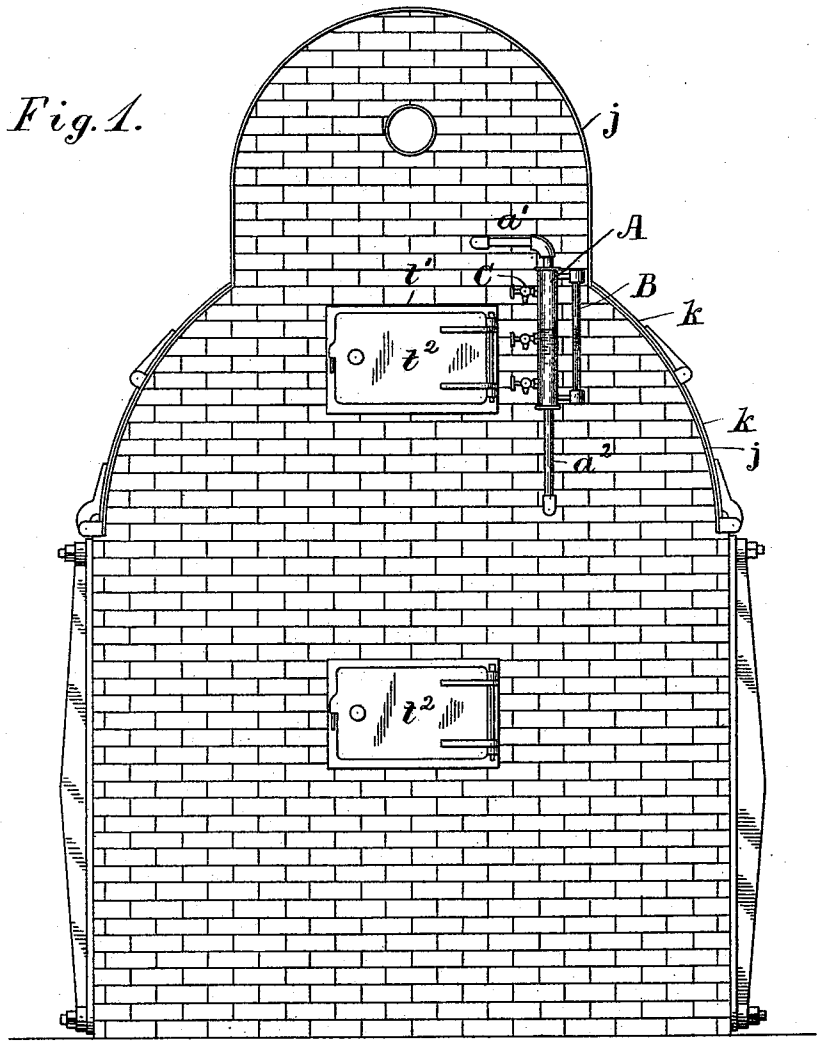
(No Model.) 6 Sheets—Sheet 1.

J. A. ENO.

STEAM BOILER.

No. 505,940. Patented Oct. 3, 1893.

Fig. 1.



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Edw. P. Kinsey

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Crane & Miller, Attys.

