(No Model.) 3 Sheets—Sheet 1.

H. A. LAUGHLIN.

STEAM BOILER.

No. 490,120. Patented Jan. 17, 1893.

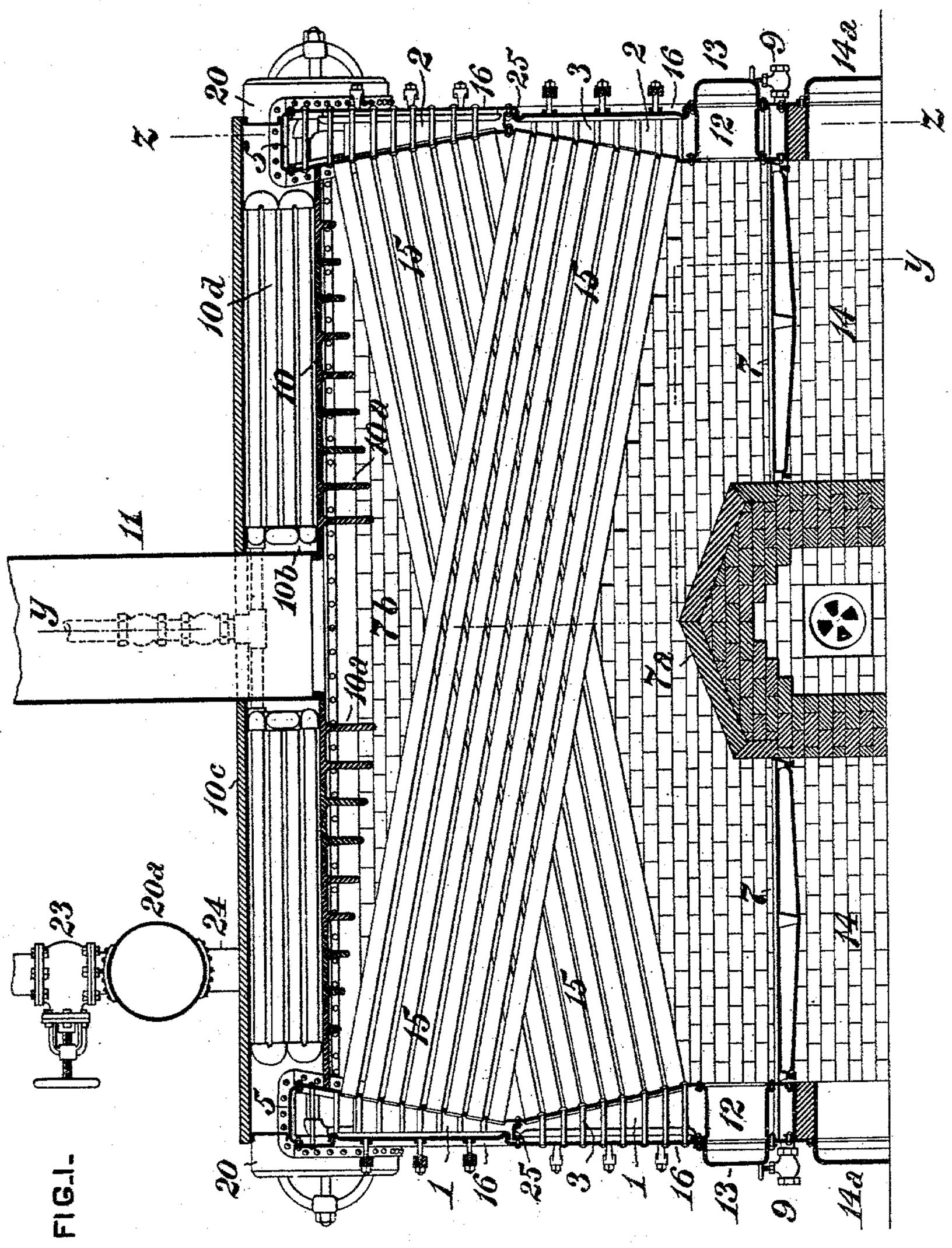

FIG. 1.

WITNESSES:

T. J. Hogan.

F. E. Gaither

INVENTOR,

Henry A. Laughlin,

by Attorndew Bell. Att'y.

