(No Model.) 5 Sheets—Sheet 1.

J. A. ENO.

MARINE BOILER.

No. 505,941. Patented Oct. 3, 1893.

Fig. 1.

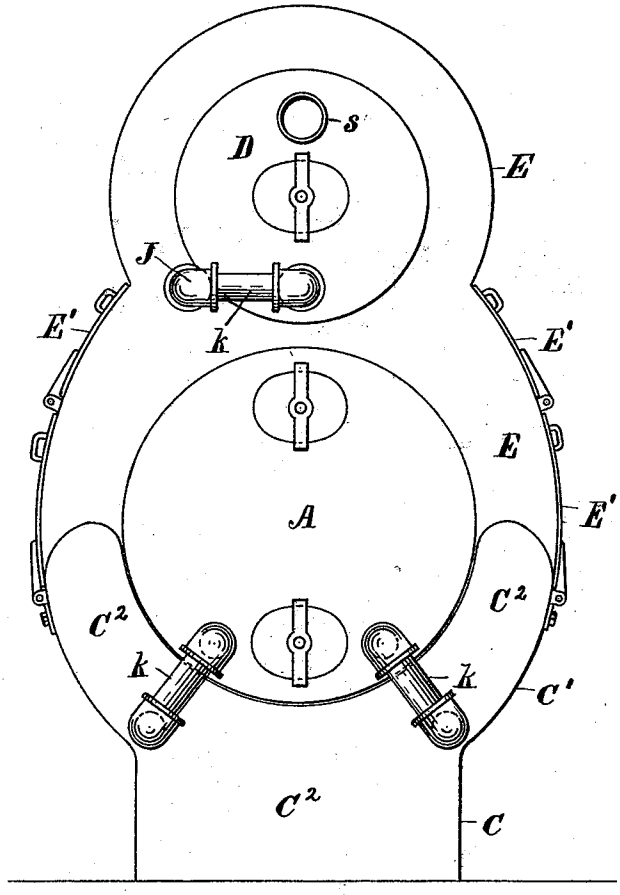

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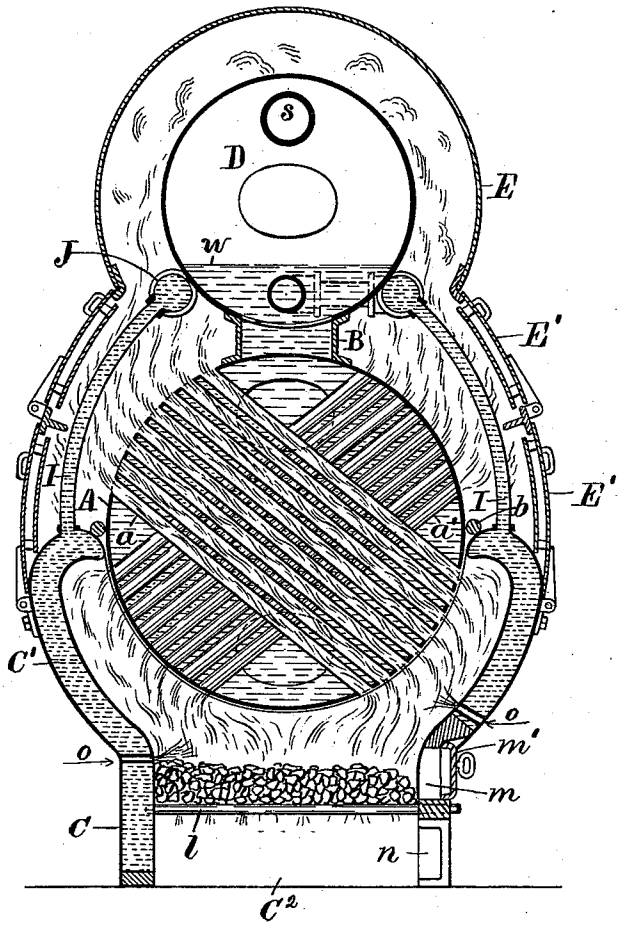
Fig. 2.



