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Boiler Maker and Plate Fabricator

December, 1936

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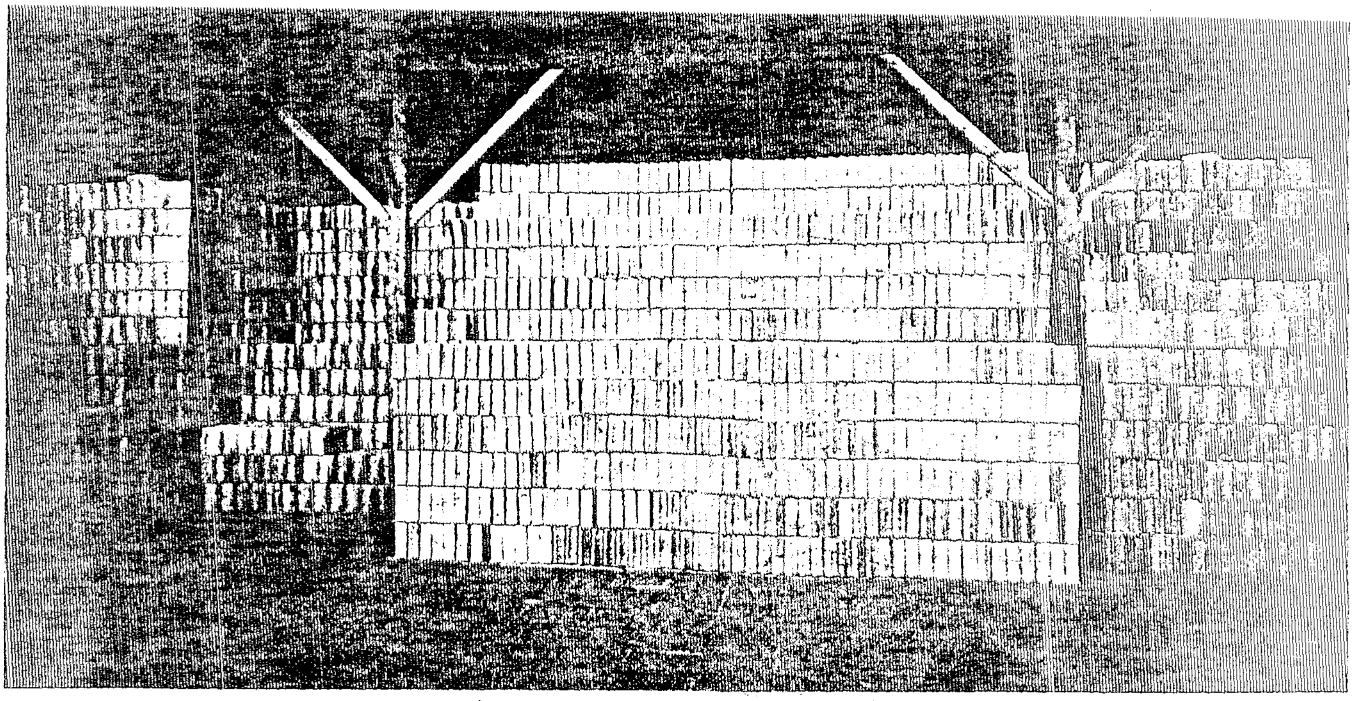

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Boiler Maker and Plate Fabricator

Newcomers in Boiler Field

The steam generating plants, the Besler automatic boiler and the Steamotive, which are featured in two articles in this issue, open up a relatively new field for the utilization of the talents of the boiler maker. The trade in this country should be given due credit for its part in what appear to be the first conspicuous and practical applications of any great success made of the high-pressure quick-steaming boiler or generator of this type.

It cannot be said that the basic ideas behind both types of steam generating plants are new or novel as both are refined developments of the flash boiler. However, the return of steam power to fields which heretofore appeared to be the exclusive property of Diesel power is definitely an event of considerable interest.

The Besler boiler is an importation from Germany where the idea has been thoroughly tested. It appears to have many qualifications to recommend it for application to existing equipment and to new trains.

The Steamotive is a native development and is a slightly less ambitious undertaking as regards evaporation rates, etc., than the Besler. The two types are similar, however, in their marked departure from the more or less established practice and introduce other ideas into the field of steam boiler manufacture.

Condition of the Industry

While accurate statistics concerning employment in the various branches of the heavy plate industry are not available, it is probably true that not since 1928 or 1929 has a year closed with better prospects for the coming one from the standpoint of steady and remunerative work.

There is nothing forced or artificial about the term in this connection, however, since it is only the natural result of a long period of curtailment in the demand for new power. The point has been reached where it is essential that the replacement program in every branch of the railroad industry be carried on at an accelerated pace. This condition extends throughout the entire maintenance and repair branches of the industry.

In these columns last month attention of the supply trade, engaged in producing materials and auxiliary equipment, was directed to the possibility of using the facilities of this publication to better advantage in presenting details of their products to the industry. By doing so a worthwhile service may be rendered to those whose duty it is to specify, select and eventually to apply such materials and equipment. Actually, a far broader field may be reached through this medium than the locomotive industry alone.

Production and consequently employment in the plate fabricating, have advanced and are still going forward to meet the accelerated demands in these fields. During the past year these industries have enjoyed a level of business not equaled at any time in six years.

November Record Month for Locomotive Orders

In the November issue of Boiler Maker and Plate Fabricator, comment was made on the encouraging indications of business recovery in the locomotive manufacturing industry as shown by the relatively large number of steam locomotives ordered in the first ten months of 1936. This amounted to 143 units and before going to press, the report of an order for 20 by the Union Pacific in the first week of November was also published, making a grand total of 163 for the year up to that time.

In November, in addition to the Union Pacific transaction, already mentioned, the New York Central Railroad placed an outstanding order for 100 steam locomotives, contracts being made with the American Locomotive Company and the Lima Locomotive Company for 50 each. The Chicago, Milwaukee, St. Paul & Pacific ordered 30 locomotives from Baldwin and one from American Locomotive. The Chicago, Burlington & Quincy began the construction of 11 units in its own shops. This brought the total number of new steam locomotives contracted for or ordered in the month of November to 162, which exceeds the total for the first ten months by 19.

From the first of December to the time of writing, 65 more locomotives have been ordered by American railroads. The Norfolk & Western is beginning in its shops the construction of 8 additional units of the 1200-class articulated type described in the September issue, the Seaboard Air Line has ordered 5 from Baldwin and the Denver & Rio Grand Western has also placed an order for 15 with this company. The Wheeling & Lake Erie ordered 10 locomotives from the American Locomotive Company and the Atchison, Topeka & Santa Fe placed an order for 27 with the Baldwin Locomotive Works.

This surge of locomotive purchasing has not been unanticipated as the pressing need for locomotive replacement has been well known to all followers of railway affairs. It is known that the locomotive builders have been preparing for the increased volume of business by rebuilding and reinforcing as much as possible the staffs and departments that were carried through the depression. It is feared, however, that the locomotive industry like other heavy industries which have suffered severe curtailment of activity will be hard put to obtain the vitally necessary experienced workmen and foremen for efficient production and considerable training will have to be given new emɔpearance somewhat comparable to the road's latest reamline coaches. The cars were stripped down, lower-eck roof sheets and some details of the old deck fram-ig removed to save weight, and new carlines and roof heets applied from side plate to upper deck sheets to ɔrm a turtleback roof.

On the power car a section 8 feet long at one end was eserved for application of the Besler boiler plant and uxiliary equipment. The entire length of 20 feet over he boiler room and baggage room on the roof is taken ıp by the condensers and exhaust steam-driven fans. A ıumber of special details of construction had to be worked out properly to carry the weight of condensers ınd fans and also maintain the necessary strength across he sides of the car. The necessary control apparatus was applied in each compartment and the train is oper-ated in either direction without turning.

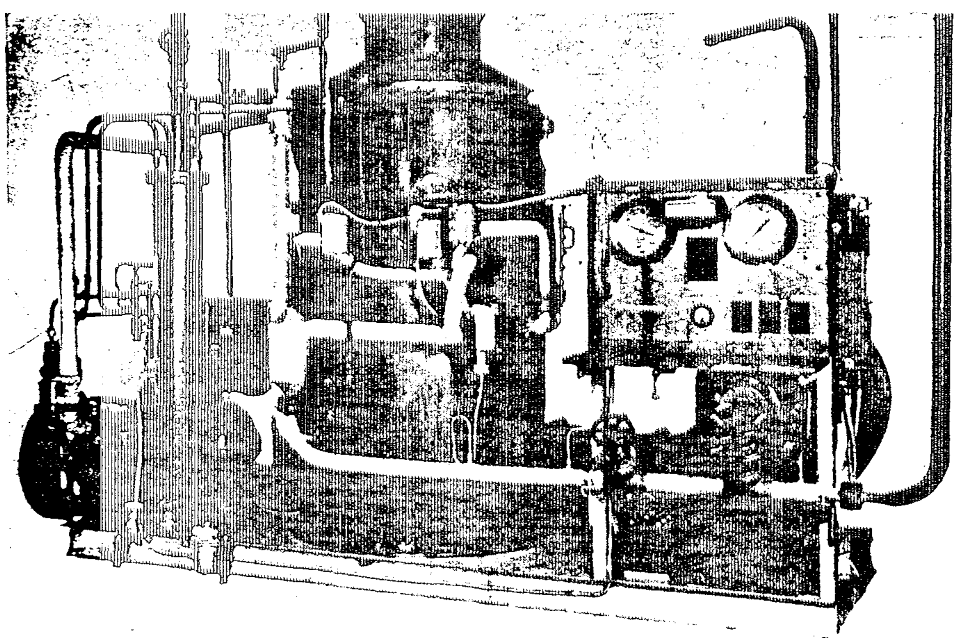
The old truck under the boiler end of the power car was replaced by the Besler power truck, all other trucks remaining the same. Fuel and water tanks of 500 gallons capacity each were applied to the power car. The cars were semi-permanently connected together, the old couplers and draft gears being retained.

The overall length of the power truck is 17 feet 8 inches, and the total width over the cylinder lagging cover is 9 feet 5 inches. The wheelbase is 11 feet 6 inches and Bethlehem low-carbon molybdenum wheels with chrome vanadium axles are used.

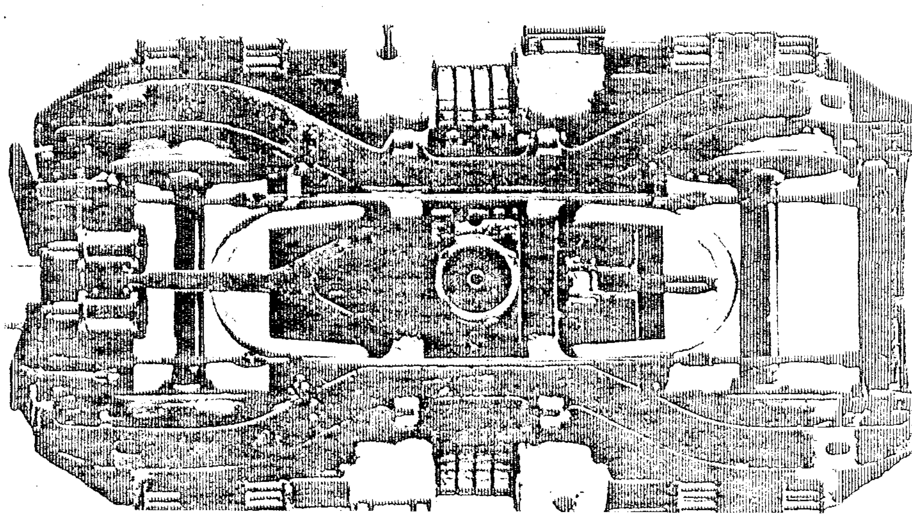
The total weight of the power truck is 35,000 pounds.

There are two direct, two-cylinder compound engines, each having cranks pressed onto extensions of the axle stub outside of the journal bearings. The high-pressure cylinder is 6½ inches in diameter and the low-pressure cylinder is 11 inches in diameter. Both cylinders have 9-inch stroke. These are conventional double-acting compound engines, with piston valves. The crossheads are cylindrical in shape and are made of cast steel with babbitted shoes. All bearings are of the roller type throughout and all working parts are machined all over.

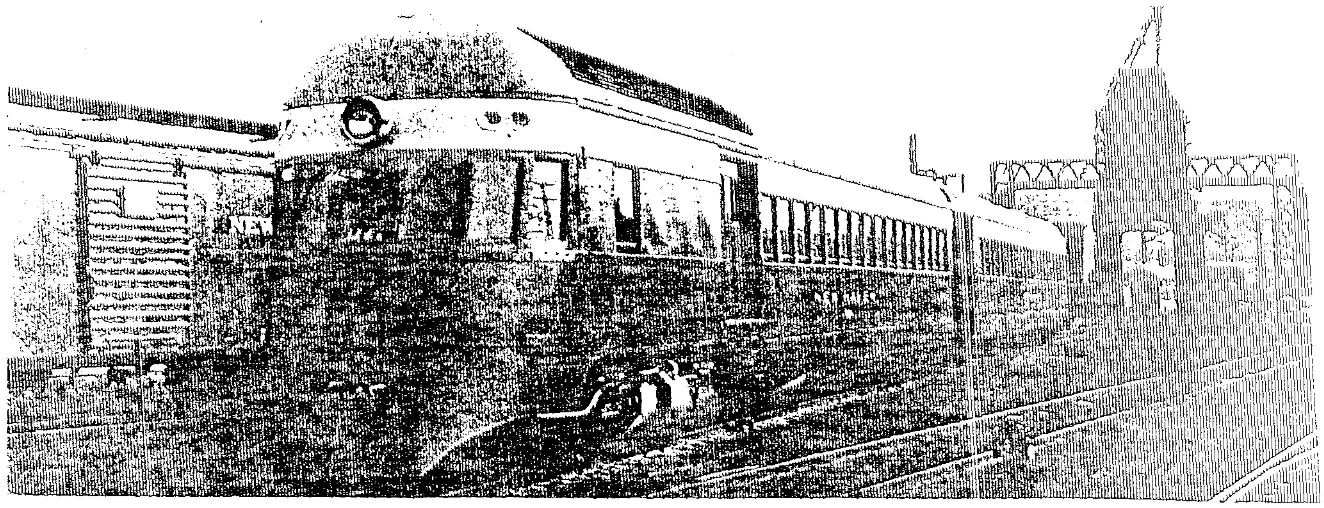
The valve mechanism is a Stephenson link motion arranged to be operated pneumatically to give two positions forward and two positions reversed. The lubrica-



Steam generator as set up in the laboratory for testing showing compactness of the Besler unit for railroad service



Top view of the power truck showing the truck and engine-frame castings as well as the brake and spring arrangement



The Besler two-car steam train on the New Haven

New Haven steam rail train features

BESLER AUTOMATIC BOILER

The New York, New Haven & Hartford now has in service, between Bridgeport, Conn., and Hartford, a two-car steam-powered rail train equipped with the Besler steam power plant. This train is operated in almost continuous service from 6:00 a.m. to 10:20 p.m. making six trips of 31.9 miles between Bridgeport and Waterbury and one round trip of 125.86 miles between Bridgeport and Hartford each day, giving a total daily mileage of 317.26.

When it was first decided by the New Haven to use a Besler power plant the idea was to make the most economical possible application, from the standpoint of initial investment, in order to be able to demonstrate in service the capabilities and reliability of the equipment. This would involve simply the application, to two existing coaches, of the power truck, boiler, condensers and control equipment, together with the operating compartments at the ends of the train. A preliminary consideration of this idea, however, indicated that a much better job could be done by a complete rebuilding and remodeling of the two coaches at a comparatively small increase in cost.

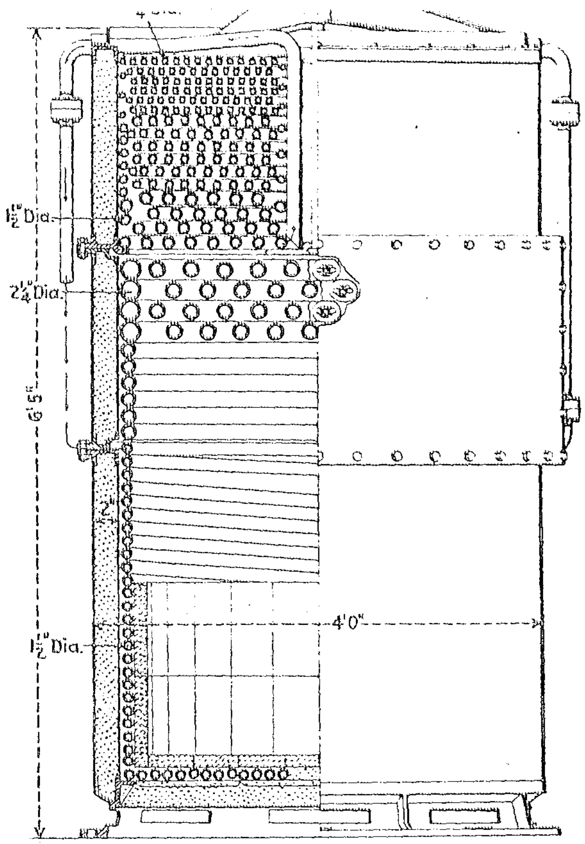
As finally completed, loaded with fuel and water ready to run, the weight of the train is 303,600 pounds. The two steel coaches which were converted into this train had a weight of 258,400 pounds. The application of the Besler power plant and the modernizing of the two cars, plus fuel and water and air conditioning equipment, therefore has only added 45,200 pounds to the weight of the original equipment. With 500 horsepower available at the rail the Besler train, ready to run, has a horse-power-weight ratio of 607 pounds (3.3 horsepower per ton). By comparison the New Haven Comet, loaded with fuel and water ready to run, weighs 260,590 pounds. This is powered with two 400-horsepower Diesel engines giving a total of 800 horsepower. If, however, all auxiliary equipment is in operation at once, considering the efficiency of the electric drive, a maximum of 600 horsepower is available at the rail. This gives a horsepower-weight ratio of 434 pounds (4.6 horsepower per ton). If, instead of applying the Besler power plant in the older steel coaches as was done in this case, such a power plant were applied to two of the modern New Haven light-weight streamline coaches, it is reasonable to expect that a two-car train could be built with a total weight, ready to run, of approximately 250,000 pounds. This would have a horsepower-weight ratio of 500 pounds (4 horsepower per ton).

Two old New Haven steel coaches, approximately 20 years old, were selected and designs worked out for remodeling them by the application of the Besler power plant and other modifications into a modern appearing streamline train. These old cars were of the monitor-room construction, with narrow letter boards. As remodeled the exterior was changed to give an outside

Note:—This article is based on papers presented before the New York Railroad Club, October 16, 1936, by K. Cartwright, N. Y., N. H. & H. (describing the train), and George D. and William J. Besler (describing the power plant), supplemented by additional details concerning the boiler. There is also included a summary of questions raised during the discussion following the presentation of the two papers.

