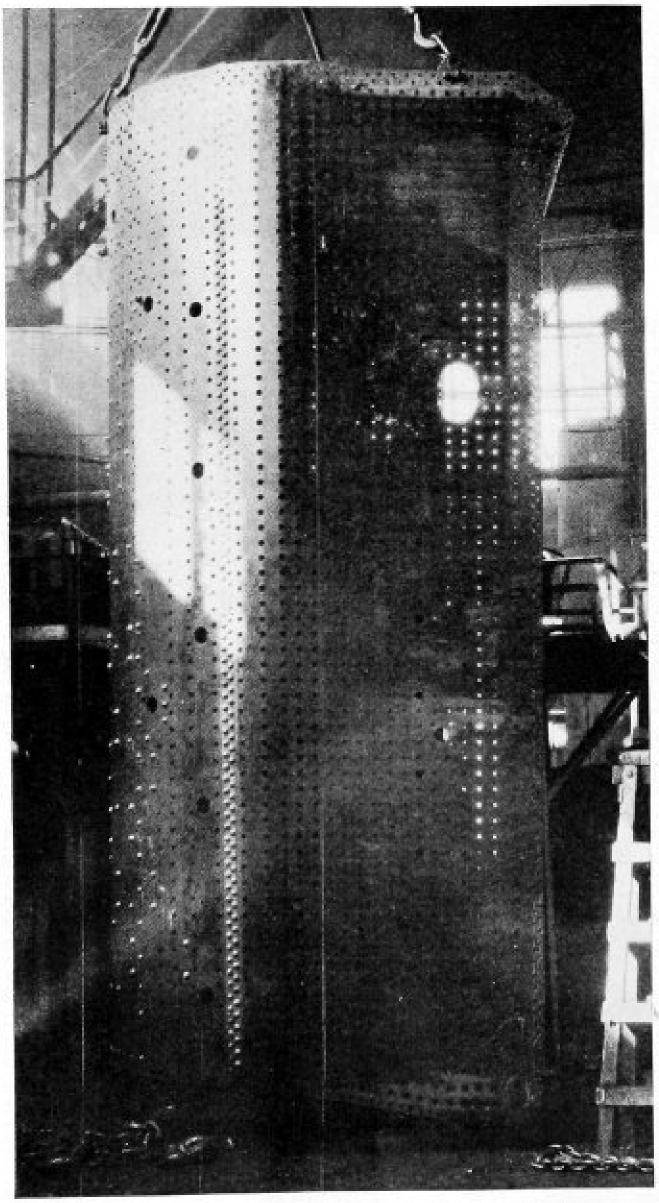
Outside of firebox, showing welded syphon connections



Inside of firebox, showing three thermic syphons in the firebox proper and two in the combustion chamber place, distortion in the crown sheet was practically negligible during the welding operation.

In welding the crown and side sheets, the plates were vee'd out about ¼ inch on the fire side, ⅛-inch gap being left between the sheets. Regular welt strips, extending the length of the seams, were bolted in place on the water side of the sheets. The plates were then joined by close-arc braid welding. On the fire side this weld was covered by lace welding about 1 inch wide and on the water side by lace welding about ½-inch wide, after the welt strips had been removed. For this firebox welding of 3-inch plate, 5/32-inch wire was used at 130 amperes. For shell welding in which the plate was 1 1/32 inches to 1 3/16 inches, 3/16-inch diameter wire was used with the amperage raised to 180, which gave increased heat in order to obtain the proper penetration. All longitudinal seams in the shell, where the plates butt, were welded in a distance of 12 inches to 18 inches.

The detailed list of welding includes combustion chamber to crown sheet, 7 feet; combustion chamber bottom seam, 3 1/3 feet; diaphragm plate, 12 feet; crown and side sheets, 42 feet; syphons to crown sheet (five syphons) 118 feet; door sheet, 19 feet; inside throat sheet, 28 feet; making a total of 229 1/3 feet. In addition to this, the total welding employed at seam edges to increase tightness includes 575 feet outside the boiler and 169 feet inside.



Outside firebox sheets in process of fabrication

Saddle Liner

The connection of the saddle liner under the second course entailed a great amount of extremely careful workmanship in order that it might be absolutely tight in test. The importance of this is evident when it is realized that should leaks develop after the completion of the locomotive, it would be necessary to practically strip the engine to correct the trouble. The detail of the design of this liner is shown in one of the illustrations, the feature being diamond pattern ends. The liner has a thickness of 1 3/16 inches and the boiler course at this point has a thickness of 1 5/32 inches.

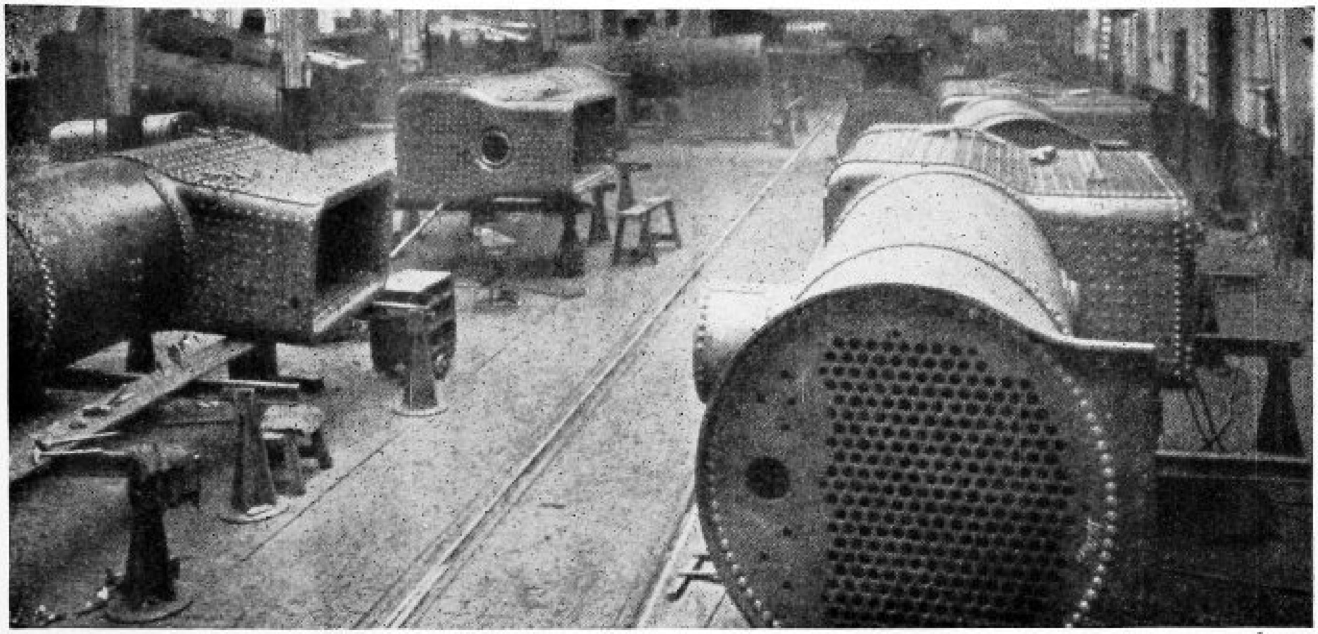
No holes for the retaining bolts were drilled in the boiler until the liner had been laid up metal-to-metal and riveted in place with 1 7/16-inch rivets. The bolt holes were then marked out on the inside of the boiler and the holes drilled by means of a spider arranged concentric with the barrel of the boiler. From the center of this spider the drill was suspended on an extension arm. This method of drilling insured all holes being radial. Chrome-nickel steel bolts 1 3/8 inches in diameter with button-heads were used. The plate under each bolt head was recessed and ¾ inch was allowed on each bolt to drive. The bolts were driven with a No. 90 air hammer.

Bushing a Pipe Thread

"THE blow-off pad on that 6 by 118 H.R.T. boiler," said the gang foreman to the shop superintendent, "has been tapped too large. The blow-off pipe screws in all over the thread, which we can't make tight. What shall I do, cut out the rivets and put on a new pad?"

"Try a wire-cloth bushing," said the foreman. "Cut a 2-inch strip of fine-mesh brass wire-cloth, such as tinners make milk strainers of. Make the strip barely long enough to lap around the hole in the blow-off pad. Daub the threads well with litharge and glycerin, screw in a piece of pipe and let it remain while the boiler is filled and tested. Trim off the wire-cloth neatly all around the blow-off pipe, letting the wire project about ¼ or ⅜ inch. Flange down the wire-cloth against the pad around the pipe and apply Smooth-on to form a neat little boss with the wire-cloth inside. Do not let the pipe remain in the wire-cloth for more than 24 hours without giving the pipe a slight turn backward to break up possible setting of the litharge against the pipe threads. If the litharge and glycerin are allowed to harden thoroughly before the pipe is moved, the bushing will be torn out with the pipe. But move the pipe occasionally for a day or two, then, after finally removing it, smooth down the wire-cloth inside the boiler shell and the bushing will last for many years without giving the least trouble."

The National Flue Cleaner Company, Inc., Groveville, N. J., manufacturer of the national soot blower for return tubular boilers, announces the appointment of three new Ohio sales representatives, namely, Craun-Liebing Company, of Cleveland, Dennis Engineering Company of Columbus, and the Bishop Engineering Company of Cincinnati.



View of boilers on the belt at the Crewe Locomotive Shops

Work at Crewe Locomotive Shops

Completing new boilers on the belt—Equipment and methods used for boiler repairs

THE belt system in operation at the Crewe Works includes ten stages carried out on 17 locations or spots. The following list includes the stages, operations and spot positions:

Progressive System of Building New Boilers

Stage		Position Berth Number
1	Fullering and calking	1
2	Fitting firebox, etc.	2
3	Riveting firedoor plate, etc.	3, 4, 5
4	Fixing and setting firebox and reaming foundation ring	6
5	Riveting foundation ring and firehole	7
6	Tapping	8
7	Staying firebox	9, 10, 11
8	Stay riveting	12, 13, 14
9	Fitting and riveting barrel brackets, leveling and tapping crown	15
10	Fitting roof stays and finishing off	16, 17

Constant for the clock = 6 hours 43 minutes.

The belt is worked to a clock set at a pre-determined time and each boiler moves along the belt at intervals of 6 hours 43 minutes. Two overhead cranes of 25 tons capacity each are used for moving the boilers from berth to berth. The system works smoothly and satisfactorily, the output being seven large new boilers per week of 47 hours. At the present time the boiler is in the belt shop only 15 days as against approximately 30 days under the old system of building.

On leaving the belt, the boilers are taken into the erecting shop where the tubes are fitted and mountings placed in position, the boiler then being tested under hydraulic and steam pressures.

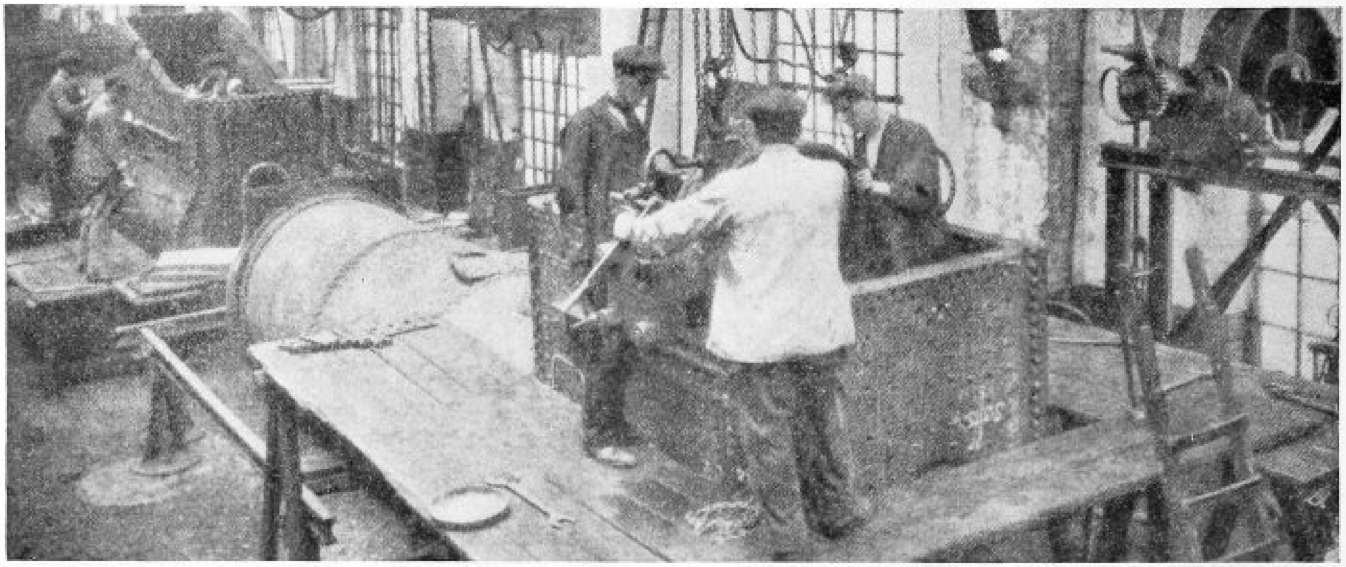
Boiler Repair Operations

The shop in which the boilers are repaired is located at some distance from the new boiler department. This building has a length of 624 feet, a width of 96 feet and is divided in three bays. Heavy repairs are carried out in this shop while lighter repairs are handled in the erecting shop. Boilers are brought to the shop with lagging and mountings in place, the first operation being that of stripping them. All tubes are removed and simultaneously Asquith portable drilling machines drill out stays, staybolts and rivets. The belt system is applied to the boiler repair shop, but only in cases where new fireboxes are to be fitted. The sequence of operations at the various stages of a belt are as follows:

Renewing Fireboxes—Operations Involved

Stage
1 Stripping mountings and taking tubes out. Drilling stays and rivets, etc. (Asquith portable drill).
2 Cutting out stays and rivets (pneumatic cutting gun).
3 Shelling out stay heads and ends (pneumatic hammer).
4 Marking firebox.
5 Drilling and tapping bush holes (Asquith portable drill).
6 Fitting in bushes. Riveting bushes (pneumatic hammer). Welding up grooves and pit holes.
7 Fitting in box and preparing for hydraulic riveting machine.
8 Riveting foundation ring, door plate and firehole (hydraulic riveting machine). Calking ring and rivets and putting corner studs in.

* Second of two articles describing the locomotive shops at Crewe, England. The first article appeared on page 311 of the November issue. The material was made available through the courtesy and co-operation of *The Railway Engineer*.