(No Model.)

3 Sheets—Sheet 2.

H. A. LAUGHLIN.

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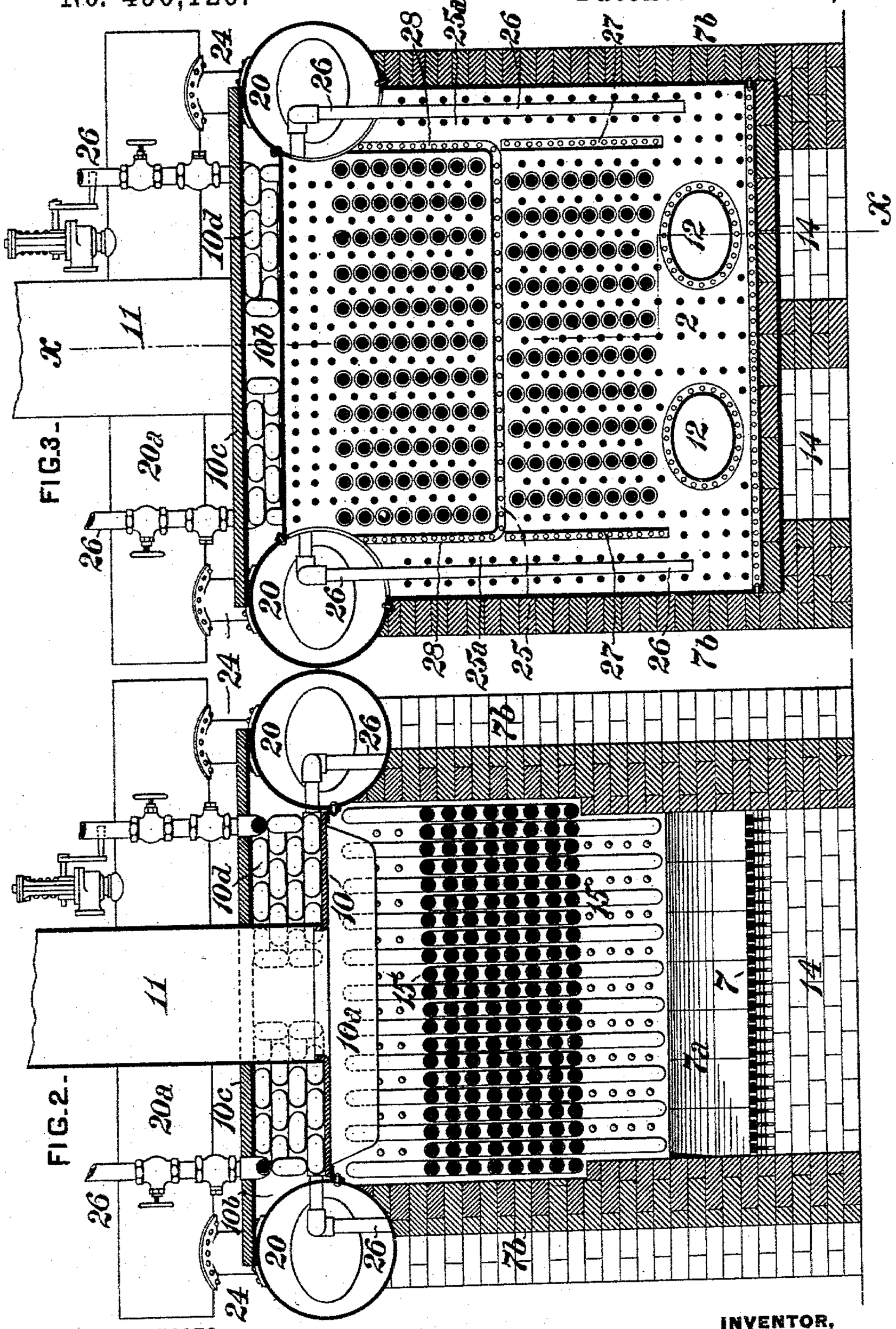

INVENTOR,
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Att'y.

(No Model.) 3 Sheets—Sheet 3.

H. A. LAUGHLIN.

STEAM BOILER.