Characteristics of Besler Train and The Comet

	Besler train	The Comet
Total horsepower	600	800
Horsepower at rail	550	590 (min.)
Seating capacity	152	160
Baggage capacity	12 ft.—3,000 lb.	None
Overall length, ft. and in.	163—2⅓	207—0
Total weight, ready to run, lb.	306,600	260,590
Distributed weight, power truck, lb.	104,000	86,835
Trailer truck power car, lb.	67,000	43,890
Trailer, inside truck, lb.	65,000	44,375
Trailer, leading truck, lb.	67,600	85,490
Weight light train, lb.	296,100	248,590
Weight power plant and control, lb.	32,700 (approx.)	71,039



Half section of the Besler Uniflow boiler

tion is accomplished by splash within a sealed crankcase, and a circulating plunger pump is furnished to assure lubrication at slow speeds. The cylinder relief valves are air operated.

The engine is designed for a steam pressure of 1500 pounds per square inch and, at 1200 pound inlet pressure, the truck has an average starting tractive force of 15,000 pounds. The truck is rated at 1000 horsepower, although it is capable of producing more than this with sufficient boiler capacity.

The boiler is of the continuous-flow, non-water level type, having no drums or headers. The general arrangement of the coils in the boiler is shown in an accompanying drawing. The tubes in the coils, vary in diameter from ¾ inch in the top rows to 2¼ inches diameter, in the superheater section. The water enters the top of the boiler, passing down through the pancake coils where it is heated in the coils in the top six-coil sections. In the next lower six-coil sections the water is gradually changed to steam. Having reached a point in the boiler directly above the superheater coils, the saturated steam passes through a tube, indicated by the arrows in the drawing, to the outside of the boiler through which it is taken to the top of the coil group which entirely surrounds the side walls and bottom of the combustion chamber. The steam in working its way through these coils passes down alternate rows to the bottom coil underneath the combustion chamber. Having completed a circuit in the bottom coil, it passes up other alternate rows of tubes to a point at the top of the combustion chamber where it enters the bottom of a seven-tube coil immediately under the superheater section. After passing through this section it goes into the superheater section composed of five rows of header type coils. The superheater coils are U-shaped in arrangement with the units at the opposite end at which clean-out hand-hole plates are fitted to the boiler shell. The formation of scale in this type boiler is confined to the superheater section and the clean-out hand-holes are provided to facilitate the use of a mechanical cleaner in the superheater tubes. The entire boiler is encased in an airtight sheet-steel housing with 2 inches of insulation between the inner and outer casings. The inner casing is constructed of corrosion-resisting Inconel and the outer casing, separated from the inner casing by insulating brick, is made of sheet iron.

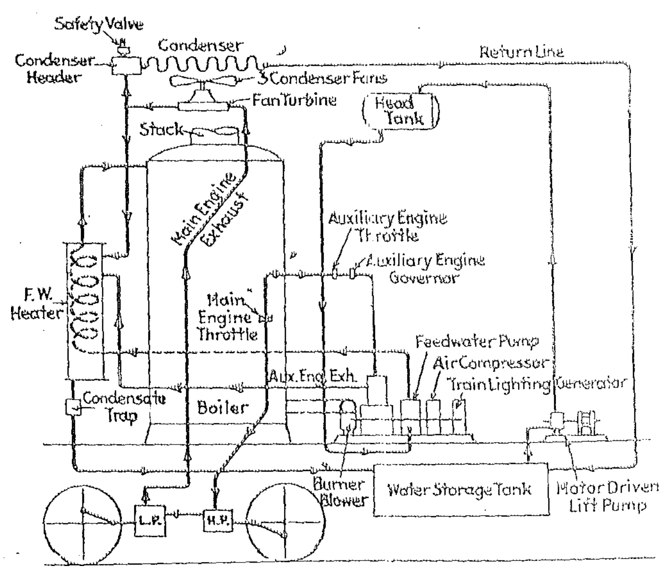
The boiler is equipped with fully automatic safety devices to protect it against empty water tanks or other contingencies.

The burner is the pressure atomizing type of Besler design and construction. It automatically meters the fuel in proportion to the flow of air which is delivered by a multivane type blower. Adjustment is not necessary because of a change of altitude or a change in draft pressure, and the burner automatically compensates for changes in air flow caused by entering tunnels, high speeds, or cross winds—in every case metering the correct amount of fuel. The burner operates fully on or off. Ignition is secured by a high-tension electric spark.

The auxiliaries are driven by a two-cylinder, 90-degree V-type double-acting steam engine. The water pump drives are integral with the main crank shaft. The auxiliary steam engine drives the electric generator through V-belts. The generator supplies current for lighting, ventilating and for the requirements of the power plant. The auxiliary engine also drives the air compressor and the forced-feed main-engine lubricators. It operates at a back pressure and exhausts into the train-heating line. When train-heating is employed the power used to drive the auxiliaries represents only two percent of the boiler output.

The condensers are of the fin and tube type, placed on the roof of the car. Propellor type fans driven by individual exhaust-steam turbines of our own design and manufacture are located adjacent to the condenser cores on the roof and draw air through the cores, discharging it upward.

The turbine speed inherently varies in proportion to the steam flow, producing the optimum relation between air flow and condenser load at all outputs.



Schematic diagram showing the relation and functioning of the various parts of the equipment

General Scheme of Operation

Reference to the accompanying schematic diagram will help clarify the functioning of the various units involved in the power plant and auxiliary. Water from the main storage tank is pumped by a motor-driven lift pump to a header tank, thence to the boiler feedwater pump which is one of the three auxiliary units driven by a high-pressure auxiliary engine. From the feedwater pump the water passes through the feedwater heater, thence to the boiler. Its course through the boiler has been previously described. Superheated steam at constant temperature and at a maximum pressure of 1500 pounds per square inch leaves the main steam outlet of the boiler. Superheated steam is used in the main engines on the power truck and in the auxiliary engine. The main engine exhaust is piped to the three condenser fan turbines. The auxiliary engine exhaust is piped to the feedwater heater. Exhaust steam after passing through the feedwater heater and the fan turbines goes to the condenser header which is equipped with a safety valve as a protection against excess pressure in the condenser coils. The condensate from the condenser passes through a return line to the water storage tank.

Questions and Answers Concerning Operation

At the New York Railroad Club meeting at which the description of this train was presented many questions were asked concerning this equipment. The answers to a number of these questions as given by W. J. Besler, are included herewith.

1. Q.—*What is the percentage of makeup water in the summer time when steam is not used for heating?* A.—It is approximately the same as in the winter when water is lost through heating. In the winter time, there is no return from the heating pipes, so that the water is wasted. No records of the amount of water consumed by the power plant are available at present.

2. Q.—*How is scale formation prevented in the boiler?* A.—Scale is not prevented. Scale forms only in a certain portion of the boiler which is provided with clean-out openings. Cleaning is accomplished either by dissolving it, or by the use of a turbine cleaner after removing the clean-out plugs, which is a simple operation. Any other means of feedwater treatment may be used to keep down the scale deposits.

3. Q.—*Is the steam superheated?* A.—Yes, the steam is superheated. At 500-pound pressure or 800-pound pressure, the temperature is maintained constant at the outlet of the boiler and runs 760 degrees. It is maintained at that point to give a good overall efficiency and good lubrication.

4. Q.—*How does oil treat the feedwater?* A.—Oil goes into the feedwater because the engines are lubricated by spraying oil into the engine cylinders. The oil is carried to the condensers and from there it is returned to the feedwater tank. This oily feedwater is pumped to the boiler, which is one of its features. In a steam automobile boiler, which is now 27 years old, the boiler has never been touched. The tubes are perfectly clean because of the presence of a large percentage of oil. Upon analysis this was found to be some four or five percent of the feedwater.

5. Q.—*Is straight mineral oil or compounded oil used?* A.—Both types of oil are used.

6. Q.—*Does the atomizing burner run intermittently or at varying speeds, so as to develop steam in proportion to the speed requirements of the train?* A.—The atomizing control mechanism which supplies water whenever the pressure is sufficiently low and whenever the temperature is right. The injection of water is proportioned according to the temperature within the boiler. It is fully automatic in operation.

8. Q.—*What kind of fuel is used?* A.—So far, any type of fuel has been used with which we have come in contact. On this train the lighter grade of fuel is preferred, as the cost is not yet prohibitory. Any of the oils produced in America can be burned, as they have been tried in the laboratory.

9. Q.—*What is the combustion rate in the boiler?* A.—Over 500,000 B.t.u.'s per cubic feet per hour, although a maximum of over 2,000,000 B.t.u.'s per cubic feet per hour have been released.

10. Q.—*What is the stack temperature?* A.—500 degrees F.

11. Q.—*What is the water rate of the engine at various speeds?* A.—10 pounds over a wide range of speeds and loads. That water rate can be maintained from 1200-pound inlet pressure down to 400-pound inlet pressure, which is the operating range at the present time.

12. Q.—*How frequently must scale be removed from this type of boiler?* A.—The present indications are that it should be removed each 30 days, although on the New Haven train, it was operated the first six weeks without removing scale.

13. Q.—*What is the weight of the boiler?* A.—5100 pounds complete.

14. Q.—*What effect will snow have on the condenser exhaust fan?* A.—When snow comes in contact with the fans two things may happen to dispose of it. Either the fans will throw it out of the way or the heat will melt it.

15. Q.—*What is the temperature of the boiler room?* A.—Temperatures as high as 140 degrees have been recorded in the boiler room, although at that time no one was in the room.

16. Q.—*Are conventional snap rings used on the pistons of the engines?* A.—Yes.

17. Q.—*How many rings are used on each piston?* A.—Six.

18. Q.—*What is the maximum speed of this train, and at what speed is maximum horsepower developed?* A.—The horsepower is constant from 12½ to approximately 65 miles per hour. The train is guaranteed to do 70 miles per hour, although on one run a maximum of 82 miles per hour was reached. Operating conditions necessitated limiting the speed, so that it is not possible to say how much more speed it might be possible to attain.

19. Q.—*Is a fireman used on this train?* A.—Yes, when the train is backing up, that is, being operated by means of the controls at the opposite end from the power unit, the fireman rides with the engineman, 160 feet away from the boiler.

20. Q.—*How much power is required for the condenser exhaust fans?* A.—The condenser fans require approximately 30 horsepower under a full load. That is available at a loss to the engine which is not very great, as 12-pound back pressure on the engines does not amount to much horsepower. Turbines are used for driving the fans.

21. Q.—*With moderate volume production, what proportion of the total cost of the train is in the power plant?* A.—On the New Haven train, approximately one-fourth of the cost is represented by the power plant and three-fourths for the train.

case of necessity? A.—If a reserve power truck were available, it would merely be a problem of lifting the car, rolling the new truck in, dropping the car and making the various steam and air connections.

23. Q.—*Is the boiler operated at constant pressure?* A.—No attempt is made to maintain constant pressure. The boiler operates at a constant superheating outlet temperature. A constant temperature is maintained, as that is what determines proper lubrication and efficiency.

24. Q.—*Is the lubricating oil atomized into the cylinders or fed onto the cylinder walls?* A.—It is fed into the valve chamber and atomized by the velocity of the steam.

25. Q.—*What is the fuel consumption per hour?* A.—One pound of fuel per horsepower hour.

26. Q.—*When the train is operated by means of the controls at the opposite end from the power unit, what controls and what gages does the operator have for feedwater for the boiler?* A.—The controls consist of a throttle, air-brake valve and reverse mechanism. There is nothing to indicate to the operator what is going on at the power plant, as the operation of the boiler is entirely automatic.

27. Q.—*What type of a transmission is used?* A.—There is no transmission. The steam engine connecting rods are directly connected to cranks which are pressed on to an extension of the axles. It is interesting to note that there is not a single gear of any description on these two cars.

28. Q.—*How is the control operated from the opposite end of the train?* A.—Pneumatically.

29. Q.—*What is the storage capacity of the boiler?* A.—Only enough to go about half a mile. Storage capacity is not carried in the boiler water, but in the hot tubes. As the pressure drops an additional quantity of water comes from the economizer section of the boiler, and in contacting the hot tubing it generates steam which gives this boiler its amazing reserve capacity.

30. Q.—*How long does it take to get the boiler hot from cold water?* A.—The rail car is able to get steam up in an average time of five minutes from dead cold. It cannot be operated in five minutes, however, because of the necessity of pumping up air for about 12 minutes. The time required from stone cold to the point where it is ready for operation depends upon the time required to pump up air. As far as the boiler is concerned, working steam pressure can be built up in approximately 3¼ to 4 minutes from the time the fire is started.

Machine-Made Jobs and Present Employment

Major industries which have instituted the greatest technological changes in the last few years have added millions of wage earners to their payrolls and many of them employ more workers today than in 1929, according to a study made by the Machinery Institute and reported recently in a pamphlet "Machine-Made Jobs."

The report is the third of a series by the Institute, of which John W. O'Leary is president, giving factual evidence that jobs are created by the advance of science and invention. The contents are "buts and ands that must be considered in connection with common statements which on the surface appear to prove that machines cause unemployment."

"Vast technological improvements have been made in the automobile industry, which have greatly increased productive capacity of workers in many jobs," says the pamphlet. "But employment per vehicle manufactured was 25 percent higher in 1935 than in 1929. And last year 109 workers had jobs making automobiles for every 100 between 1923 and 1925."

It deals with many of the leading industries in which machine developments are often accused of having destroyed employment opportunities. Among the facts presented are:

Telephone girls increased by more than 50,000 during the ten years that the dial system was being installed, and linemen increased 100 percent.

Ice dealers more than doubled between 1920 and 1930 because mechanical refrigerators popularized all refrigeration.

It takes far more workers to furnish the textile demands of a thousand Americans today than it did in the colonial days of spinning wheels, due to increased use of textile products as a result of lower prices when machine methods are used.

Machines have revolutionized office work in recent years, yet stenographers and typists increased 32 percent and bookkeepers, cashiers and accountants increased 27 percent between the last two census years. Population increased only 16 percent.

Sound pictures displaced 50 percent of all theater musicians, but during the same years musicians and teachers of music increased by 35,000, actors by 17,000, theater ushers by 7000 and radio employes by 15,000.

A printer today can set more than five times as much type as one without a linotype did in 1890, yet there are five times as many employed in the industry as there were then because machinery has lowered prices and made possible the vast growth of the printing and publishing business.

"Some of the greatest technological developments in America in recent years have taken place in the iron and steel industries," says the pamphlet.

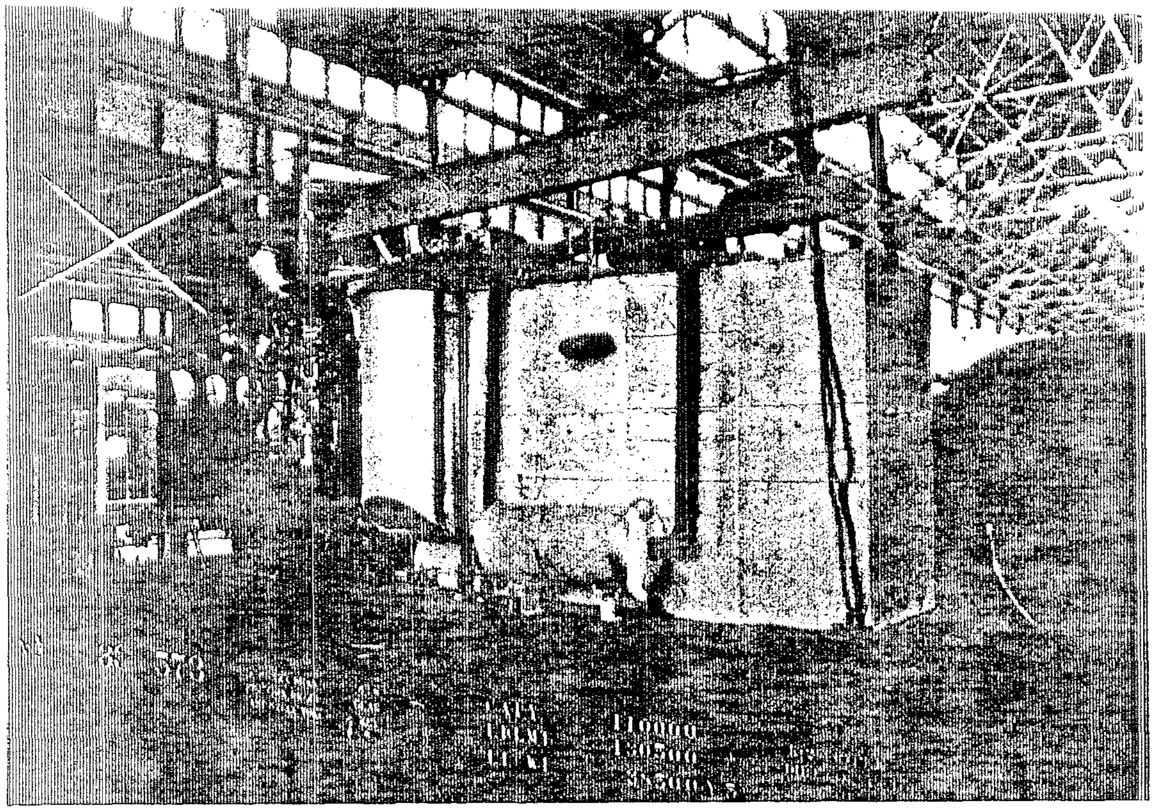
"But the use of steel in the United States increased from 2600 pounds per person in 1900 to 16,800 pounds in 1935. There used to be only two or three kinds of steel, but today there are about 10,000 different specifications as to alloys, sizes, finishes and shapes that modern industry demands.

"And employment has grown from less than 150,000 sixty years ago to about a half million today, and despite, or because of, the recent technological changes employment in 1936 passed the 1929 peak. Production is far below capacity and with its inevitable rise employment will go even higher."

The employment of both women and children in manufacturing industries has declined during the last generation while mechanization has been greatest, and the employment of men in manufacturing and mechanical industries has more than doubled since 1890, according to the Institute. Wage and salary earners get a larger percentage of the national income today than ever before, largely because machinery has increased workers' productive capacity and earning power.

Western Boiler Maker Dies

Richard J. O'Neill, former national president of the Boiler Makers' Association of America, died November 12 at his home in Denver, Colo. He was 78 years of age. Mr. O'Neill had been employed by railroads in every part of the United States. Forty years ago he built the first camel-backed locomotive in Rawlins, Wyo. He first came to Colorado in 1904 to accept a position with the Colorado & Southern Railroad. At the time of his retirement he was general foreman boiler maker for that road.



Steamotive unit on flat car ready for shipment

Steamotive—A Modern Power Unit

The design and testing of a new type of steam-generating unit of good efficiency, relatively light in weight and requiring a minimum of space, was described jointly by the General Electric, Babcock & Wilcox, and Bailey Meter companies at the annual meeting of the American Society of Mechanical Engineers, in New York City, November 30, by E. G. Bailey of the Babcock & Wilcox Company. A. R. Smith of the General Electric Company, and P. S. Dickey of the Bailey Meter Company presented the paper at the meeting.