Riveting the mud ring on a new firebox

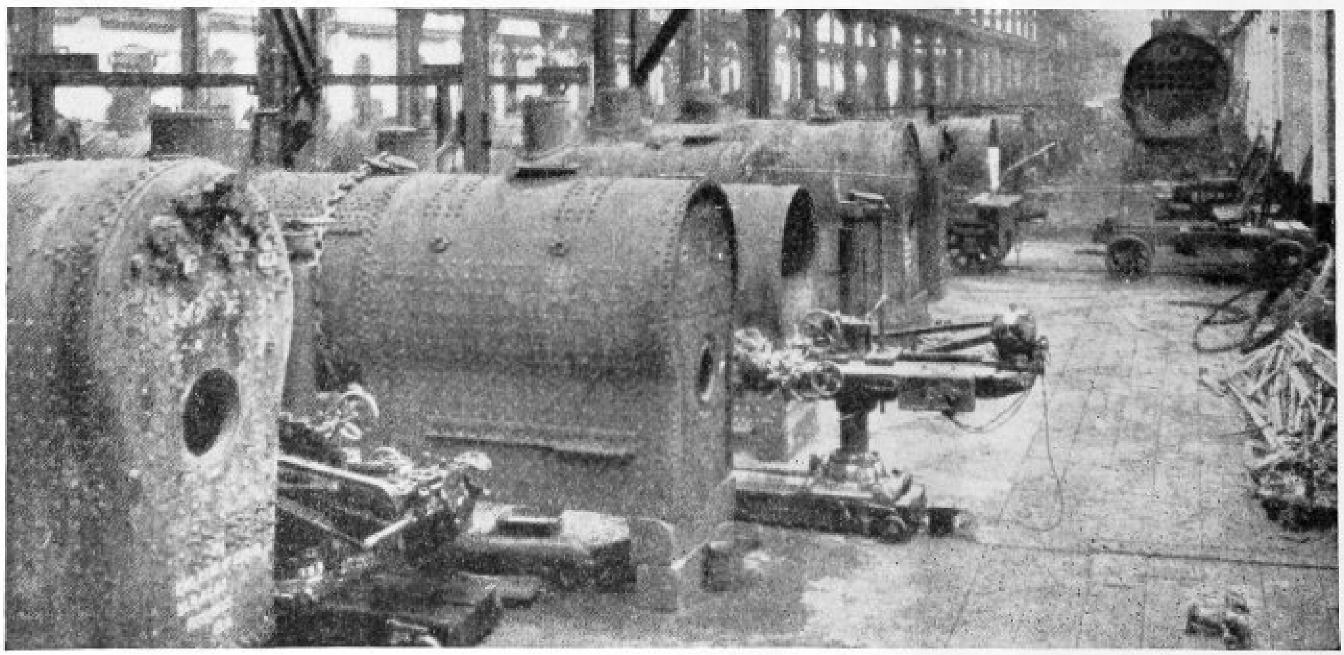
9 Tapping stayholes and tacking firebox.
10 Fitting in stays.
11 Riveting stays (pneumatic hammer); calking and fullering, etc.
12 Belpaire crown.

At stage 12, which, as shown on the list, is set apart for Belpaire boilers, the holes are tapped in the wrapper and in the new inner firebox and the crown stays are placed in position. It will be noticed from the above that stage 4 consists of marking off the firebox. This is necessary owing to alterations having been made to the seams of the firebox prior to the adoption of the single-plate wrapper some three or four years back. This stage will be eliminated as the old three-piece wrapper sheets disappear. The time occupied at present for the above operations is 22 days, and when the scheme is fully organized and in working order, this—it is confidently anticipated—will be considerably reduced. Originally 40 to 45 days were required for boiler repairs of this character.

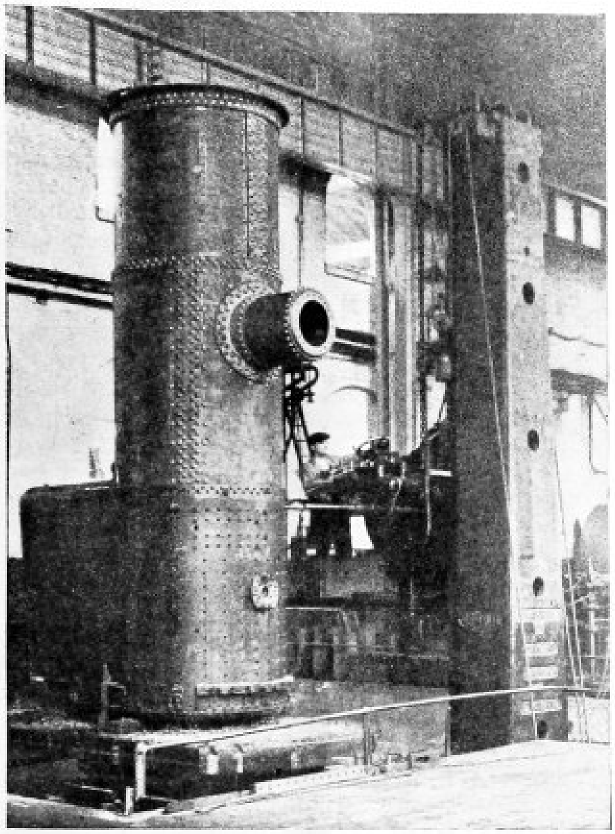
Planning of Work

The boiler shop foreman is advised of the classes of engines coming in for repair, that is, engines "Agreed for shopping," as explained in the previous article. A statement or list is received in the boiler repair department weekly, giving the class of engine and its number, date of last repair, mileage since last repaired, and whether a heavy or light type of boiler. The assistant boiler shop foreman supplies daily advice of the boilers that are actually moving in. The boilers are examined after being stripped, and the tubes taken out, and a decision is then reached as to what repairs are necessary. As already explained, the belt system is only employed in cases where fireboxes are being renewed, but it is contemplated to extend the same principle to other heavy repairs.

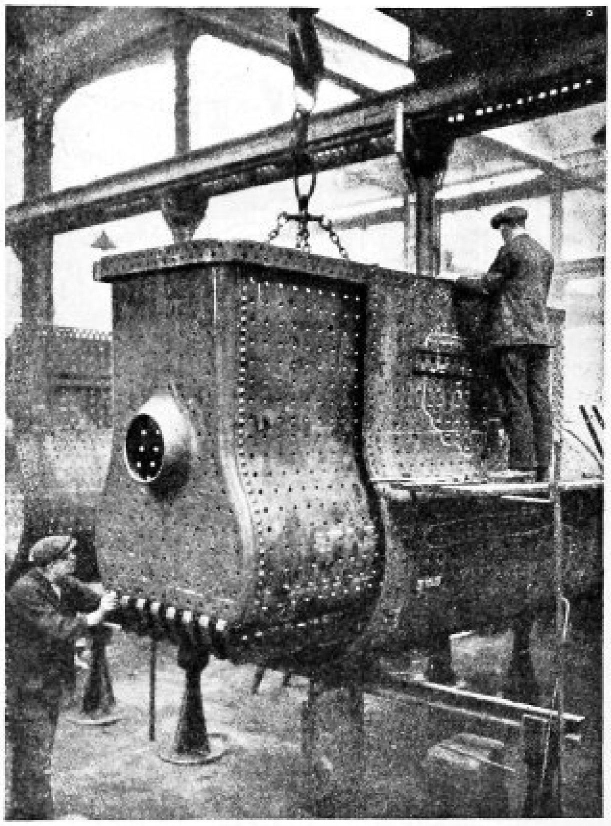
Minor repairs are not at present processed round the shop. Such boilers as are in bad condition are examined by the foreman, who reports to the works manager, the latter deciding upon the course of action to be pursued. In some cases the boiler is repaired and in others it is scrapped, the copper either being used in the brass foundry or sold, while the steel portions are sent to the steel works.



General view of south bay in the boiler repair shop

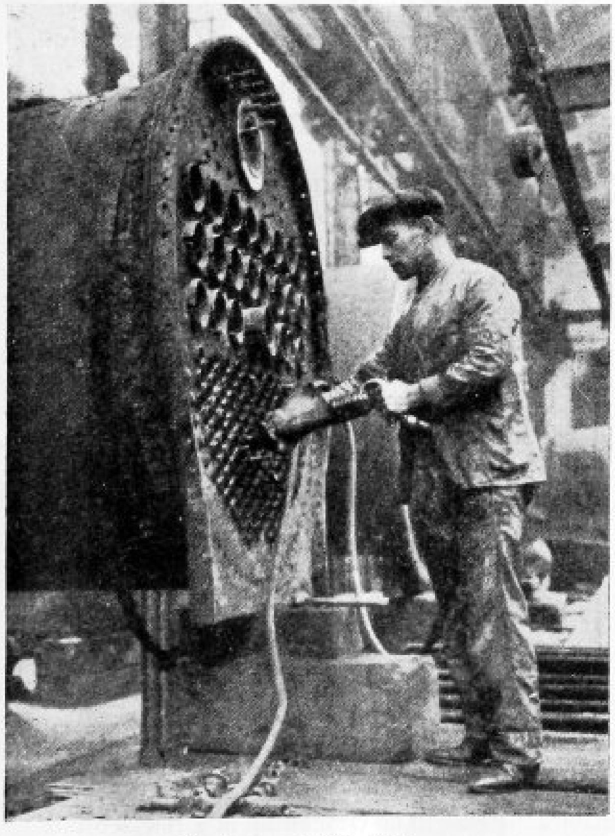


Three spindle drilling machine at work on boiler shell

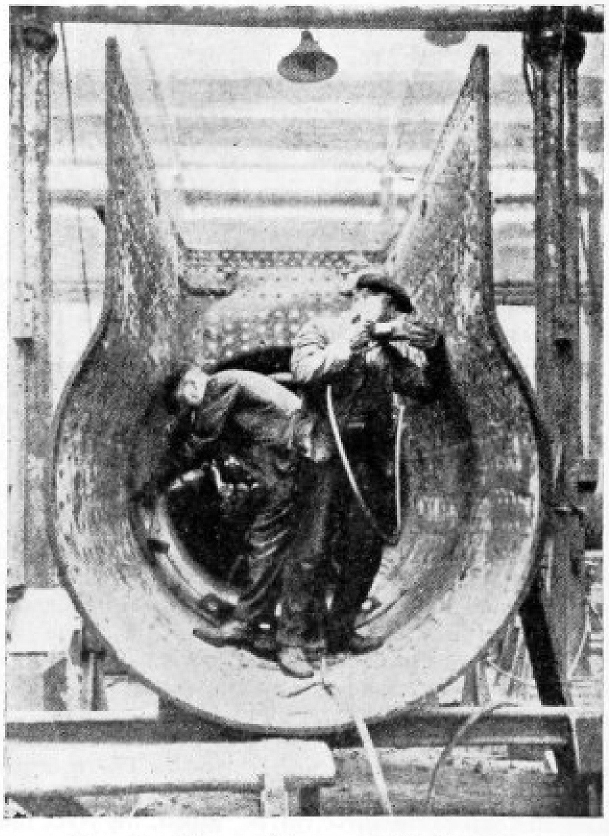


New firebox being installed in a repaired boiler shell

The boiler repair shop is equipped with electric overhead cranes, those in the north bay being of 25 and 15 tons capacity, and those in the south bay of 20 tons and 10 tons, the middle bay having two cranes, each of 10 tons capacity. All of these were made in the Crewe Works. The machinery in the shop consists of a hy-



Cutting out boiler tubes



Removing burrs with pneumatic hammers

draulic riveting machine, also tapping and drilling machines. Portable compressed-air drills, pneumatic hammers and rivet-cutting guns are utilized, these being of the Boyer, Ingersoll-Rand and Cincinnati makes.

Boilers on leaving the repair department are transferred from the finishing berth to railway tracks and conveyed on trolleys to the mounting shop nearby, where the tubes, boiler mountings, lagging, etc., are fitted and the boilers tested. The boilers are then ready to be transferred to the new erecting shop, there to be placed on the frames of locomotives on the belt. The center portion of the boiler repair shop is used for general plate work, not only for locomotives but also articles for out-stations such as turntables, stop blocks, etc. All stationary boiler work is done here as well, the space devoted to this purpose being roughly one-third of the area of the shop. Ashpans for locomotive fireboxes are made and built up in this section, as also are wheel splashers, smokebox sides and other articles. A series of machines consisting of leveling rolls, punching and shearing machines, horizontal bending rolls and planing machines are utilized in connection with these various operations.

One of the most difficult and time-occupying operations in the repair of a boiler is that of taking out the tubes. This has been very much simplified at Crewe and the cost considerably reduced by use of small pneumatic hammers. A strict record is kept of every class of repair done to a boiler.

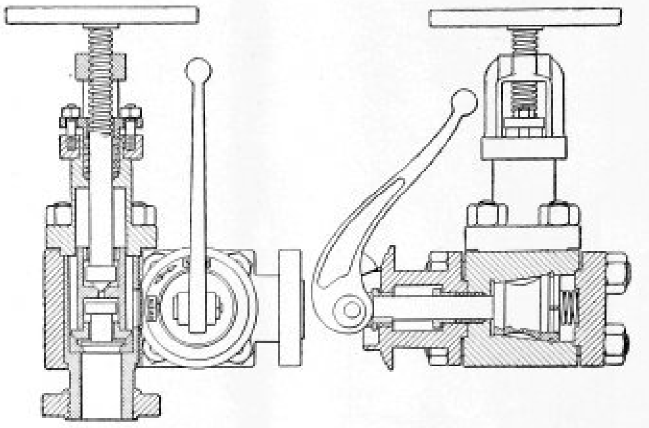
At one end of the shop a space is set apart for dealing with condemned boilers, this space being equipped with a traveling gantry crane. In the first place, the barrel is separated from the firebox with a cutting torch and cut into small pieces suitable for the melting furnaces. The inner firebox is cut from the outer casing, all stays and rivets being removed by compressed-air cutting guns. No hand work is involved in the cutting up of boilers, all being effected by compressed air tools, while a small hydraulic machine is used for punching out staybolt heads. The manner in which the material represented by the broken-up boilers is disposed of has already been explained. Condemned boilers totaled 250 in 1927.

Tandem Blow-Off Valve

THE Cochrane Corporation, Philadelphia, Pa., has recently developed a tandem boiler blow-off valve with a one-piece forged-steel body. This valve has been designed to meet the conditions caused by the modern use of high steam pressures and to conform with the boiler inspection laws of most states where in the interest of safety, the use of two valves in tandem in the blow-off line from a steam boiler is required.