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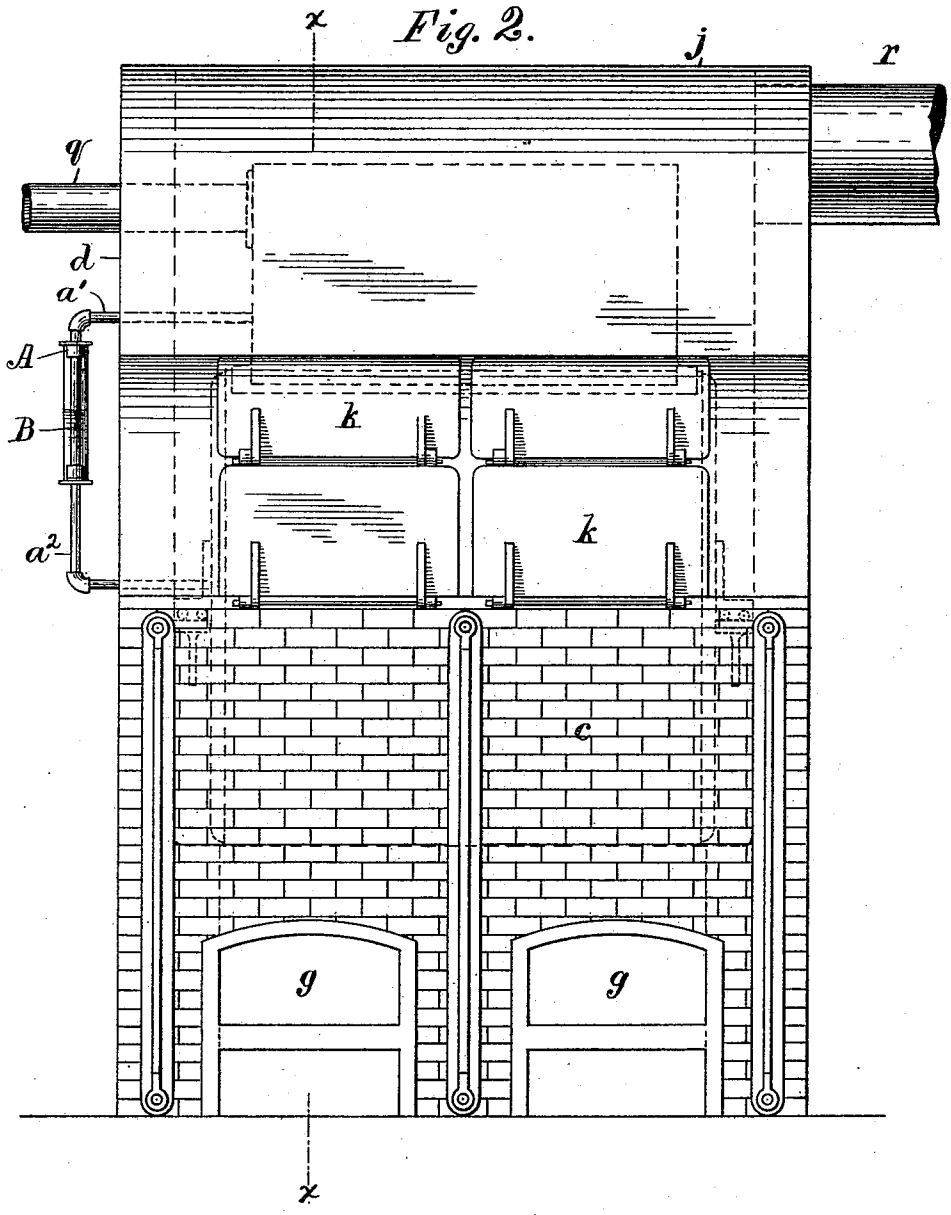
Fig. 2.



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STEAM BOILER.