The new type of steam-generating equipment has been named the Steamotive. In it, steam is generated at high pressure and temperature; and fully automatic control in response to changes in demand has been incorporated. The units are intended for capacities of from 2000 to 10,000 horsepower.

Two such units have already been built. The first, now in service in the Lynn, Mass., works of the General Electric Company, is used to test marine and other small turbines. It has an output of 21,000 pounds of steam per hour at a pressure of 1500 pounds per square inch.

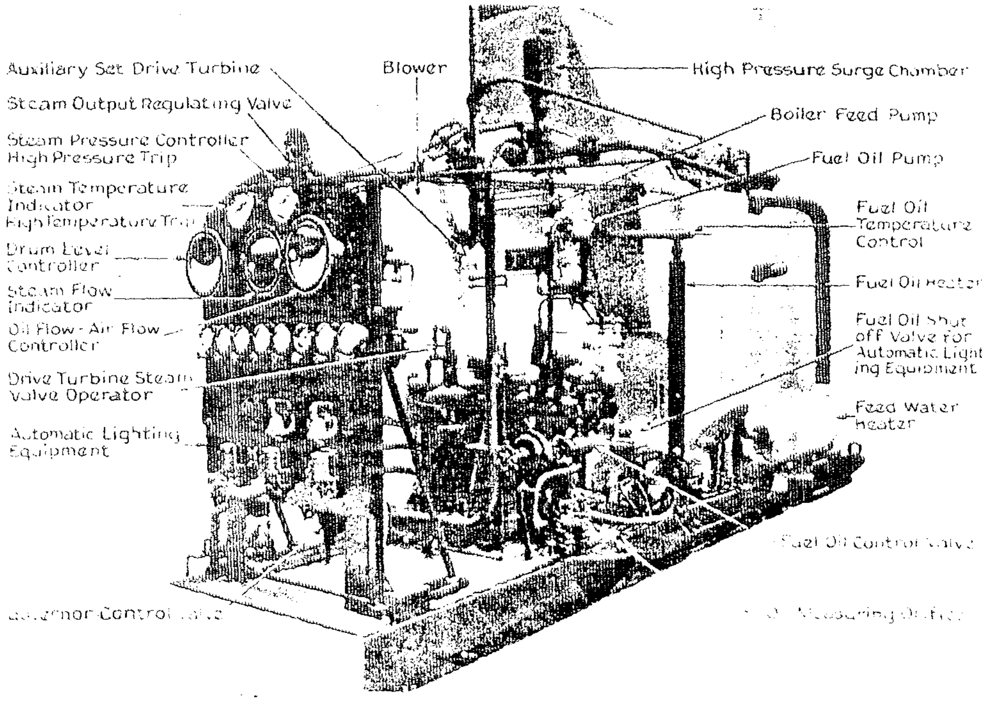
Another, a completely co-ordinated power-generating plant incorporating the Steamotive and turbine-generator, with a capacity of 10,000 pounds per hour and furnishing steam to a turbine at 1200 pounds per square inch and 950 degrees F., is being installed in a small, isolated plant of a large industrial concern to supply electric power and low-pressure steam for building heating. Both are oil-fired.

Two oil-fired Steamotive units, each with a capacity of 40,000 pounds per hour, are now being constructed for the Union Pacific Railroad for driving two 2500-horsepower electric locomotives, it was announced at the meeting. These units will furnish steam to the turbines at 1500 pounds per square inch and 950 degrees F.

Indicating the compactness of the Steamotive unit, the one for Lynn was shipped complete from Schenectady on a railroad flatcar.

Objectives sought in the design of the new equipment were pointed out by the speakers as high steam pressure and temperature, minimum weight and size per unit of steam produced, wide range of capacity with ability of the unit to respond quickly to wide variations in load conditions, adaptability to wide range of fuels, completely co-ordinated auxiliaries, completely co-ordinated automatic control, and units of simple design and constructed in sizes small enough to be portable.

Answering these specifications, the Steamotive boiler was designed and built by The Babcock & Wilcox Company at Barberton, O. The meters and complete automatic control were designed and built by Bailey Meter Company, Cleveland. The auxiliaries which supply fuel, air, and feed water are controlled in accordance



General view of generating unit now in commercial service at the Lynn, Mass., works of the General Electric Company for testing

with demands for steam. Complete automatic ignition and safety equipment are included.

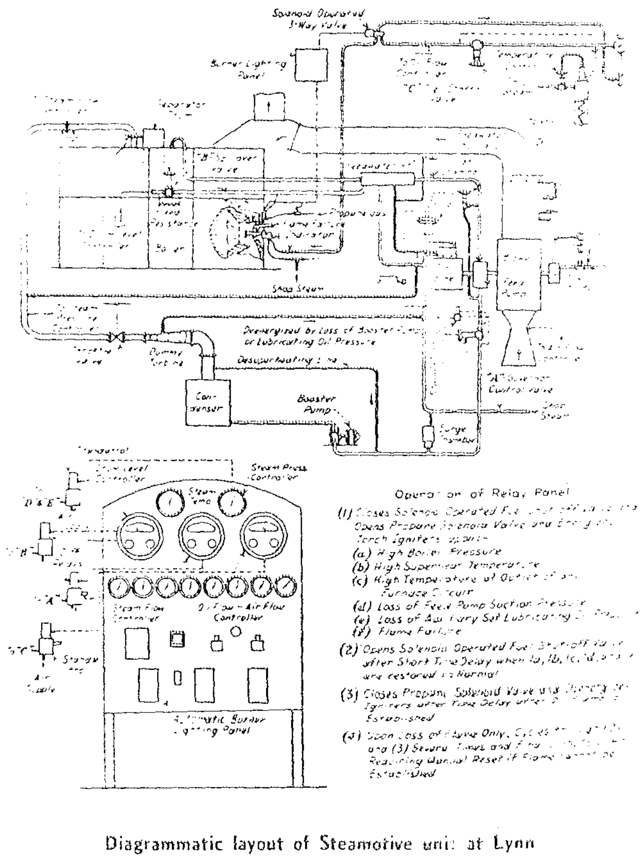
The auxiliary set was designed and built by the General Electric Company, which company also did the assembly work of the complete unit at its Schenectady plant. The auxiliaries, geared together as one turbine-driven unit, in the case of the unit at Lynn consist of a feed pump delivering 25,000 pounds of water per hour at a pressure of 2000 pounds, a blower for 30,000 pounds of air per hour at 60-inch water pressure, a fuel-oil pump, and a lubricating-oil pump. The complete Steamotive unit was designed and constructed so as to be suitable for installation in a locomotive in conjunction with turbine-electric drive installed by the General Electric Company.

In the operation of the Steamotive unit, the flame and gases pass from the burner through the completely water-cooled furnace, thence [illegible] down around the separator, through the [illegible] and air heater, and up the stack. The air for combustion leaves the blower at relatively high pressure passing through lanes intersecting the stack, and down around the air-heater tubes to the oil burner. There is no induced draft fan, the blower forcing the air through the burner and furnace under pressure.

The feed water enters the economizer inlet header, and, after leaving the outlet header, is divided into several circuits, all of which form the floor, sides, and roof of the furnace, as well as the sets of loops forming the boiler screen. All the steam is generated in these furnace and boiler circuits, and enters the separator, with a surplus of water in each circuit. From the separator, the dry steam goes through the superheater, and directly to the main turbine. The water from the separator is called the spillover, and it passes through a heat exchanger to the hot well, where it mixes with the condensate, and is refed to the boiler by the feed pump.

Due to the compact arrangement of the Steamotive unit, it constitutes what is practically a packaged power plant.

"Tests made on the developmental Steamotive unit and subsequent design studies indicate that a steam-generating unit of this type is entirely practical for generation of high-pressure and high-temperature steam," it was reported at the meeting. "The principal advantages of this type of unit over natural-circulation boiler installations are the small space required and the reduction in weight of the unit (For example, in locomotives). It is possible to fit this type of boiler into a restricted space and the design is flexible in its adaptability to limits in height, width, or length.



Diagrammatic layout of Steamotive unit at Lynn

"The elimination of refractory in the furnace and boiler setting, replaced by waterwalls and insulating block, not only results in a large saving in weight and volume, but also in reduced heat capacity that materially affects the ability to change output quickly. The small water content of the forced circulation boiler results in quick response to load changes and insures safety in spite of the high-temperature and high-pressure steam conditions. These factors permit quick starting from a cold condition, requiring less than ten minutes from lighting the burner to full output. It has been found that combustion liberation rates up to 400,000 British thermal units per cubic foot per hour can be obtained with low excess air and smokeless combustion with oil fuel. The pressure furnace which utilizes forced draft only is entirely practicable and materially simplifies the draft equipment and control therefor.

"The wide-range burners used on this unit and the co-ordinated auxiliary set make complete automatic control a thoroughly practicable device. Completely automatic lighting of the burners has been entirely satisfactory, and the use of safety devices which automatically cut off the oil fire has proved a more effective protection than safety valves and other protective devices common on natural-circulation boilers.

"It is essential that the application of a unit of this character be carefully considered, since reduction in weight and space requirements can only be obtained through increase in auxiliary power and reduction of plant efficiency, especially at high loads. In certain applications the problem is simple, since the space requirements are definitely fixed. However, where space is available, it is generally more economical to use a larger unit, improve boiler efficiency, and reduce auxiliary power."

Marine Steam Boiler Developments

By G. P. Blackall

Signs are now evident that a new phase is beginning in marine steam generation in which far higher pressures and temperatures will be employed. The steam conditions of the *Prinsendam,* for example, the new 33,000-ton Holland-America liner, are 600 pounds pressure and 770 degrees F. temperature, and they constitute a notable advance on the conditions of 430 pounds pressure and 650 degrees temperature adopted in the *Statendam,* built for the same owners in 1929.

In dealing with the future of steam propulsion in his Thomas Lowe Gray lecture this year, John Johnson referred to a typical installation "B" of 30,000 shaft horsepower as being representative of the practice of 1930, with steam conditions of 375 pounds pressure in the high pressure receiver, say 425 pounds at the boiler stop valve, and 740 degrees F. temperature, for which an oil fuel consumption of 0.57 pound per shaft horsepower hour for propulsion was indicated. In a comparison with a hypothetical installation denoted as "C" and dated 1936, to work at 450 pounds pressure and 850 degrees temperature, Mr. Johnson stated that with these conditions a fuel consumption rate of 0.5 pound of oil per shaft horsepower hour would be maintained in service. He mentioned that the designs for the latter vessel, with machinery of 28,000 shaft horsepower, are completed. The new Hamburg-Amerika liner *Gneisenau* has turbine machinery working at 735 pounds and 878 degrees F.

In all these cases the boilers are of the drum type working with natural steam and water circulation. The *Prinsendam* is to have Yarrow boilers, but the new Canadian Pacific tonnage will presumably have the improved Johnson type of watertube boiler. The new Hamburg-Amerika liners have Wagner boilers. In these respects, therefore, the designs represent a natural evolution along lines which are now accepted as the result of satisfactory experience. With increasing boiler pressure difficulties arise in boiler drum construction because of the heavier scantling of material required, while the factor of circulation demands fuller consideration. New designs of boiler are therefore being introduced in which the drum is omitted and forced circulation adopted, with the result that a considerable increase in heat transmission rate becomes possible with substantial reduction in size and weight of boiler.

A good measure of boiler capacity is provided by the evaporation expressed in terms of pounds of steam per hour per ton weight of boiler. This figure is about 800 for high-capacity generators with natural circulation. The Benson boiler installation in the liner *Potsdam,* working at 1325 pounds pressure and 878 degrees F. temperature, has a corresponding capacity coefficient of about 1250, and an approximately similar figure applies to the Velox forced-circulation boiler with steam conditions of 450 pounds pressure and 825 degrees. A Velox boiler has recently been installed on one of the Messageries Maritimes liners.

The Rotterdam Lloyd liner *Kertosono* has recently been speeded up by replacing one of the original cylindrical boilers with a Sulzer mono-tube super-pressure steam generator, working at 880 pounds per square inch and 700 degrees F., and fitting a high-pressure back-pressure turbine unit to act as a primary turbine to the existing plant. Output has been raised from 4500 horsepower to 6000 horsepower, raising the speed from 13 to 15 knots.

The future would appear to lie evenly between the high-capacity natural circulation boiler working at appreciably higher pressures than have hitherto been employed, with the advantages it offers in retention of the water and steam drums to serve as a feed reservoir for meeting emergencies, and the forced-circulation generator working at the highest pressures and temperatures practicable, with heat transmission rates substantially greater than with existing orthodox practice, which will result in very large savings in weight.

Explosions in Compressed Air Lines

Fatalities occurred in two metal plants recently when air line accidents occurred in rooms where employes were working.

One of the failures was attributed to a combustion explosion in a high-pressure 2-inch diameter line carrying air at 500 pounds pressure for use in die casting machines, the pipe failing at several points. A 2-inch forged steel elbow was split cleanly, and two safety valves were shattered. The operator of one die casting machine was killed and there was considerable damage to piping, valves, fittings, equipment and walls adjacent to the exploded lines. While the cause of the accident could not be definitely determined, it is believed reasonable that some of the lubricating oil from the compressor was carried over into the system and ignited, probably at one of the die casting machines where the air was in contact with molten metal. The compressor supplying the system was equipped with both an intercooler and an aftercooler and the piping was tested at intervals in the interest of safety. After the accident double extra heavy pipe of $\frac{7}{16}$ inch thickness was installed, and to minimize the possibility of a similar occurrence an oil separator was placed between the after cooler and the receiver. It also was advised that oil being fed to the compressor be kept at an absolute minimum.

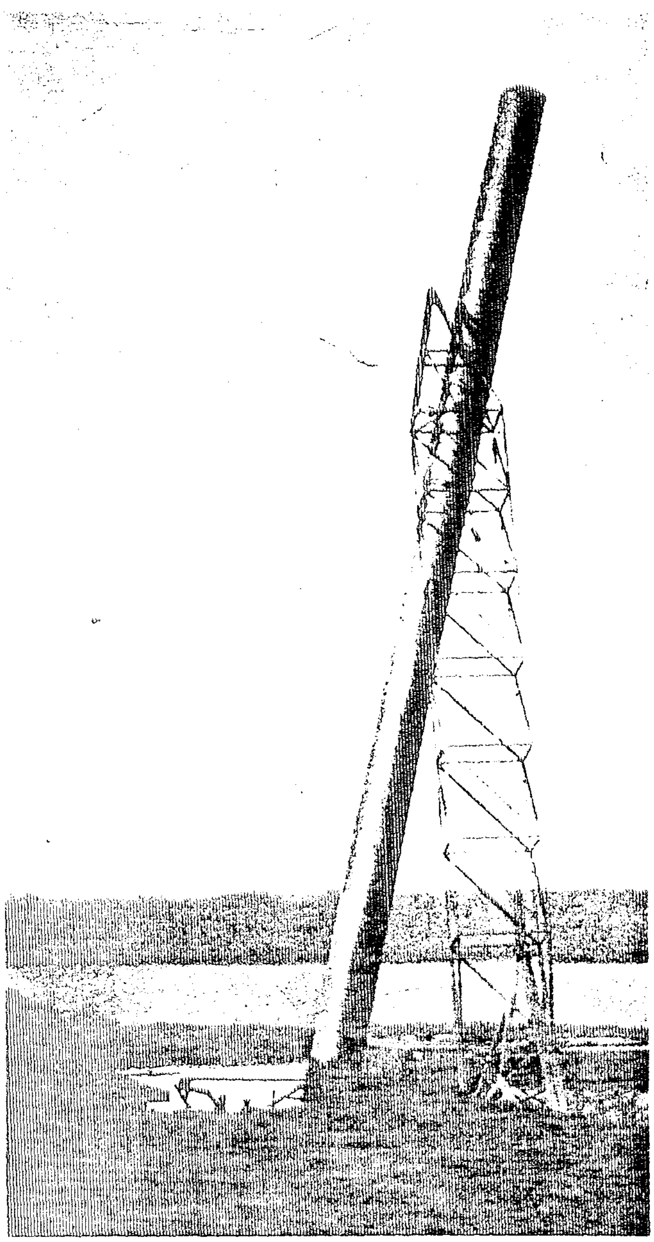
The other accident occurred to piping used in connection with air hammers at a Pennsylvania steel mill. When the air line broke, an air receiver toppled over on a workman with fatal results.—*The Locomotive*.

All-welded Smoke Stack Erected

In building a plant to heat its factory at Peoria, Ill., R. G. Le Tourneau, Inc., manufacturers of heavy grading equipment, were confronted with the problem of constructing and erecting a smokestack tall enough to carry the smoke clear.

Inside the plant, ¼-inch plate was pre-fabricated into an all-welded stack 104 feet high, 57 inches in diameter and weighing approximately 10 tons. This is thought to be the tallest pre-fabricated steel stack ever erected. The stack is anchored to the floor and roof of the boiler house, which reduces its outside height to 83 feet. A portable tractor-powered crane of all-welded design was built to lift and place this stack and for other heavy duty.

To erect this stack, a feat which was performed in 30 minutes, the crane was equipped with an 84-foot boom. It is reversible, however, the boom becoming a tongue and the 22-foot tongue a boom, which gives it a 40-ton capacity.



Hoisting all-welded stack into position

Income Derived from Manufacturing

Manufacturing is the largest industrial source of the national income, generally contributing 20 percent to 25 percent of the total, according to a study just published by the National Industrial Conference Board. In 1935, the board estimates receipts from manufacturing in salaries, wages, dividends, interest, and other payments at $12 billion.

The Conference Board's study makes available for the first time estimates of income from manufacturing in each of the individual states. Other studies will be ready shortly giving income by states.

Income from manufacturing was a little over $18 billion in 1929, but dropped rapidly with the advent of the depression and in 1932 and 1933 was less than $8.5 billion. From this low point it has risen steadily. Preliminary indications are that a substantial gain will be recorded for 1936.

Approximately three-fourths of the total income from manufacturing, the Conference Board points out, is received in the northeastern section of the United States. Of the total estimated income for 1935, the Middle Atlantic states received 34 percent, the East North Central states 30 percent, and the New England states 11.5 percent. New York alone received $2,014 million, or 17 percent of the total. Pennsylvania, the second largest manufacturing state, received an estimated $1,352 million, or nearly 12 percent of the total.

Salaries and wages are by far the largest single type of income contributed by manufacturing industry and account for 80 percent to 85 percent of the total. Dividends, the second largest type of payment, account for 12 percent to 15 percent of the total. The remaining 4 percent or 5 percent of income from manufacturing is made up of entrepreneurial income, interest, and net rent.

New Line of Electrodes Announced

Metal & Thermit Corporation, 120 Broadway, New York, announces an addition to its line of Murex heavy coated electrodes for arc-welding.