There are two main valves in tandem, as required by law, but both valves are combined in a single, forged-steel body. The valve nearer the boiler is of the rotating gate type, and in ordinary operation is intended to be opened before the main valve is opened and to be closed after the main valve is closed. The gate member is conical in shape and is ordinarily held to its seat by a seating spring and by the water pressure. In order that it may be turned easily and without scratching the valve or seat, provision is made for lifting it from the seat before it can be turned. The operating lever is locked by a projection which fits into an index plate and before the valve can be turned, the lever must be pulled back or lifted free. By this operation, through the action of a cam upon the stem of the valve, the latter is forced from its seat. The lever is then swung through 90 degrees, but the valve cannot be seated until it has reached the final position. At this point a slot in the index plate permits of the lever again being pushed in. The valve member is a one-piece, stainless steel forging, hardened and ground.

The main blow-down valve also embodies in itself the double-tightness principle. It has a main sealing disk and a check disk. The sealing disk is provided with a



The Cochrane tandem blow-off valve

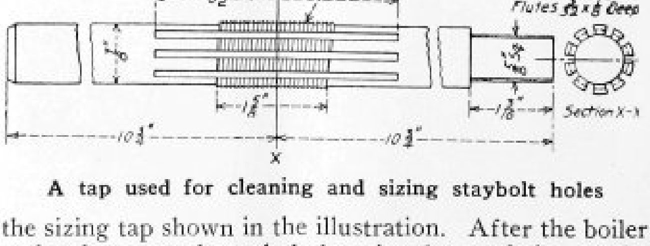
by-pass valve to equalize the pressure while the seating disk is being opened and closed. The check disk is in series with the main disk and the by-pass, and takes all of the wear and wire drawing of the actual opening and closing under pressure and flow. The function of the check disk is merely to hold the pressure while the sealing valve is being seated or unseated and its perfect tightness is relatively unimportant. The sealing disk and seat, on the other hand, are not subjected to wire drawing, cutting or abrasion.

Staybolt Sizing Tap

By R. W. Barrett

TO obtain good results in boiler construction it is essential for staybolts to fit perfectly in staybolt holes. Unless staybolts are made to suit each individual tap, this condition is difficult to obtain, owing to the differences in the sizes of taps, due to wear and allowable tolerances.

If all staybolts are threaded to suit a standard gage, the difficulty of fitting may be overcome by the use of



A tap used for cleaning and sizing staybolt holes

the sizing tap shown in the illustration. After the boiler maker has tapped one hole he tries the staybolt. If the staybolt is too tight he will run a sizing tap through. This will clean up the thread sufficiently to allow the staybolt to fit snugly. This sizing tap is made oversize 0.005 inch and the short length of the thread section enables the hole to be cleaned up in a few seconds.

Maximum Allowable Working Fiber Stresses in Welded Structures*

Proposed formula based on the ductility and percentage of elongation of weld metal

By S. W. Miller

THE question of what working fibre stress should be used in designing any structure has always been in the minds of engineers. Economy demands the least possible amount of material, while safety urges the engineer in the other direction; that is, to add plenty of material to assure the safety of the structure. The allowable fiber stress depends somewhat on the conditions under which the structure operates, but it seems evident that the most important thing to be considered is that in service the structure must not permanently distort under any stress that may be applied to it.

Let us consider the case of mild steel of an ultimate strength of 55,000 pounds per square inch, having a yield point of 35,000 pounds per square inch. If the material were homogeneous and we were sure that no greater strength than 34,000 pounds per square inch would ever be applied to it, we could safely use a design fiber stress of 34,000 pounds per square inch. As a matter of fact, in this country, when such material is used for boilers, a working fiber stress of only 11,000 pounds is permitted by the A. S. M. E. Boiler Code, while for the same material in locomotive boilers a stress of 12,-200 pounds is permitted, and in England for stationary boilers 13,750 pounds is allowed. All of these are below the yield point of the material, but even the highest of them is nowhere near the yield joint. The highest is 25 percent greater than the lowest, and it may well be asked what reason is there for this 25 percent variation. I am perfectly willing to admit that I do not see any, and I do not believe that any other conclusion can be reached that that we are, in this country, following a custom of many years' standing without any definite knowledge on which to base our design.

I do not intend in any way to condemn the use of a factor of safety of 5 in boiler construction. My only purpose is to point out that our factors of safety are not based on definite knowledge that we rightfully should have. It is very probable that the factor of safety of 5 used in boiler construction is on the safe side.

Strength of Welded Vessels

In welded construction in which mild steel is used, of course the same problems of design are encountered as with other types of joints. We must assume, in discussing welded joints, that we are talking about properly made ones, because we cannot admit that we would base any design on bad material or construction. Assuming that proper procedure is followed in making, for example, a welded pressure vessel, we can have no doubt as to the tensile strength of the weld metal or of the base metal, because these can be easily determined by the tensile test. This has been done numberless times, and many results have been published. In a general way, it can be said that this tensile strength runs from 45,000 to 75,000 pounds per square inch, depending on the welding rod and the process used, and this refers to welds that have not been heat treated. With mild steel plate, then, there is evidently no difficulty in obtaining sufficient tensile strength in the weld to break the plate.

The ductility of welds also varies with the welding rod and the process of welding, but it would seem perfectly fair, and indeed almost obvious that two welds made by different processes or with different rods, but which have the same tensile strength and ductility should be allowed the same working fiber stress, for the present disregarding its amount.

Ductility of Weld Metal

The measurement of the real ductility of weld metal is impossible in an ordinary welded tensile test piece, because the yield point of the weld metal in mild steel, when its tensile strength approximates that of the plate, is always higher than the yield point of the plate, so that during the tensile test the base metal elongates and begins to neck down before the weld metal does. As an illustration, the yield point of the majority of welds is in the neighborhood of 42,000 to 45,000 pounds per square inch, while the yield point of ordinary mild steel is about 35,000 pounds per square inch, and as most of the elongation in any tensile test piece occurs during the last few thousand pounds of the load, the result is a comparatively small elongation in the weld metal, its real ductility not being shown. For instance, certain weld metal has an ultimate strength of 70,000 pounds per square inch and an elongation of 25 percent in 2 inches in a standard 0.505-inch test piece. Nothing like this elongation can be obtained in an ordinary welded tensile test piece, as the results will show only about 10 percent elongation in 2 inches over the weld.

It is quite common, although not universal, to record in a tensile test the percent reduction of area, and many engineers believe that this is a better measure of ductility than the elongation as usually given. It is interesting to note that the bend test combines both the elongation and reduction of area, and for this reason is a better measure of the ductility in my judgment, than pure elongation. After all, the elongation measured in 2 inches or 8 inches does not give a true idea of the ductility of the metal. In an 8-inch test piece, the original inch in which the greatest elongation takes place may have stretched in mild steel as much as 90 percent while the total elongation may be 30 percent. The elongation also depends on the geometry of the test piece. The reduction of area, taking place in a short distance, is not subject to these variations, so that any test that includes even a portion of the usual reduction of area, gives, to my mind, a fairer measure of the ductility than the result that is based on the usual elongation figure. I believe this to be true of all metals.

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* Paper read at the fall meeting of the American Welding Society held in Philadelphia, Pa.

In any case, the bend test seems to be the only method by which the ductility of the weld metal can be determined with reasonable accuracy, so that if the results of this test could be combined with tensile strength in some way, it would seem that reasonable decisions could be made as to the proper fiber stresses that could be allowed in welds of different kinds.

Determining Working Fiber Stress

As there seems to be no theoretical basis for a working fiber stress, it is necessary at present to depend on practical results for the development of any formula that would be used for the purpose. If we know that certain fiber stresses have been used successfully with welds of certain tensile strength and elongation as measured by the bend test, we can create a formula to cover these results. Of course, the more figures we have the more accurate will be the formula, which undoubtedly is true of any formula that is empirical; but an additional element of accuracy that it is fair to consider, is the opinion of engineers based on their experience as to allowable fiber stresses for different kinds of welds. The tensile strength and elongation of such welds can be determined, and the formula checked.

It would also seem fair that the formula should take account of ductility in such a way that a lower working fiber stress would be allowed where the material has low ductility, and that the working fiber stress should depend directly on the tensile strength.

Such a formula has been devised by A. B. Kinzel, and is as follows:

$$S = \frac{T}{7.15} \sqrt[3]{\frac{E}{10}}$$

in which S is the allowable working fiber stress, T the ultimate tensile strength, and E the percentage of elongation as determined by the bend test before referred to.

Table 1. Proposed Maximum Allowable Working Fiber Stresses in Pounds Per Square Inch of Plate Section for Welded Steel Pressure Vessels

Percent Elongation By Bend Test	Ultimate Strength in Thousands of Pounds per Square Inch							Factor of Safety
	45	50	55	60	65	70	75	
5	5000	5600	6100	6700	7200	7800	8300	9.0
7½	5800	6400	7000	7700	8300	8900	9600	7.8
10	6300	7000	7700	8400	9100	9800	10500	7.15
12½	6800	7600	8300	9000	9800	10500	11300	6.65
15	7200	8000	8800	9600	10400	11100	12000	6.25
17½	7600	8400	9300	10100	11000	11700	12700	5.9
20	8000	8800	9700	10600	11400	12300	13200	5.7
22½	8300	9200	10100	11000	11800	12800	13700	5.5
25	8600	9500	10500	11400	12400	13200	14200	5.3

Using different values for T and E, Table 1 has been prepared. The factor of safety in the last column is the same for any given percentage of elongation. The ultimate strength is either that of the weld metal if the weld breaks during the test, or of the base metal if the fracture occurs in it, and obviously a structure cannot be designed, as far as tensile strength is concerned, except on the strength of the weakest part. It is easily worked out that a factor of safety of 5 is reached at an elongation of somewhat over 29 percent.

Any change in the constant 7.15, would change the fiber stress in direct proportion. For instance, if 7 were taken instead of 7.15 the difference would be only 2 percent which is evidently of practically no effect. The only reason why 7.15 was used is because it fits more closely the results of the tests on which the formula is based.

The part of the formula covering the factor of elongation decreases the allowable working fiber stress more rapidly than the elongation decreases, and on the other hand, increases the fiber stress more slowly than the elongation. This seems quite logical, because there must be a point beyond which an increase in elongation increases the value of the metal but slightly, and the metal becomes less reliable in service.

The allowable working pressure in the Power Boiler Code is based on the minimum ultimate strength of the plate of 55,000 pounds per square inch, the efficiency of the joint, and a factor of safety of 5, so that 11,000 pounds per square inch is the allowable working fiber stress.

In the Pressure Vessel Code, while the allowable fiber stresses are really based on a factor of safety of about 5 for riveted construction, a definite fiber stress of 10,000 pounds per square inch is permitted for plates less than 55,000 pounds per square inch ultimate strength, and 11,000 pounds per square inch for plates of 55,000 pounds per square inch or greater ultimate strength. So it might be feasible to simplify the table by adopting some plan similar to that in the Pressure Vessel Code, and Table 2 is submitted as showing what might be done in this direction.

Table 2. Proposed Maximum Allowable Working Fiber Stresses in Pounds Per Square Inch of Plate Section for Welded Steel Pressure Vessels. Simplified Form of Presenting Table No. 1.

Percent Elongation by Bend Test	Ultimate Strength in Thousands of Lbs. Per Sq. In.						
	Over 45 up to 50	Over 50 up to 55	Over 55 up to 60	Over 60 up to 65	Over 65 up to 70	Over 70 up to 75	Over 75
5 to 7½	5400	6000	6500	7200	7700	8300	8900
Over 7½ to 10	6000	6700	7300	8000	8700	9300	10000
" 10 to 12½	6500	7300	8000	8700	9400	10100	10900
" 12½ to 15	7000	7800	8500	9300	10100	10800	11600
" 15 to 17½	7400	8200	9000	9800	10700	11400	12300
" 17½ to 20	7800	8600	9500	10300	11200	12000	12900
" 20 to 22½	8200	9100	9900	10800	11600	12500	13400
" 22½ to 25	8500	9400	10300	11200	12100	13000	13900

Also it may be unnecessary to make such small steps as Table 1 shows when the factors of safety are as large as they are, and when the tanks are tested to three times the working pressure. It is also true, with welding as it is with riveting, that no two joints are exactly the same, and that allowable commercial differences in welding rods will have some bearing on the physical properties of the weld metal. Therefore, some such form as Table 2 may be allowable.

Table 1 gives higher values for welds than have ever before been presented for consideration, but no higher than have actually been used in practice with safe results in the cases on which the table is based. It is not believed that they can be used without proper procedure control, but it is felt that they are perfectly safe when such procedure control is followed in the construction of the tank.

In applying the formula it is rather interesting that it so happens that the allowable fiber stress at 50,000 pounds per square inch and 5 percent elongation is 5600, the same as is used in the Pressure Vessel and Heating Boiler Codes.

At the values of tensile strength and elongation of cast iron, say 20,000 pounds per square inch and 0.2 percent, the formula gives a fiber stress of 750 pounds per square inch. As a common factor of safety for cast iron under shock is 20, the formula does not seem to be unreasonable at this extreme.

At the other end, we may take nickel steel that has been used for boilers. It has a tensile strength of 70,000 pounds per square inch and an elongation of 23 percent. The formula rating for this material is 12,900 pounds per square inch, and with a factor of safety of 5 it would be allowed 14,000 pounds per square inch working stress.

Locomotive Boiler Construction—V*

Layout of crown and sides sheet, radial stays and staybolts —Machining and rolling operations

By W. E. Joynes†

HAVING completed the layout and machine work of the boiler front-end plates (except the front tube sheet) to the point of assemblage, the layout, machine and flange work for the back or firebox-end plates will now be presented. These plates are: Crown and sides sheet, roof and side sheets, backhead and firebox back sheets, back tube sheet, inside and outside throat sheets, front tube sheet and roof sheet liners.

Fig. 21 is the development plate drawing of a one-piece crown and sides sheet. This drawing shows the developed outline, the crown stays, staybolts and rivet hole locations as they are to be laid out on the flat metal plate.

Fig. 22 is the metal plate layout or pattern plate, as it is designated when duplicate plates are wanted.

