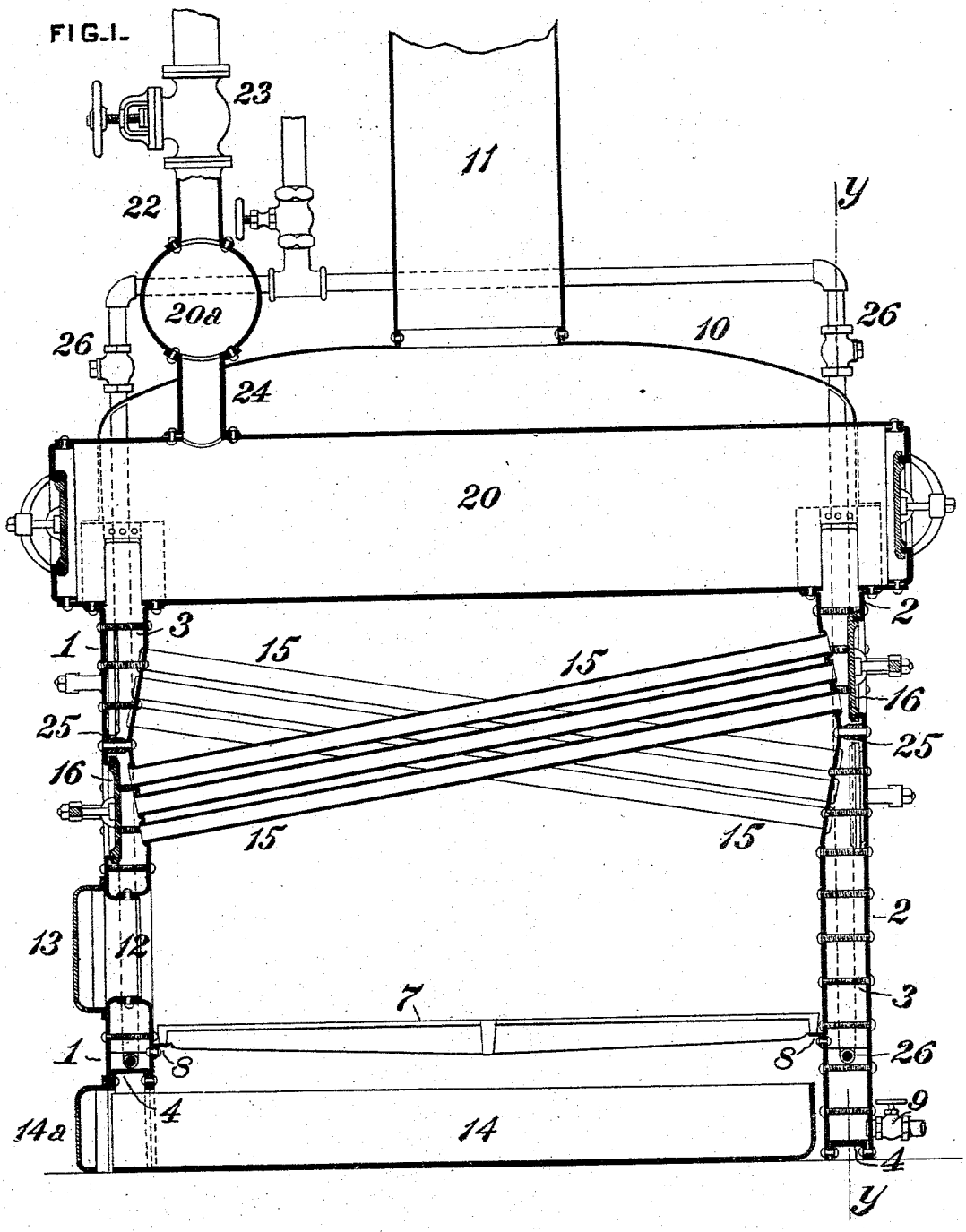
(No Model.) 3 Sheets—Sheet 1.

H. A. LAUGHLIN.

STEAM BOILER.

No. 490,119. Patented Jan. 17, 1893.

FIG. 1.



WITNESSES:

T. J. Hogan.

F. E. Gaither.

INVENTOR,

Henry A. Laughlin,

by Thornton Bell, Att'y.

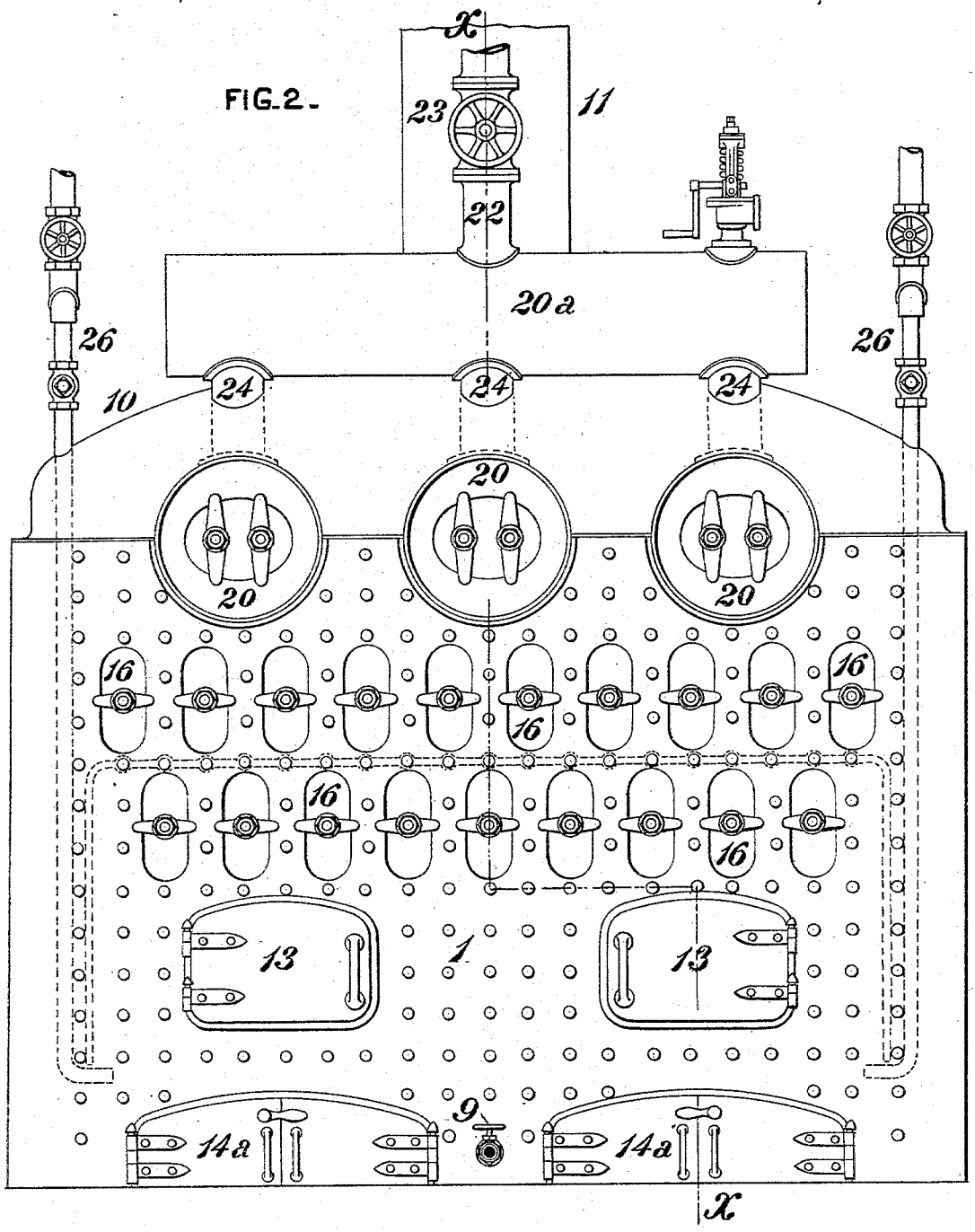
(No Model.) 3 Sheets—Sheet 2.

H. A. LAUGHLIN.

STEAM BOILER.

No. 490,119. Patented Jan. 17, 1893.

FIG. 2.



WITNESSES:

T. J. Hogan.

F. E. Gaither

INVENTOR,

Henry A. Laughlin,

by Alexander Bell, Att'y.

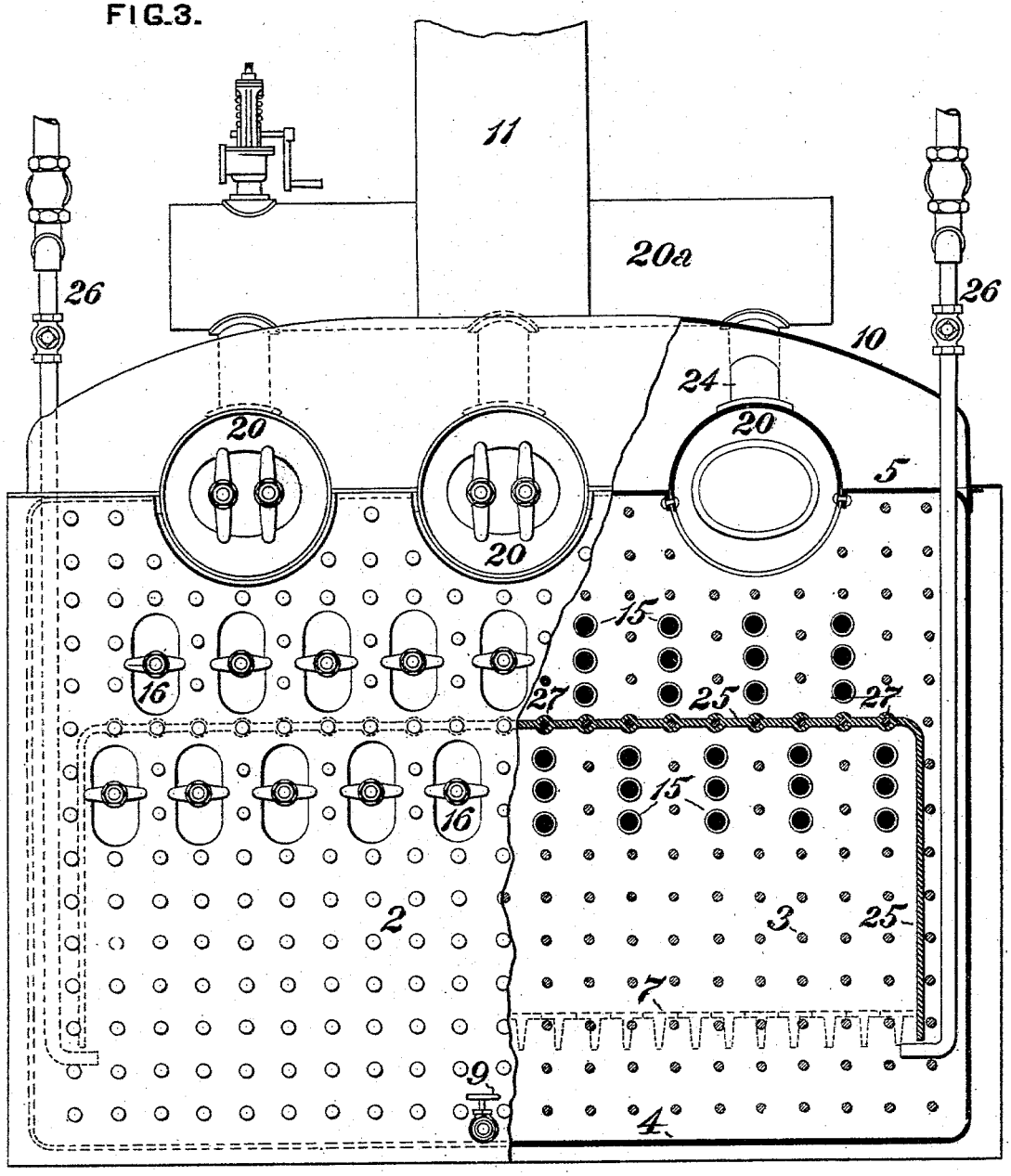
(No Model.) 3 Sheets—Sheet 3.

H. A. LAUGHLIN.

STEAM BOILER.

No. 490,119. Patented Jan. 17, 1893.

FIG. 3.



WITNESSES:

T. J. Hogan.
F. E. Galther

INVENTOR,

Henry A. Laughlin,
by J. Howard Bell, Att'y.

UNITED STATES PATENT OFFICE.

HENRY A. LAUGHLIN, OF PITTSBURG, PENNSYLVANIA.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 490,119, dated January 17, 1893.

Application filed September 14, 1892. Serial No. 445,880. (No model.)

To all whom it may concern:

Be it known that I, HENRY A. LAUGHLIN, a citizen of the United States, residing at Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented or discovered a certain new and useful Improvement in Steam-Boilers, of which improvement the following is a specification.

The object of my invention is to provide a "tubulous" or "water tube" steam boiler, of simple, strong, and comparatively inexpensive construction, in which a large amount of grate area and direct heating surface may be afforded within small compass, without involving the employment of the large number of joints and connecting elements ordinarily used in boilers of this type, as well as to render all portions of the structure readily and conveniently accessible for purposes of cleaning, repair or renewal, to insure a free, rapid, and continuous circulation of water, and to afford ample facilities for the delivery of dry steam.

To this end, my invention, generally stated, consists in the combination of two end casings or legs, a steam receptacle connected thereto adjacent to their upper ends, inclined water tubes connecting said end casings, and a diaphragm or circulating plate located in one of said end casings above the lower ends of the water tubes.

The improvement claimed is hereinafter fully set forth.

In the accompanying drawings: Figure 1 is a vertical longitudinal section, at the line x, x, of Fig. 2, through a steam boiler illustrating a form of embodiment of my invention; Fig. 2, a front view of the same, and; Fig. 3, a rear view, partly in section at the line y, y, of Fig. 1.

In the practice of my invention, I provide a front and a rear end casing or leg, 1, 2, each of which is of substantially rectangular form, and is constructed similarly to the water legs of ordinary tubular boilers, that is to say, formed of sheets set at a proper distance apart to provide an intermediate water space, and connected and braced, as against internal pressure, by socket bolts, or by screw stays 3, as shown, the casings being closed at bottom by mud rings, or, as shown, by channel plates 4, and being closed at top, (except where they communicate with a steam drum or drums, as presently to be described) by similar plates 5, and being also closed at their sides. The casings 1 and 2 are set at such distance apart as to afford space between them for a fire and combustion chamber of the length desired, and may, if desired, be connected by longitudinal tie rods. A fire grate 7, which, in this instance, is composed of grate bars of the ordinary form, extending longitudinally from one casing to the other, but which may, if desired, be a water grate, is supported on bearers 8, above the lower ends of the casings, which extend downwardly for a sufficient distance to provide a space removed from the direct action of the fire, for the deposition of separated impurities, which may be discharged, as from time to time required, by suitable blow off cocks 9.

The space between the end casings is closed, at its sides, by walls which may, in stationary boilers, be of brick, or, in the case of marine or portable boilers, be formed of light sheet metal, lined with fire brick or tile, and cased with wood or any suitable and preferred non-conducting covering. The fire and combustion chamber, formed by the space between the casings above the grate 7, is closed at top by a cap plate 10, provided with an exit flue or stack 11, and access to the fire chamber is had through one or more openings 12 in the front casing, located above the grate and provided with the usual fire doors 13. An ash pan 14 is located below the grate, and ash pan doors 14^a, at the front thereof, are provided for the regulation of draft and the removal of ashes.

The end casings 1 and 2 are connected, at lower and higher levels respectively, by inclined water tubes 15, which are secured, at their opposite ends, to, as by being expanded into, the inner sheets of the respective sections, and which thereby establish communication between the water spaces of the two casings. The water tubes 15 are preferably arranged in vertical rows of two or any desired greater number, three being shown in each vertical row in the drawings, and with an alternately opposite inclination of the respective vertical rows. It will be obvious that the number of tubes or of vertical rows, and the number of tubes in a vertical row, may be varied in the discretion of the constructer, in

accordance with the proportions of width and height of the boiler which may be adopted in different cases. Removable plates 16 are inserted in and secured to the outer sheets of the casings 1, 2, opposite the ends of the tubes 15, said plates closing openings in the sheets for the insertion of the tubes, and of an expanding tool for securing the tubes in position in the sheets, as also for admitting access to the tubes when desired for cleaning or removal. In order to enable the tubes 15 to be securely expanded in the inner sheets of the casings, as well as to promote circulation, as hereinafter described, the inner sheets may be bent outwardly and inwardly opposite the lower and upper ends, respectively, of the tubes, as shown in Fig. 1, so that their surfaces will be perpendicular, or approximately so, to the tubes, at each end thereof.

In order to provide proper and ample steam liberating surface and steam chamber volume, the casings 1 and 2 are, near their upper ends, connected to and communicate with a steam drum or drums, in which the normal water level is maintained. In the instance shown, a series of cylindrical drums 20 is employed, thereby affording a material increase of liberating surface, as compared with a single one, without involving the weakness due to the necessarily larger diameter of the latter. The drums 20 extend across the combustion chamber, which incloses their lower portions between the end casings, and the drums may be riveted to flanges turned on the inner and outer sheets of the casings 1 and 2, or be connected thereto by angle irons. The steam supply pipe 22, leading to the engine, is provided with the usual stop valve 23, and is, in this instance, shown as connected to a supplemental steam drum 20^a, which extends transversely to the drums 20, and is connected thereto by short pipes 24.

A diaphragm or circulating plate 25 is fitted between the inner and outer sheets of each of the end casings 1 and 2, a short distance above the lower ends of the upper rows of water tubes 15, said plates being preferably, as shown, located between the inwardly and outwardly bent portions of the inner sheets of the casings, and therefore at or near the narrowest portions of the water spaces. The circulating plates extend horizontally across the casings from points between the outer rows of tubes and the adjacent ends of the casings, and are then downwardly prolonged, at one or both ends, to a level adjacent to, and preferably below, that of the grate, a vertical passage or passages, one of which is seen on the right of Fig. 3, being thus provided between the downwardly extending portion or portions of each circulating plate and the adjacent end or ends of the casing. In the instance shown, the circulating plates 25 are downwardly extended at both ends, but if so extended at one end only, their horizontal portions should extend to the opposite ends of the casings. The circulating plates may be connected to the inner and outer sheets in any suitable manner, and are here shown as provided with a series of sockets 27, through which passes a line of screw stays 3, connecting the inner and outer sheets and securing the circulating plates thereto.

When located as above described, the circulating plates 25 act to intercept the upward passage of currents of water in the end casings beyond the lower ends of the upper water tubes 15 of each vertical row, and to deflect said currents into the tubes, through which they pass, exposed to the direct action of the fire, and are, by reason of the upward inclination of the tubes, and of their tendency to ascend when heated, delivered, at a higher level, into the water spaces of the opposite casings, being replaced by currents of cooler water, which descend, through the spaces between the downward projections of the circulating plates and the ends of the casings, and thereafter ascend, through the water spaces below the horizontal portions of the circulating plates, by which they are in turn deflected into the lower ends of the water tubes. The inclined portions of the inner sheets and the circulating plates provide receiving spaces diminishing in capacity from bottom to top, and delivery spaces increasing in capacity from bottom to top, thereby correspondingly promoting the ingress and egress of water to and from the tubes.

Feed water pipes 26, provided with ordinary check valves, and adapted to be connected to a pump or injector, are led into the casings 1 and 2, with their discharge ends opening thereinto below the diaphragms or circulating plates 25, and in order to impart heat to the entering feed water, as well as to assist in cooling those portions of the casings in which it is desired that a downward traverse of water shall take place, the feed pipes 26 may, as shown, enter the casings 1 and 2 at their tops and extend downwardly through the same to points below the ends of the downward portions of the diaphragms, and then be extended horizontally toward the center lines of the casings.

It will be obvious that as an alternative and equivalent construction, the diaphragms 25 may, if desired, be extended entirely across the casings 1 and 2, and communication established for the passage of water from their upper to their lower sides by outside pipes, connected to the casings above and below the diaphragms, into which connecting pipes the feed water pipes may be led. The construction shown is, however, deemed preferable, in the particulars of being within the requirements of a self contained boiler, and of affording ample space for the downward passage of water, in the normal and desired circulation thereof during steam generation.

While, in the construction herein shown, the fire chamber is provided with a lower fire grate for the combustion of solid fuel, such fire grate is not an essential of my invention,

and is not employed in cases where waste gases from furnaces, or other gaseous fuel, is desired to be utilized in the generation of steam.

In the operation of a boiler in which the essential elements of the construction above described are embodied, the action of the radiant heat of the ignited fuel upon the grate, and the heat of the products of combustion thereof which pass upwardly to the stack 11, is exerted directly upon the inner walls of the end casings 1 and 2, the surfaces of the water tubes 15, and the lower portions of the drums 20. The water in the end casings below the circulating plates, and in the inclined water tubes 15, as it becomes heated, ascends through the water tubes, and is delivered to the portions of the end casings above the circulating plates, and thence to the drums 20, its place being supplied by colder water, which descends in the casings through the passages between the downward projections of the circulating plates 25 and the adjacent ends of the casings, these passages being preferably formed, as indicated in the drawings, by extensions of the casings beyond the grate and side walls of the fire chamber, so that they are not exposed to the direct heat of the fire. As the cooler water passes under, and enters the water spaces on the inner sides of the downward projections of the diaphragms 25, it is heated, and ascending through said spaces, enters the lower or receiving ends of the water tubes, being prevented from passing above the upper tubes of the vertical rows by the horizontal portions of the diaphragms, as before explained. The active circulation thus instituted is promoted by the heat imparted to the rising currents of water in their passage through the inclined water tubes, and is insured by the delivery of the feed water into a portion of the boiler from which its natural and unopposed tendency is to ascend and pass into the receiving ends of the water tubes.

My improvement is particularly adaptable to marine service, and to conditions where the rapid and safe generation of steam of high pressure is required to be effected within comparatively limited space. It will be seen that under a construction substantially as above described, a rapid and constant natural circulation of water may be effected, with a corresponding evaporative efficiency, and that any desired amount of grate and heating surface permitted by determined circumscribing limits may be provided. A further feature of substantial practical advantage is the avoidance of the numerous tube joints ordinarily found in boilers of this type, and which are frequently so located as to be rapidly deteriorated by the direct action of the fire, and to be difficult of access for removal and repair. The only tube joints necessary under my improved construction are those made with the inner sheets of the end casings, which are readily and securely made by expanding, and are conveniently accessible without disturbing any other members, by the removal of the oppositely located plates in the outer sheets. The large area of liberating surface afforded by the drums, and the direct connection of the latter with the end casings are, further, of material advantage in the prevention of priming, by promoting the delivery of dry steam.

I claim as my invention, and desire to secure by Letters Patent:

1. The combination, in a steam boiler, of two end casings or legs, an upper steam receptacle connected to said casings, inclined water tubes connecting said casings, and a diaphragm or circulating plate located in one of said casings above the lower ends of the water tubes, substantially as set forth.

2. The combination, in a steam boiler, of two end casings or legs, an upper steam receptacle connected to said casings, oppositely inclined water tubes connecting said casings, and a diaphragm or circulating plate located in each of said casings between the lower ends of the tubes which are inclined in one direction and the upper ends of the tubes which are inclined in the other direction, substantially as set forth.

3. The combination, in a steam boiler, of two end casings or legs having portions of their inner sheets inclined relatively to their outer sheets, an upper steam receptacle connected to said casings, inclined water tubes connected at opposite ends to the inclined portions of the inner sheets of the casings, and diaphragms or circulating plates located in each of said casings above the upper and below the lower ends, respectively, of the water tubes, so as to provide receiving spaces diminishing upwardly in capacity, and delivery spaces increasing upwardly in capacity, substantially as set forth.

4. The combination, in a steam boiler, of two end casings or legs, an upper steam receptacle connected to said casings, inclined water tubes connecting said casings, a diaphragm or circulating plate located in one of said casings above the lower ends of the water tubes, a water passage connecting the spaces above and below the circulating plate, and a feed water pipe leading into the space below the circulating plate, substantially as set forth.

5. The combination, in a steam boiler, of two end casings or legs, an upper steam receptacle connected to said casings, inclined water tubes connecting said casings, a diaphragm or circulating plate located in one of said casings above the lower ends of the water tubes, a downwardly projecting extension connected to either or both ends of the circulating plate and forming the inner wall of a water passage connecting the spaces above and below the horizontal diaphragm, and a feed water pipe leading into the space below the diaphragm, substantially as set forth.

6. The combination, in a steam boiler, of

two end casings or legs, an upper steam receptacle connected to said casings, an interposed combustion chamber of less width than said casings, inclined water tubes connecting said casings, a horizontal diaphragm or circulating plate located in one of said casings above the lower ends of the water tubes, a downwardly projecting extension connected to either or both ends of the circulating plate and forming the inner wall of a water passage in the portion of the casing projecting beyond the combustion chamber, which passage connects the spaces above and below the horizontal circulating plate, and a feed water pipe leading into the space below the diaphragm, substantially as set forth.

In testimony whereof I have hereunto set my hand.

HENRY A. LAUGHLIN.

Witnesses:
J. SNOWDEN BELL,
F. E. GAITHER.