The new electrode, known as Murex Type N, is designed for bridging gaps where fit-up between plates is poor and, in the smaller sizes, may be used on vertical and overhead work, or to make rapid, single pass welds on light-gage materials. The physical properties of the metal deposited by this electrode are said to range from 74,000 to 84,000 pounds per square inch in tensile strength, with 26 percent to 24 percent ductility. The new electrode is also said to work equally well with either direct current or alternating current and may be used either with straight or reversed polarity.

Application of code rules to

Vessels Under External Pressure*

By W. D. Halsey**

The action of a vessel under external pressure is different, in many respects, from its action under internal pressure. A vessel under internal pressure, is, for the most part, under tensile stress and it tends to change to a shape of greater strength. That is to say, a cylindrical vessel under internal pressure tends to take the shape of a sphere and would do so if the material were sufficiently ductile. On the other hand, a vessel under external pressure tends to change to a weaker shape. As the change in shape occurs, its resistance to such change is very much reduced and failure takes place rapidly at a pressure even less than the vessel could safely withstand in its original form.

The action of vessels under either internal or external pressure may be compared to the action of test specimens of steel under tensile stress or under compression. The material in the shell of a vessel under internal pressure acts in the same manner as a specimen under tension.

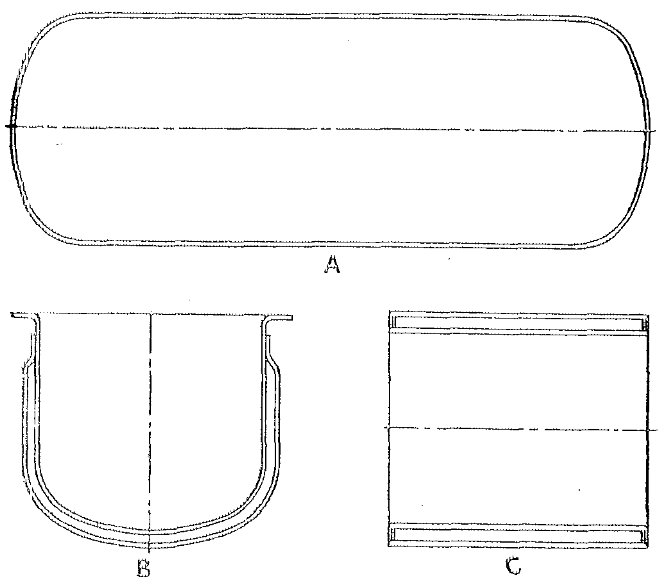


Fig. 1

A vessel under external pressure acts in a manner quite similar to a specimen under compression. This comparison of the effect of external pressure may be carried a little further by considering the action of long and short specimens under compression. Specimens in which the thickness or diameter is small as compared with the length will, under compression, tend to bend easily. Some bending may take place before the stresses reach the yield point or elastic limit of the material. If, when a certain amount of deflection has occurred, and before the yield point of the material is reached, the load is removed, the specimen will return or spring back to its original condition.

However, when the specimen bends, it immediately loses strength, it very soon passes the yield point and, because of the change in shape, the continued application of the load will cause it to fail. Specimens which have a large thickness or diameter as compared to their length will not bend under a compressive load but will upset or change shape by increasing in diameter or cross section.

A specimen in which the thickness or diameter is small as compared with the length is said to fail by "instability." On the other hand, a specimen that has a large diameter as compared with the length is said to fail by "yielding." Pressure vessels under external pressure may fail in either of these ways.

The *ratio* of plate *thickness* to diameter and also the ratio of the length of cylinder to diameter are very important in the analysis of vessels subject to external pressure and will be extensively used in this discussion.

Vessels with walls that are relatively thin as compared to the shell diameter change shape readily under external pressure and, by such action, become weaker and deflect still further from the original shape. However, until actual permanent change in shape takes place the stresses in the material do not reach the yield point. Such vessels are said to fail by instability. Other vessels which have walls that are relatively thick as compared with the shell diameter do not fail until the stresses in the material reach the yield point. They then start to deflect and thus become progressively weaker. The yield strength of a short thick column is easy to calculate, it being simply a matter of dividing the load by the cross sectional area of the specimen. It is also easy to calculate the strength of a vessel that will fail by yielding, as the computation is the same as that used for vessels under internal pressure. However, just as the strength of a slender column depends upon its length and its cross-sectional dimensions, so also does the strength of a vessel, that has a thickness small in comparison with its diameter, depend upon its length, thickness, diameter, and, of course, upon the physical properties of the material.

In a cylindrical vessel under external pressure, the heads, by maintaining the circular shape of the vessel at its ends, tend also to strengthen the entire structure. Therefore, the distance between the heads, or supporting rings, of a vessel enters into the determination of its strength. On the other hand, when the length of a vessel reaches a certain point the heads no longer help support the middle portion, so that the collapsing pressure remains unchanged for any further increase in length.

The calculation of vessels under external pressure involves some very complex mathematics. The new rules for external pressures in the Unfired Pressure Vessel

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

** Assistant chief engineer, Boiler Division, Hartford Steam Boiler Inspection and Insurance Company.

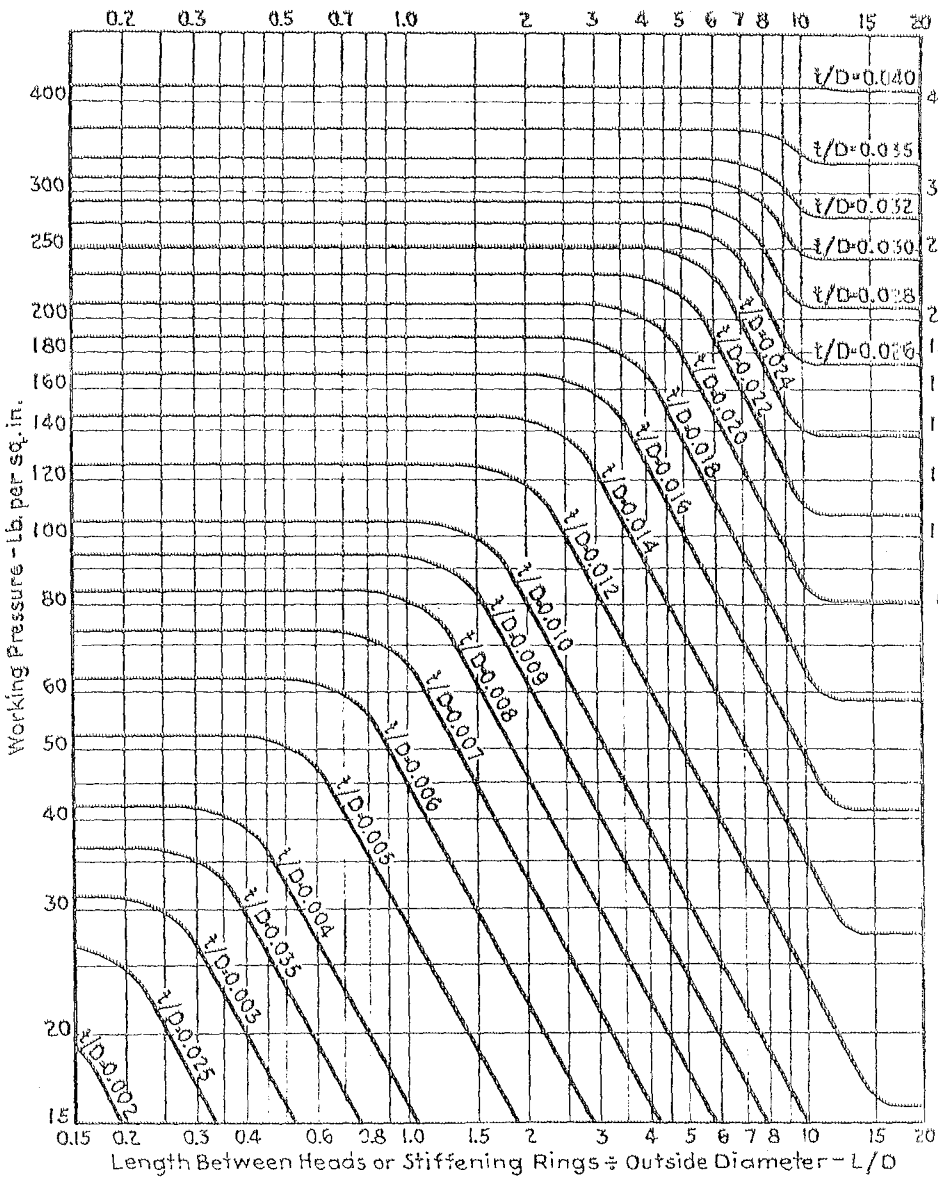


Fig. 2

Code of the American Society of Mechanical Engineers relate only to vessels of the three general types shown in Fig. 1 and only when they are built of ordinary boiler steel or material having practically the same physical properties.

The vessel (A) in Fig. 1 will be recognized as a plain cylindrical vessel which might be used as a vacuum tank, the external pressure being only that of the atmosphere. (B) Fig. 1, represents the typical, cylindrical, jacketed vessel or autoclave. (C) Fig. 1 is a type of vessel, extensively used, of which a fat melter in the packing industry is typical. It has been found by experiment that vessels having the same ratios of length to diameter and of thickness to diameter will collapse at the same pressure. For instance, two vessels, one of which is 100 inches diameter, 200 feet long, of 1-inch plate, the other 50 inches diameter, 100 feet long and ½-inch plate have the same collapsing pressure, the t/D and L/D in each case being 0.01 and 2 respectively.

Because of the fact that the thickness, diameter and length of a vessel all enter into the computation for its strength, and in a very involved manner, it has been found convenient to refer to the t/D and L/D ratios rather than the actual values of thickness, diameter and length. Furthermore, since the mathematics involved in making calculations are very complex, charts have been devised to make easier the solution of any given problem. The chart applying to cylindrical vessels of the three types shown in Fig. 1, when constructed of ordinary boiler steel or similar material, is given in Fig. 2.

The extreme right-hand side of this chart applies to those vessels which have a great length as compared to the diameter. That is to say, the L/D ratio is high and in such vessels the ends do not give any support to the middle section. Therefore, the collapsing pressure or the safe working pressure is independent of their length. The middle section of the chart where the lines are diagonal represents those vessels in which the strength is affected by the length. It will be noted that as the ratio of length to diameter decreases, the working pressure increases.

At the left-hand side of the chart the lines again become horizontal. This section represents those vessels that fail because of yielding of the material irrespective of the strength afforded by the heads or supporting rings. That is to say, as a design is shortened in length, a point is reached where failure will occur in the same way as a short column. Just as with a short column, where the strength remains the same regardless of its length, the design of a cylindrical vessel reaches a point where failure will occur by yielding and the collapsing pressure or safe working pressure is not changed by designing a shorter vessel.

Just for a moment, take a vessel which has a length twice as great as its diameter. With a given thickness and a given diameter that vessel at t/D ratio 0.8 would have an allowable pressure of 45 pounds. If that vessel were twice as long, in other words the length were 4 times the diameter and the L/D ratio up to the 0.8 line, we would find the allowable pressure is 22 pounds. When we make the vessel longer the heads do not give the same support as they did when they were closer together, and therefore there is a lower safe working pressure on those vessels. So that you see the length and the diameter length ratio of a vessel under external pressure are very important whereas they have no bearing on a vessel under internal pressure.

In the calculation of a vessel under external pressure, the length may be taken as the difference between any two points where the support is sufficient adequately to hold the vessel in circular form. The heads on a vessel whether flat, dished, or hemispherical, are considered to be adequate supports of this nature. For heads that are riveted to the shell, the length of the vessel may be taken as the distance between the head seams. In the case of heads butt welded to the shell, the length should be taken as the distance between the points where the curvature of the heads begin.

Supporting rings may be attached to vessels under external pressure and, provided they are of adequate strength, the length L may be taken as the distance between such supports. The method for determining whether ring supports are adequate will be discussed later.

To illustrate the distance that is to be taken as L in the application of this chart, a few typical constructions are shown in Fig. 3. In the lower left-hand sketch of this figure, several designs of reinforcing rings, and possible methods of attachment are shown.

Although the rules given in the A.S.M.E. Code for vessels subjected to external pressure are primarily intended for the guidance of designers these rules may also be used to determine whether a vessel already in use has been properly designed and whether it is adequate for the pressure to which it is subjected.

The simplest illustration of a vessel under external pressure is a vacuum tank. As

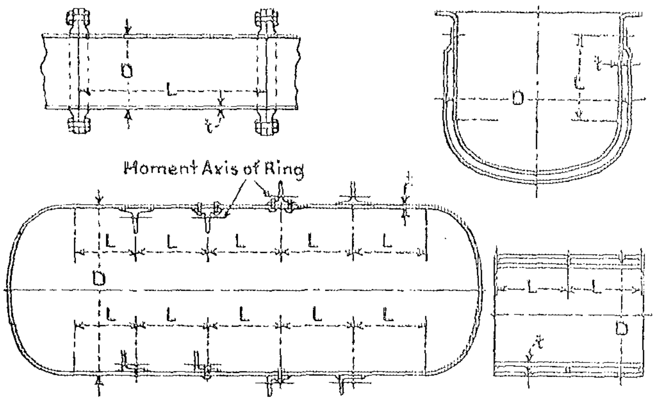


Fig. 3

a typical case, assume a tank of riveted construction, with butt type longitudinal joints, a diameter of 5 feet, a length of 20 feet between the head seams and a thickness of the shell plate of ½ inch.

In this vessel the L/D ratio is 20/5 or 4. The t/D ratio is 0.5/60 or 0.00833. Carefully note that both the

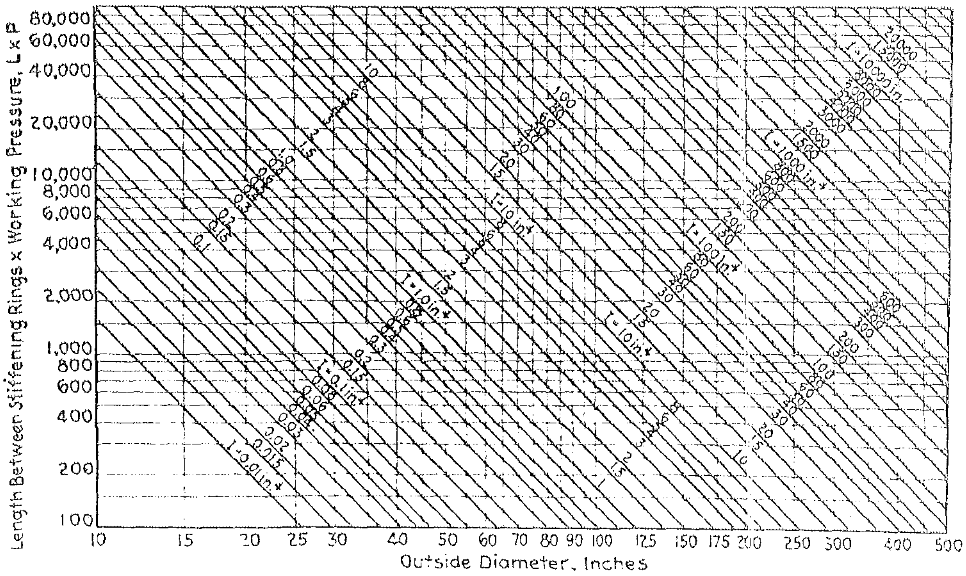


Fig. 4

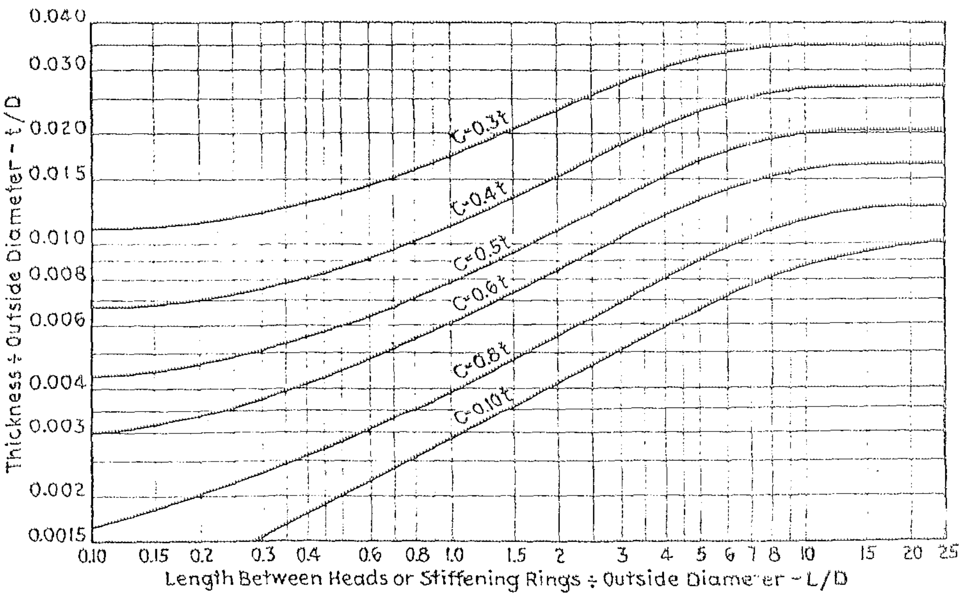


Fig. 5

numerator and the denominator of these ratios must be given in the same units of measurements, that is, both must be in inches or both in feet.

Referring to the chart, Fig. 2, find the vertical line marked "4" representing the L/D ratio of that amount. Follow vertically on this line to the line representing a t/D ratio of 0.00833. While there is actually no such line, there is one for 0.008 and one for 0.009, so that the line for 0.00833 would be about one-third the distance between the two or approximately at 25 pounds, and the vessel would be adapted to that pressure. It is evident, therefore, that the vessel is entirely satisfactory for use as a vacuum vessel which is subjected to only 15 pounds external pressure.

The question may be asked how thin a vessel 5 feet in diameter and 20 feet in length, may be and still be satisfactory for use as a vacuum tank. At the bottom of the chart find the horizontal line for 15 pounds pressure and note that the vertical line for L/D crosses this 15 pound line a short distance to the left of the t/D line for 0.007. Estimating the distance between the t/D line 0.006 and that for 0.007 it will be found that the L/D line 4 crosses the 15-pound line at a t/D value of 0.0069. In other words, the vessel in question should have a t/D ratio of 0.0069.

If the ratio of t/D is 0.0069 then the thickness will be that ratio multiplied by the diameter. In other words,

$$\begin{aligned} &\text{if } t/D &&= 0.0069 \\ &\text{then } t &&= 0.0069 \times D \\ &\text{and since } D \text{ is } 60 \text{ inches} \\ &\quad t &&= 0.0069 \times 60 = 0.414 \text{ inch} \end{aligned}$$

As a second illustrative example, consider a jacketed autoclave, as shown at the upper right corner of Fig. 3, with a diameter of 45 inches, a length of 36 inches, and a thickness of $^7/_{16}$ inch or 0.4375 inch. The desired working pressure is 140 pounds per square inch, but it is not certain that the thickness is sufficient.