The order of laying out the metal plate is as follows:

Draw a base line at the front end of the plate about ½ inch from the edge to allow for bevel shearing. Erect a right angle center line at the center of the plate. Draw in the back set line 93¾ inches from the front base line, extending the line the full length of the plate. Measure the 6-inch and smaller ordinate space lines on this line. With a steel square, square short lines, from these points, to the back edge of the plate. Measure sets 18 13/16 inches, 18¾ inches, etc., on these lines. Draw the ordinate lines at the front end of the plate and measure the sets as dimensioned.

Now measure half the width of the plate 92⅞ inches,

* The first instalment of this series appeared on page 218 of the August issue, the second on page 253 of the September issue, the third on page 291 of the October issue, and the fourth on page 321 of the November issue.

† Boiler designing department, American Locomotive Company, Schenectady, N. Y.

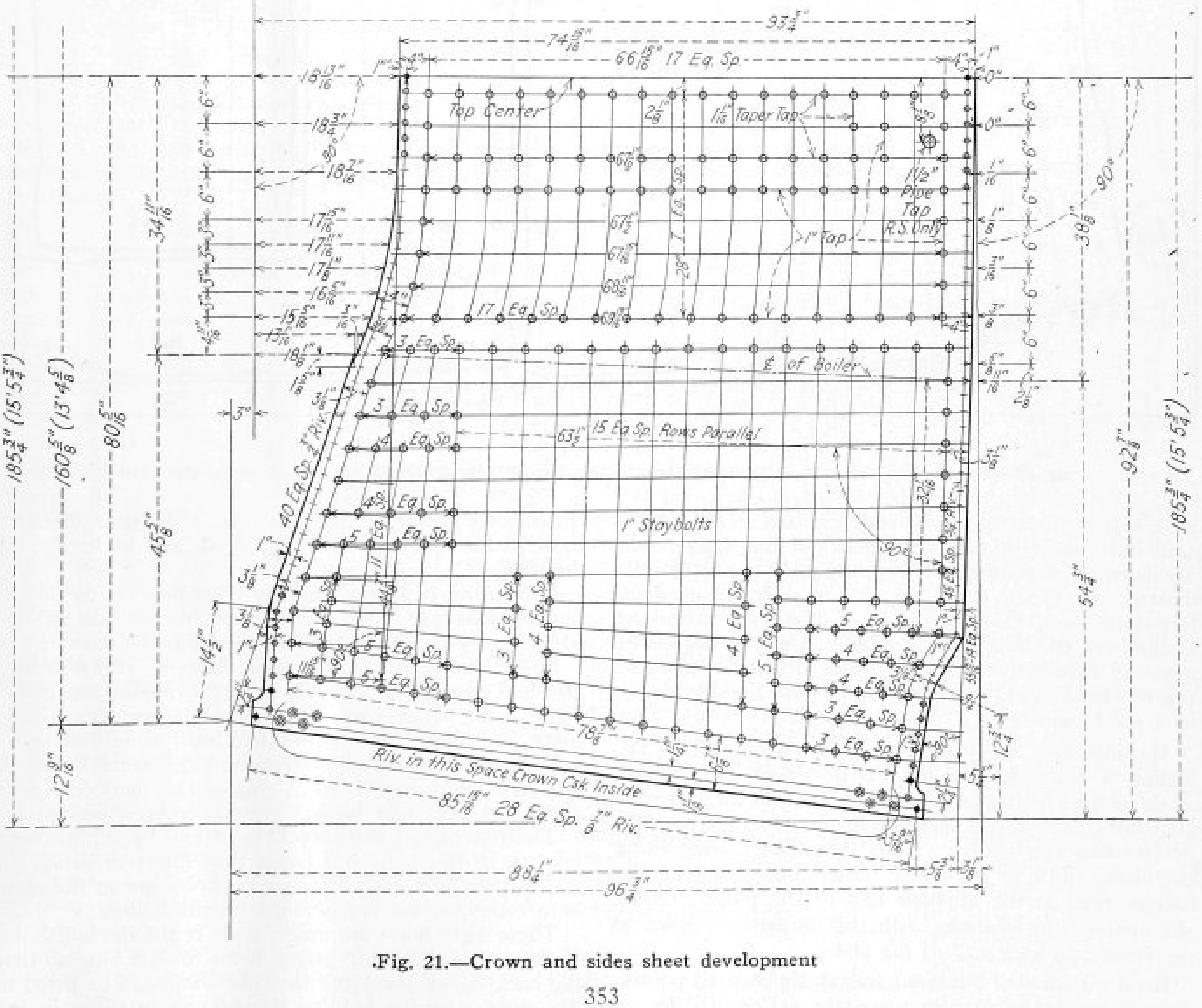


Fig. 21.—Crown and sides sheet development

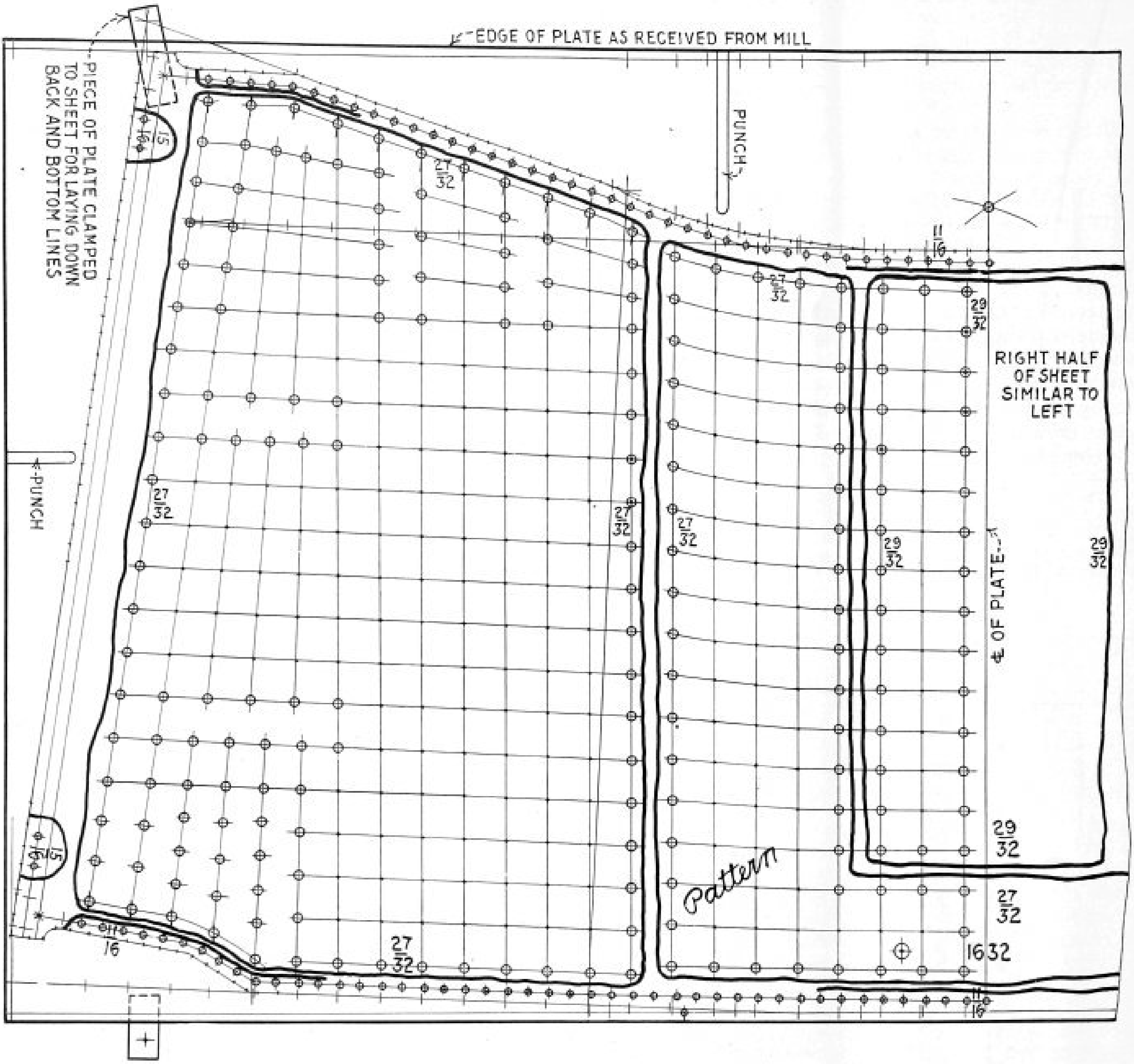


Fig. 22.—Crown and sides sheet pattern plate layout before any machine work is done on the plate

each side of the center line, front and back. Then measure half the width 80 5/16 inches at the back end. Measure between the 80 5/16-inch and the 92⅞-inch dimension points to check the 12 9/16-inch bottom slope line dimension. Measure the 3-inch off-set dimension at the back end and check the total length of the development, 96¾ inches. Check the length of the plate at the top center, 74 15/16 inches, against the 18 13/16-inch set dimension.

Measure the set dimensions 3⅛ inches and 5⅜ inches on the side base line, at the front end. Draw in the sloped bottom edge of the plate and the two parallel lines, just above the bottom line, for locating the firebox-ring rivet holes. Move the straight-edge along the plate; draw in the boiler center lines and then the bottom lines at the opposite end of the plate. Check the center line locations with the dimensions given at the front and back end of the plate.

Bend a batten to the front sets and measured points; draw in the top half of the plate edge. Bend the batten to the back edge sets and draw a line for the back half, between the boiler center lines. With the straight-edge, draw in the bottom half of the front and back edge of the plate.

Locate the front firebox-ring rivet hole on the lower line by squaring a point from the intersection of the 5⅜-inch set dimension and the base line, as shown.

Space off the firebox-ring rivet holes 85 15/16 inches, 28 equal spaces, on a metal strip. Transfer the metal strip to the lower rivet line, at the bottom edge of the plate, and mark the first, second, fourth and fifth rivet hole locations at the back end and the second, fourth and fifth holes at the front end of the plate, the first front end rivet hole having previously been located.

The fourth and fifth holes, front and back, right and left, are drilled 1/16 inch larger than the rivet size given and are the only firebox-ring rivet holes put in the plate before the firebox is assembled in the boiler.

These eight holes are used for drift pin and bolt holes to draw this sheet into place on the firebox ring so that the back flange sheet and the tube sheet can be fitted to the same, and for holding the firebox in place in the final assemblage.

Bisect the location of the front and back rivet hole on the top firebox-ring rivet line; the direction of the bottom corner edges of the plate are drawn from these holes to points as dimensioned above. This completes the laying out of the plate outline.

Draw lines for the rivet lap at the front and back edge of the plate. Space-off and soap-stone circle the number of flange connecting rivets as shown on these lines. Omit the bottom rivet holes. The second hole from the bottom and the hole on the top center are punched for tack holes front and back.

The bottom hole is omitted until the flange sheets are assembled for riveting, when it is then drilled with a portable machine drill. These bottom holes are not drilled in the flat plate because of the liability of the holes drawing out of shape when the ends are scarfed.

Layout points that do not come within the plate edge are reached by clamping a strip of plate to the sheet as shown on the pattern plate layout of the crown and sides sheet, Fig. 22.

Radial Stay and Staybolt Layout

Locate the bottom staybolt line 6⅞ inches from the bottom of the plate. Measure 3 9/16 inches back of the first firebox-ring rivet hole and project this point onto the staybolt line, for the front bottom row staybolt location. Measure 78⅞ inches from the front staybolt hole to the back staybolt hole, on this line.

Scribe a short 11 15/16-inch arc, centered at the back staybolt, for locating the back developing line, as shown. Also, measure 18⅛ inches from the back set line onto the boiler center line. Draw the developing line straight from the center line, tangent to the 11 15/16-inch arc at the bottom. The developing line above the boiler center line should have the same curve as the front edge of the sheet.

Layout the front and back radial stay and staybolt lines from the edge of the plate as dimensioned.

Measure 2⅛ inches from the top center to the first radial stay line, then 28 inches from this line to the last or outside radial stay line. Measure 44⅞ inches, on the developing line, from the last radial stay line. Square this point 90 degrees to the developing line. This line should intersect the center of the back bottom staybolt hole, which has been laid out on the bottom staybolt line. Space off the 7 equal radial stay and 11 equal staybolt spaces on the back developing line. Project a point for each one of the staybolt divisions, 90 degrees to the developing line, onto the back staybolt line.

The radial stay and staybolt dimensions at the front end are measured along the front edge of the plate, which is also the front developing line. The developing line is, of course, extended below the tube sheet break in the sheet to the bottom staybolt and as dimensioned at the base line. The front staybolt divisions are also projected at right angles to the developing line onto the front staybolt line.

The longitudinal radial stay lines are always drawn directly from the divisions as spaced on the developing lines.

The longitudinal staybolt lines are, of course, drawn from the points that have been projected on the front and back staybolt lines.

The distance between the front and back radial stays, on each longitudinal line, is gaged with a metal strip. The number of equal stay spaces, as shown on the plate development drawing, are spaced off on the metal strip (four lines on each strip) and then marked onto the plate.

The main staybolt spaces are also spaced on a metal strip and then marked on the plate. The broken up staybolt spaces at the back and front corners of the plate are spaced off directly on the plate. Also, the transverse broken-up staybolt spaces in the bottom part of the plate are spaced off on the plate.

The radial stay and staybolt divisions as spaced on the metal strips are reserved for the roof sheet layout.

Soap-stone circle the boundary and broken up spaces of stay centers as shown.

This completes the laying out of the sheet. The work should now be checked thoroughly: then center punch each rivet and stay hole center; block off and mark; white lead the rivet and stay drilling sizes, after which the plate is transferred to a punching machine for punching the tack holes and for punching out the back end and bottom surplus stock as shown. Punching the surplus plate into smaller pieces, facilitates trimming the plate after it is drilled.

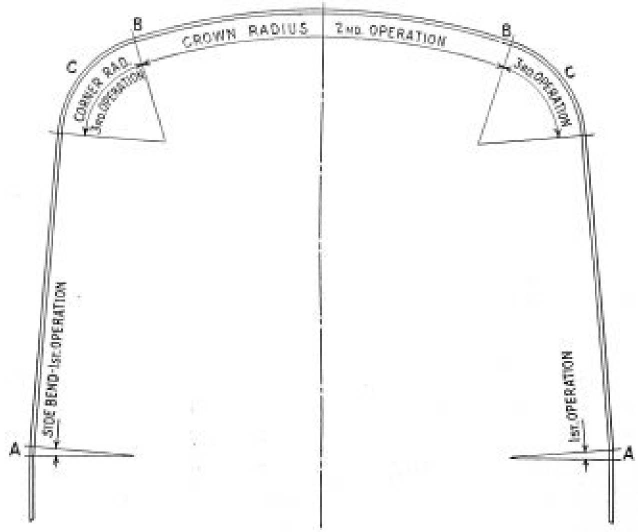


Fig. 23.—Cross section of a one-piece crown and sides sheet rolled into shape, showing locations of the rolling operations

The plate is now returned to the laying out floor for center punching the tack hole locations in the duplicate plates; also, for marker punching lines to indicate where the surplus pieces of plate are to be punched out. The length of these surplus pieces is important when the same are to be used for boiler reinforcing liners, and should be laid out on the pattern plate by the layer out to include the size of liner plate required.