No. 490,120. Patented Jan. 17, 1893.

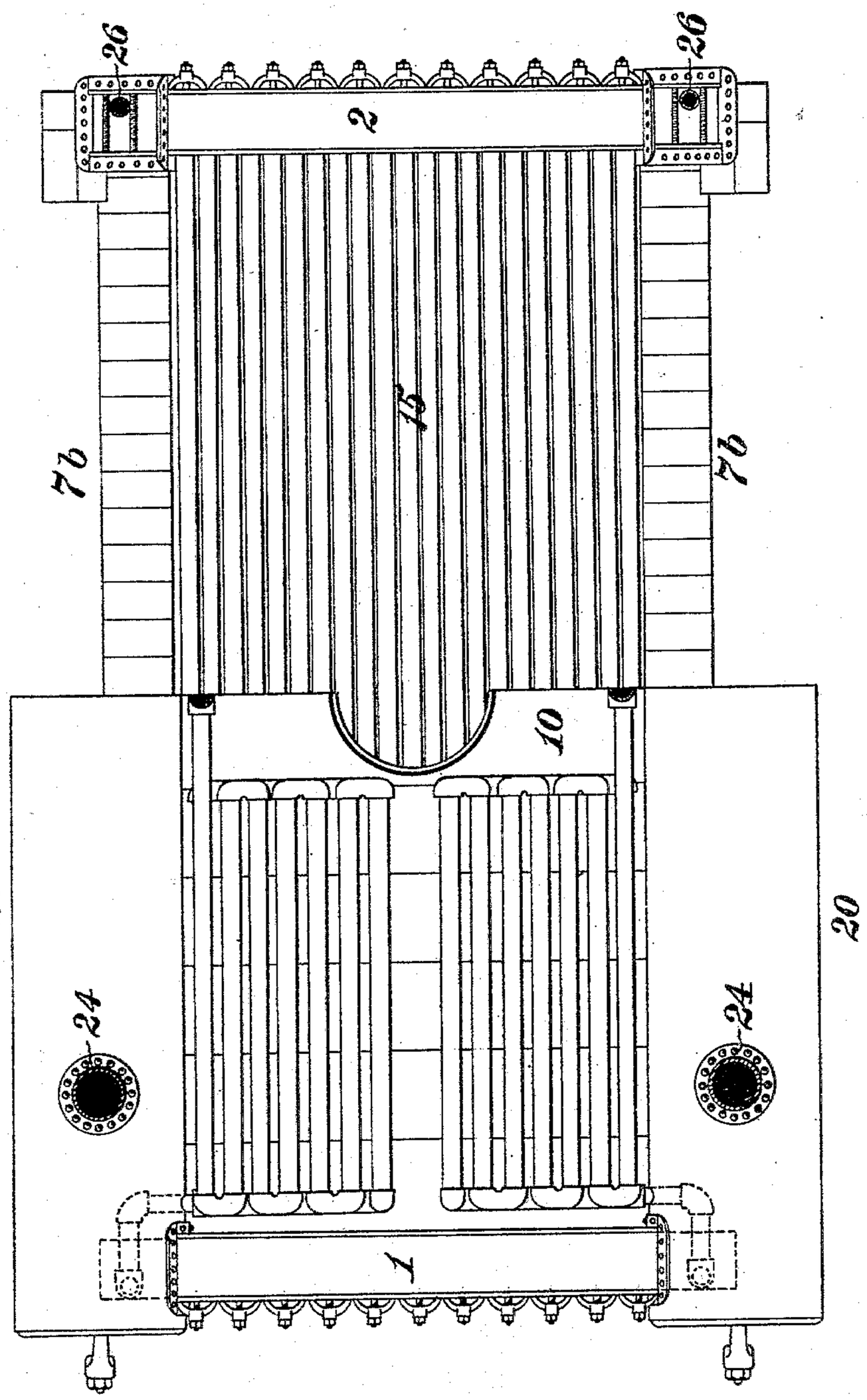

FIG.4.

WITNESSES:

T. J. Hogan.

F. E. Gaither

INVENTOR,

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Att'y.

UNITED STATES PATENT OFFICE.

HENRY A. LAUGHLIN, OF PITTSBURG, PENNSYLVANIA.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 490,120, dated January 17, 1893.

Application filed November 15, 1892. Serial No. 452,034. (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, inclined water tubes connecting said casings, a transverse diaphragm or circulating plate located in one of said casings above the lower ends of the water tubes, and a vertical diaphragm or circulating plate extending between the transverse diaphragm and the upper portion of the casing; also in certain other novel combinations hereinafter fully set forth.

In the accompanying drawings: Figure 1 is a vertical longitudinal section, at the line x, x, of Fig. 3, through a steam boiler illustrating a form of embodiment of my invention; Figs. 2 and 3, vertical transverse sections, at the lines y, y, and z, z, respectively, of Fig. 1, and; Fig. 4, a plan or top view, the cap of the feed water heater casing being removed, in the left hand half of the figure, and the steam and water receptacles and entire feed water casing being removed, in the right hand half of the figure.

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, 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, in the lower portion of which there is fitted a fire grate or grates 7, of any suitable and preferred construction.

Where comparatively long tubes are employed, as in the instance shown, and in other cases where desirable, a central fire bridge 7^a, which may be provided with means for the admission of air above the grates, is extended across the fire and combustion chamber, and a grate 7 is placed on each side of the fire bridge, said grates extending therefrom to the respective adjacent end casings 1 and 2, and being supported in the usual manner. The grates 7 are shown, in this instance, as composed of grate bars of the ordinary form, but may, if desired, be water grates. The lower ends of the casings 1 and 2 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 provision of a central fire bridge and separate end grates, in the fire and combustion chamber, enables the heat of the fuel to be fully applied to the inclined water tubes throughout their entire length, and obviates any tendency, which might otherwise be found, for the escaping products of combustion to escape to the stack without exerting their calorific effect upon the entire length of the tubes around which they pass. The space between the end casings is closed, at its sides, by walls 7^b, 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-con-

ducting covering. The fire and combustion chamber, formed by the space between the end casings 1 and 2 and side walls 7^b, is closed at top by a cap plate 10 provided with a central exit flue or stack 11, and access to the fire chamber is had through one or more openings 12 in the end casings, said openings being located above the grates and provided with the usual fire doors 13. Ash pits 14 are located below the grates, and ash pit doors 14^a, are provided for the regulation of draft and the removal of ashes. The end casings 1 and 2 are connected, at their 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, eight 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 constructor, 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 sheet 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 tops and at their ends, connected to, and there communicate with, a steam and water receptacle or drum 20, in which, and in the casings 1 and 2, the normal water level is maintained. As shown in the drawings, two cylindrical drums 20 are preferably employed, one being located above, and resting on the top of, each side wall 7^b, and communicating near each of its ends, by a lateral opening or passage in its shell, with the adjacent end casing 1 or 2. The inner face of each side wall 7^b is tangential, or nearly so, to the adjacent drum, the drums thus extending parallel with, but exterior to, the fire and combustion chamber.

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 suppiemental steam drum 20^a, which extends transversely to the drums 20, and is connected thereto by short pipes 24.

The cap plate 10, of the fire and combustion chamber, is preferably formed of cast iron, and forms the lower wall of a feed water heater chamber 10^b, which is closed at top by a cap or cover 10^c, extending from one drum 20 to the other.

A feed water heater 10^d, of any suitable and preferred construction may be located in the chamber 10^b, the form shown in the drawings consisting of a series of return bends or manifolds formed in the feed water pipes 26.

In order to promote the transmission of heat to the feed water heater chamber as well as to deflect the heated products of combustion toward the surfaces of the upper tubes 15, a series of downwardly extending ribs or flanges 10^a, is formed upon the lower side of the cap plate 10, said ribs increasing in depth from the ends toward the central portion of the plate, in accordance with the inclination of the tubes.

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 upwardly prolonged, by a vertical extension 28, at one or both ends, to or near the openings in the shell of the adjacent drum or drums 20, a vertical water passage 25^a, being thus provided between each of the diaphragms 28 and the adjacent end of the casing, as shown in Fig. 3. Circulating plates 27, in or about in line with the diaphragms 28, are also fitted in the casings 1 and 2, and extend from points adjacent to the diaphragms 25 to points slightly below the lower ends of the lowest rows of tubes 15, so that the water passages 25^a are caused to extend from the drums to a level near or slightly below that of the lowest rows of tubes. The several diaphragms may be connected to the inner and outer sheets in any suitable manner.

When located as above described, the circulating plates 25 and 27 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 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 passages 25^a, and thereafter ascend through the water

spaces below the diaphragms 25 and between the diaphragms 27, by which they are, in turn, deflected into the water tubes. The diaphragms 28 divide the downward currents of cooler water from the upward currents of hotter water passing out of the upper ends of the tubes 15, and prevent interference of these respective currents, one with the other, a substantially continuous passage being provided for the currents of cooler water from the drums 20 to the lower portions of the end casings 1 and 2.

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, said feed pipes being preferably connected with suitable feed water heaters 10^d, as before described. In the instance shown, the feed water pipes extend below the lower vertical diaphragms 27, so as to deliver the feed water into the coolest portions of the boiler, and at points where it most readily tends to enter the lower ends of the water tubes 15. 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 be 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. 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, and the surfaces of the water tubes 15. 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 water passages 25^a between the vertical circulating plates 28, 27, and the adjacent ends of the casings, these passages being preferably formed, as indicated in the drawings, by outward extensions of the casings 1 and 2 beyond the grate and inner surfaces of the 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 vertical diaphragms 27, 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 diaphragms 25 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 is, further, of material advantage in the preventation of priming, by promoting the delivery of dry steam.

A steam boiler of the same general type as that herein set forth, forms the subject matter of applications Serial Nos. 432,033 and 445,880, filed by me under dates of May 5 and September 14, 1892, respectively. Such features of construction described and shown herein as may accord, in substance, with features set forth in said applications, are, therefore, not claimed as of my present invention.

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, inclined water tubes connecting said casings, a transverse diaphragm or circulating plate located in one of

said casings above the lower ends of the water tubes, and a vertical diaphragm or circulating plate extending between the transverse diaphragm and the upper portion of the casing, substantially as set forth.

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

3. The combination, in a steam boiler, of two end casings or legs, an upper steam and water receptacle connected to said casings, a transverse diaphragm or circulating plate located in one of said casings above the lower ends of the water tubes, and a vertical diaphragm or circulating plate extending from said transverse diaphragm to or near an opening in the steam and water receptacle, substantially as set forth.

4. The combination, in a steam boiler, of two end casings or legs, inclined water tubes connecting said casings, a transverse diaphragm or circulating plate located in one of said casings above the lower ends of the water tubes, and vertical diaphragms or circulating plates extending between the transverse diaphragm and the upper and lower portions, respectively, of the casing, substantially as set forth.

5. The combination, in a steam boiler, of two end casings or legs, inclined water tubes connecting said casings, a fire and combustion chamber inclosed by said casings and by side walls and a cap plate extending between them, an upper steam and water receptacle connected to and communicating with the outer ends of said casings, so as to be substantially exterior to the fire and combustion chamber, inclined water tubes connecting said casings, a transverse diaphragm or circulating plate located in one of said casings, above the lower ends of the water tubes, and a vertical diaphragm or circulating plate extending from said transverse diaphragm to or near an opening in the steam and water receptacle, substantially as set forth.

6. The combination, in a steam boiler, of two end casings or legs, inclined water tubes connecting said casings, a fire and combustion chamber inclosed by said casings and by side walls and a cap plate extending between them, an upper steam and water receptacle connected to and communicating with the outer ends of said casings, so as to be substantially exterior to the fire and combustion chamber, inclined water tubes connecting said casings, a transverse diaphragm or circulating plate located in one of said casings, above the lower ends of the water tubes, and vertical diaphragms or circulating plates extending between an opening in the steam and water receptacle and the lower portion of the casing, so as to form a water passage, between the outer row of tubes and the adjacent end of the casing, from the steam and water receptacle to a level below the lower rows of tubes, substantially as set forth.

In testimony whereof I have hereunto set my hand.

HENRY A. LAUGHLIN.

Witnesses:
J. SNOWDEN BELL,
R. H. WHITTLESEY.