In this case the L/D ratio is 36/45 or 0.8, and the t/D ratio is 0.4375/45 or 0.0097. Following up the vertical line 0.8, to a point were a line for a t/D ratio of 0.0097 might be drawn, it will be found that the allowable pressure would be only slightly more than 100 pounds. Continuing up the line 0.8 to the 140-pound line, it will be found that the required t/D value is approximately 0.0135. Since the diameter is 45 inches, the required thickness should be 45×0.0135 or 0.608 inch thus showing that the original thickness of $^7/_{16}$ was not sufficient. It has been stated previously that if supporting rings attached to vessels are of adequate strength the length L may be taken as the distance between such rings. The question arises as to just what constitutes adequate strength.

It will be recognized that the required size of supporting rings depends upon the outside diameter of the vessel, the length between the stiffening rings, and the working pressure. The size of such rings may be determined by the application of a theoretical formula relating to the buckling of circular rings under uniform external pressure. However, this formula is somewhat difficult to use and it seems best, both for the purpose of clarification of the matter and for readiness of application of the code, to obtain the required size of such rings from a chart which is shown in Fig. 4.

In applying this chart from a design standpoint, the product of the length, in inches between the centers of the stiffening rings and the working pressure is calculated and the line representing this product is located on the side of the chart. Follow horizontally along this line until the vertical line representing the outside diameter of the vessel in inches is ... of these horizontal and vertical lines there will be found the value for the required moment of inertia of the stiffening rings. For the purpose of illustration, consider the vacuum vessel 5 feet in diameter and 20 feet long that has been mentioned previously. That vessel had an L/D ratio of 4 and it was found that the required thickness would be 0.414 inch. Suppose that it were decided to use a single stiffening ring in the middle of the vessel with the idea that the thickness of the shell might be decreased. If such construction were used, the L/D ratio would be 2, the t/D ratio would be 0.00525, and the required thickness of the shell would be 0.315 inch. For this construction, the L, or the length between the head and the ring, would be 10 feet, or 120 inches. The working pressure is 15 pounds so that the product of these two is 1800. Locating this value on the chart for stiffening rings and following the line horizontally to a diameter of 60 inches, it will be found that a moment of inertia of 2.5 is required. By reference to structural steel tables it can be seen that an angle 3½ inches by ⅜ inch thick would be satisfactory if the 3-inch leg were attached to the shell. Of course any other shape having a moment of inertia of 2.5 would be satisfactory. For instance, a rectangular bar of iron 2⅜ inches by 2⅜ inches would meet the requirement.

Instead of one ring two or even more could be used and it would be found that for this particular vessel every increase in the number of rings would result in a thinner plate and a smaller size of stiffening ring. The limit to such construction would be an economical one and consideration would have to be given to the relative cost of additional rings and the expense of attaching them as compared to the cost of the vessel without rings or with a small number of rings.

While the above discussion has been from the standpoint of design, the same principles can readily be applied to the determination of the safe working pressure for a given vessel. In making such a determination it is well to first determine to what pressure a vessel would be limited by the size and spacing of the rings attached to it. If those rings are found adequate for the desired pressure, then the question of whether the shell plate of the vessel is of sufficient thickness may be investigated.

Supporting rings may be either internal or external. It will be apparent that when internal rings are used, it is sufficient merely to secure the rings in place so that they will not move. In the case of outside rings it is necessary to provide sufficient rivets or a sufficient amount of welding to adequately secure the rings to the shell. The size and spacing of such rivets and the minimum amount of welding are given in the code.

In developing methods for the calculation or design of cylindrical vessels under external pressure, it has been assumed that such vessels are truly cylindrical, and it will readily be appreciated that out-of-roundness of such vessels decreases their resistance to collapse. On the other hand, some degree of out-of-roundness must be permitted since it is practically impossible to construct a vessel that is truly cylindrical. The decrease in strength by the out-of-roundness that is permitted is taken into consideration in the factor of safety required.

The effect of out-of-roundness on decreasing the resistance of a vessel to collapse depends on both the L/D and t/D ratios and it, therefore, is impossible to give the permissible tolerance as a fraction of the diameter or of the thickness of the vessel. While formulae have been developed for determination of the permissible tolerance, they are rather complex and, again for simplification of the problem, a chart has been made as shown in Fig. 5.

(L/D of 4, t/D of 0.0069, and t of 0.414) it will be found from Fig. 5 that an eccentricity of 0.9 times the thickness would be permitted. Since the thickness of shell is 0.414 the permissible out-of-roundness is 0.372 or approximately ⅜ inch.

The degree of eccentricity is the difference between the maximum and minimum diameters of the vessel and should be measured at several points. In the case of vessels with lap-seam construction, the amount of eccentricity may be the value obtained from the chart plus the plate thickness. Whereas this provision permits a greater degree of eccentricity in vessels of lap construction, on the other hand such vessels are permitted only one-half the pressure that would be allowed on a vessel of butt-seam construction.

Still another point to which consideration must be given in connection with cylindrical vessels under external pressure is the manner in which they are supported, which should, in all cases, be such that no concentrated loads are imposed on the shell. In the case of horizontal vessels they should be supported at the heads or from the reinforcing rings, if such rings are used. If no supporting rings are provided and if the vessel is of such length that it would sag or be unduly stressed should the only support be at the heads, then intermediate supports should be provided but these should be in the form of a saddle, the arc of which extends over at least one-third of the circumference. On vertical vessels the legs or brackets that might be used should not be attached directly to the shell but to a substantial ring which in turn is secured to the shell, thus distributing the load.

Russia Building Locomotive Flash Boiler

By G. P. Blackall

It has just been announced from Moscow that the Kolomensk Locomotive Works near that city is shortly to build a new type of flash boiler with condenser, which will consume considerably less fuel than existing locomotive boilers. The locomotive will be able to travel 7000 miles without having to take water.

The new boiler is designed for a pressure of 1400 pounds per square inch. Though only 20 tons heavier than the Russian "IS" locomotive, the new locomotive will be able to develop 4000 horsepower, as against the 2500 horsepower of the "IS" locomotive, with a consumption of 60 percent less fuel.

The Kolomensk Works is at present building an experimental 600-horsepower locomotive of the new design, and, when this has been thoroughly tested, building will start on the 4000-horsepower locomotive.

Large Welded Pressure Vessel

Four 50-ton evaporators recently made in the United Kingdom for the new sugar refinery of Tate and Lyle, Ltd., at Silvertown, London, are claimed to be the largest welded pressure vessels ever made to Lloyd's Class 1 code.

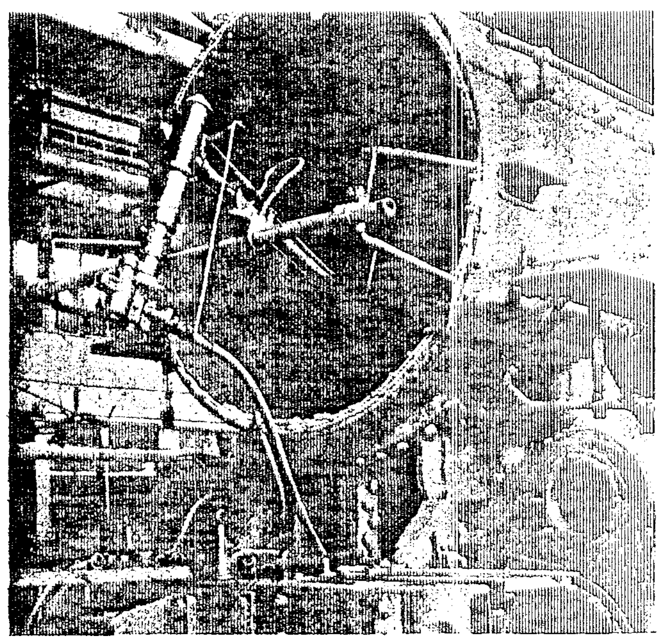
These vessels, which have been made by G. A. Harvey and Co., Ltd., are 26 feet 9 inches high and 11 feet in internal diameter. They are designed for a working pressure of 250 pounds per square inch on the shell. Each consists of two shells, both 10 feet 4 inches high, and a domed top and bottom. The bottom shell, known as the calandria section, is fabricated of 1¹⁵⁄₃₂-inch plate, and has two tube plates, each in one piece, 1 inch thick. There are 1792 tubes of 1½-inch bore welded into and connecting the two tube plates.

The calandria section was subjected to a test pressure of 375 pounds per square inch and the upper shell 285 pounds per square inch. All the main seams were X-rayed, and altogether about 1200 X-ray photographs were taken of the welding of the four vessels.

Two Boiler Shop Tools

Two devices which assist greatly in connection with boiler works at the Denver, Colo., shops of the Chicago, Burlington & Quincy are shown in the illustrations. The first is a power attachment for cutting off and rolling flues in the front end. This device consists of a reversible air motor with power attachment and worm-gear drive to a 6-foot cutter bar, this bar being mounted on a 3-inch horizontal steel tube suitably supported by brackets bolted to the boiler front ring. A gear box makes two speeds available for use, dependent upon whether large flues or small tubes are being cut. Reference to the illustration shows that the cutter bar is capable of swinging vertically or sliding horizontally on the 3-inch horizontal tube. The machine may thus be used for cutting an entire set of flues without resetting the supporting bar and brackets.

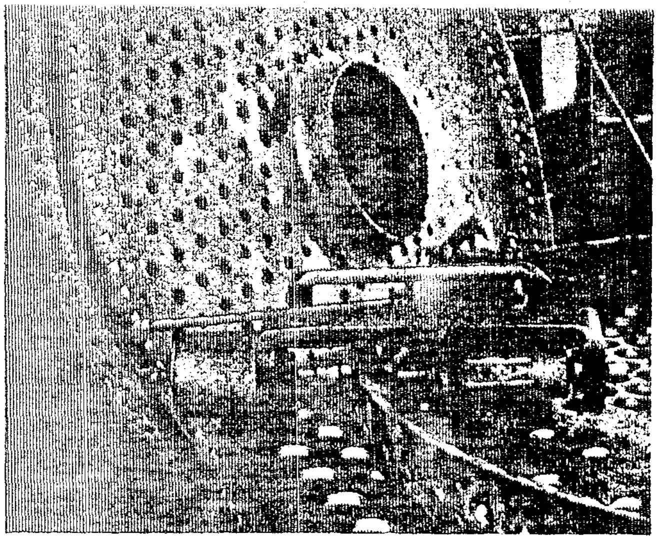
The cutter bar has a telescoping bar and universal



Efficient power attachment for cutting off and rolling boiler tubes and flues

socket arrangement to accommodate various lengths, dependent upon the angle of cutter bar adjustment necessary for any particular tube or flue. Only one knuckle joint is necessary with this arrangement, and in view of the rigidity of the drive, very satisfactory work is performed and a longer life assured for the cutters. The safety factor is also important, as the machine is strongly made and designed so as to present little opportunity for personal injuries. The rubber hose connection to the air motor and conveniently accessible control levers required for one-man operation.

The device shown in the second illustration is an unusually compact and effective arrangement for countersinking the rivet holes in flue sheets. This consists of



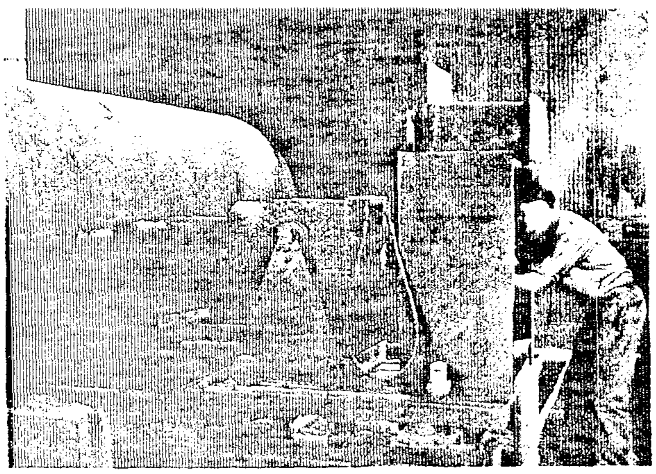
Easily handled device for counterboring rivet holes in flue sheets

a steel frame to which is attached an angle motor for operating the countersink and a small cylinder and air-operated plunger which backs up the countersink and provides the necessary feed. A convenient handle is welded to the frame for greater ease in adjustment of the device and the air line to the cylinder is installed and connected so that when air is applied to operate the motor, pressure in the cylinder pulls the countersink into the rivet hole. The overall length of this device is approximately 24 inches. The cylinder has a 4-inch bore and 3½-inch stroke. The air line is made of ¼-inch steel pipe and the air pressure used is that of the shop line, or about 100 pounds per square inch.

Locomotive Boiler Built with Welded Barrel

What is thought to be the first high-pressure boiler ever made with welded barrel and dome, under U-68 (Class I) rules of the A.S.M.E. Code for fusion welded vessels, was recently completed by Farrar and Trefts, Inc., Buffalo, N. Y.

The new boiler is of locomotive type and is for use in oil fields. The barrel is 16 feet 6 inches long, 62½ inches



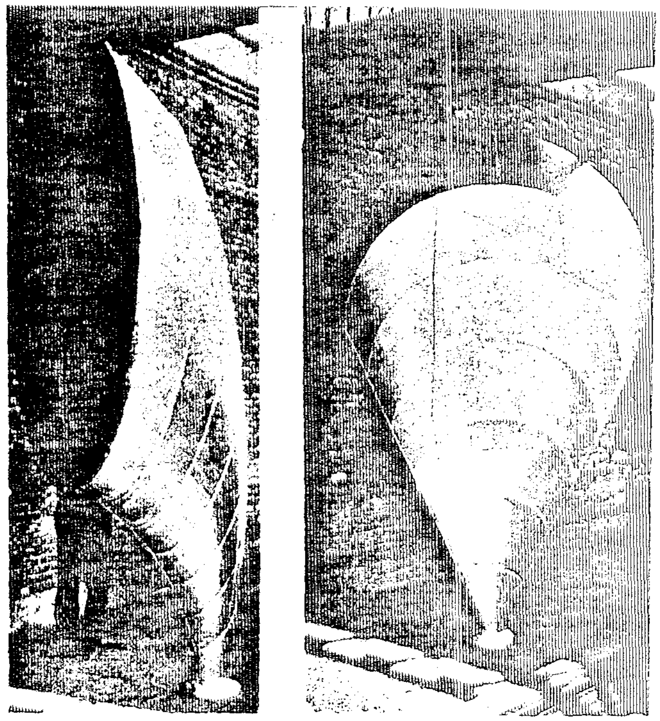
Fabricating welded locomotive type oil field boiler

outside diameter and made of steel plate 1.15 inches thick, electrically welded by the shielded-arc process with equipment supplied by The Lincoln Electric Company, Cleveland.

Welded construction of the barrel eliminated a large amount of calking of seams which was necessary with the former method of construction employing riveting. The two longitudinal welds of the barrel were hammer tested at 575 pounds and leak tested at 700 pounds hydrostatic pressure, revealing high quality leak-proof seams. The welding was done with "Fleetweld 6" electrodes.

Welding Used in Odd Fabricating Job

This horn-shaped structure, spreading out from 8 inches diameter at the bottom to 8 feet at the top, was once a single flat piece of $\frac{3}{16}$-inch ingot iron. The structure is still a single piece of metal—only the shape



Welded funnel outlet for sewage disposal

is different. It was made by cutting out 26 pieces, then fusing them all together into one integral unit by the shielded-arc process of electric welding. The structure is now being used as an outlet fitting for the cone of a clarifying tank in sewage disposal work. It was fabricated by the Farrel Manufacturing Company, Joliet, Ill.

Atlantic City to Have 1937 Metal Congress

The 1937 Metal Congress and Exposition will be held October 18 to 22, in the Atlantic City Auditorium, according to an announcement made recently by W. H. Eisenman, managing director of this annual metal show and national secretary of the American Society for Metals, after a meeting of the Society's board of trustees in Cleveland.

Practical Plate Development—XIX

Layout of a Smokestack Breeching

By George M. Davies

A reader has requested that a method of developing the smokestack breeching as illustrated in Fig. 158 be given in connection with the Practical Plate Development series.

The smokestack breeching illustrated in Fig. 158 is of the conventional type, with a round top and a wash-boiler section where it joins the boiler. For convenience in laying out the breeching, all lines have been taken on the neutral axis of the plate and all joints are assumed to be welded, no allowance being made for lap joints.

The breeching to be developed is shown in Fig. 159, the elevation; Fig. 160, the plan, and Fig. 161, the end view. The elevation and plan are readily constructed from the illustration in Fig. 158. The connection between the breeching and the boiler in the end view, Fig. 161, must be obtained by projection from Figs. 159 and 160, as follows:

Divide the semicircle *E'-B'-F'* of the plan, Fig. 160, into any number of equal parts, the greater the number of equal parts taken, the more accurate the final development. In this case ten were taken and the points numbered from 1 to 11 as shown. Then parallel to the center line *M-N*, draw lines through the points 1 to 11, extending same down into the elevation, Fig. 159, cutting the arc *K-B* and locating the points 1′ to 11′. Next draw lines parallel to the center line *T-U* through the points 1′ to 11′, Fig. 159, extending these lines into the end view, Fig. 161. In the end view, Fig. 161, on the center line R-S construct the profile, Fig. 162, of the semicircular end of the wash boiler section and divide this section end into the same number of equal parts as was taken in the plan view. Number these points from 1 to 11, corresponding to the same points in the plan view, Fig. 160.

Then parallel to the center line *R-S*, draw a line through the point 1 of the profile, Fig. 162, and extend the line into the end view, cutting the line drawn from the point 1′ of the elevation. The point 1″ in the end view, Fig. 161, is thus located, and in like manner, draw a line through the point 2 of the profile, Fig. 162, and extend it into the end view cutting the line drawn from the point 2′ of the elevation thereby locating the point 2″ in the end view, Fig. 161. Continue to use this method and locate the points 3″ to 11″ of the end view. Connect the points 1″ to 11″ with a line completing the end view, Fig. 161.

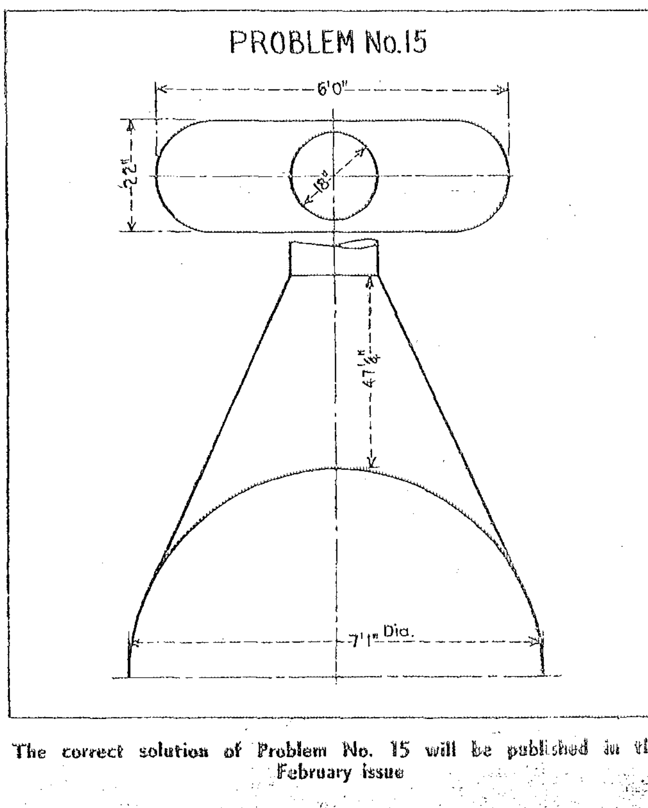
In examining the plan view, it will be noticed that the center line *M-N* divides the breeching into two symmetrical halves and, therefore, a development of one half of the plan view will be all that is necessary; a duplicate of this development will complete the layout of the breeching.