Machine Operations

The plates are now removed to the multiple drilling machines where five plates, including the pattern plate, are bolted through the tack holes and further clamped together along the edges with heavy screw clamps.

When the drilling of the plates has been completed a rough line of the rivet lap plus ½ inch, is marked all round the edge of the plate. The front and back edges of the plate are then removed to this line with a cutting-off punch. The bottom or firebox-ring edges are sheared off with the straight cutting shearing machine. Sharp corners are punched out nearer the finish line with a round punch.

The edges of this sheet are required to be beveled for calking. A soap-stone line of the rivet lap or the actual finished outline of the plate is now marked all around the duplicate plates similar to the outline that has been center punched around the pattern plate.

The edges of the plates are now run through a bevel shearing machine. The soap-stone outline is marked on the plate just before the shearing of each plate.

The reason for not removing all of the surplus stock with the bevel shearing machine, is due to the fact that the depth of the mouth and the roller guide of this machine will only allow a small amount of stock to be sheared off. This is all of the material that it is practical to handle when doing bevel shearing.

The next operation on this plate, is that of scarfing the outside surface of the front and back bottom ends to fit the firebox-ring corners. The scarfing is done under a power-driven, foot-operated hammer.

Rolling

Rolling the plate, into the firebox shape, is the last operation required on this sheet before bolting the same to the firebox-ring, for fitting and assembling the flanged sheets.

The first rolling operation on a one-piece crown and sides sheet is the bending of the sheet along the bottom edges, as shown at *A* in the cross section of the firebox Fig. 23. Rolling the crown radius *B* is the second operation and rolling the corner radii *C* completes the firebox contour.

(*To be continued*)

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, 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 records of the interpretations of the committee in Cases Nos. 603-608, inclusive, as formulated at the meeting on September 13, 1928, all having been approved by the council. In accordance with established practice, names of inquirers have been omitted.

CASE No. 603—*Inquiry*: Is it necessary for the construction of enameled vessels, that a dished head convex to pressure must be inserted into the shell with a driving fit and then constricted on the end to a smaller diameter than the original as required by Par. U-74 of the code? It is felt that this requirement should not apply to enameled vessels.

Reply: It is the opinion of the committee that this requirement is not intended to apply under the conditions of construction involved for enameled vessels in Pars. U-97 to U-109, and that for such purpose the head may be inserted in the shell and welded to the edge thereof as shown in Fig. U-3*k* of the Code.

CASE No. 604—*Inquiry*: Is it permissible under the Code for miniature boilers to insert flanged threaded rings for the washout opening in openings in the shell from the interior and secure them in place by welding on the exterior?

Reply: It is the opinion of the committee that if the flanged ring is arranged as stated in the inquiry so as to carry the stress due to steam pressure, the welding thereof as described will not conflict with the requirements of the Code.

CASE No. 605—*Inquiry*: What is the maximum permissible diameter under the Code for low-pressure heating boilers for a corrugated semi-cylindrical furnace top or crown sheet without staybolt or other mechanical supports?

Reply: The Code for low-pressure heating boilers has no requirements that pertain to a construction of the sort. It is the opinion of the committee that where a construction is contemplated the stresses in which are difficult to compute, it will be advisable to subject a full-sized sample to hydrostatic test until the construction passes the yield point, using special indicating apparatus to show the stresses that develop therein.

CASE No. 606—*Inquiry*: Should the heating surface contained in an integral economizer be added to the heating surface of the boiler in determining the minimum safety-valve relieving capacity required by Par. P-274, it being understood that in any event the requirements of Par. P-270 are to be met?

Reply: It is the opinion of the committee that the heating surface on which to base the minimum safety-valve relieving capacity required by Par. P-274 shall not include any economizer surface.

CASE No. 607—(In the hands of the committee).

CASE No. 608—*Inquiry*: *a* In the calculation of the maximum allowable working pressure of a locomotive-type boiler shell with a tapered course, what diameter is to be used?

b In locating a dome on the tapered course of a locomotive-type boiler shell, what diameter of the tapered course should be used for establishing the limit of size of the dome as provided for in Par. P-194?

Reply: *a* It is the opinion of the committee that the maximum allowable working pressure of a tapered-course shell should, in applying the formula in Par. P-180, be based on the maximum diameter of the tapered course.

b In applying the limitation of dome diameter given in Par. P-194, to a dome located on a tapered course, it is the opinion of the committee that the maximum allowable diameter of the dome should be based on that diameter of the tapered course which intersects the axis or center line of the dome.

The Independent Pneumatic Tool Company, Chicago, Ill., plans to build an addition to its factory located in Aurora, Ill. The new structure will consist of a modern, fire-proof building and will add 36,000 square feet to the present capacity of the plant.

P. W. Guthrie, Jr., has recently been appointed vice-president in charge of sales of the Reading Iron Company, Reading, Pa. Mr. Guthrie was born in Pittsburgh, in 1876, and has been associated with the pipe industry most of his life. During his career he has been affiliated with the Longmead Iron Company, South Chester Tube Company, Park Brothers and Company, Black Diamond Steel Works, and the Philadelphia Company of Pittsburgh.

Surface Defects in Boiler Plate

By E. N. Treat

A GREAT number of defects in boiler plate manufacture are found in the surface of the plate. These defects are costly to the manufacturer who may lose a large plate or a number of small plates because of a small area that is affected by pits, scabs, cold pieces or slivers. It does not concern the inspector how or why a plate became defective, but it does concern the manufacturer in a financial way, for he must scrap the defective plate and make a new one to fill the order. The defective plate is a total loss and the manufacture of another plate in its place is a costly procedure. When small orders are considered, the profit on plate manufacture may be negligible.

Many of these defects are sufficiently serious to warrant the rejection of the plates without great consideration, while other defects may be at a portion of the plate where a manhole or flue is to be cut. It is likely that the inspector has taken the location of the defect into consideration and may accept the plate, knowing that the defective part is to be scrapped in the process of fabrication.

An instance of this occurred not long ago, when an inspector, who had accepted a large plate at the rolling mill, and had done all in his power to have it shipped to his boiler shop as speedily as possible because of the great need for this particular plate, was much surprised to receive instructions from his superior at the shop to report there at once. He was notified that this plate was received and found to have a deep impression due to a cold piece embedded in its surface. The foreman boiler maker refused to use the plate because, in his opinion, it had not been as rigidly inspected as it should have been. It was evident that if it had been rigidly inspected, the defect would have been easily located, and for this reason it had not been unloaded at the boiler shop.

The inspector made a clean breast of the situation. He admitted having inspected that plate and had noted the deep depression which he concluded was not serious enough to reject the plate. He suggested that it be unloaded at once; and if it could not be used for the purpose intended, he offered to pay for the plate from his salary. The plate was unloaded, placed in the shop, the pattern laid out and it was found that the defective portion of the plate would be cut out for a manhole. The plate was used as intended and during fabrication no other defect was found. This shows that though a plate may contain a defect it may be used by eliminating that part as surplus material.

Surface Defects in Plates

Carelessness is given as the cause of many surface defects due to the embedding of slag, brick or other foreign matter into the surface of the plate. Frequently such matter is embedded to an extent that it is practically fused into the metal itself. Such substances are often difficult to remove.

Pitting may be caused by other occurrences more rare than the embedding of surface slag, which leaves its depression after the substance has been removed. In the case of ingots which show pin holes on the surface, cinder will run into these pin holes when the material is overheated. Then when the ingots are rolled into a plate, that plate will be rendered useless. If the ingot is drawn from the heating furnace with scale attached and ready to fall off, the surface of the finished product invariably will be free from foreign matter.

More frequently cinder or slag is found embedded in the plate. If this is not too deep, it often may be removed by means of a chisel and hammer. Some inspectors will allow the peening or grinding of the edges of the depression after all foreign material has been removed, where there is an excess thickness of material above the specified minimum thickness of the plate. This practice is just, for if the plate gages 0.5 inch thickness, and the minimum thickness specified in the order be 0.4 inch, there is an excess thickness of 0.1 inch over the lowest permissible thickness. The plate is gaged and thickness found, then by means of a depth gage the depression is measured. If there still remains sufficient thickness at the deepest point of the depression, the inspector may accept the plate after it has been peened or ground.

Either operation is performed in the presence of the inspector, who watches the operation to see that it does not consist of filling up the depression by striking the highest edges of the plate about the depression and forcing the metal over the lowest point of the reduced thickness. He should see that the performance is intended to dress up a depression in the proper manner. Unless the operator wields his hammer in the proper manner, the plate will present an appearance far worse than the defect. This method of dressing such defects is proper, for the intent is to correct rather than to cover over the defect. A thickness at the bottom of the depression in excess of that stipulated by the specifications must be left.

Another method of dressing up surface defects which are more unsightly than serious is by grinding down that part of the plate where the depression exists by means of a portable electric grinding machine. This process consists of grinding down the edges of the depression to the depth of the removed foreign matter and, if the plate be sufficiently thick at that part, there seems no good reason to believe that the material has been injured.

In all cases such surface defects are matters for the individual inspector to pass upon. The mill authorities will not permit the dressing of even a slight surface defect until the inspector has examined and approved of the proposed procedure. To do otherwise would result no doubt in the rejection of that plate.

Such defects are not daily occurrences for the inspector, for many plates may be inspected at the mill loading bank and few found with defective surfaces. This fact is due in a measure to the watchful eye of the mill inspector who eliminates such plates before submitting the lot to the inspector. If defective-surfaced plates were presented to the inspector at frequent intervals too much time would be consumed dressing such defects, and the result would be the elimination of the few plates now permitted to be dressed.

Defects Hidden by Mill Scale

Methods of bringing to light such defects hidden by mill scale vary. Pickling in acid is sometimes resorted to in order to remove the scale, but at the plate mills this procedure is costly and undesirable. In such localities where civil authorities do not permit the release of acid into the sewers or streams, and lowlands are not available, the installation of evaporative means for disposal of the acid is a costly procedure. The use of the sand blast is rapidly becoming the means of cleaning the surfaces of plates or fabricated parts where the finished container is to be subjected to the action of certain liquids. The sand may be used several times and easily performs the work of removing surface scale. Such material which has been sand blasted presents a cold gray steel appearance which renders visible any defects near the surface.

Surface Defects

The illustration shows a small section of plate into which foreign matter was rolled. On one side of the plate the foreign substance is loosened and at the other

Section of plate showing surface defects caused by a deposit of foreign matter

side the foreign matter is rolled into the plate. Directly below this matter may be seen a depression the depth of which was 0.121 inch. The thickness of that plate was but 0.416 inch and because of the depth of the depression and its location from which there could be no discard this plate was rendered useless for the purpose for which it was made.

Steel Boiler Orders

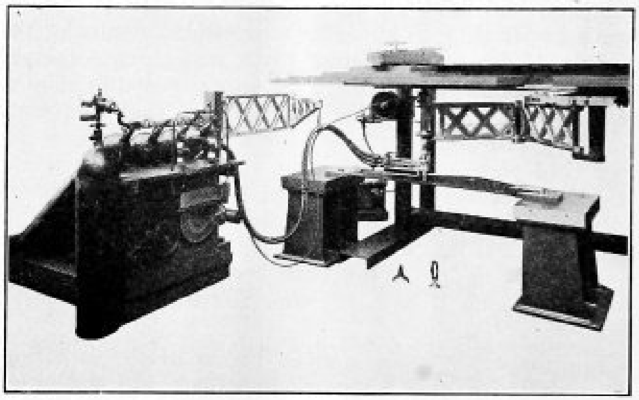
NEW orders for 1514 steel boilers were placed in October, as reported to the Department of Commerce by 72 manufacturers, comprising most of the leading firms in the industry, as compared with 1425 boilers in September and 1270 in October, 1927. The following table presents the number and square footage of each kind of boiler ordered for the past ten months, including comparisons with the corresponding period last year.

Oxy-Acetylene Plate Cutting Machine

THE Hubar-Jones Corporation, 13 Astor Place, New York, has placed on the market the Godfrey oxygen jet plate cutting machine, which is especially adapted for car, boiler and locomotive shop work. It will automatically cut out a ½-inch nut, a locomotive link, and other machinery parts of complicated design. It can cut iron and steel up to 10 inches thick and 10 feet in length by 3 feet 6 inches in width. Irregular shaped profiles 10 feet in length can be cut by using a simple wood template. The machine is equipped with a specially designed automatic attachment for cutting irregularly shaped openings. A compound template, which is used as a guide can be made on a separate special machine which is also supplied.

The machine is operated with the same fine speed control as the standard universal machine. This speed control, in conjunction with the special Godfrey torch with which the machine is equipped, insures such fine and accurate cutting that no further tooling is necessary unless a machined working surface is required.

The torch can be adjusted to any angle up to 45 degrees for bevel cutting. It is economical in the con-



The Godfrey No. 1 oxy-acetylene plate cutting machine

sumption of oxygen and acetylene and, owing to its extremely mild heating flame, obviates the necessity of subsequently annealing the iron or steel cut. The machine is operated by two small ¼ horsepower motors.

Machines of this type can be supplied to cut iron and steel 10, 20, 30, 40 feet long and longer.