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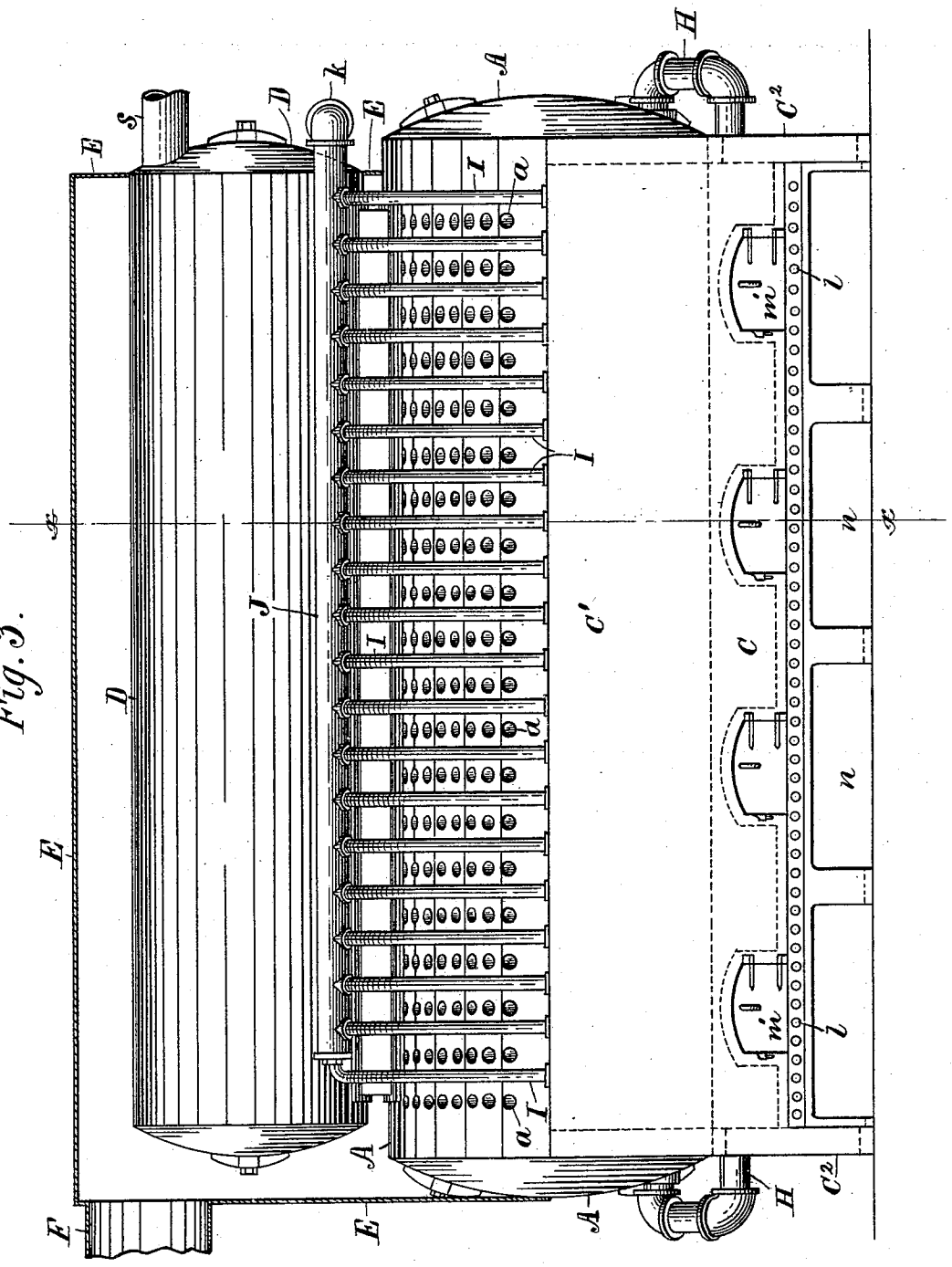

Fig. 3.

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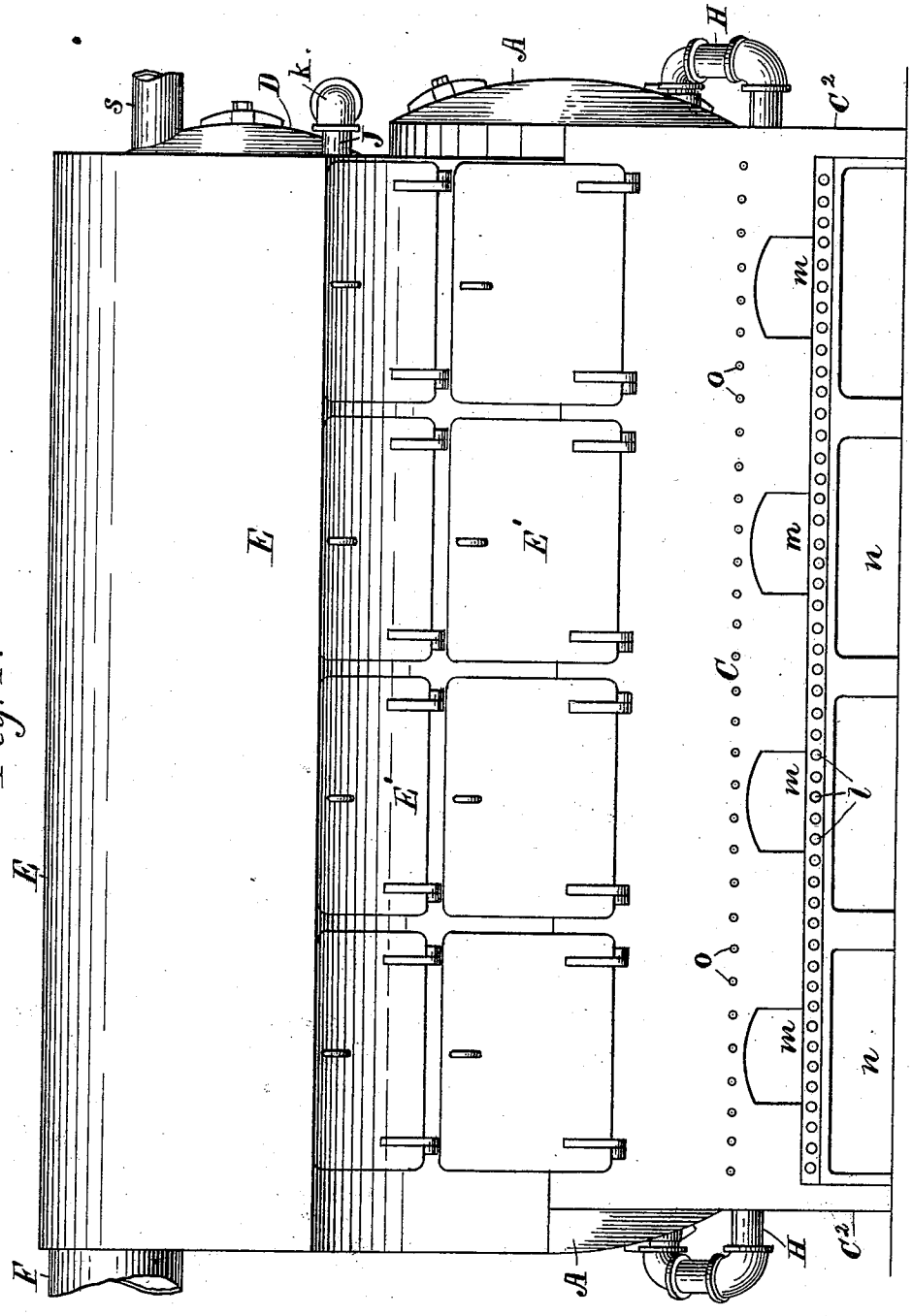

Fig. 4.

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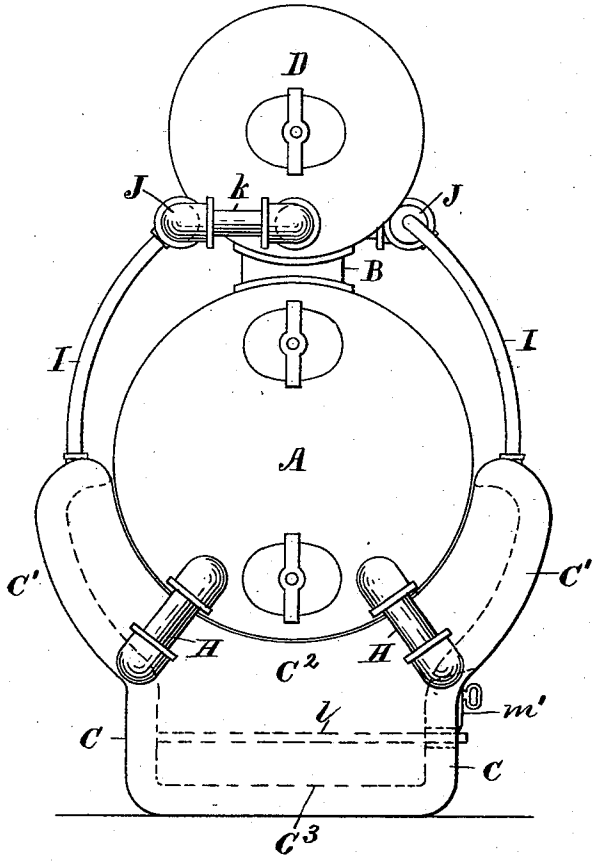
No. 505,941. Patented Oct. 3, 1893.

Fig. 5.



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UNITED STATES PATENT OFFICE.

JOSEPH A. ENO, OF NEWARK, NEW JERSEY.

MARINE BOILER.

SPECIFICATION forming part of Letters Patent No. 505,941, dated October 3, 1893.

Application filed January 31, 1893. Serial No. 460,263. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH A. ENO, a citizen of the United States, residing at Newark, Essex county, New Jersey, have invented certain new and useful Improvements in Marine Boilers, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to a marine boiler in which a cylindrical shell having interior fire tubes is combined with a water leg furnace by means of tubular connections adapted to promote a continuous circulation through the water leg and shell.

The construction will be understood by reference to the annexed drawings, in which—

Figure 1 is an end elevation of the boiler and casing. Fig. 2 is a transverse section of the same on line x, x, in Fig. 3, which is a longitudinal view of the boiler with the casing removed. Fig. 4 is a side elevation of the boiler; and Fig. 5 is an end elevation like Fig. 1, showing an alternative construction for the water leg.

The shell of the boiler is a longitudinal cylinder A having two sets of fire tubes a, a', inserted obliquely across the same, with their lower ends below the center of the shell and their upper ends above the same. Between the upper ends of the tubes a connection B is bolted to the shell to sustain a steam drum D, having steam discharge pipe s.

The water leg is formed to embrace the entire furnace, and the lower half of the shell A is supported within the same. The water leg is formed with sides C, C', and ends C^2, the portion C being vertical to form the walls of the fire box, and the portion C' being curved upward beneath the sides to admit the flames to the lower ends of the tubes a, a'. The top of the portion C adjacent to the middle line of the shell is curved inwardly nearly to the shell, and formed with a sloping seat upon its upper side; and an expansion flame joint is formed between the two by longitudinal rolls b fitted between the sloping seat and the sides of the shell. The ends C^2 of the water leg are fitted upon their upper sides to support the ends of the shell, and a casing E with doors E' is extended over the upper half of the shell and around the periphery of the steam drum D. The casing is closed at the ends and provided with a smoke outlet F. The space within the casing forms a combustion chamber for the gases which are discharged from the tubes a, a'. Both ends of the shell are connected near the bottom with the lower part of the water leg by pipe connections H. A series of water tubes I is extended from the top of the water leg upon each side of the shell up to a longitudinal pipe J which is fixed adjacent to the lower side of the steam drum D and connected therewith at the ends by pipes k. The water line w is shown across the lower part of the steam drum just above the inlet of the pipes k; but the water line may be carried at a lower level. Apertures are made in the shell A and the steam drum D within the connection B, through which the steam generated in the shell is freely discharged into the drum. The grate bars l are shown extended across the water leg near the bottom, with a series of openings m in the side of the water leg above the grate to supply the fuel, and openings n under the same to clear the ash pit. The openings m are closed by doors m'.

In Fig. 2 the flames rising from the fuel on the grate are shown circulating within the water leg below the bottom half of the shell A, and passing thence in an oblique direction upward through the tubes a, a', into the space within the casing E. The fire tubes a, a', are arranged alternately in vertical rows, as shown in Fig. 3, and the water tubes I are arranged intermediate to the upper ends of the fire tubes, by which construction free access is afforded to the upper ends of the fire tubes for removal or repairs.

The doors E' are made large enough to uncover the upper ends of the fire tubes, and also afford access to the joints at the ends of the water tubes I.

The flames from the fire tubes, as shown in Fig. 2, circulate freely between the water tubes I, thus heating the same in the most effective manner, and the flames then circulate around the entire surface of the steam drum and escape finally from the casing by the smoke pipe F.

The fire tubes afford the most effective heating surface, as they receive the flames directly from the furnace, and the steam is therefore generated rapidly within the shell A and

discharged upward into the steam drum D. The steam is also freely generated in the water tubes I and passes upward to the drum through the pipes J and *k*. The steam and water which rise in the water tubes I are replaced by a downward current in the pipes H, which connect the end of the shell with the water leg, and thus supply it with a constant current of water.

The relation of the fire tubes *a*, *a'*, to the shell is not claimed herein, as it is claimed in a separate patent application Serial No. 457,726, in which the shell is shown without any water leg or tubes I. By the addition of these elements, a large increase of heating surface is secured in the most effective relations to the fire, as the water leg constitutes the furnace itself, and the water tubes I are exposed to the flames which are driven through the fire tubes *a*, *a'*. By this construction the flames are not brought into contact with any brick work, but are conducted against the walls of tubes I which are disposed to generate steam most effectively.

The boiler shown herein is formed with a long cylindrical shell and provided with a furnace throughout its entire length, having four openings *m* for fire doors; but the boiler may be made of any length and provided with any number of furnaces, as may be preferred.

The portion C of the water leg at the rear side of the furnace is extended downward to the bottom of the ash pit; but at the front side of the furnace is terminated at the level of the grate, as a perfect circulation could not be secured in the lower part if perforated by ash pit doors. The water leg may however, if desired, be extended entirely beneath the furnace, as shown in Fig. 5, to form a water bottom C^3 to the ash pit; but such construction is not preferred, as the flat surfaces would be exposed to great pressure and would be liable to leak, through irregular expansion.

With the construction shown in Figs. 1 and 3, all the parts of the boiler are very accessible, and it can therefore be repaired with the utmost facility. It is thus especially adapted for use as a marine boiler, although it may be used in other situations where it is necessary to generate steam with great rapidity. The surfaces in contact with the water in the boiler are practically rendered fire surface by the peculiar construction and arrangement of the various tubes, and each square foot of surface is thus more efficient than in a return flue boiler. The boiler is thus adapted to generate more steam in proportion to its weight than boilers of many other constructions, which also adapts it especially for use in steam vessels.

To improve the combustion, holes *o* may be formed through the water leg, as shown in Figs. 2 and 4, to admit jets of air to the furnace above the fuel. Such jets furnish oxygen to the gases which are generated from the fuel, and thus promote a perfect combustion within the furnace and casing. The air holes may be formed by inserting thimbles through the water leg or by any other suitable means.

The essential features of my invention are the extension of the fire tubes obliquely across a cylindrical shell, with a water leg forming a fire box around the lower ends of the tubes, a casing forming a combustion chamber around the upper ends of the tubes, and suitable water connections, as the pipes H, between the shell and the water leg; and I do not therefore limit myself to the particular construction shown in the drawings, nor exclusively to the use of the water tubes I, in carrying out my invention. Such water tubes are adapted however to very greatly increase the efficiency of the boiler, and are therefore claimed as a specific form of my invention. With the latter construction, and the water connections H between the shell and water leg, a very perfect circulation is maintained throughout all parts of the boiler, and a uniform temperature is thus secured, by which unequal expansion is prevented, and leakage and all the other injuries incidental to unequal expansion are avoided. The construction is thus very durable and compact, and owing to the great amount of fire surface, is highly efficient in proportion to its weight.

Having thus set forth my invention, what I claim is—

1. In a boiler, the combination, with a horizontal cylindrical shell having fire tubes extended obliquely across the same, of a steam drum connected with the top of the shell, a separate water leg forming a fire box around the lower ends of the tubes, a casing inclosing the steam drum and the upper ends of the tubes with a smoke pipe extended from the casing, and a pipe connection from the shell to the water leg, substantially as set forth.

2. In a boiler, the combination, with a horizontal cylindrical shell having two sets of fire tubes extended obliquely across the same from opposite sides, of a steam drum connected with the top of the shell, a separate water leg inclosing the lower half of the shell, and a casing inclosing the steam drum and upper half of the shell with a smoke pipe extended from the casing, and a pipe connection from the shell to the water leg, substantially as set forth.

3. In a boiler, the combination, with a cylindrical shell having fire tubes extended obliquely across the same, of a steam drum connected with the top of the shell, a water leg forming a fire box around the lower ends of the tubes, a longitudinal pipe at the side of the steam drum with a connection thereto at the end, water tubes connecting the top of the water leg with such longitudinal pipe, and a casing inclosing the water tubes and the upper half of the shell, with a smoke pipe extended from the casing, substantially as herein set forth.

4. In a boiler, the combination, with a cy-

lindrical shell having fire tubes extended obliquely across the same, of a steam drum connected with the top of the shell, a water leg forming a fire box around the lower ends of the tubes, a longitudinal pipe at the side of the steam drum with a connection thereto at the end, water tubes connecting the top of the water leg with such longitudinal pipe, a casing inclosing the water tubes and the upper half of the shell, and doors in the casing adjacent to the water tubes, as set forth.

5. In a boiler, the combination, with a cylindrical shell having vertical rows of fire tubes extended obliquely across the same, of a steam drum connected with the top of the shell, a water leg forming a fire box around the lower ends of the tubes, a longitudinal pipe at the side of the steam drum with a connection thereto at the end, water tubes connecting the top of the water leg with such longitudinal pipe intermediate to the vertical rows of fire tubes, and a casing inclosing the water tubes and the upper half of the shell, with a smoke pipe extended therefrom, as set forth.

6. In a boiler, the combination, with a cylindrical shell having fire tubes extended obliquely across the same, of a steam drum connected with the top of the shell, a water leg forming a fire box around the lower ends of the tubes, longitudinal pipes at the sides of the steam drum with connections thereto at opposite ends, water tubes connecting the top of the water leg with such longitudinal pipes, pipes connecting the ends of the shell with the water leg, and a casing inclosing the water tubes and the upper half of the shell, as set forth.

7. In a boiler, the combination, with a cylindrical shell having fire tubes extended obliquely across the same, of a steam drum connected with the top of the shell, a separate water leg forming a rectangular fire box embracing the lower half of the shell, and fitted to the bottom of the shell at its ends to support the same, openings for fire doors through such water leg, a grate fixed within the water leg pipe, connections from the shell to the water leg, and a casing inclosing the upper half of the shell and the steam drum, substantially as set forth.

8. In a boiler, the combination, with a cylindrical shell having vertical rows of fire tubes extended obliquely across the same, of a steam drum connected with the top of the shell, a water leg forming a fire box beneath the lower half of the shell, and fitted to the bottom of the shell at its ends, fire doors through such water leg, a grate fixed within the water leg, pipes connecting the ends of the shell with the water leg, longitudinal pipes at the sides of the steam drum with connections thereto at opposite ends, water tubes connecting the top of the water leg with such longitudinal pipes, as set forth.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

JOSEPH A. ENO.

Witnesses:
JOSEPH W. BABBITT,
THOMAS S. CRANE.