Divide the semicircle *H'-D'-J'*, Fig. 160, into the same number of equal parts as were taken for the semicircular end of the wash-boiler section *E'-B'-F'* and number these points from *a* to *k* as shown. Parallel to the center line *M-N*, draw lines through the points *a* to *k* extending them into the elevation, Fig. 159, cutting the line *C-D*. Number the intersections from *a'* to *k'*. Connect the points *a'* to *k'* with the points 1′ to 11′ in the elevation, Fig. 159, by means of dotted and solid lines as shown. These lines will be the surface lines of the object, and in order to develop the pattern further, their true lengths must be found. Divide the arc *K-E* of the elevation into any number of equal parts, four being taken in this case and numbered from *m* to *E* and from *F* to *u* as shown. Connect the points *m* to *E* and *F* to *u* with the point *H* in the elevation. These lines will be the surface lines of the triangular sections *H-E-G* and *J-F-K*.

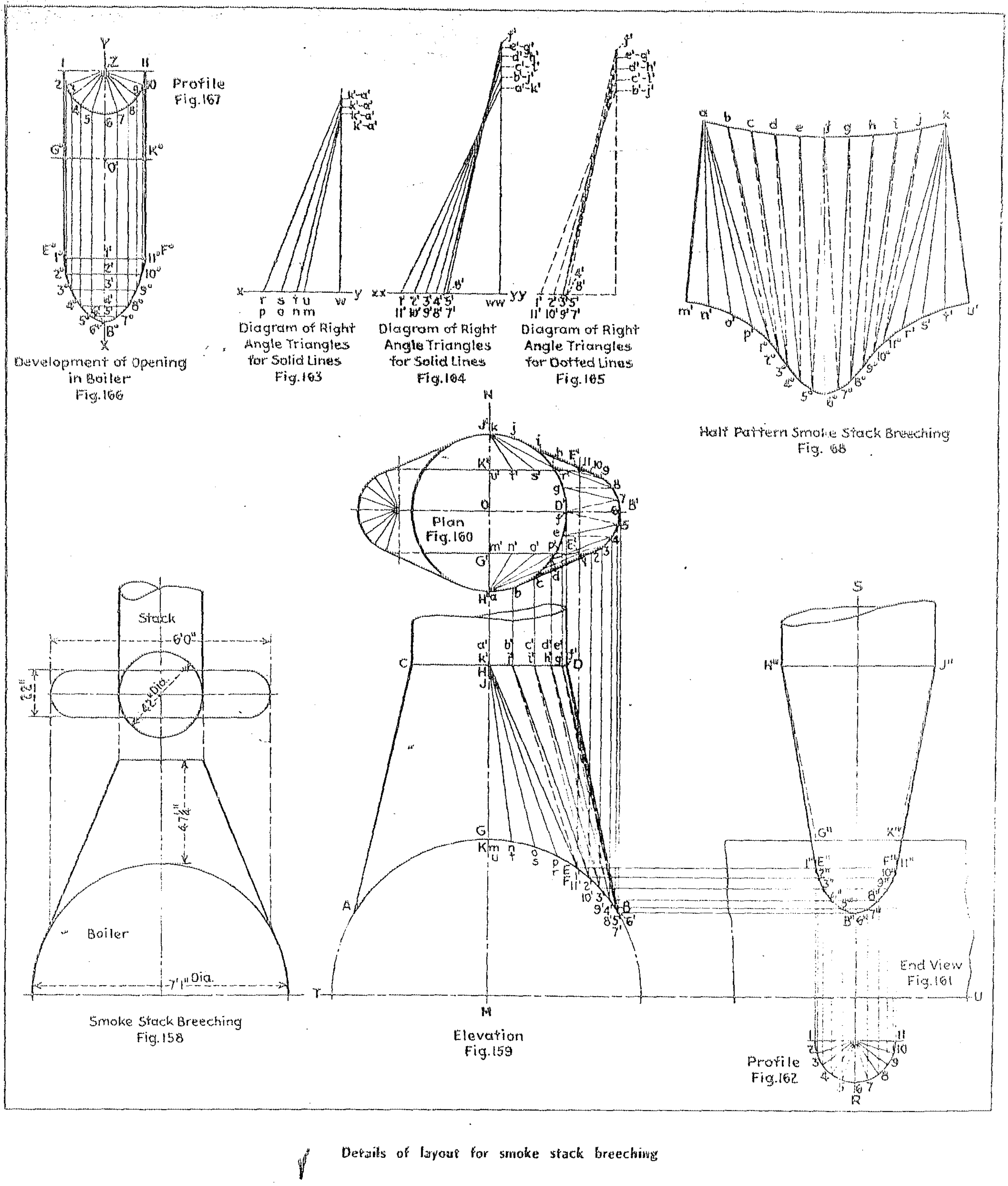
Next, parallel to the center line *M-N*, draw lines through the points *m* to *E* and *F* to *u* extending same into the plan and cutting the lines *G'-E'* and *K'-F'*. Number these intersections on *G'-E'*, *m'-n'-o'-p'* and on *K'-F'*, *u'*, *t'*, *s'*, *r'* as shown. Connect the points *m'*, *n'*, *o'*, *p'*, *E'* with the point *H'* and the points *u'*, *t'*, *s'*, *r'*, *F'* with the point *J'* in the plan, Fig. 160.

The next step is to obtain the true length of all the solid and dotted surface lines as drawn on the elevation, Fig. 159, and to accomplish this, it will be necessary to construct a series of right angle triangles.

Problem No. 15 for Readers to Lay Out



The correct solution of Problem No. 15 will be published in the February issue



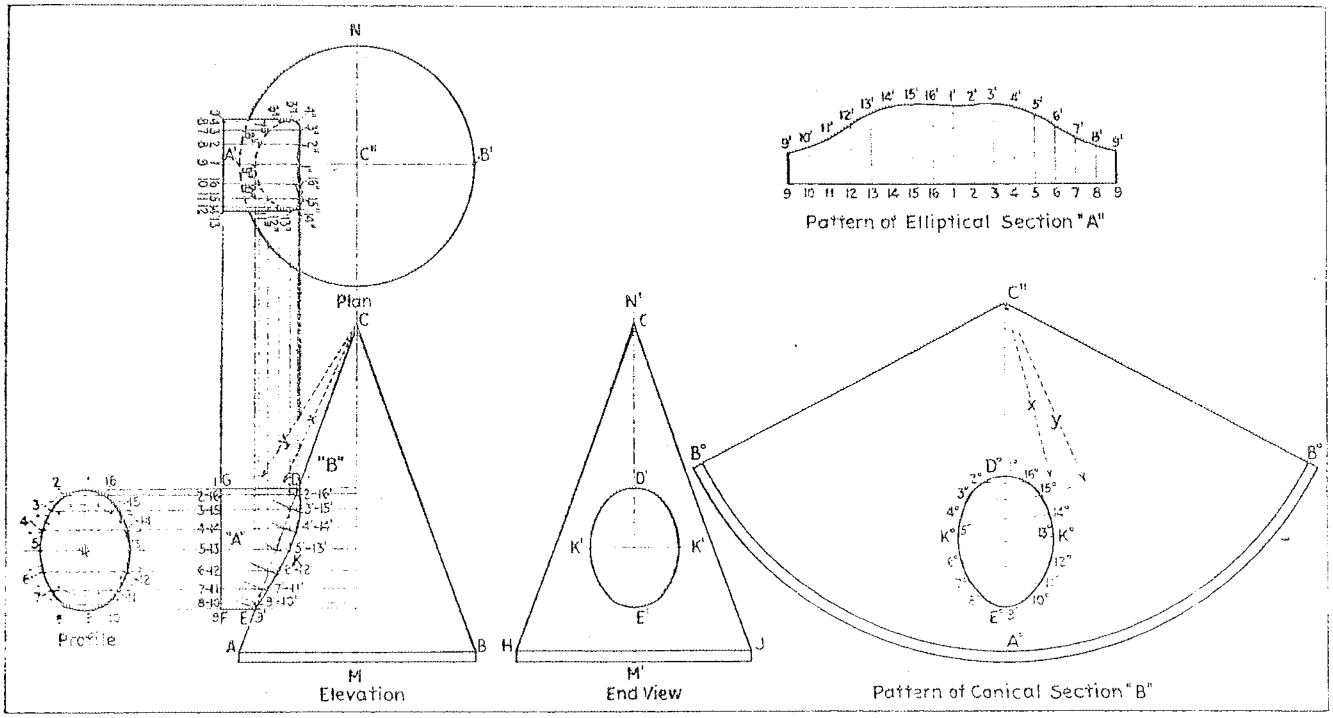
Details of layout for smoke stack breeching

Construction of Right Angle Triangles

In constructing the right angle triangles in order to obtain the true lengths of the solid surface lines of the triangular sections *H-E-G* and *J-F-K* of the elevation, draw any line as *x-y*, Fig. 163, and at *w* erect a perpendicular to it. From *w* on the base line, step off the distance *w-m* equal to *a-m'* of the plan and from *w* on the perpendicular step off the distance *w-a'* equal to *a'-m* of the elevation. Connect the points *a'-m*, Fig. 163. This line will be the true length of the surface line *a'-m* of the elevation, Fig. 159. In like manner, from *w* on the base line, step off the distance *w-n* equal to *a-n'* of the plan, Fig. 160, and from *w* on the perpendicular, step off the distance *w-a'* equal to the vertical distance between the point *n* and the line *C-D* of the elevation. Connect this point *a'* with point *n*, the line *a'-n* being the true length of the surface line *a'-n* of the elevation. Continue in this manner, taking the bases of the triangles *w-o*, *w-p* equal to *a-o'* and *a-p'* of the plan and *w-r*, *w-s*, *w-t*, *w-u* equal to *k-u'*, *k-t'*, *k-s'*, *k-r'* of the plan. This will also make the altitudes *w-a'* and *w-k'* equal to the vertical distances between the points *o*, *p*, *r*, *s*, *t*, *u* and the line *C-D* of the elevation, completing the solid surface lines of the triangular sections.

Problem No. 14—Correct Layout

Cone and Elliptical Intersection



Problem No. 14 appeared on page 242 of the September issue. The correct solution is published herewith in order to give our readers who have developed the problem an opportunity to check their work

The true lengths of the solid surface lines of the semicircular ends must be obtained next. Draw any line as xx-yy, Fig. 164, and at ww erect a perpendicular to it. From ww on the base line, step off the distance ww-$6'$ equal to f-6 of the plan, Fig. 160, and from ww on the perpendicular, step off the distance ww-f' equal to the vertical distance between the point $6'$ and the line C-D of the elevation, Fig. 159. Connect the points $6'$-f', Fig. 164, with a line, which will be the true length of the solid surface line f'-$6'$ of the elevation, Fig. 159.

Continue in same manner, making the bases of the triangles equal to the distances e-5, d-4, c-3, b-2, a-1, g-7, h-8, i-9, j-10, k-11 of the plan and the altitudes of the triangles equal to the vertical distance between the line C-D and the points $5'$, $4'$, $3'$, $2'$, $1'$, $7'$, $8'$, $9'$, $10'$, $11'$, respectively. Then connect the points as shown in Fig. 164, completing the right angle triangles for the solid surface lines.

The true lengths of the dotted surface lines are obtained in the same manner and are shown in Fig. 165. The bases of the right angle triangles are made equal to f-5, e-4, d-3, c-2, b-1, f-7, g-8, h-9, i-10, j-11 of the plan, Fig. 160, and their respective altitudes are made equal to the vertical distance between the line C-D and the points $5'$, $4'$, $3'$, $2'$, $1'$, $7'$, $8'$, $9'$, $10'$, $11'$, of the elevation, Fig. 159. Connect the points f'-$5'$, e'-$4'$, d'-$3'$, c'-$2'$, b'-$1'$, f'-$7'$, g'-$8'$, h'-$9'$, i'-$10'$, j'-$11'$ with dotted lines and these lines will be the true lengths of their corresponding dotted surface lines in the elevation.

Development of Opening in Boiler

Draw any line as X-Y, Fig. 166, and at O' erect a perpendicular to it. On the perpendicular, step off O'-G° and O'-K° equal to O-G' and O-K' of the plan view, Fig. 160. Through G° and K° draw lines parallel to X-Y. On these lines, step off G°-E° equal to G'-E' and K°-F° equal to K'-F' of the plan view, Fig, 160. Draw the line E°-F°, Fig. 166, and from E°-F° on the line X-Y step off the distances $1'$-$2'$, $2'$-$3'$, $3'$-$4'$, $4'$-$5'$, $5'$-$6'$ equal to the distances $1'$-$2'$, $2'$-$3'$, $3'$-$4'$, $4'$-$5'$, $5'$-$6'$ in the elevation, Fig. 159. Then parallel to E°-F°, draw lines through the points $1'$, $2'$, $3'$, $4'$, $5'$, and $6'$, extending them on both sides of the line X-Y. At the point Z on X-Y, draw the profile, Fig. 167, of the semicircular end of the wash-boiler section and divide it into the same number of parts as was taken in the plan view, Fig. 160. Number these points from 1 to 11, corresponding to the same points in the plan.

Then through the points 1 and 11, Fig. 167, draw lines parallel to the center line X-Y, extending same into Fig. 166 and cutting the line drawn through point $1'$, Fig. 166, thereby locating the points 1° and 11°. In the same manner, through the points 2 and 10, Fig. 167, draw lines parallel to the center line X-Y and extend these lines into Fig. 166 cutting the line drawn through the point $2'$ and locating the points 2° and 10°, Fig. 166. Similarly, locate the points 3° and 9°, 4° and 8°, 5° and 7°, and 6°. Connect the points $G^\circ 1^\circ$ to 6° to 11° to K° with a line, which will complete the development of the opening in the boiler.

Development of the Pattern

Draw any line as in Fig. 168 and on it step off the distance f-6° equal to f'-$6'$, Fig. 164. With 6° as a center and with the dividers set equal to 6°-7°, Fig. 166, scribe an arc. Then with f as a center and with the trams set equal to f'-$7'$, Fig. 165, scribe a second arc, cutting the arc just drawn and locating the point 7°, Fig. 168. With f as a center and with dividers set equal to f-g, Fig. 160, scribe an arc, then with 7° as a center and with the trams set equal to $7'$-g', Fig. 164, scribe another arc, cutting the arc just drawn and locating the point g, Fig. 168. Continue in this manner, making 7°-8°, 8°-9°, 9°-10°, 10°-11° equal to their corresponding distances in Fig. 166 and making g-8°, h-9°, i-10°, j-11° equal to g'-$8'$, h'-$9'$, i'-$10'$, j'-$11'$, Fig. 165, and 8°-h, 9°-i, 10°-j, 11°-k equal to $8'$-h', $9'$-i', $10'$-j', $11'$-k', Fig. 164, and g-h, h-i, i-j, j-k equal to g-h, h-i, i-j and j-k, Fig. 160, completing the pattern to the line k-11°.

With 11° as a center and with the dividers set equal to $11'$-r, Fig. 159, scribe an arc, and with k as a center and with the trams set equal to k'-r, Fig. 163, scribe an arc, cutting the arc just drawn, locating the point r', Fig. 168. Continue in the same manner, making r'-s', s'-t', t'-u' equal to r-s, s-t, t-u, Fig. 159, and k-s', k-t', k-u' equal to k'-s, k'-t, k'-u, Fig. 164, completing the pattern to the line k-u'.

From the line $c°$-f' develop the opposite side of the pattern in the same manner, completing the half pattern of the breeching. A duplicate of this pattern will complete the full pattern of the breeching as shown in Fig. 158.

Baldwin-Southwark Develop Weld Tester

A new hydraulic machine for accurately testing the strength of spot welds has been developed and built by the Baldwin-Southwark Corporation, Philadelphia, for the Edward G. Budd Manufacturing Company. This 10,000-pound tension testing machine is supplied with a round base for rolling from place to place and a hoisting hook for moving with a crane. It is a completely self-contained unit having an overall height of 70 inches, an 18-inch diameter steel base, a low center of gravity, and weight of approximately 800 pounds.

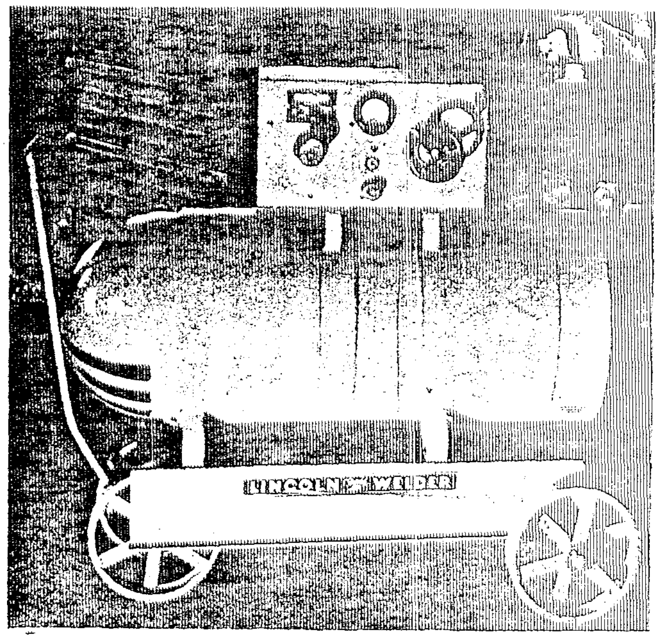
An 8-inch precision dial indicates the load. Fluid under pressure is pumped by a gear pump situated in the base of the machine. This pump is direct-connected to a ¼-horsepower motor. A specially designed type of self-alining, lever-operated, renewable file-face grips is used. These grips are so designed that hard, sharp faces can be quickly installed at a very low cost, being made of short sections of machine cut files. The upper grip is of the open face type, while the lower grip is of the closed type with wide angle entrance. These grips will accommodate offsets in welded specimens from the smallest gage to ¼-inch thick without using backing plates or liners. Specimens up to 1¼ inches wide can be tested.