	Total 10 mos., 1928		Total 10 mos., 1927		July, 1928		August, 1928		September, 1928		October, 1928		October, 1927	
	No.	Sq. ft.	No.	Sq. ft.	No.	Sq. Ft.	No.	Sq. Ft.	No.	Sq. Ft.	No.	Sq. Ft.	No.	Sq. ft.
GRAND TOTAL	13,983	13,162,125	13,569	12,764,279	1,615	1,528,053	*1,647	*1,457,203	*1,425	*1,256,868	1,514	1,325,037	1,270	930,342
STATIONARY														
Total	13,807	12,741,324	13,560	12,351,296	1,597	1,478,034	*1,637	*1,452,173	*1,407	*1,221,277	1,505	1,308,818	1,261	921,941
Watertube	1,096	5,533,493	1,076	5,351,028	133	563,404	115	535,286	*93	*415,129	82	503,445	67	326,580
Horizontal return tubular	1,125	1,427,083	1,075	1,370,801	129	185,064	169	205,196	110	131,731	138	163,079	88	106,797
Vertical fire tube	1,355	402,123	1,369	401,586	109	41,616	*129	32,716	93	27,571	136	39,661	148	36,675
Locomotive (not railway)	250	134,722	246	134,439	17	8,708	22	9,662	14	8,559	19	9,133	15	8,850
Steel heating[1]	8,827	4,312,457	8,662	4,196,558	1,084	567,462	997	484,221	929	499,473	1,021	496,886	856	380,987
Oil country	515	504,697	493	470,820	64	62,722	132	137,831	78	77,020	52	57,554	30	23,677
Self contained portable[2]	518	365,494	512	358,618	54	45,191	55	39,522	73	53,403	52	36,616	46	29,740
Miscellaneous	121	61,255	127	67,446	7	3,867	18	7,739	17	8,391	5	2,444	11	8,635
MARINE														
Total	176	420,801	176	412,983	18	50,019	10	5,030	18	35,591	9	16,219	9	8,401
Watertube	71	372,414	68	361,335	9	47,668	2	3,182	12	34,416	4	14,579	1	3,500
Pipe	2	2,775	1	1,881	...	......	...	......	...	......	1	894	...	......
Scotch	89	37,642	88	40,711	4	982	6	1,098	6	1,175	4	746	3	3,815
2 and 3 flue	11	4,347	16	5,433	5	1,369	2	750	...	......	...	......	5	1,086
Miscellaneous	3	3,623	3	3,623	...	......	...	......	...	......	...	......	...	......

[1] As differentiated from power. [2] Not including types listed above.

* Revised.

Reinforcing Pad Design for Nozzle Connections in Cylindrical Tanks*

By H. Le Roy Whitney†

IN order to meet the exacting requirements under which pressure vesels are now required to work due to the increasing working pressures and temperatures, the pressure vessel manufacturer has been called upon to design these vessels with a great deal more care and accuracy than heretofore required. When pressures and temperatures were comparatively low, the common formula and Clavarino's formula seemed to take care of the design of vessels without any difficulty, in fact, Clavarino's formula for simple cylindrical shells is probably the best that can be used under any working conditions. But with the increasing pressures and temperatures, it has been necessary to develop separate formulae in order to design the component parts of pressure vessels, such as the dished heads, nozzle opening, etc.

A great deal of excellent work has been done in the past few years on the design of dished heads and it is felt that this part of the design data has been thoroughly covered and solved. Unfortunately no reliable data of stresses existing around nozzle openings has as yet been published and, because of this fact, it was decided that a test be run on a tank containing nozzles, both reinforced and unreinforced. From this test an empirical formula could be developed, which would enable the engineer to design nozzles reinforced in such a way as to hold the stress around the nozzle down to the stress existing in the free part of the cylindrical shell.

With this point in mind a test was run on a 60-inch inside diameter vessel, 1¼-inches thick by 10 feet 6 inches long, to which a 14-inch inside diameter flued nozzle was attached.

Test on Sixty-Inch Diameter Tank

The first test was run on a nozzle of the above dimensions, having a 1 inch thick reinforcing plate attached. The test was run on the reinforced nozzle first so that the pressure could be carried up to a higher point without affecting the unreinforced nozzle, which at this time had not been attached to the tank. After the first test was completed an unreinforced nozzle of the same dimensions was attached diametrically opposite the first nozzle in the same tank and was tested under the same conditions. It was hoped that the data derived from the strain gage readings on these two nozzles would be sufficient to draw a direct comparison between the stresses existing, so that an empirical formula could be derived, whereby a reinforcing pad could be designed to hold the stresses down to such a point that the factor of safety existing around the nozzle would be the same as the factor of safety on the other parts of the vessel.

The vessel was equipped with flat heads 1½ inches thick. This was done because no dished heads were obtainable at the time the test was to be run and it was thought that by using flat heads and supporting them on the outside in the large testing machine the results would be equally satisfactory.

In order to give a clearer idea of how the reinforcing plate was applied to the nozzle in the first test the following description is given:

A disk 28½ inches by 1-inch thick was fitted closely to the shell at the point where the nozzle was to be. This disk had a hole in its center slightly larger than the hole cut in the shell. It was tack-welded into place, after which the disk and the shell were heated and flued out into a common die. This operation insured a very close fit between the flued neck on the shell and the neck on the reinforcing pad. After the fluing was completed the neck of the pad was acetylene-welded to the neck of the nozzle. A piece of tubing 14 inches inside diameter by 16 inches outside diameter was then forge-welded to the neck of the nozzle and during this forging operation the acetyline welding at the top of the reinforcing pad was forged into the neck of the nozzle at the same time. This forging operation not only gave a smoother finish to the outside of the nozzle neck but made a more homogeneous structure throughout. The opening in the end of the nozzle was closed with a flat plate.

The vessel was placed in the horizontal testing machine with the heads backed up as described, in such a way that there was no chance of excess pressure being developed on them in either direction. After filling the tank with water, an internal pressure of 400 pounds per square inch was applied and held for an appreciable length of time in order that the vessel could assume its natural shape before strain gage readings were taken.

The internal pressure was reduced to zero and after several minutes had elapsed a set of zero readings was taken at all points. Pressure was then raised to 200 pounds per square inch and readings taken again. Readings were taken at 200, 400, 500, 600, 700, 800 and 900 pounds. Between each of these readings the pressure was reduced to zero when another set of zero readings was taken. At 900 pounds the stresses in the shell adjacent to the reinforcing pad seemed to be close to the elastic limit and no higher pressure was applied, as it was desired to save the tank in order to run a duplicate test on a plain unreinforced flued nozzle. Stresses were calculated from the various strain gage readings and the curves indicating these stresses drawn. The stresses nearest the knuckle of the flued opening were less than the stresses in the shell, while the stresses adjacent to the reinforcing pad were only slightly higher than the stresses in the shell. This indicates that a marked benefit was obtained by the use of the reinforcing pad.

Test with Unreinforced Nozzle

After the test described above was completed, the vessel was returned to the welding shop and an unreinforced nozzel was attached as described above. The strain gage readings were taken every 100 pounds up to 500 pounds per square inch, the pressure each time being lowered to zero and readings taken before each succeeding pressure was applied. At 500 pounds pressure the stress indicated at the point nearest the knuckle of the nozzle was approximately 37,500 pounds per square inch, and it was thought advisable not to read with the gage extensions for pressure above this point. However, permanent set readings were taken after applying pressures of 600, 700 and 900 pounds per square

* Abstract of a paper presented at the annual meeting of the National Board of Boiler and Pressure Vessel Inspectors.

† M. W. Kellog Company, New York city, research department.

inch. After the 900 pounds pressure had been applied it was decided to increase the pressure until failure. This was done and the tank broke through some fault in the plate at an internal pressure of 1200 pounds per square inch. The break started at the end of the tank farthest from the nozzle and about 2 feet from the longitudinal weld in the tank. From there the crack ran along straight and then turned toward and split for a short distance under the reinforcing pad on the reinforced nozzle, turned out again and ran to the other end of the tank.

Conclusion

It is concluded from the above test that a reinforcing pad of the type tested is of material benefit and should be used where the stress in the plate of the vessel at working pressure is high. It is felt, however, that a plain nozzle as normally used is amply efficient to serve its purpose when the stress in the wall of the vessel is at a comparatively low value.

At 500 pounds pressure the maximum stress for the plain nozzle was 345 per cent of the shell stress. The maximum stress in the reinforced nozzle, at this same pressure, was 121 percent of the shell stress. It will be remembered that the thickness of the reinforcing pad was one inch, while the shell thickness was $1\frac{1}{4}$ inches, or in other words, the pad was 80 percent as thick as the shell. This means that by using a reinforcing pad whose thickness is 80 percent of shell thickness the maximum stress was reduced from 345 percent of shell stress in the plain nozzle to 121 percent of shell stress in the reinforced nozzle.

It can be seen from the above that an advantage of 224 percent of shell stress was realized by the use of the pad. From a direct comparison of these two stresses and thickness, the required pad thickness can be found which will keep the maximum stress around the nozzle equal to the shell stress. This is done as follows:

345—121=224 percent advantage realized by use of 80 percent thick pad.

345—100=245 percent advantage necessary to keep maximum stress equal to shell stress.

X=required pad thickness.

From a direct ratio:

$$\frac{224}{80} = \frac{245}{X}$$

X = 87.5 percent of shell thickness.

By this same procedure X is found to be 90 percent, 93.5 percent and 92.5 percent for the pressure 400 pounds, 300 pounds and 200 pounds respectively. The average value of X in this test is 91 percent of the shell thickness.

From a general study of this test it is felt that if a pad, having a thickness equal to the thickness of the shell, is properly attached to the nozzle opening, the maximum stress around the nozzle will not exceed the stress existing in the wall of the vessel.

After all work on the above test was completed, sections were cut from both the transverse and longitudinal axes of the reinforced nozzle to determine the character of the fit between the nozzle and the pad. Upon examination of these sections it was found that the fit was excellent, it being fully 95 percent metal-to-metal contact.

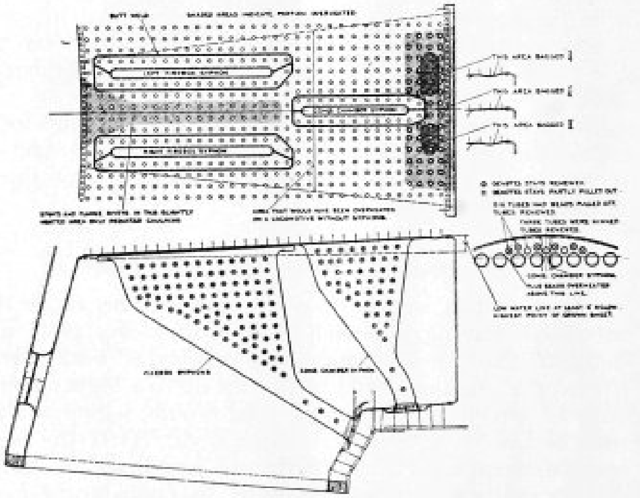
The machine surfaces of these samples were then etched to determine the soundness of the weld. This was also found to be good. But to make absolutely sure X-ray pictures were taken through the weld by the Watertown Arsenal who reported that they "were unable to detect any flaw in the weld."

It is felt from these last investigations that the results of this test should be quite accurate because of the tightness of the pad, it being quite obvious that unless the fit is nearly perfect, the stress in the nozzle will exceed the pad stress by the amount necessary to allow the nozzle to accommodate itself to the pad. In taking the strain gage readings during the test the stresses in the shell and pad increased at practically the same rate. This would also indicate that the fit between the two was good.

Even though the conditions under which this test was run were excellent, it is not considered advisable to rely entirely on the results of any one test. With this thought in mind orders have been issued to the shop to take strain gage readings on all vessels containing nozzles before they are shipped. It is hoped with the data collected in this manner, that the results of the above test may be verified.

Thermic Syphons Protect Crown Sheets from Low Water

THE illustration shows the condition of the crown sheet of a Mikado locomotive equipped with Thermic syphons, manufactured by the Locomotive Firebox Company, 310 South Michigan avenue, Chicago, after recently passing a severe low water test. Two syphons are located in the firebox and one in the combustion chamber. The water had been inadvertently permitted to drop about 6 inches below the highest point of the crown sheet. There was no boiler explosion and the damage to the crown sheet was repaired at a cost of about $230. Six staybolts were partly pulled out; six tubes, the beads of which were pulled off, were renewed; three kinked tubes were renewed; the crown sheet was repaired where it had bagged from $\frac{1}{4}$ inch to $\frac{3}{4}$ inch, and staybolts and flange rivets were recalked where required.



The condition of the crown sheet after the water had reached a level 6 inches below the highest point of the sheet

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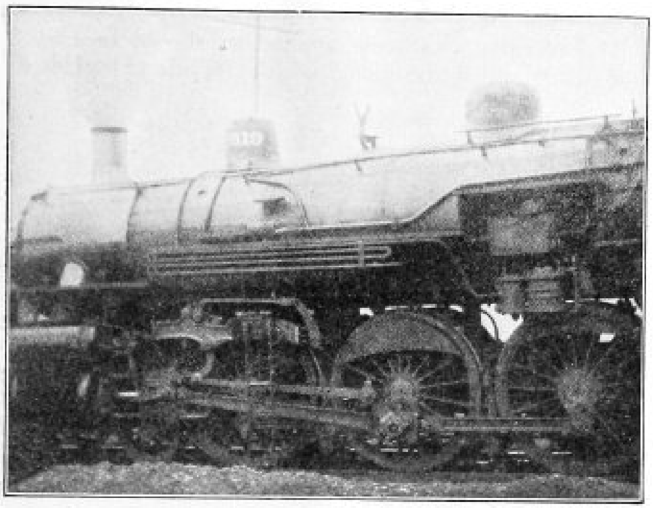
The Reading Iron Company, Reading, Pa., has transferred its general sales offices from Reading to 30 Church Street, New York City, N. Y.

New Water Treater Fits on Locomotives

APPARATUS for chemically treating boiler feedwater that is attached directly to the locomotive, has been developed and put in use on the Chicago & North Western. This apparatus consists of a small chemical container which fits like a sleeve or drum over the boiler feedwater or branch pipe on the locomotive, next to the boiler check valve. The drum is filled with a chemical through a removable plug, and a single short tube inserted in the branch pipe is the only opening between that pipe and the drum. There are no valves or similar fittings in the system.