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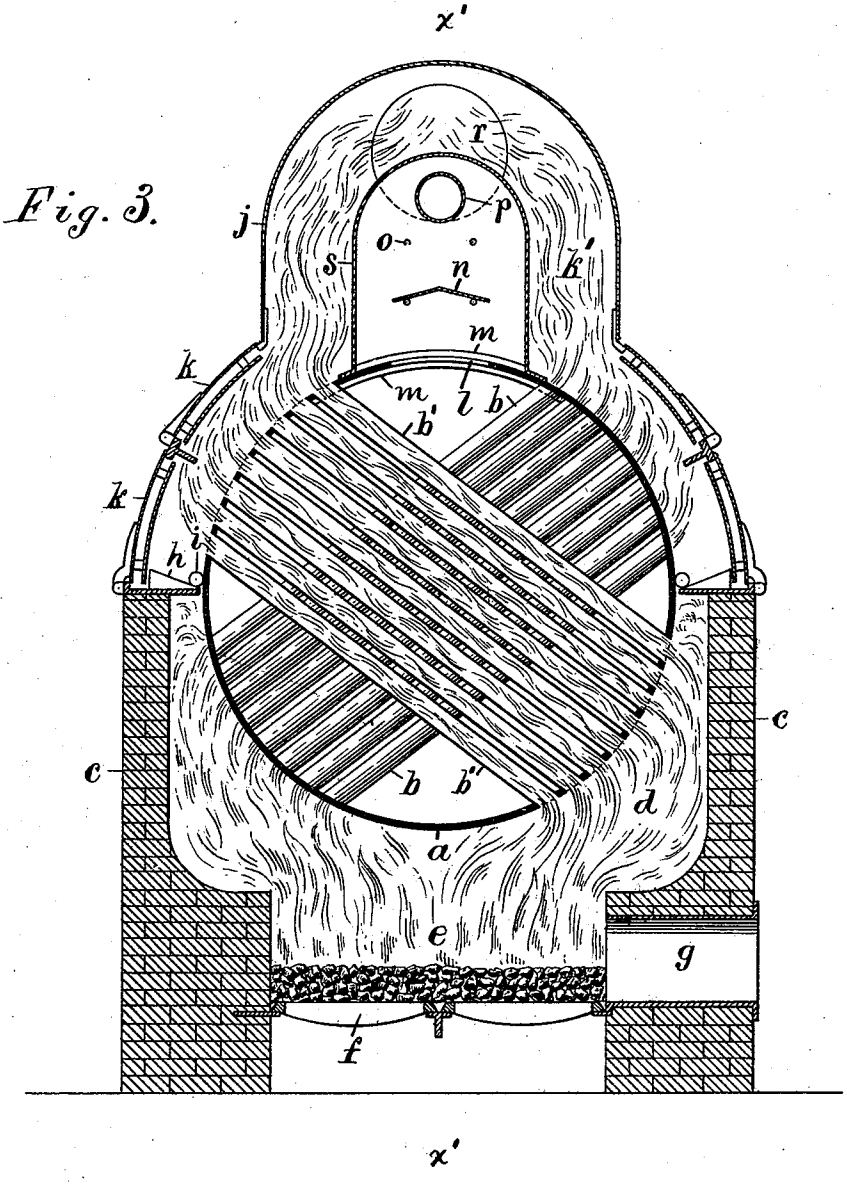
Fig. 3.



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(No Model.)

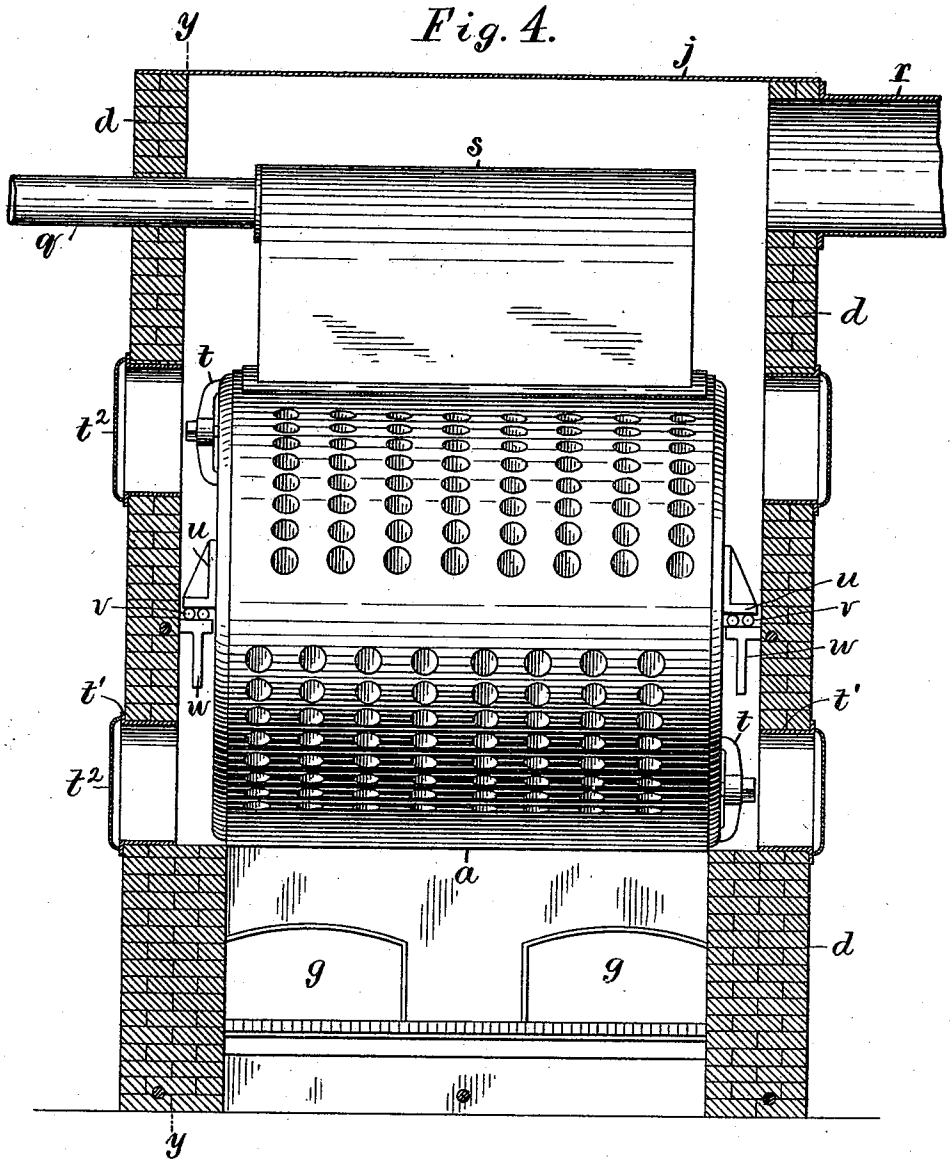
6 Sheets—Sheet 4

J. A. ENO.

STEAM BOILER.

No. 505,940. Patented Oct. 3, 1893.

Fig. 4.



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STEAM BOILER.

No. 505,940. Patented Oct. 3, 1893.

Fig. 5.

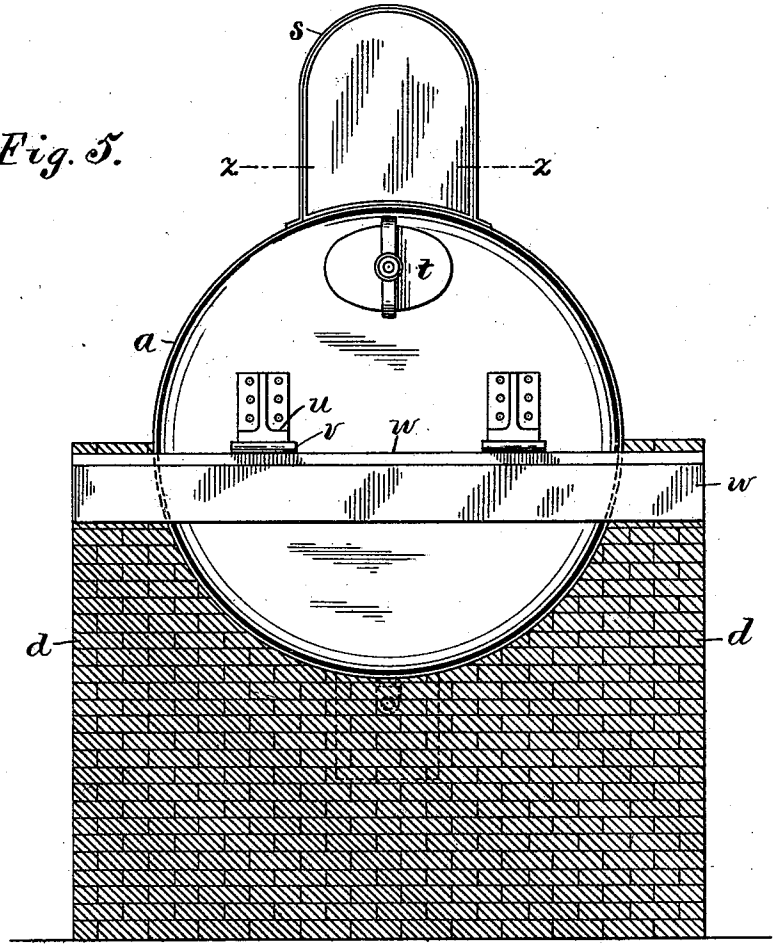
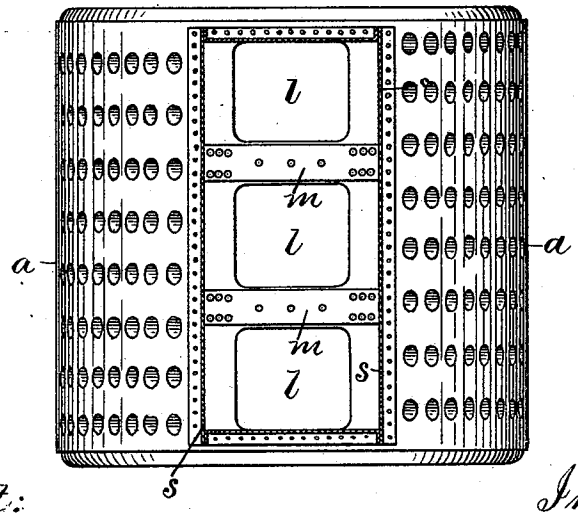


Fig. 6.



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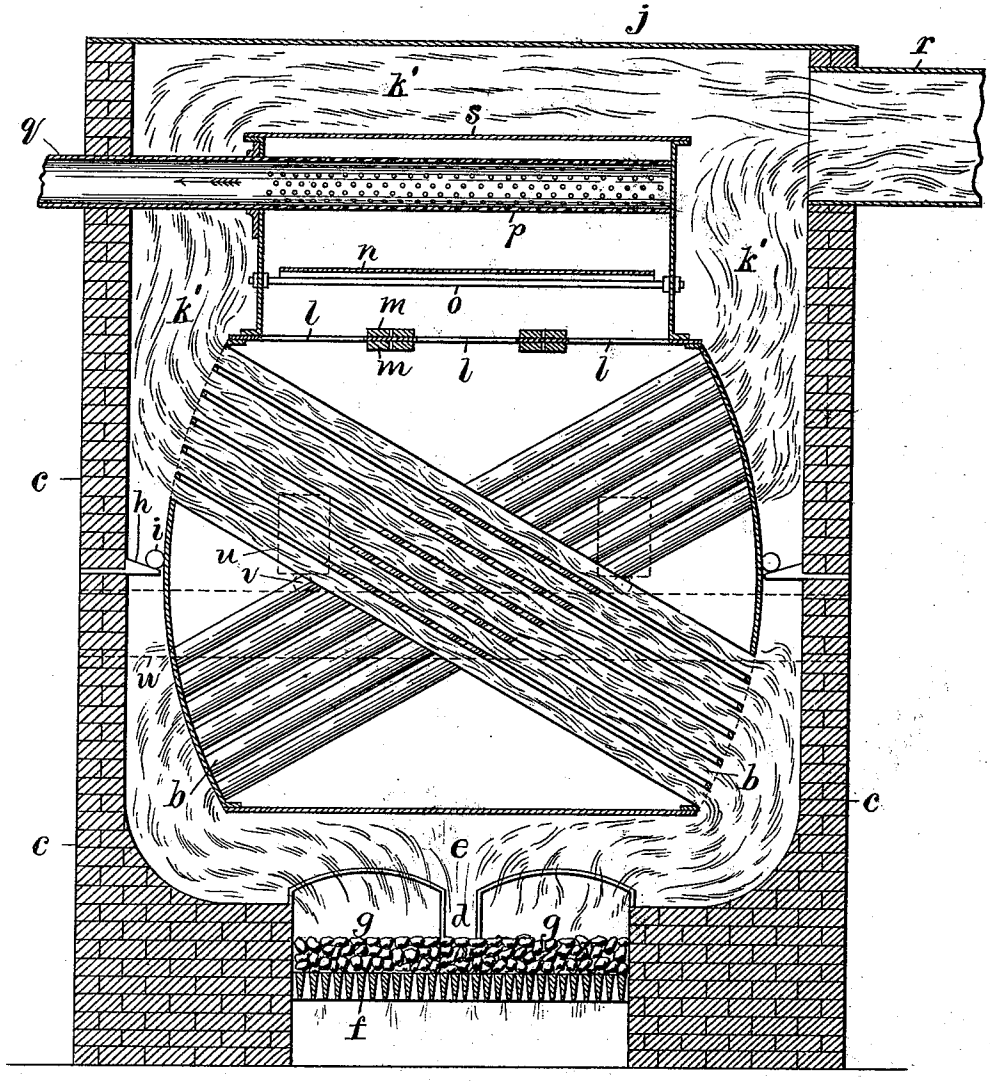
STEAM BOILER.

No. 505,940. Patented Oct. 3, 1893.

Fig. 7.



Attest:
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UNITED STATES PATENT OFFICE.

JOSEPH A. ENO, OF NEWARK, NEW JERSEY.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 505,940, dated October 3, 1893.

Application filed January 9, 1893. Serial No. 457,726. (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 Steam-Boilers, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

The object of this invention is to increase the fire surface in a tubular boiler so as to greatly augment its efficiency without increasing its dimensions. This object is attained in the present invention by extending two sets of inclined tubes through the shell alternately in opposite directions and applying a furnace to the lower ends of both sets of tubes.

It is well known that the fire surface upon the boiler adjacent to the furnace is much more efficient in the absorption of heat and generation of steam, than the heating surface upon other parts of the shell or within the return flues.

By my present construction I increase the fire surface very considerably by extending the furnace under the entire lower half of the boiler shell and by providing inclined fire tubes with their lower ends in the periphery of the shell directly over the furnace; and by forming a smoke chamber to retain the products of combustion in contact with the upper half of the shell as they issue from the tubes. The two sets of tubes necessarily cross one another within the boiler, and can be inserted in vertical rows to the best advantage by placing the tubes crosswise of the shell. By this arrangement of the tubes the gases are conducted through the two sets of tubes in opposite directions simultaneously, and are discharged from the upper ends of the tubes into a suitable smoke chamber. A steam dome is applied to the upper side of the shell between the upper ends of the two sets of tubes, and the smoke chamber is formed by inclosing the upper half of the boiler and the steam dome in a suitable jacket or casing. The smoke chamber is separated from the furnace by an expansion joint, and the jacket is provided with doors opposite to the upper ends of the tubes to facilitate the cleaning or repairing of the same. The tubes are arranged in vertical rows, and the alternate rows are inclined in opposite directions, thus bringing the lower ends of the tubes upon the opposite sides of the furnace and their upper ends upon the opposite sides of the smoke chamber. I prefer to employ a horizontal cylindrical shell, and the tubes may in such case be inserted through the shell either crosswise or lengthwise. Both arrangements are shown in the annexed drawings, in which—

Figure 1 is an end elevation of the boiler. Fig. 2 is a side elevation of the same. Fig. 3 is a cross section on line, $x\,x$, in Fig. 2. Fig. 4 is an elevation similar to Fig. 2, with the setting in section on the line x', x', in Fig. 3. Fig. 5 is an elevation like Fig. 1, with the brick wall removed outside the line y, y, in Fig. 4. Fig. 6 is a plan of the boiler shell with the steam dome in horizontal section on line z, z, in Fig. 5; and Fig. 7 shows an alternative construction with the tubes extended lengthwise of the boiler, the view being taken in vertical section upon the longitudinal section line.

In Figs. 1 to 6 inclusive, a designates the boiler provided with two sets of crosswise tubes b, b'. Walls c and d form a square furnace around the lower half of the shell the walls d touching the ends of the shell and thus confining the flames to the cylindrical surface. A fire box e, with grates f, is formed in the bottom of the furnace and fed through doors g in the walls c. The walls c extend up to the center of the shell, and are provided upon the top with sloping plate h upon which rolls i are placed to bear against the periphery of the boiler. A steam dome s is extended nearly the whole length of the boiler upon the top side, and the tubes b and b' are inclined upward through the shell from opposite sides of the furnace into the smoke chamber at the opposite sides of the steam dome. A jacket or casing j is extended from the walls c around the upper half of the boiler and its steam dome, and doors k are formed in the casing opposite the upper ends of the tubes. Apertures l are formed through the shell a to discharge the steam into the steam dome, and straps or bars m (see Fig. 3) are extended across the shell between the apertures to restore the strength which is impaired by such openings. A baffle plate n is shown within the steam dome in Figs. 3 and 7, supported upon brace rods o which are extended

lengthwise of the dome to support its ends. A dry-pipe p with perforations in its upper side is extended lengthwise through the upper part of the dome and connected with the steam outlet q. The walls d are extended upward to the top of the casing j and one of them is provided with a smoke outlet r to connect with a suitable chimney. Manholes, with covers t, are shown in the heads of the shell, and door frames t' with doors t^2 are shown in the walls d to afford access to such manholes and other parts of the boiler. The boiler is sustained by beams w which are arranged transversely across the heads of the boiler and supported upon the walls c. Rolls v are inserted between the top of each beam and the boiler brackets u, to permit of longitudinal expansion in the boiler, and the use of the rolls i with the inclined plates h at the sides of the boiler also furnish an expansion joint between the furnace and the smoke chamber k'. A water-column A is connected with the steam dome by pipe a', and with the boiler by pipe a^2, and is furnished with the usual glass gage B and water gage-cocks C. With this construction a large combustion chamber is provided between the grates f and the lower half of the shell a, and the course of the gases generated in the furnace is fully shown in Fig. 3. The flames which rise against the bottom of the shell are admitted at both sides of the same into the tubes b, b', whence they pass through the tubes to the upper half of the shell at opposite sides of the steam dome. The gases then circulate within the casing j in contact with the exterior of the steam dome, and the whole upper half of the shell, and are then discharged from the casing through the smoke pipe r.

By the present construction the body of water within the shell is not only intersected by the tubes in the most effective manner, but the products of combustion are admitted to the tubes in their hottest condition, and are thus adapted to produce a higher temperature in the water than when they have been conducted first through other passages, as is often done with horizontal tubular boilers.

By my construction the entire surface of the shell and of the tubes is, by its relation to the furnace, converted into fire surface, and each square foot of such surface is therefore of much greater efficiency in vaporizing the water than a similar area of heating surface in a different relation to the fire.

In my construction the boiler shell is preferably made of a short thick cylinder, and the flames are applied to its entire bottom half, from which they pass immediately into the upwardly inclined tubes b, b', which thus afford fire surface of the very best kind. The flames emerging from the upper ends of the tubes cover the entire upper surface of the boiler and also envelop the steam dome within the casing j; so that all the surface of the boiler is exposed to the gases in their hottest condition. The construction is thus adapted for rapid firing and for the generation of large volumes of steam within a contracted space, as in the case of marine boilers.

The ends of the tubes may be secured in the shell by screw threads, by thimbles, or by expanding tools, or by any other desired means, and the expanding tools can be operated successfully although all the tubes do not penetrate the shell at right angles. In the alternative construction shown in Fig. 7, the tubes are extended lengthwise of the shell so that their ends are inserted in the heads a' of the shell instead of the cylindrical drum a. To avoid staying the heads they are made convex which adapts them to receive the ends of the tubes at a convenient angle.

In Fig. 7 all the parts are lettered the same as in the other figures, excepting the tubes b^2 and b^3 which are arranged differently in such figure. In this alternative construction the expansion joint is formed at the ends of the boiler against the heads a', the sloping plates l being provided with suitable rolls i to prevent the passage of the gases from the furnace into the smoke chamber k'. The operation of this construction is precisely the same, all the tubes having their lower ends in the furnace and being inclined upwardly therefrom so as to discharge the gases into the smoke chamber above the middle line of the shell. The gases entering at one end of the boiler are necessarily discharged at the opposite end, and circulate thence around the upper half of the boiler shell and the steam dome s to reach the smoke outlet r.

In Fig. 3 the side walls c of the furnace are set off from the boiler at its middle line, and the grates are made considerably shorter than the space between such walls. This construction produces combustion chambers at each side of the boiler shell above the grate, in which chambers the gases are thoroughly ignited before they enter the tubes b, b'.

As shown in Fig. 4, the furnace extends the whole length of the boiler, in the preferred form of my invention; and very large space is thus provided for combustion, so that the gases are heated in the highest degree before they are discharged from the vicinity of the fuel. I thus secure the perfect ignition of the gases before they are brought into contact with the colder surfaces of the tubes, and secure a perfect combustion of the gases in their entire passage through the boiler.

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

1. The combination, with a horizontal cylindrical shell, of a furnace embracing the lower half of the boiler, a smoke chamber above the middle line of the boiler, vertical rows of tubes extended obliquely through the shell with the lower ends of the alternate rows upon the opposite sides of the furnace and their upper ends in the smoke chamber, substantially as herein set forth.

2. The combination, with a boiler shell, having two sets of tubes extended obliquely

through the shell from opposite sides, of a furnace for applying the gases simultaneously to the lower ends of both sets of tubes, means for sustaining the boiler over the furnace, a smoke chamber for receiving the gases from the upper ends of all the tubes, and an expansion joint between the furnace and the smoke chamber, substantially as set forth.

3. The combination, with the shell having two sets of tubes extended obliquely through the shell from opposite sides, of a steam dome upon the top of the shell, a furnace for applying the gases simultaneously to the lower ends of both sets of tubes, a smoke chamber inclosing the upper half of the shell and the steam dome, and an expansion joint between the furnace and smoke chamber, as set forth.

4. The combination, with the shell having two sets of tubes extended obliquely through the shell from opposite sides, of a steam dome upon the top of the shell, a furnace for applying the gases simultaneously to the lower ends of both sets of tubes, a smoke chamber inclosing the upper half of the shell and the steam dome, doors in the sides of the smoke chamber adjacent to the upper ends of the tubes, and an expansion joint between the smoke chamber and furnace, as set forth.

5. The combination, with a cylindrical shell, of a furnace with hangers at the ends of the shell to sustain the boiler above the same, a jacket forming a smoke chamber above the middle line of the boiler, an expansion joint between the furnace and smoke chamber, vertical rows of tubes extended transversely through the shell with the lower ends of the alternate rows upon the opposite sides of the furnace and their upper ends in the smoke chamber, and doors in the jacket opposite the upper ends of the tubes, as set forth.

6. The combination, with the shell having two sets of tubes extended obliquely through the shell from opposite sides, of a steam dome applied to the shell between the upper ends of the tubes and extended its entire length, apertures through the shell into the steam dome, and straps applied to the shell adjacent to the apertures to strengthen the shell, substantially as herein set forth.

7. The combination, with the shell having two sets of tubes extended obliquely through the shell from opposite sides, of a steam dome applied to the shell between the upper ends of the tubes and extended its entire length, apertures through the shell into the steam dome, a baffle plate in the steam dome above such apertures, and a perforated dry pipe in the upper part of the dome for discharging the steam therefrom, substantially as set forth.

8. The combination, with a horizontal cylindrical boiler and brick walls inclosing the same, of the expansion joint consisting in the inclined plate *h* attached to the wall and clear of the boiler, and the roll *i* applied to the plate in contact with the shell of the boiler, substantially as herein set forth.

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

JOSEPH A. ENO.

Witnesses:
L. LEE,
H. J. MILLER.