Valve Leaks Cause Boiler Explosion

A leaky stop valve on the pilot light and a leaky plug cock on the main burners of a gas-fired power boiler—No. 2 of a pair in a California plant—caused a furnace explosion which did $2500 damage to the boiler setting. The escaping gas, which had filled the furnace and flues of the idle boiler, was ignited through cracks in the center brick wall between the two boilers five minutes after the No. 1 burner had been lit. The rear wall was bulged and pushed back about nine inches. The right-side wall was blown out entirely, leaving no support under that side of the boiler, as the boilers were set on brickwork instead of being supported from the beams. This caused an excessive strain on the main steam pipe which held the boiler in place. Fortunately, there was no water in the boiler at the time, for that added weight would probably have caused the piping to break and the boiler to fall. *The Locomotive.*

Continuous Dual Arc Control Welder

A new line of single operator arc welders has recently been made available by The Lincoln Electric Company, Cleveland. These new welders will be known as the "Shield Arc SAE" and will supersede the present type of "Shield Arc" which have been on the market for the last six years. The predominating feature of this new arc welder is a new method of arc control which makes



New continuous S A E dual control arc-welder

possible the adjustment of both arc heat and arc penetration in a continuous sequence of fine increments. It is claimed this continuous dual control assures absolute uniformity of performance at every control setting and adds greatly to the successful operation of arc welding. These claims are based on the operation of a large number of this type welder which have been in actual service in customers' plants for the last year.

It is a well-known fact that for certain types of arc welding a low voltage with wide range of current control is desired. For other types of work a higher voltage with the same wide range of current is highly desired. The new welder therefore permits the use of the correct voltage and current for all classes of work in the range of each size of machine.

P.R.R. Research Activities

How the Pennsylvania, through research and experimentation, utilizes the advances of science, new inventions and improved technical processes for the improvement of its freight and passenger service is told in a special report which has recently been made public

Committee Reports on Dust Control

The report of the preventive engineering committee of the Air Hygiene Foundation, written by Professor Philip Drinker of Harvard, chairman, and other technical specialists on the committee, advises that engineers in the "dusty trades" can and should cut heavy dust concentrations below the present limits warranted by medical knowledge. This action is important, the report explains, not only to further safeguard the health of workmen but to give employers the maximum protection against unjust claims.

Concerning the size of dust particles, the report observes that much has been made of the fact that particles found in autopsied lungs are of the order of 1 micron ($\frac{1}{25000}$ of an inch)—about like the common bacteria. It is argued, therefore, that the human anatomy and physiology exercises "some phenomenally accurate size grading which excludes larger particles."

The report says "there is no reason whatever to look for any such mysterious explanation. The sizing is done in the air before the dust is breathed and not by the man after it has been breathed." It is pointed out that the larger particles tend to fall from the air by their own weight and that "only those small enough to act as part of the transporting air stream are likely ever to reach the lungs."

"In diseases such as silicosis and asbestosis, particles must reach the alveoli (minute air sacs of the lungs) or no silicosis or asbestosis results. In maladies like hay fever, the harm is done by particles which may be 15-30 microns instead of 1 micron.

"Toxic dusts such as lead and manganese are much more likely to produce ill effects if breathed than if swallowed. The reason for this difference is physiological; it is established and should not be ignored in dust control problems. Again, common-sense tells us that the finer particles of lead are vastly more apt to be breathed than the larger.

"It follows then that dust control for hygienic reasons should be aimed at the fine rather than the coarse particles. Continuing this argument to its logical conclusion, if one could avoid use of 1 micron dusts or less, or exclude them from the dust which passes a 325-mesh screen, nearly all dust diseases would be eliminated. This is not at all an academic idea, for de-dusting processes are not new and are being applied in many industries. If some of the mechanical ingenuity which is now being applied unthinkingly to creating 1 micron dust were directed to ways for avoiding it, probably it would be discovered that dusts which are too large to be breathed would serve many processes just as well as those which are around 1 micron in size."

The report includes a table giving latest available information on the minimum air velocities necessary in certain industries to insure the maintenance of dust concentrations at safe levels.

The preventive engineering committee asserts that many firms have neglected heavy dust concentrations in cases where the dust is of no proven harm, and adds:

"There is no satisfactory medical answer at present to this question, but the engineer is making a bad mistake if he lets men breathe heavy dust concentrations of any material. If no other reason for dust control can be found, then one should read transcripts of some of the recent suits at common law in which fantastic damages for alleged silicosis were granted to men who breathed dust containing little or no silica. The courts and compensation boards are not impressed with subtle distinctions between dusts with 10 percent and 40 percent quartz, especially when medical experts are reluctant to make definite statements as to the comparative significance of such differences.

"It would be well to realize that men working in dusty trades suffer far more from respiratory troubles of all kinds than do men who work in clean air. The evidence that excessive dustiness of any kind is harmful is beyond argument."

The committee attributes the handicap in this general field to the lack of fundamental data and recommends a number of specific engineering researches for the Foundation to undertake in the coming year.

Republic Appoints Special Representative

William Hogenson has been named special representative on Toncan Iron enameling stock, according to an announcement by F. H. Ramage, manager of sales promotion, Republic Steel Corporation. His work will be in conjunction with that department under the new Product Development Division. Mr. Hogenson comes to Republic with a background of technical and business training gained at the universities of Michigan and Chicago, and a close association with the enameling industry through his most recent connection, Chicago Vitreous Enamel Products Company.

Engineering Experiments' Bulletins

The Engineering Experimental Station of the University of Illinois has issued recently a series of bulletins dealing with a variety of engineering problems. Bulletin No. 283, written by Frederick G. Straub, deals with "A Study of the Reactions of Various Inorganic and Organic Salts in Preventing Scale in Steam Boilers." Bulletin No. 284, dealing with "Oxidation and Loss of Weight of Clay Bodies during Firing," was written by William R. Morgan. Bulletin No. 285, "Possible Recovery of Coal from Waste at Illinois Mines," was written by Cloyde M. Smith and David R. Mitchell. Bulletin No. 286, by Hardy Cross, discusses and describes an "Analysis of Flow in Networks of Conduits or Conductors." Copies of these publications may be obtained without charge upon application to the Engineering Experimental Station, Urbana, Ill., up to March 1, 1937, or until the supply is exhausted.

Byers Appoints New Manager of Sales Promotion

M. J. Czarniecki, vice-president in charge of sales, A. M. Byers Company, Pittsburgh, announces the following appointments that were made effective November 2, 1936:

George B. Cushing as manager of sales promotion. Mr. Cushing came with A. M. Byers Company in 1928 to organize and head the present advertising department. Subsequently in 1931 he organized a technical promotion group now known as the Engineering Service Department.

B. D. Landes, who has been in the technical group since its inception, has been appointed manager of the Engineering Service Department.

T. C. Winans, who has been in the advertising department since 1930, has been appointed advertising manager.

Both the manager of the engineering service department and the advertising manager become a part of the

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

VOLUME XXXVI NUMBER 12

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Request for change of address should reach us on or before the 15th of the month preceding the issue with which it is to go into effect. It is difficult and often impossible, to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address, please be sure to send use your old address as well as the new one. Address H. E. McCandless, circulation manager, 30 Church Street, New York, N. Y.

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BUSINESS MANAGER: Warner Lumbard.

Contents

newly formed sales promotion group headed by Mr. Cushing.

R. H. Gardner, formerly of the Washington, D. C., office of A. M. Byers Company, has been appointed manager of pipe sales and will take over all sales management duties in connection with wrought iron and steel tubular products.

Applications of Welding Studied

Realizing the need for co-operative development of the industrial applications of the electric welding process, the electric welding section of the National Electrical Manufacturers' Association has established development headquarters in the Frick Building, Pittsburgh. The welding section has initiated a program of co-operative industry development to investigate the electric welding market and determine the possibilities of extending it.

It has been conservatively estimated that by securing the widest possible adoption of applications which have been definitely successful, the use of electric welding in the manufacture of heavy machinery can be increased many fold. As a first step therefore, the program will concentrate on the converting of cast parts to welded steel in machinery construction.

H. S. Card, formerly editor of the *Welding Engineer*, has been appointed development director of the welding section and will be in charge of the Pittsburgh office.

D. L. Mathias Joins Metal and Thermit Corporation as Research Engineer

The Metal & Thermit Corporation, 120 Broadway, New York, announces that D. L. Mathias joined its staff on November 2 in the capacity of research engineer. He is the inventor of a number of types of welding electrodes and processes; and at the Metal and Thermit Corporation will be in charge of electrode research and development.

Trade Publications

Riveted Plates.—A pamphlet describing the construction of a large tunnel shield fabricated by riveting has been issued by the William B. Pollock Company, steel plate fabricator, Youngstown, O.

Blast Cleaning.—The Pangborn Corporation, Hagerstown, Md., has issued bulletin No. 201a on the Pangborn type RA-2 Rotoblast cleaning unit. This device is used for the cleaning of castings and forgings of various metallic materials and steel products of innumerable shapes and sizes and operates without the use of condensed air.

Airco Acetylene.—A booklet entitled "Airco Acetylene" has been prepared by the Air Reduction Sales Company, New York, and gives a concise presentation of the story of acetylene versus various other fuel gases. A diagram worthy of consideration is included in the booklet and shows the comparative consumption of oxygen by the various fuel gases.

Forging Presses.—The Chambersburg Engineering Company, Chambersburg, Pa., has published recently a new catalogue on the Chambersburg "United" high-speed steam-hydraulic forging presses. A complete description is given of the operation of the various types of presses. Illustrations are shown of installations in various industries and tables of dimensions of the complete line of presses are included.

Monel Metal.—A bulletin entitled "Strength Plus" has been recently published by the International Nickel Company, Inc., New York, that describes the solution to scores of metal problems encountered by the engineer. This bulletin, profusely illustrated, covers specific problems in engineering fields from hydroelectric and steam-power plants to highway maintenance, refrigeration and automobiles, in which applications of Monel can be used successfully.

Steam Generating Equipment.—A new boiler catalogue, No. 102, of striking design and appearance, has been recently published by the Edge Moor Iron Works, New York, manufacturer of process equipment, boilers and welded steel products. All types of watertube boilers manufactured by the Edge Moor Iron Works are covered in the catalogue and important accessories such as water walls, air preheaters, and waste-heat boilers are briefly discussed.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. 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 special permission is given to do so.

By George M. Davis

Smokestack Breeching

Q.—In regard to the layout of smokestack breechings, can the same method of layout be applied to a smaller stack or one of less than 22 inches diameter with flat seats on the boiler? J. L. T.

A.—The development of the breeching submitted with the question is shown in Practical Plate Development Article XIX.

The method of developing the breeching would be the same should the diameter of the stack be made less than 22 inches. Problem No. 15 of Practical Plate Development shows such a condition, the solution of which will appear in the January issue.

Locomotive Boiler Horsepower

Q.—In your Questions and Answers Department of BOILER MAKER AND PLATE FABRICATOR, I see that you give some very interesting and helpful information, and I wonder if you would publish the methods used to calculate the horsepower of an ordinary locomotive boiler which carries 200 pounds per square inch steam pressure. M. W. S.

A.—The question does not include the proper information for determining the horsepower of a boiler.

Boiler horsepower is taken as a measure of evaporation. One boiler horsepower is equal to the evaporation of 34.5 pounds of water per hour from and at 212 degrees F. For locomotive boilers, it is generally desirable to make the boiler and cylinder horsepower equal.

The following rules are based on cylinder and boiler horsepower and on proper evaporating values being assigned to firebox, tube and flue, arch tube and combustion chamber heating surfaces.

Horsepower $= 0.02120 \times P \times A$ for saturated steam.
Horsepower $= 0.02290 \times P \times A$ for superheated steam.

Where:

P = boiler pressure, pounds per square inch.
A = area of one cylinder in square inches.

Maximum horsepower is assumed to be reached at the following piston speeds:

Saturated steam—700 feet per minute.
Superheated steam—1000 feet per minute.

The amount of steam required per hour, per horsepower is taken as follows:

Saturated steam = horsepower × 27.0 pounds.
Superheated steam = horsepower × 20.8 pounds.

The pounds of steam evaporated per hour per square foot of heating surface are taken as follows:

Firebox heating surface = 55 pounds per hour per square foot heating surface.
Combustion chamber heating surface = 55 pounds per hour per square foot heating surface.
Firebox watertubes = 55 pounds per hour per square foot heating surface.
2-inch tubes, 18 feet long, $^{15}/_{16}$-inch spaces = 9.54 pounds per hour per square foot heating surface (base figure).
2¼-inch tubes, 18 feet long, $^{15}/_{16}$-inch spaces = 10.0 pounds per hour per square foot heating surface (base figure).

The values for tube heating surfaces vary with the spacing and length of the tubes. Various engineering handbooks give tables of evaporation for tubes and flues for various lengths and spacing.

Example:

A locomotive with 23-inch by 28-inch cylinders, using saturated steam at 200 pounds pressure:

Horsepower $= 0.02120 \times P \times A$.
Horsepower $= 0.02120 \times 200 \times 415.48$.
Horsepower = 1761.
Total steam consumption per hour $= 1761 \times 27 = 47{,}547$ pounds.
Firebox area assumed to be 212 square feet with evaporation at 55 pounds: consumption = 11,660 pounds per hour.
47,547—11,660 = 35,887 pounds steam to be evaporated by tubes.
The heating surface area of one 2-inch tube, 20 feet long, after deducting for tube sheets = 10.423 square feet.
Tubes 2 inches diameter, 20 feet long, spaced ¾-inch rate of evaporation = 8.32 pounds per hour per square foot heating surface.
Evaporation for each tube $= 10.423 \times 8.32 = 86.7$ pounds per hour.
Number of tubes required $= 35{,}887 \div 86.7 = 414$.

With a given boiler, the problem reverts to obtaining the horsepower based on the actual heating surface of the boiler and comparing it with the cylinder horsepower based on the size of the cylinders and the boiler pressure.

The boiler horsepower based on evaporation should be at least equal to 100 percent of the cylinder horsepower.

Flue Sheet Braces and Staybolts

Q.—What would be the load in pounds per square inch on a front flue sheet brace of 1 3/16-inches diameter, supporting 80 square inches of a boiler 102 inches in diameter and carrying 220 pounds pressure per square inch. Please show figures in full showing how this is done.

Also show figures in full showing how to find the area of any size of a staybolt at the root of thread or at the reduced section, minus the area of the telltale hole.—J. G. M.

A.—The question does not include sufficient information on the type of brace used, or the manner in which the brace is connected to the tube sheet to give a complete answer. Using the information as given in the question, the problem resolves itself into determining the stress on a $1\,^3/_{16}$-inch diameter brace rod supporting 80 square inches of a front tube sheet, supporting 220 pounds boiler pressure, and is as follows:

The product of the net area in square inches multiplied by the maximum allowable working pressure in pounds per square inch, gives the load to be supported by the brace. Assuming 80 square inches to be the net area to be supported by the brace, the total load supported by the brace would be:

$80 \times 220 = 17{,}600$ pounds, load supported by brace.

The load on the brace in pounds per square inch, usually termed the stress on the brace in pounds per square inch, would be the total load on the brace divided by the net cross-sectional area of the brace.

The cross-sectional area of a $1\frac{3}{16}$-inch diameter brace would be:

$$3.1416 \times \left(\frac{1.1875}{2}\right)^2 = 1.108 \text{ square inches.}$$

The stress in pounds per square inch on the brace would be:

$17{,}600 \div 1.108 = 15{,}893$ pounds per square inch, total load or stress on the brace.

This load would be in excess of the maximum allowable stress for staybolts and stays or braces as provided for in the A.S.M.E. Power Boiler Code. The code provides as follows:

MAXIMUM ALLOWABLE STRESSES FOR STAYBOLTS AND STAYS OR BRACES

Description of staybolts and stays or braces	Stresses, pounds per square inch: For lengths between supports not exceeding 120 diameters[1]	For lengths between supports exceeding 120 diameters[1]
a Unwelded or flexible staybolts less than twenty diameters[1] long, screwed through plates with ends riveted over	7,500	....
b Hollow steel staybolts less than twenty diameters[1] long, screwed through plates with ends riveted over	8,000	....
c Unwelded stays or braces and unwelded portions of welded stays or braces	9,500	8,500
d Steel through stays or braces exceeding 1½ inches diameter[1]	10,400	9,000
e Welded portions of stays or braces	6,000	6,000

[1] Diameters taken at body of stay or brace

Assuming that the stay in question was an unwelded stay, the length of which exceeds 120 diameters, the diameter of the brace, in order to support the load as

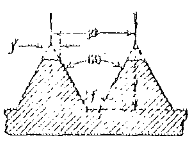

Fig. 1.—U. S. Standard Thread

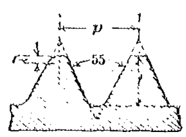

Fig. 2.—Whitworth Standard Thread

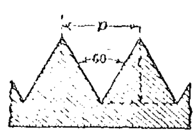

Fig. 3.—Sharp V Thread

given in the question and still stay within the maximum allowable stress on braces, would be calculated as follows:

Determine the required cross-sectional area of the brace, by first computing the total load to be carried by the brace, and dividing the total load, by the value of the allowable stress for unwelded braces for lengths between supports exceeding 120 diameters.

Total load on brace $= 17{,}600$ pounds.

Allowable stress on stay $= 8500$ pounds per square inch.

$17{,}600 \div 8500 = 2.07$ square inches.

Referring to any engineering handbook, we find that a 1⅝-inch diameter brace has a cross-sectional area of 2.074 square inches. Thus, to support 80 square inches of surface, under a load of 220 pounds per square inch and stay within the allowable stress of 8500 pounds per square inch, a 1⅝-inch diameter brace rod would have to be used.

Staybolts, generally, are either threaded with U. S. Standard, Whitworth or Sharp V-threads, with 12 threads per inch. The area at the root of the thread is found by obtaining the diameter at the root of the thread, as follows:

First obtain the depth of the thread from the following formulas:

U. S. Standard Thread (Fig. 1)

$$p = \text{pitch} = \frac{1}{\text{No. threads per inch}}$$
$$t = \text{depth} = \text{pitch} \times 0.6495$$
$$f = \text{flat} = \frac{\text{pitch}}{8}$$

Whitworth Standard Thread (Fig. 2)

$$p = \text{pitch} = \frac{1}{\text{No. threads per inch}}$$
$$r = \text{radius} = \text{pitch} \times 0.1373$$
$$t = \text{depth} = \text{pitch} \times 0.64033$$

Sharp V Thread (Fig. 3)

$$p = \text{pitch} = \frac{1}{\text{No. threads per inch}}$$
$$t = \text{depth} = \text{p} \times 0.750$$

then obtain the diameter at the root of the thread from the following formula:

$$D' = D - 2t$$

where:

D' = diameter at root of threads in inches.
D = diameter of staybolt in inches.
t = depth of threads in inches.

The area at the root of thread would then be:

$$\text{Area at root of threads in square inches} = \pi \times \left(\frac{D'}{2}\right)^2$$

where:

$\pi = 3.1416.$
D' = diameter at root of threads in inches.

From this area, the cross-sectional area of the tell-tale hole is then taken and the resultant area would be the least cross-sectional area of the staybolt.