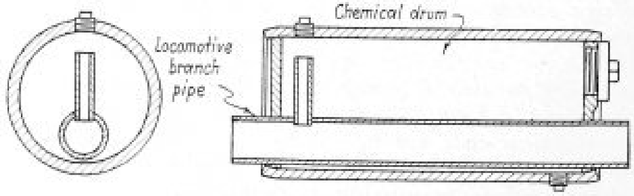


Locomotive with branch pipe equipped with water treater

No Attention Required During Run

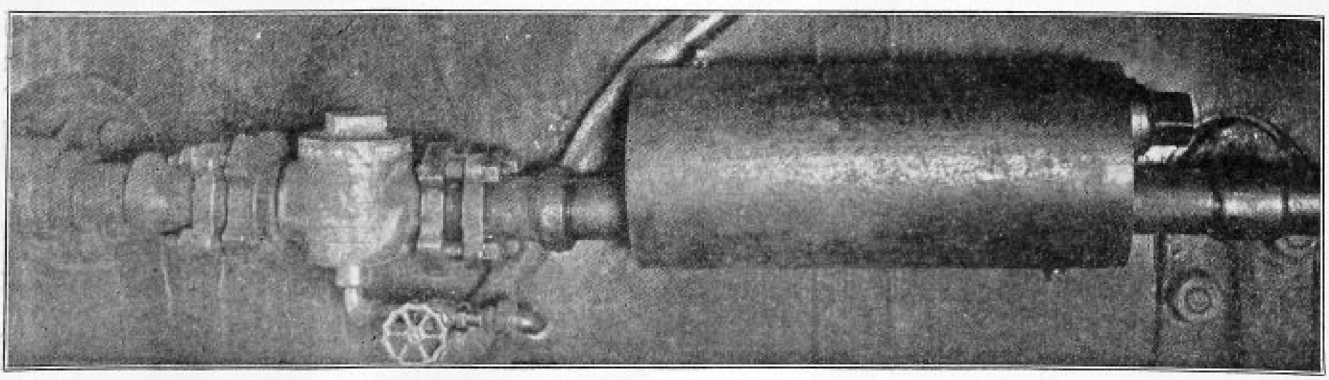
Sufficient water-treating chemical for an entire trip is put into the drum at the engine terminal and the apparatus is then ready for service, without further attention on the trip. When the injector or feedwater pump is started, a portion of the feedwater passing through the branch pipe enters the chemical drum under pressure through the connecting tube, and this water dissolves part of the chemical and compresses the air which accumulates in the drum. At each drop in pressure in the branch pipe, resulting from the pulsation of the injector or feed pump, this air expands and forces the solution into the feedwater line through which it is forced into the boiler. This flow of feedwater into the treater and back into the branch pipe with dissolved chemicals continues automatically with the operation of the injector, and ultimately discharges all of the chemical into the boiler.

The device was developed in 1924 by R. E. Coughlan, supervisor of water supply, Chicago & North Western, co-operating with the mechanical department forces, to solve a problem on the branch line between Tyler, Minn., and Astoria, S. D., where the water contains approximately fifty grains of scale-forming material, both soft and hard. The amount of water supplied at individual water stations on this line did not justify the construction of treating plants, and the introduction of boiler chemicals into the locomotive tenders was not favored because of the uncertainty of enginemen introducing the chemical each time water was taken and also because of the difficulty of keeping branch pipes and injectors from clogging with deposits before the water reached the boilers. The device was later applied to locomotives operating between Casper, Wyo., and Chadron, Neb., where the water contains an average of 20 grains of scale, and its use has since been extended until over 200 locomotives on the system are now equipped with it. It has also been applied to stationary boilers.



Sectional views of water treater on feed water line

The kind and quantity of chemical depends in all cases upon the character of the water supplied to the locomotives. The men in charge of the boiler work are supplied with chemical testing equipment with which they make rapid tests of water taken from the boilers to determine its scaling tendency at all times, and the results of these tests are sent to the supervisor of water supply who formulates the treatment in each case. This road operates 55 water treating plants of the roadside type, which supply approximately eight million gallons of soft water to locomotives daily. Where such facilities have not been provided, this device affords an efficient method of applying internal treatment.



Water treater on locomotive branch pipe next to boiler ch eck valve

Questions and Answers

Problems in design, construction and repair of boilers, heavy plate and tank work

Conducted by George M. Davies

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.*

Method of Applying Tubes

Q.—Please explain the method of applying tubes to a locomotive-type boiler.—G. M.

A.—*Smokebox end of tubes*: The holes in the front tube sheet should be drilled out 1/32-inch larger than the outside diameter of the tube. The hole should be carefully cleaned. The edge of the hole should be chamfered to 1/16-inch radius on the front and back sides.

The ends of the tube should have the scale removed by filing and put in place and expanded as in Fig. 1.

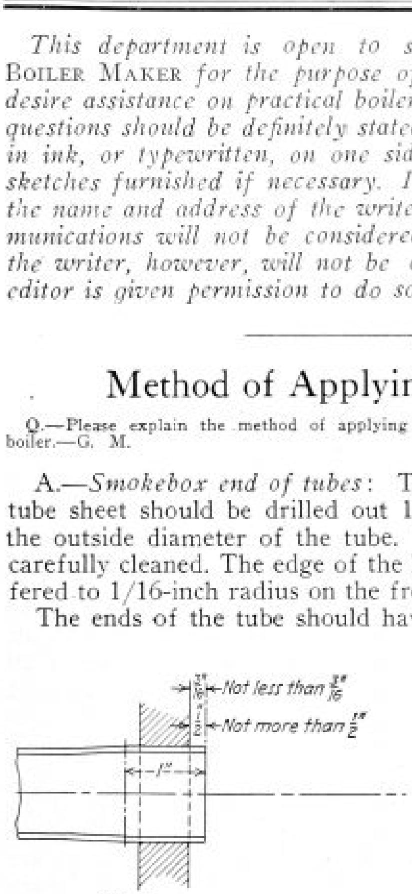
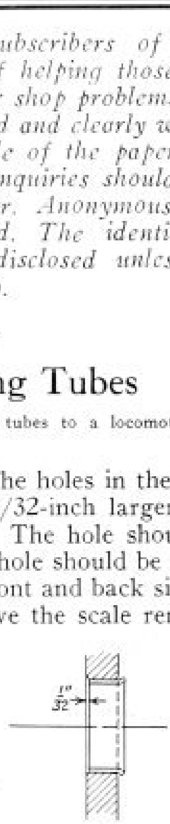


Fig. 1



Ferrules located as shown, Rolled and Belled with Ferrule Expander
Fig. 2

The tube should then be firmly rolled and beaded, or rolled, beaded and welded around the edge of the head.

Firebox end of tubes: The holes in the firebox tube sheet should be bored out 1/8-inch less in diameter than the outside diameter of the tube. The holes should be carefully cleaned. The edge of the holes should be chamfered to 1/16-inch radius on the front and back sides of the sheet.

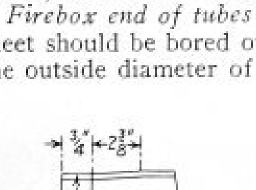


Fig. 3

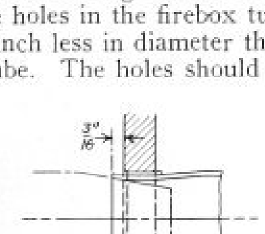


Fig. 4

The copper ferrules should be the same outside diameter as the diameter of the tube hole and should be 5/8-inch long for 1/2-inch and 9/16-inch thickness of tube sheet and 3/4-inch long for 5/8-inch or 11/16-inch thickness of tube sheet. The ferrules should be furnished slightly tapered which allows them to be easily inserted in the tube sheet.

The ferrules should be applied as shown in Fig. 2 and lightly rolled and belled with a ferrule expander to allow the tubes to be inserted. The tube should then be swaged out as shown in Fig. 3.

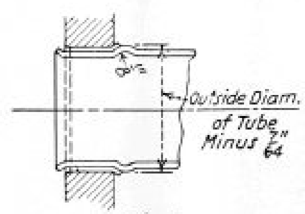


Fig. 5

The ends of the tubes should have the scale removed by filing, then put in place and set with a pinning tool to hold the tube in place, the tubes are then belled for beading as shown in Fig. 4.

The tubes are then prossered as shown in Fig. 5. A pin should be driven into the expander until the tube is solid against the flue sheet.

The tubes are then beaded, care being taken that nothing enters between the bead and the flue sheet. In no case shall the tube end extend more than 3/8-inch beyond the tube sheet.

Steam Space in Scotch Boilers

Q.—How is the steam space in Scotch boilers determined?

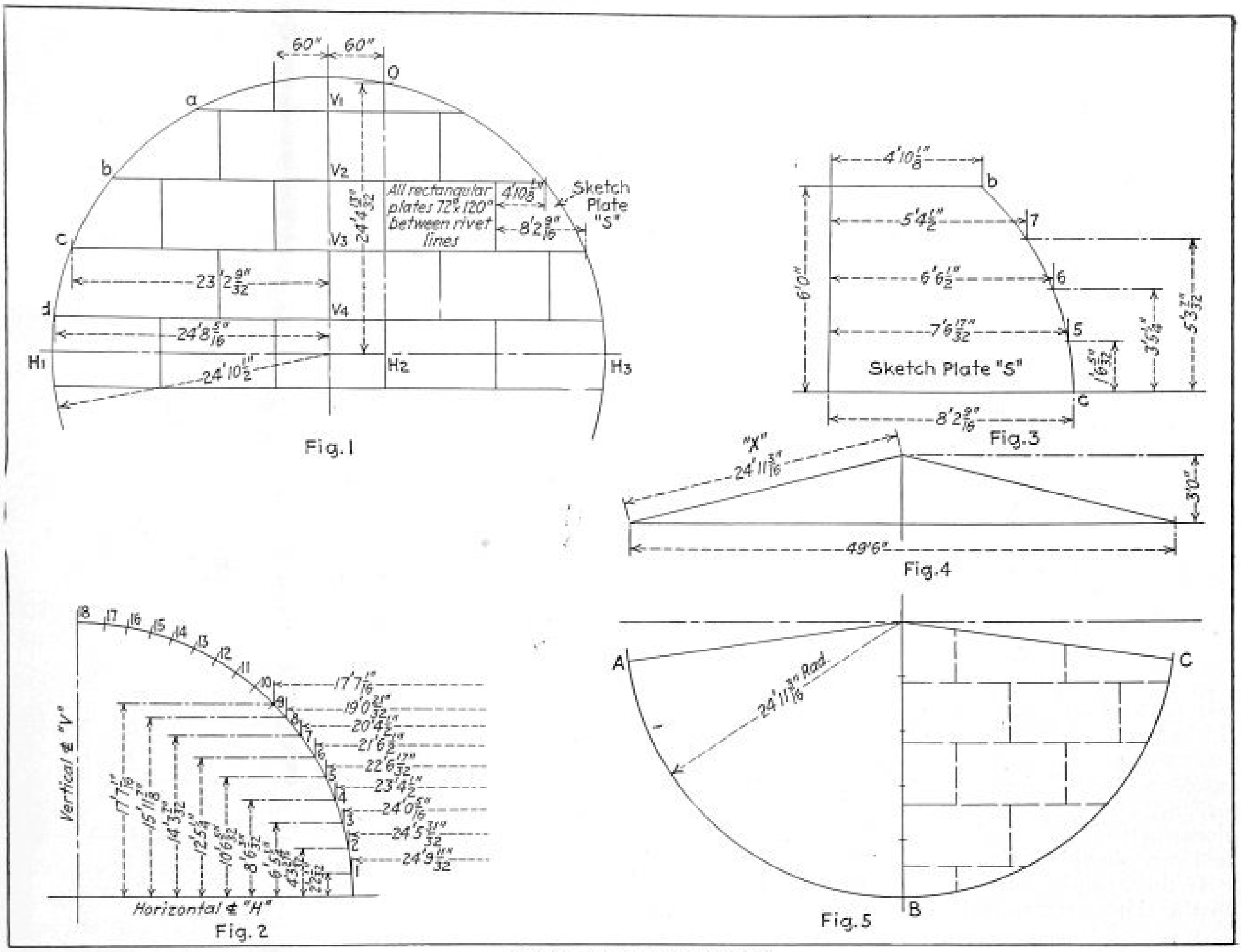
A.—The amount of steam space required in Scotch boilers varies somewhat with conditions but the following formulae will give locations for the upper row of tubes, which will assure sufficient steam space:

Distance in inches from centerline of boiler to centerline of upper row of tubes (for boilers with common combustion chambers) 0.2 × diameter of boiler; (for boilers with separate combustion chambers) 0.166 × diameter of boiler. For tugs and coastwise vessels which are not subject to quite as much heavy weather as ocean-going vessels, the steam space may be somewhat smaller.

Layout of Conical Tank Roof

Q.—Please explain how to layout a conical tank roof. Can the hyperbolic curve formed by the plate seams in elevation be obtained mathematically by measuring the bottom chord and the rise of the hyperbole?—W. T.

A.—I do not believe that the hyperbolic curve can be procured mathematically from the method as explained in the question. It is, however, unnecessary to obtain



Details of tank roof layout

the same in order to lay out the development of a tank top and bottom where the plates are laid straight across as in the diagram.

The following has been given as a simple and practical method of developing the plates for this type of tank construction.

Fig. 1 shows a tank bottom with a 49-foot 9-inch diameter rivet circle and made up of plates 72 inches by 120 inches (between rivet lines).

The first step is to calculate (Fig. 1) the lengths of the lines $O\text{-}H_2$, $a\text{-}V_1$, $b\text{-}V_2$, $c\text{-}V_3$, etc. It is known that in the case of any line such as $O\text{-}H_2$, intersecting the circumference at O and perpendicular to the diameter $H_1\text{-}H_2$, the proportion exists.

$$\frac{H_1\text{-}H_2}{O\text{-}H_2} = \frac{O\text{-}H_2}{H_2\text{-}H_3}, \text{ or } O\text{-}H_2^2 = H_1\text{-}H_2 \times H_2\text{-}H_3$$

then,

$$O\text{-}H_2 = \sqrt{H_1\text{-}H_2 \times H_2\text{-}H_3}$$

substituting

$O\text{-}H_2 = \sqrt{29.875 \times 19.875} = 24.367$ feet or 24 feet 4 13/32 inches.

In the same way we find that

$a\text{-}V_1 = \sqrt{9.625 \times 39.875} = 19.60$ feet or 19 feet 7 3/16 inches.

Next we will decide on the number of rivet spaces to be used in the circumference of the tank: In this case 936, or 234 to the quarter will be used. Convenient factors of 234 are 18 and 13, therefore a quarter circle is constructed, Fig 2, and divided into 18 spaces, each of which represents 13 rivet spaces. Obviously each of these 18 spaces subtends a central angle of $1/18 \times 90$ degrees or 5 degrees, and proceed with the calculations as follows:

Length *V-1* or the horizontal distance of point *1* from the vertical center line equals radius × the cosine 5 degrees or

$24.975 \times 0.9962 = 24.777$ feet or 24 feet 9 11/32 inches.

Similarly:

V-2 = 24.875 × cosine 10 degrees = 24.497 feet or 24 feet 5 31/32 inches.

V-3 = 24.875 × cosine 15 degrees = 24.026 feet or 24 feet 0 5/16 inches.

Length *H-1* or the vertical distance of point *1* from the horizontal center line equals radius × sine 5 degrees or 24.875 × 0.0872 = 2.169 feet or 2 feet 2 1/32 inches.

Similarly:

H-2 = 24.875 × sine 10 degrees = 4,320 feet or 4 feet 3 27/32 inches.

H-3 = 24.875 × sine 15 degrees = 6,437 feet or 6 feet 5¼ inches.

It will be necessary to make these computations for only half of the quadrant as it is obvious that *V-9* = *H-9*, *V-10* = *H-8*, *V-11* = *H-7*, etc. Simply transpose the dimensions.

The sketch plates may now be detailed as shown in Fig. 3. It is seen that the points *b* and *c*, Fig. 1, and 5, 6 and 7, Fig 2, determine the curved rivet line of the sketch plate "*S*" and we have only to substract from the dimensions *V-5*, *V-6*, *H-5*, etc., the lengths of the intervening rectangular plates. From the data indicated in Fig. 3, it is a simple matter to make the actual layout. Having located the circumferential points on the plate, the rivet arc is drawn through them by means of a sweep or curved template previously prepared and the spaces sub-divided with dividers.

For a cone roof which is similarly made up of rectangular plates, figs. 4 and 5, first ascertain the generating radius X of the roof as follows:

$$X = \sqrt{\left(\frac{49.5}{2}\right)^2 - (3.0)^2} = 24.93 \text{ feet or } 24 \text{ feet}$$

11 3/16 inches.

To find the number of degrees in the stretch out of a cone we use the formulae:

$$C = \frac{180D}{X}$$

where C = central angle

D = diameter of cone

X = generating radius of slant height of cone.

In the case of our roof,

$$C = \frac{180 \times 49.5}{24.93} = 357 \text{ degrees, } 24 \text{ minutes and } 26 \text{ seconds}$$

and the half stretchout of the roof indicated in Fig. 5 will subtend a central angle of 178 degrees, 42 minutes, 13 seconds. The arc A-B of the quarter stretchout may now be divided into a convenient number of equal spaces and detailed exactly as the bottom was. Due to dealing with an uneven number of degrees and fractions thereof, computations will be a little more tedious and care should be observed to insure accuracy.

If the work is done correctly every hole will be fair to the thirty-second part of an inch.

Stress on Staybolts

Q.—There are 9 staybolts situated in a square 4 inches apart as shown in the illustration; in a boiler carrying 200 pounds steam pressure, if one of the staybolts breaks, leaving a strain on the eight staybolts surrounding it, do all of these solid bolts take care of the load evenly or do some of them carry a heavier load than the remaining bolts? How is the strain divided up and how much strain is there on each bolt before and after the break of the center bolt? J. H. J.

A.—Referring to P-220 (a) A. S. M. E. Code, 1927:

The full pitch dimensions of the stays shall be employed in determining the area to be supported by a stay, and the area occupied by the stay shall be deducted therefrom to obtain the net area. The product of the net area in square inches by the maximum allowable working pressure in pounds per square inch gives the load to be supported by the stay.

Referring to Fig. 1, and assuming that the staybolts are ⅞-inch diameter; the load carried by each staybolt, before the staybolt E was broken, would be:

4 inches × 4 inches = 16 square inches.

Area of ⅞-inch staybolt at root of thread = 0.4637 square inch.

16 — 0.4737 = 15.5363 square inches, area to be supported.

15.5363 × 200 = 3107 pounds, load on each staybolt.

Par. P-204 A. S. M. E. Code, 1927, is as follows:

The formula in Par.-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, providing 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.

Applying this paragraph to the problem and considering staybolt E broken, then the pitch for the staybolt D would become 4 inches × 6 inches and also for staybolts B, F and H. These four staybolts support the load that was carried by the bolt E.

The load on each on these bolts would then be:

4 inches × 4 inches × 5 = 80 square inches.

4 × 0.4637 = 1.8548 square inches.

80 — 1.8548 = 78.1452 square inches, area to be supported.

$$\frac{78.1452 \times 200}{4} = 3907 \text{ pounds, load on each bolt.}$$

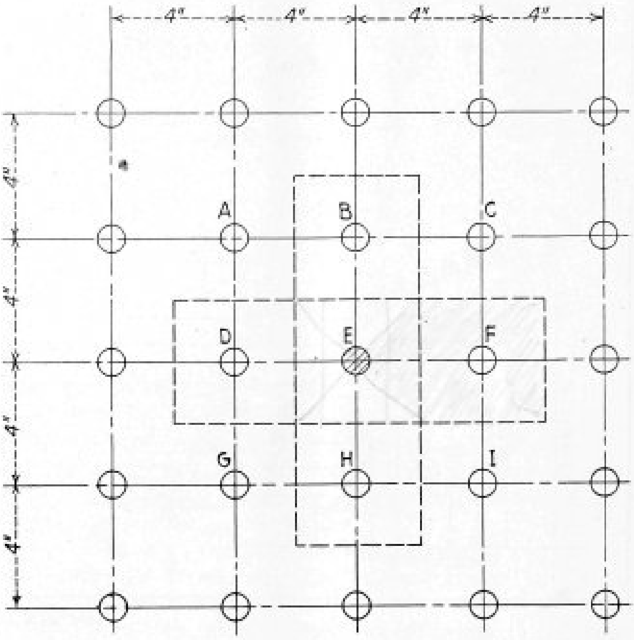


Fig. 1.—Determining the load carried by staybolts

Taking 0.4185 square inch as the net cross sectional area of a ⅞-in. staybolt, the stress of these staybolts would be:

3907 ÷ 0.4185 = 9338 pounds per square inch, against a permissible stress of 8000 pounds per square inch.

Trade Publications

TANK HEADS.—The Commercial Shearing & Stamping Company, Youngstown, Ohio, has issued a booklet entitled "Commercial Tank Heads and Tank Specialties Make Better Tanks." Tables of dimensions of all sizes of dished, parabolic, double dished flanged, and obround heads are given.

SUPERHEATERS.—The Foster Wheeler Corporation, New York city, has issued catalogue No. 304, which deals with the construction of Foster superheaters. Short statements covering the history of Foster superheaters and their application to many types of boilers are given. The types of superheaters particularly emphasized are convection, radiant-heat, combination, separately-fired, waste-heat and portable. The catalogue is completed with a steam table extending up to 1500 pounds absolute pressure and 300 degrees superheat.

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

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.	St. Louis, Mo.	Nashville, Tenn.
Erie, Pa.	Scranton, Pa.	Omaha, Neb.
Kansas City, Mo.	Seattle, Wash.	Parkersburg, W. Va.
Memphis, Tenn.	Tampa, Fla.	Philadelphia, Pa.

Selected Boiler Patents

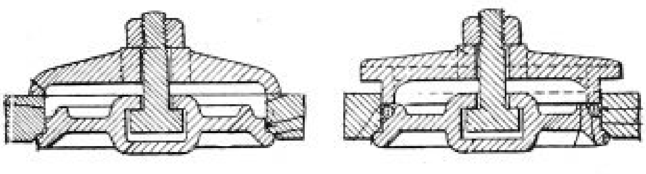
Compiled by
DWIGHT B. GALT, Patent Attorney,

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.

1,662,279. HANDHOLE COVER. JOHN C. PARKER, OF PHILADELPHIA, PENNSYLVANIA.

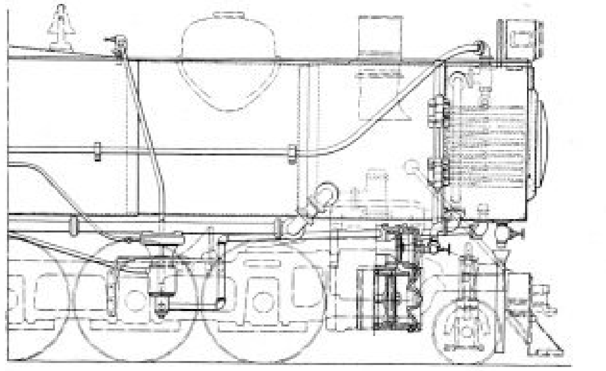
Claim.—The combination with a sheet having a hand hole therein, of a cover forming with said sheet an internal continuous ground joint and an



external channel, an elastic packing in said channel, and means for pressing said packing in its channel to form a tight continuous external joint.

1,660,261. FEED-WATER HEATER FOR LOCOMOTIVES. GEORGE H. EMERSON, OF BALTIMORE, MARYLAND.

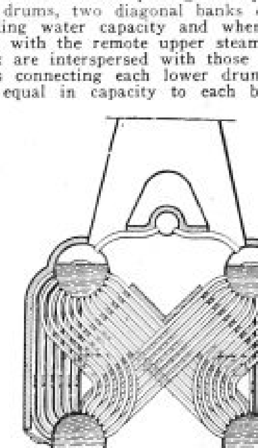
Claim.—In a locomotive, a boiler having a smokebox at the forward end thereof; a smokestack for said smokebox; and a feedwater heater



pivotally mounted on the portion of said smokebox in advance of said smoke stack, said feedwater heater being independent of said smoke stack but constituting a continuation of the walls of said smokebox. Thirteen claims.

1,662,815. WATER-TUBE BOILER. HENRY CHARLES BADY, OF HOBOKEN, NEW JERSEY.

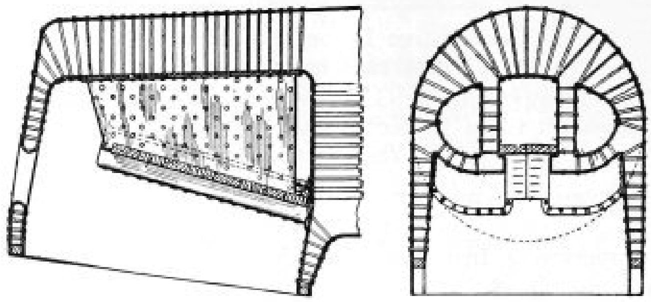
Claim.—A watertube boiler comprising two upper steam-and-water drums, two lower water drums, two diagonal banks of crossing up-comer tubes having corresponding water capacity and whereof each bank connects a lower water drum with the remote upper steam-and-water drums, and the tubes of one bank are interspersed with those of the other bank, a bank of up-comer tubes connecting each lower drum with the adjacent upper drum and being equal in capacity to each bank of diagonal up-comer



tubes, and a bank of down-comer tubes connecting each upper drum with the adjacent lower drum and being equal in capacity to two adjacent banks of up-comer tubes, baffle walls located adjacent the upper portions of the respective diagonal banks in the spaces between the respective water drums and the crossing portions of the tubes of said diagonal banks, and a baffle structure comprising inclined members spaced laterally of and above said walls and extending across the planes of the respective up-comer banks, and also an arch member covering the outer tubes of the said diagonal banks adjacent their angle of intersection. Four claims.

1,663,585. LOCOMOTIVE BOILER. MICHAEL M. CROWLEY, OF SIOUX CITY, IOWA.

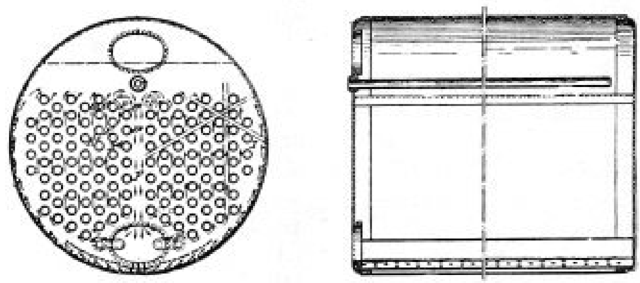
Claim.—In a locomotive boiler having a crown belly, and legs, a pair of water boxes connected, at their forward ends, to the belly and, at their sides, to the legs, said water boxes being spaced apart and inclined rear-



wardly, upwardly, and laterally away from the center of the fire box, and a pair of vertically disposed longitudinally extending imperforate water channels connecting the inner sides of the boxes with the space above the crown. Nine claims.

1,675,724. FIRETUBE BOILER. JOHN PETTY, OF LEBANON, PENNSYLVANIA, ASSIGNOR TO JO PET, INC., OF LEBANON, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

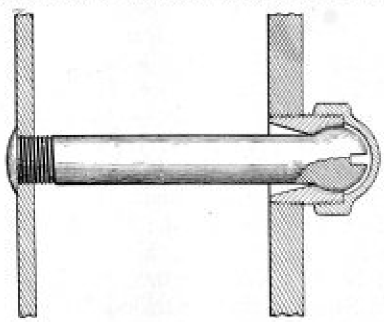
Claim.—In a fire tube boiler, a boiler shell having tube groups extending through it separated by a vertical space for down flow of water in combina-



tion with a feed water pipe extending horizontally through the boiler directly above the vertical space between the tube groups, said pipe having downwardly directed openings for the outflow of water throughout its length. Four claims.

1,660,960. FLEXIBLE STAY BOLT AND METHOD OF MAKING. GROVER R. GREENSLADE, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF DELAWARE.

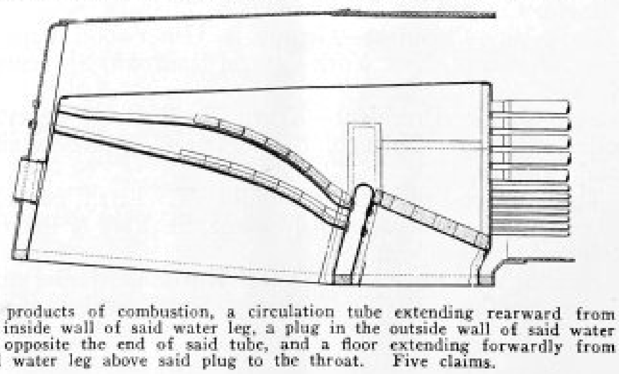
Claim.—The combination of a headed staybolt and a seat therefor hav-



ing co-operating bearing surfaces, at least one of which is much harder than the metal of the main body of the bolt member. Twelve claims.

1,665,339. BOILER FIRE BOX. JAMES T. ANTHONY OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO AMERICAN ARCH COMPANY, A CORPORATION OF DELAWARE.

Claim.—A locomotive firebox having a transverse water leg occluding its lower forward portion behind the throat with passage thereover for



the products of combustion, a circulation tube extending rearward from the inside wall of said water leg, a plug in the outside wall of said water leg opposite the end of said tube, and a floor extending forwardly from said water leg above said plug to the throat. Five claims.