Assuming for example, a staybolt 1-inch in diameter, 12 V-threads per inch, with a $\frac{3}{16}$-inch tell-tale hole, the least cross-sectional area would be:

first, obtain pitch of threads. (p)

$$p = \frac{1}{12}$$

$p = 0.0833$ inch

then, obtain depths of thread. (t)

$t = 0.0833 \times 0.75 = 0.062475$ inch

then, obtain diameter of root of thread.

$D' = 1 - 2 \times 0.062475$
$D' = 1 - 0.124950$
$D' = 0.875$ inch.

then, obtain area at root of thread as follows:

$$\text{Area} = 3.1416 \times \left(\frac{0.875}{2}\right)^2$$

Area $= 0.6013$ square inch

from this deduct the area of a $\frac{3}{16}$-inch diameter circle or:

$0.6013 - 0.02761 = 0.57369$ square inch area at root of thread with area of the tell-tale hole deducted.

The area at the reduced section is obtained by using the diameter of the staybolt at the reduced section. This diameter should be checked against the diameter at the root of the threads and whichever is the least should be used in obtaining the least cross-sectional area of the staybolt.

Associations

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Assistant Chief Inspector—J. A. Shirley, Washington.
Assistant Chief Inspector—J. B. Brown, Washington.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Director—Joseph B. Weaver, Washington, D. C.

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Boiler Code Committee of the American Society of Mechanical Engineers

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Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.
International Secretary-Treasurer—Chas. F. Scott, Suite 506, Brotherhood Block, Kansas City, Kansas.
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Vice-President: William N. Moore, general boiler foreman, Pere Marquette Railway.
Secretary-Treasurer: Albert F. Stiglmeier, general foreman boiler maker, New York Central System, West Albany Shop. Address, 29 Parkwood Street, Albany, N. Y.
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Steel Plate Fabricators Association

President — Merle J. Trees, 37 West Van Buren Street, Chicago, 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
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

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

States

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

Cities

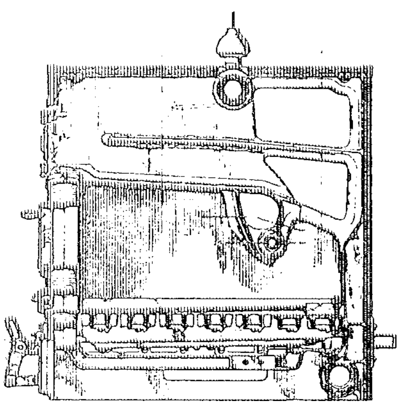
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,868,445. BOILER. CHARLES W. BRABBEE, OF BRONXVILLE, NEW YORK, ASSIGNOR TO AMERICAN RADIATOR COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

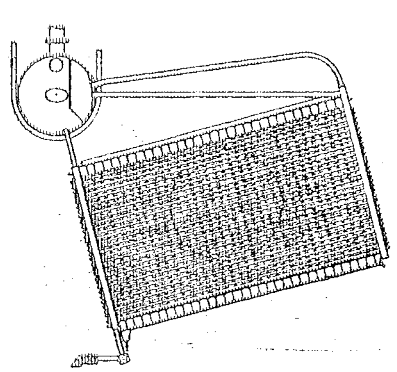
Claim.—A boiler comprising a grate, a plurality of sections arranged side by side, certain of said sections each having a depending water member communicating therewith and terminating at its lower end above



the grate, each of said members having a transverse opening, said depending water members being arranged side by side and cooperating to form a depending baffle extending transversely of the normal plane of said sections and dividing the space above the grate into two chambers arranged one to the rear of the other, said transverse openings alining communicatively to form a duct extending through said baffle, and means at the lower portion of said baffle for discharging a combustion supporting gas from said duct. Thirty-two claims.

1,864,737. MERCURY CONDENSER WATER TUBE STEAM BOILER. WILLIAM A. JONES, OF WESTERLEIGH, NEW YORK, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

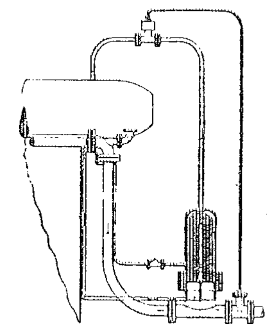
Claim.—A water tube boiler comprising tubes and headers, an air tight casing around said tubes attached to said headers, supports to prevent



said casing from moving toward said tubes, and means closing the spaces between said headers which together with said headers constitute the ends of said casing. Ten claims.

1,890,245. STEAM TEMPERATURE REGULATOR. JOHN E. BLACK, OF RUMSON, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

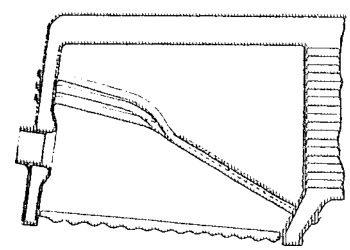
Claim.—In combination, a boiler having a steam space, a superheated steam pipe, a temperature regulator connected to said pipe and having a chamber beneath the normal water level of the boiler, means for maintaining a supply of water in the chamber, means for passing the steam from the pipe through the chamber while maintaining it out of contact



with the water therein, a connection from the upper part of said chamber to said steam space, two connections from the lower part of the chamber to the water space of the boiler, and means for causing a circulation through said water connections and chamber. Ten claims.

1,918,420. ARCH FOR BOILER FIREBOXES. ROBERT J. NEEDHAM, OF TORONTO, ONTARIO, CANADA.

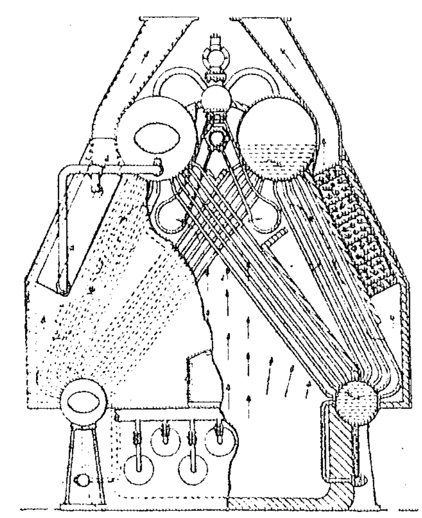
Claim.—In a locomotive boiler firebox, a baffle arch structure dividing the firebox into a combustion chamber and a furnace chamber and comprising a series of water tubes having spaced parallel brick-supporting reaches and reaches laterally converged and disposed in superposed posi-



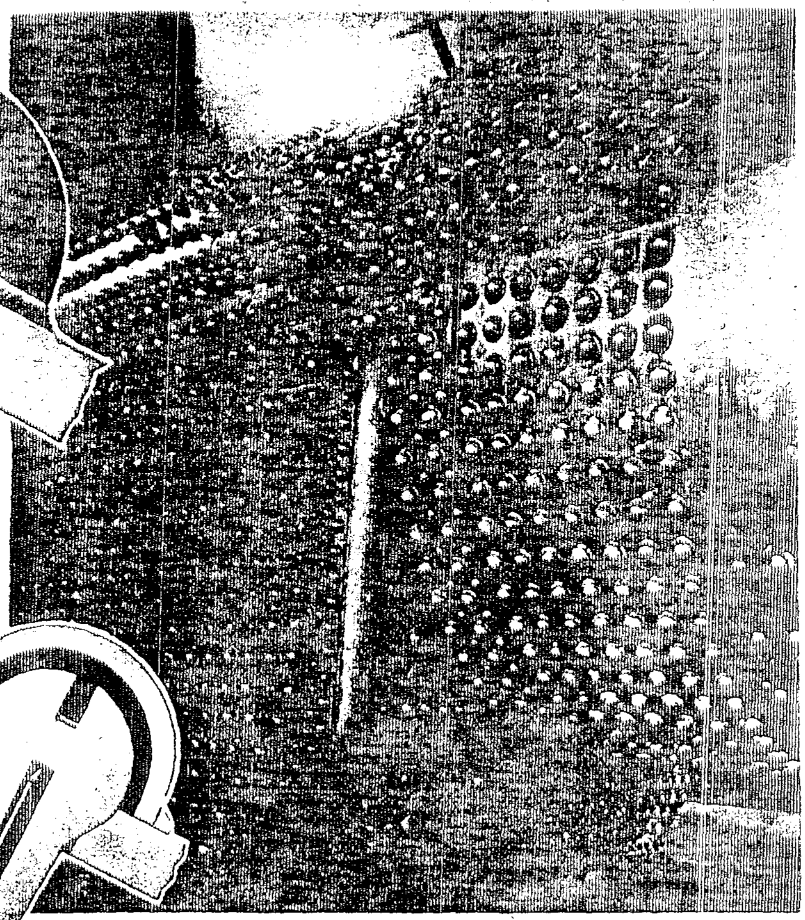
tions to provide increased communicating space between said combustion chamber and furnace chamber; and bricks supported by said parallel reaches of the tubes and closing the spaces therebetween. Eleven claims.

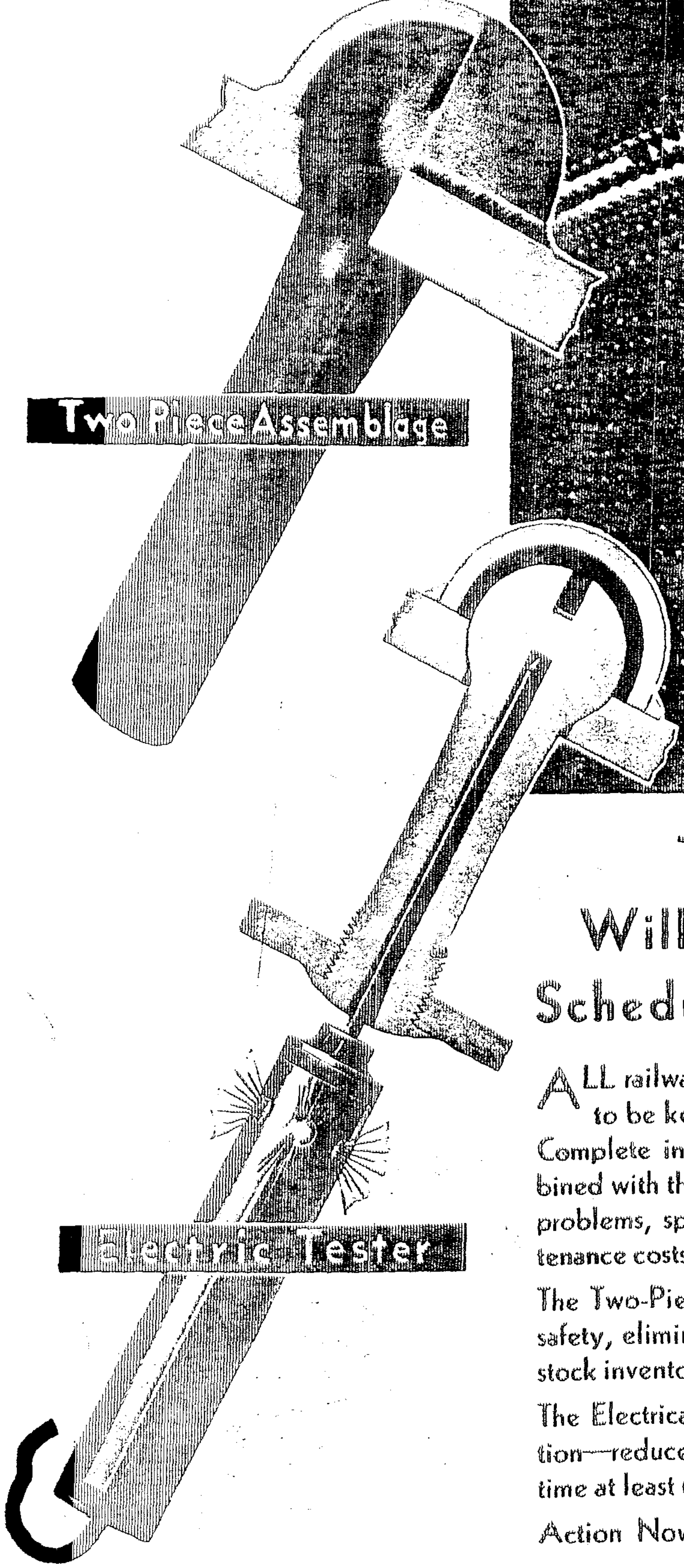
1,917,617. STEAM BOILER. HENRY A. ULRICH, OF LOS ANGELES, CALIFORNIA.

Claim.—A steam boiler comprising a casing, a fire box in said casing, means for heating the fire box, a pair of parallel steam drums arranged in the casing directly above the fire box, lower drums arranged in the casing adjacent the fire box, downwardly and outwardly extending banks of tubes connecting the steam drums to the lower drums, diagonally extending and inter-crossing banks of tubes connecting the lower drums to



the steam drums and arranged directly in the path of combustion from the fire box, deflectors arranged between the first and second banks of tubes, deflectors arranged between the first mentioned deflectors and the walls of the casing for forming downwardly and upwardly extending passages with the first mentioned banks of tubes arranged in the downwardly extending passages, means connecting the upwardly extending passages to a smoke stack, feed water heating means in the upwardly extending passages and connected to the steam drums, a steam collecting drum arranged in the casing between the steam drums, a series of tubes connected to the steam drums throughout the lengths thereof and to the steam collecting drum, a superheated steam outlet header arranged below the steam collecting drum, and superheated tubes connecting the steam collecting drum with the super-heated steam outlet header and extending downwardly through the second mentioned banks of tubes. One claim.





This Combination Will Help You Maintain Schedules And Reduce Costs

ALL railway reports indicate that the boiler shops are going to be kept very busy for some time to come.

Complete installations of the Two-Piece Assemblage combined with the use of the Electrical Tester will eliminate many problems, speed up repairs and assure big savings in maintenance costs.

The Two-Piece Assemblage will provide a higher factor of safety, eliminate the cause for most broken bolts and reduce stock inventories.

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FLANNERY BOLT COMPANY

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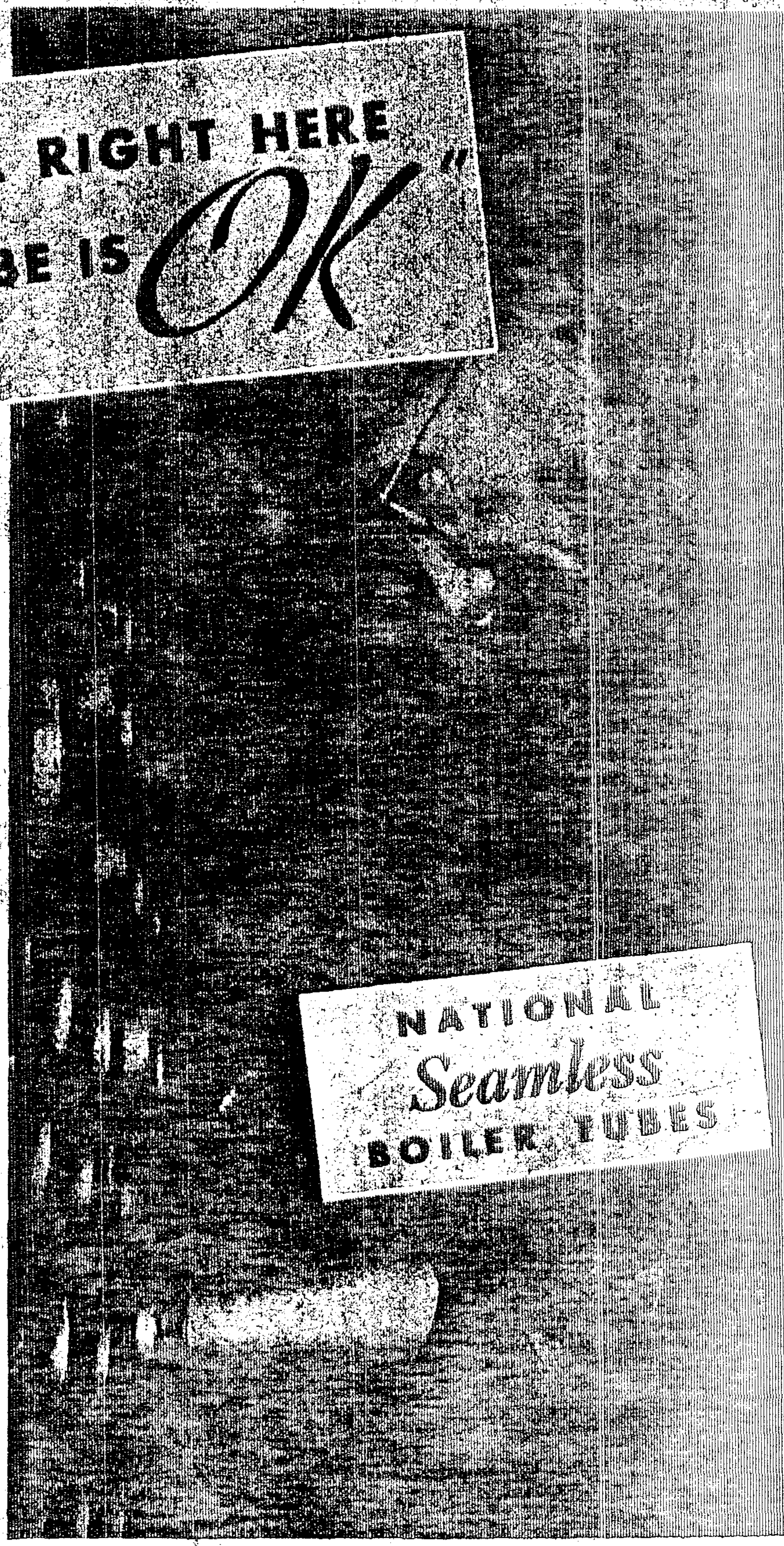
"I CAN TELL RIGHT HERE IF THE TUBE IS OK"



THIS man knows boiler tubes. For thirty years he's been building boilers. Hundreds of tubes have passed through his skillful hands. He's watched them go in — and he's seen them when they came out. He knows just about what to expect from a tube the first time he puts a tool to it. Listen to what he says about NATIONAL Seamless Tubes:

"They go in without trouble." That's because NATIONAL Seamless Boiler Tubes are straight, true to gauge, smooth, clean and round. Exacting mill tolerances insure their dimensional accuracy. They slide through the tube sheet more easily. Each one is exactly like the other.

"They're fast and easy to install." NATIONAL Seamless Boiler Tubes can be easily flared, rolled and headed into flue sheets because they are exceptionally ductile, and because every tube is *completely* annealed. That means fast installation and low labor cost for you.

"I've never seen one split yet." No, and he never will, for the very good reason that NATIONAL Boiler Tubes are seamless—pierced from a solid billet of steel—without welds that might split or fail during installation or when the service gets tough.

"They last longer." Why? Because they're made only of "killed" open-hearth or electric furnace steels—of higher creep strength, uniform density and soundness—free from laminations—with improved heat transfer characteristics. Ask for complete descriptive data.

NATIONAL TUBE COMPANY

PITTSBURGH, PA.

Columbia Steel Company, San Francisco, *Pacific Coast Distributors* · United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL