

No. 672,251.

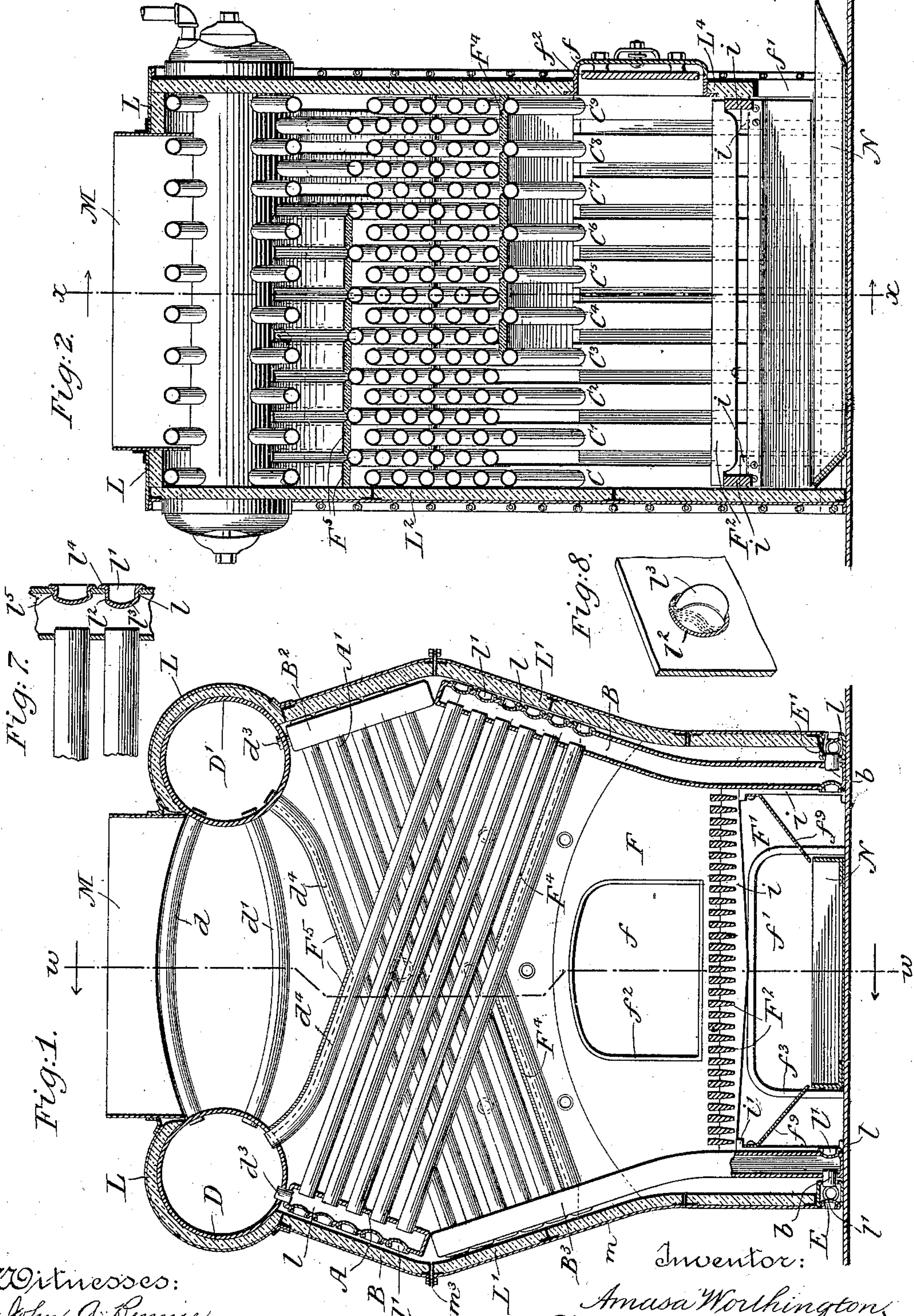
Patented Apr. 16, 1901.

A. WORTHINGTON.
BOILER.

(No Model.)

(Application filed Jan. 8, 1901.)

3 Sheets—Sheet 1.



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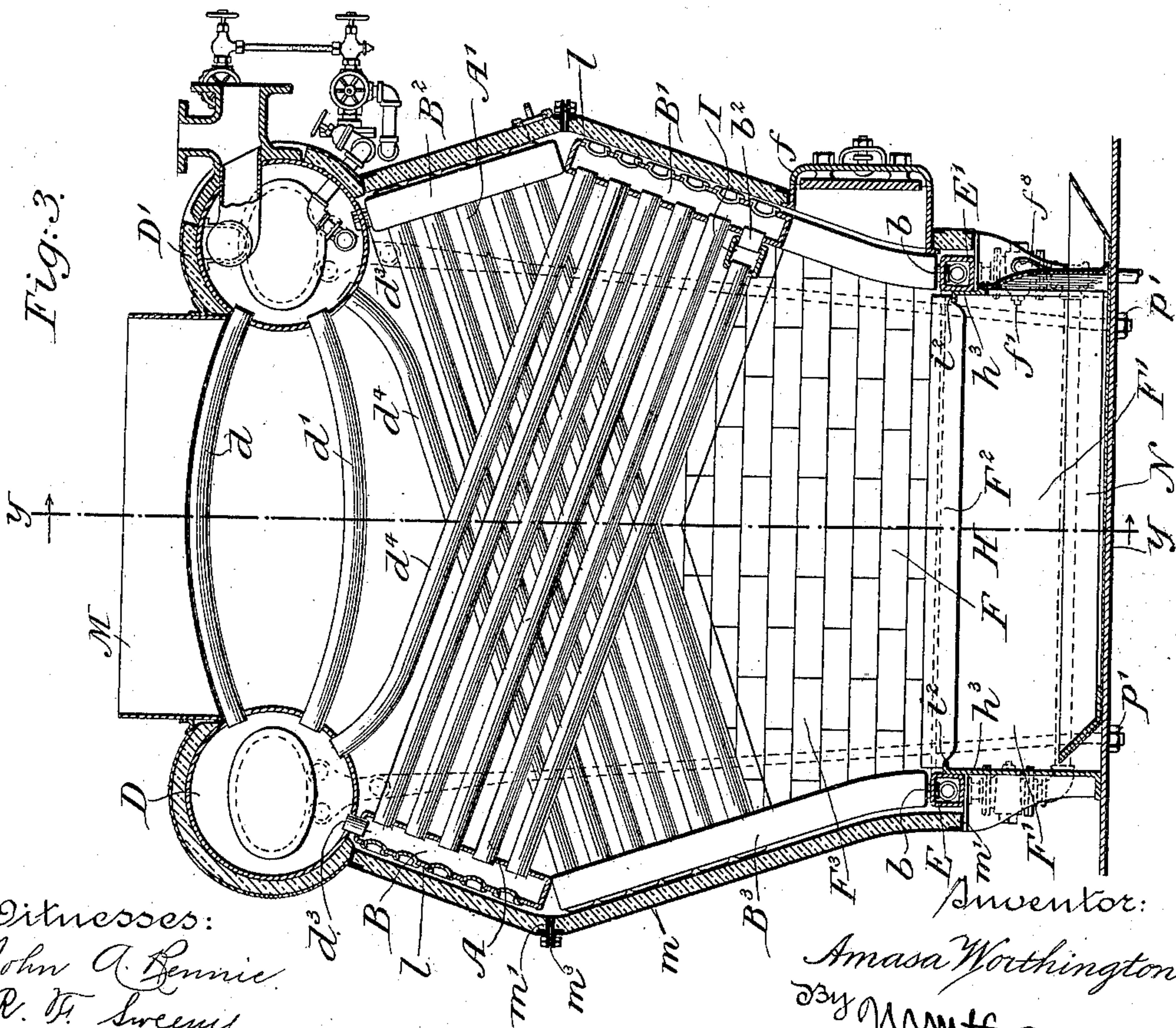
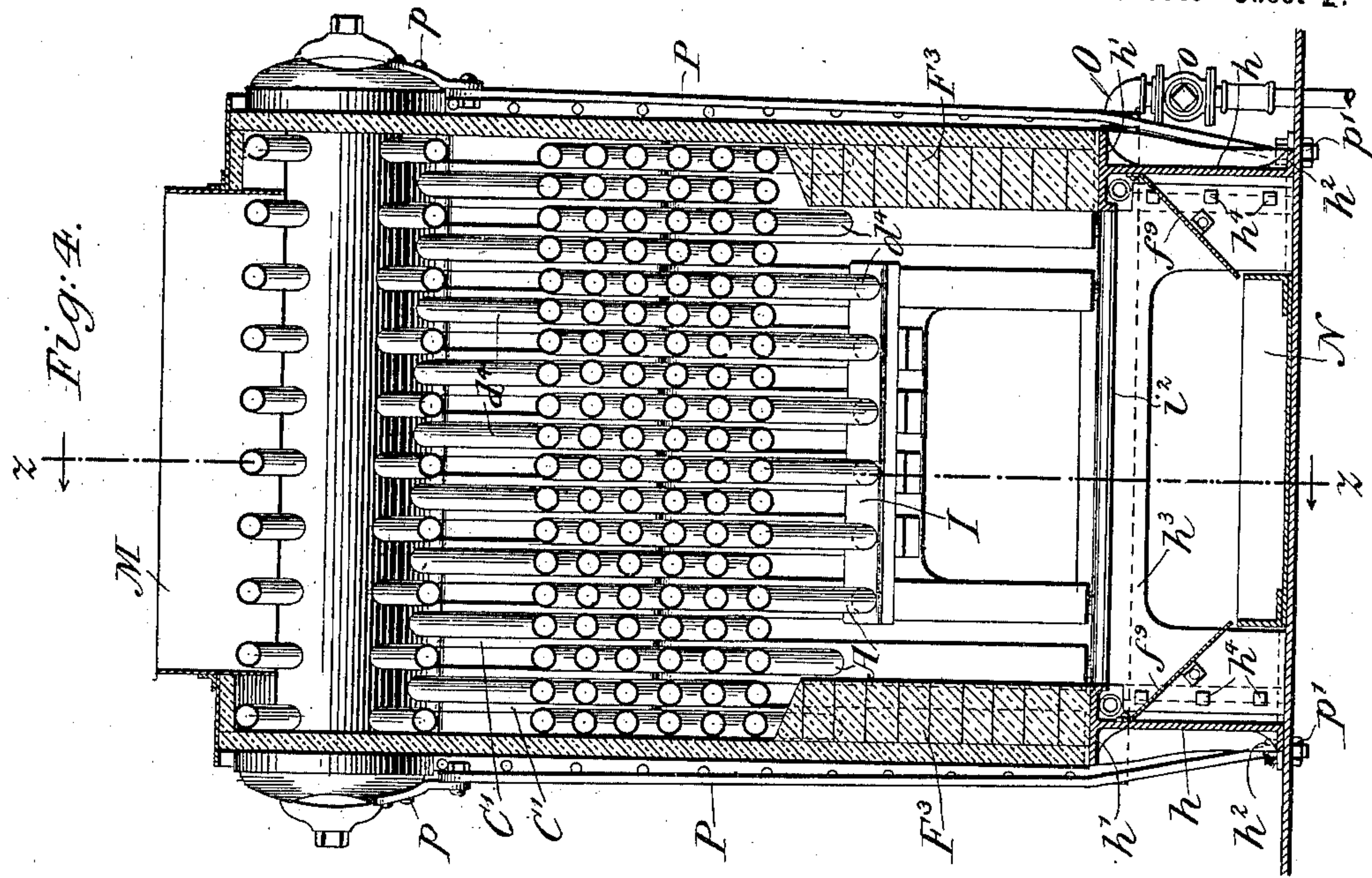
A. WORTHINGTON.
BOILER.

Patented Apr. 16, 1901.

(No Model.)

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3 Sheets—Sheet 2.



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3 Sheets—Sheet 3.

Fig. 6.

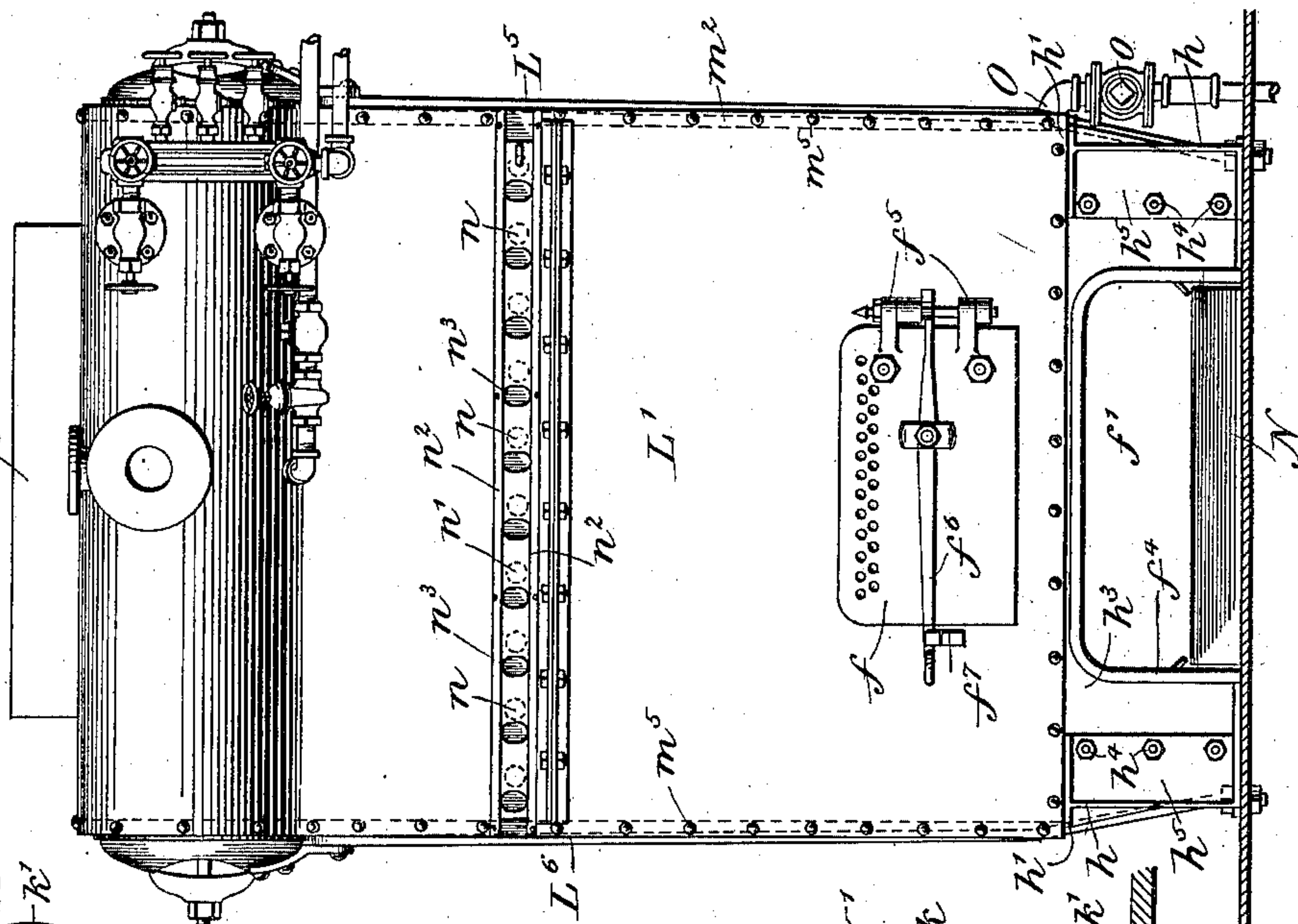


Fig. 10.

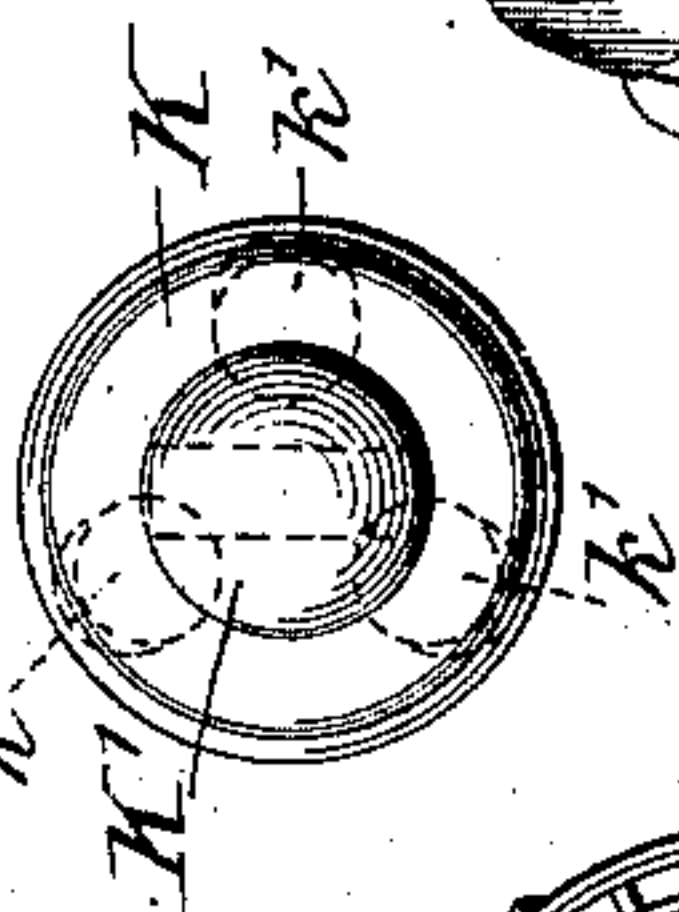


Fig. 5.

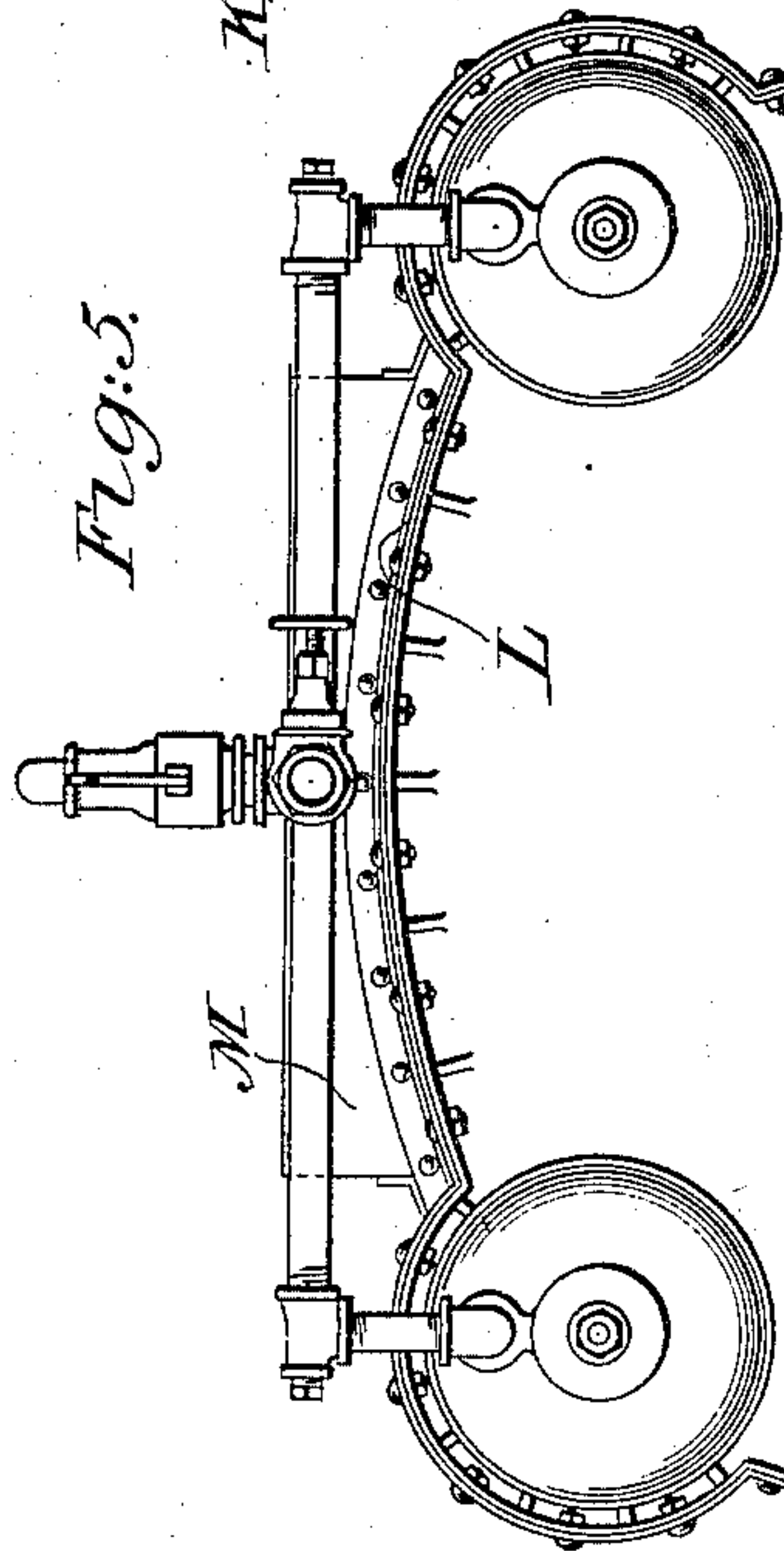
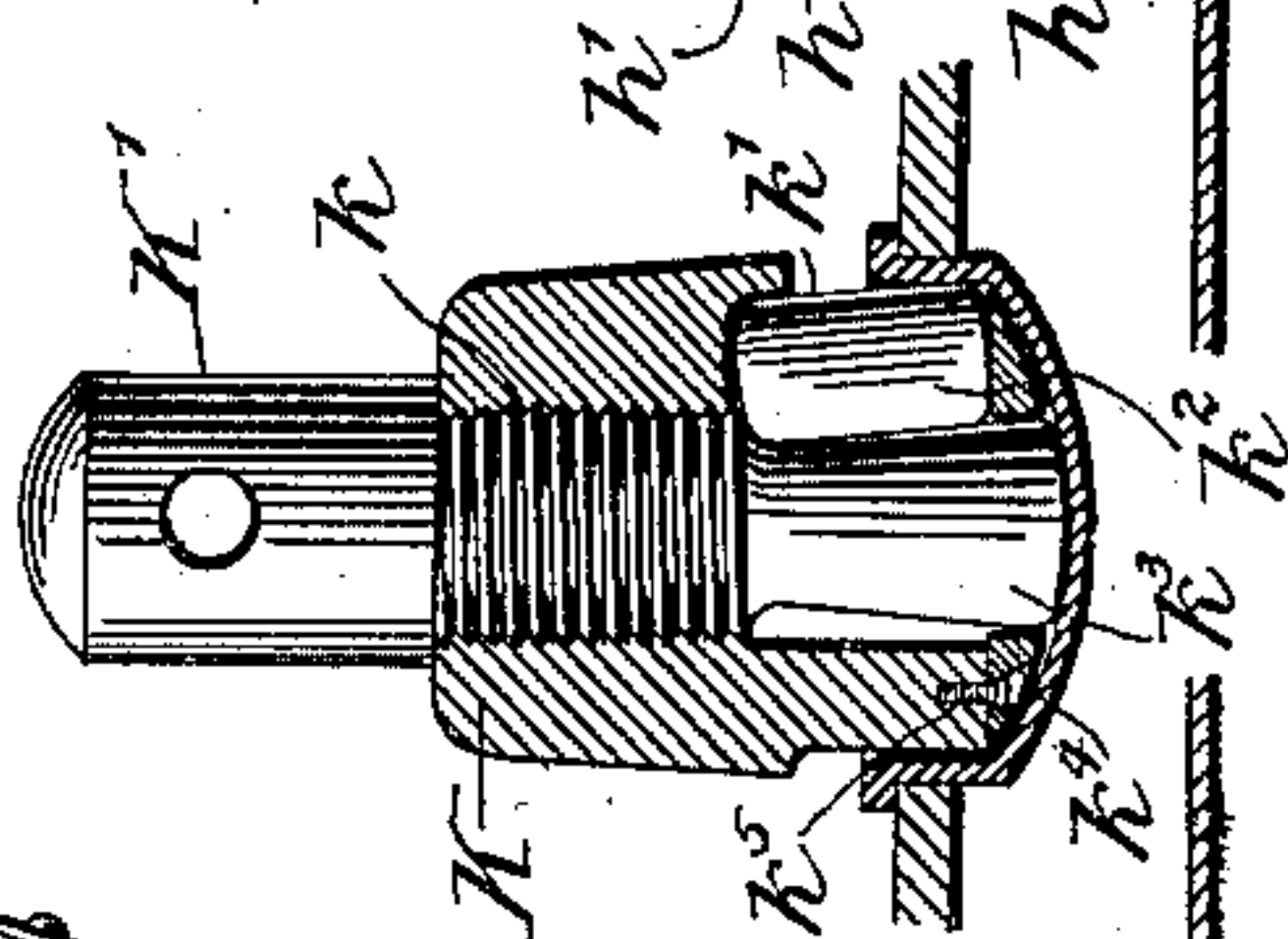


Fig. 9.



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UNITED STATES PATENT OFFICE.

AMASA WORTHINGTON, OF BROOKLYN, NEW YORK.

BOILER.

SPECIFICATION forming part of Letters Patent No. 672,251, dated April 16, 1901.

Application filed January 8, 1901. Serial No. 42,494. (No model.)

To all whom it may concern:

Be it known that I, AMASA WORTHINGTON, a citizen of the United States, and a resident of the borough of Brooklyn, in the city of New York, county of Kings, and State of New York, have invented certain new and useful Improvements in Steam-Boilers, of which the following is a specification.

My invention relates to steam-boilers of the water-tube class, and especially to the form thereof that has the alternate sections of its water-tubes inclined in opposite directions, and is designed more particularly for marine use, while yet being capable of general application, its object being to provide a boiler of this character which while simple and compact in construction and efficient in operation shall at the same time dispense with the necessity for masonry settings and have certain of the side walls of its fire-box or furnace formed by the extension of portions of the boiler through which the water circulates.

To these ends the invention consists, first, in certain novel features of construction in the boiler itself; second, in the peculiarities of construction of the fire-box or furnace and in its combination with the parts of the boiler; third, in the means whereby access to the water tubes and headers is afforded to allow of the removal of dust and ashes from them when required, and, fourth, in various other constructions and combinations of parts, all as will hereinafter more fully appear.

Referring to the accompanying drawings, which form a part of this specification, Figure 1 is a vertical transverse section of a boiler constructed in accordance with my invention, taken in the plane xx of Fig. 2; Fig. 2, a vertical longitudinal section of the same, taken in the line ww of Fig. 1; Fig. 3, a similar vertical transverse section of a boiler likewise constructed in accordance with my invention, but of a slightly-modified form, taken in the plane zz of Fig. 4; Fig. 4, a vertical longitudinal section thereof, taken in the line yy of Fig. 3; Fig. 5, a front elevation of a boiler constructed in accordance with that shown in Figs. 1 and 2; Fig. 6, a similar front elevation of a boiler constructed in accordance with the forms shown in Figs. 3 and 4; Fig. 7, a detail side elevation of a portion of two of the water-tubes and of one of their co-

operating headers, with the latter shown in section; Fig. 8, a detail isometric projection of one of the hand-hole-closing devices and a portion of the wall of the member in which it is secured, showing the manner of cutting and distorting the former when its removal is required; Fig. 9, a sectional edge view of one of the closing devices before being expanded and a portion of the wall in which it is to be secured, taken axially of the former, with a side elevation, partly in section, of a mechanism by which the expanding of the closing device may be effected; and Fig. 10, a top or plan view of the closing-device-expanding mechanism shown in Fig. 9.

In all the figures like letters of reference are employed to designate corresponding parts.

A and A' indicate the water-tubes, and B B' B² B³ the headers with which these tubes respectively coöperate. These water-tubes are preferably disposed in a number of series, with the individual tubes of each series arranged the one above the other in a vertical row, and are secured at their opposite ends in their appropriate headers, which are preferably constructed of rectangular form in cross-section and provided with suitably-formed orifices in which these ends enter. The different series of water-tubes A, with their respective headers B and B', are inclined to the horizon in one direction and are alternated with the different series of the water-tubes A', which, with their respective headers B² and B³, are similarly inclined in the opposite direction. As thus disposed the various series of water-tubes lie side by side in a horizontal direction throughout the extent of the boiler and constitute with their respective headers separate and independent sections C C' C², &c.

Located above the headers B and B² are the respective steam and water drums D and D', which extend transversely over the various series of water-tubes A and A' and are connected at different points along their lengths by tubes d and d' , that extend across from one of the drums to the other and enter at their opposite ends suitable orifices formed in their walls, with the tubes d preferably disposed above and the tubes d' below a horizontal line extending through their axes. To

the steam and water drums thus located the respective headers B and B² are connected by suitable nipples *d*³, which enter at their opposite ends suitable orifices formed in the latter and the walls of the former, as shown. The headers B and B² being thus connected to their respective steam and water drums D and D', the headers B' and B³ are in like manner connected with them; but instead of this connection being made with the drum immediately above them they are connected across to the opposite drums, for which purpose the tubes *d*⁴ are employed, which, entering at one of their ends suitably-formed orifices in their respective headers, extend across to the opposite steam and water drums and enter at their opposite ends suitable orifices formed in them. By thus connecting the under headers B' and B³ as well as the upper headers B and B² with their respective steam and water drums D and D' and similarly connecting these latter by appropriate tubes not only is the free and uninterrupted circulation of the water through the various series of water-tubes A and A' and the steam and water drums permitted, but the flow of this water is facilitated by the inclination of these water-tubes with respect to the horizon, as before explained. While the upper ends of the headers B' and B³ are thus connected with the steam and water drums D and D', their lower ends are similarly connected with their respective mud-drums E and E', and to permit of this being accomplished they are severally provided with downwardly - extending portions through which this connection is effected. In some instances these downwardly-extending portions, in addition to serving as a means for connecting their appropriate headers to the mud-drums, likewise serve to form a portion of the vertical walls of the fire-box F and ash-pit F', as shown in Figs. 1 and 2, while in other instances they will form a portion of the vertical walls of the fire-box alone, as shown in Figs. 3 and 4. When availed of to form a portion of the vertical walls of the fire-box and ash-pit, and the doors *f* and *f*' of the fire-box and ash-pit are located at one end of the boiler, as shown, for instance, in Figs. 1 and 2, then these downwardly-extending portions of both of the series of headers B' and B³ will be extended downwardly past both the fire-box and ash-pit and will rest at their lower ends either upon the floor or foundation of the boiler or upon their coöperating mud-drums E and E', which in these cases will similarly rest thereon. So, too, when employed to form a portion of the vertical walls of the fire-box alone, and the doors of the fire-box and ash-pit are similarly located at the end of the boiler, then the downwardly-extending portions of these headers will be extended downward past the fire-box; but instead of being extended downward past the ash-pit and resting at their lower ends either upon the floor or foundation of the boiler or upon their respective mud-drums that rest

thereon these ends will rest either upon a stand or support H, in which the ash-pit is formed, or upon their respective mud-drums, which will likewise rest upon it. On the other hand, when their downwardly-extending portions are employed to form a portion of the vertical walls of the fire-box and ash-pit and the doors for the fire-box or ash-pit are located at one side of the boiler, as shown in Figs. 3 and 4, then only the downwardly-extending portions of the headers B³ and such of the downwardly-extending portions of the headers B' as are situated on opposite sides of the doors will be extended downward past both the fire-box and the ash-pit and such of the downwardly-extending portions of these latter headers as are in line with these doors will be extended downward only to the top of the upper one, *f*. The same is likewise true when the downwardly-extending portions of these headers are employed to form a portion of the vertical walls of the fire-box alone and the doors *f* and *f*' of the fire-box and ash-pit are similarly located at the side of the boiler and only the downwardly-extending portions of the headers B³ and such of the downwardly-extending portions of the headers B' as are on opposite sides of the doors will be extended downward past the fire-box and those of such downwardly-extending portions of these latter headers as are in line with the doors will be extended downwardly only to the top of the door *f* of the fire-box, as shown.

When the downwardly-extending portions of the headers B' and B³ rest at their lower ends upon the floor or foundation of the boiler, the mud-drums E and E', which are or may be constructed of rectangular form in cross-section, will be preferably arranged outside of the downwardly-extending portions of their respective headers, as shown in Figs. 1 and 2, and be connected with them through the intervention of nipples *b*, which enter at their opposite ends suitable orifices formed in the sides of the former and latter, respectively. On the other hand, when these downwardly-extending portions rest at their lower ends upon the mud-drums, as shown in Figs. 3 and 4, then instead of these drums being connected with their sides they are connected with their lower ends and the nipples *b* enter at their opposite ends suitable orifices formed in the upper sides of the mud-drums and the lower ends of the extending portions of their respective headers B' and B³. While thus the lower ends of such of the downwardly-extending portions of the headers B' and B³ as extend downwardly past the fire-box and ash-pit in one case and past the fire-box in the other are connected with their respective mud-drums, the lower ends of such of these downwardly - extending portions as extend downwardly only to the top of the door to the fire-box are likewise connected and bound together by a tube I. This tube, which is preferably constructed of rectangular form

in cross-section and with closed ends, is made of a length to extend not only across the lower ends of such of these downwardly-extending portions as are terminated at the top of the fire-box door, but also across the downwardly-extending portion that is located on each side thereof and is connected with both the former and latter through the medium of nipples b^2 , which enter at their opposite ends suitable orifices formed in the front and rear faces of the tube and each of the extending portions, respectively.

In those instances where the doors of the fire-box and ash-pit are located at the ends of the boiler all the water-tubes A and A' will preferably be secured at their opposite ends in their respective headers. On the other hand, in those instances where the doors to the fire-box and ash-pit are located on the side of the boiler, as in Figs. 3 and 4, then instead of securing the opposite ends of all the water-tubes in their appropriate headers the ends of such of these water-tubes as lie directly above those doors and adjacent thereto are preferably secured in the tube I. As thus connected, the free circulation of water through these several headers is insured, while through the connection of the remaining headers with their respective mud-drums the farther circulation of water through them is likewise permitted, and any mud or other sediment separated out from the water will settle in the latter, from which it may be discharged through appropriate pipes and valves, as shown, for instance, at O and o, respectively, in Figs. 4 and 6.

The stand or support H when employed to support the boiler and form an ash-pit for it is preferably constructed of rectangular form, with the top and bottom thereof left open, and is composed of the side walls h , which are provided along their respective top and bottom edges with the laterally-extending longitudinal flanges h' and h^2 and are connected at their ends and held at the proper distance apart by the plate-like girths h^3 , that extend across between them and are secured at their opposite ends by suitable bolts or screws h^4 to appropriate flanges h^5 , with which these sides are provided. As thus constructed the stand or support is adapted to rest with its open bottom upon the floor or other foundation provided to receive it and not only sustain the boiler, which will rest upon its open top, but also afford within itself an ash-pit therefor.

With the boiler constructed either to rest directly upon the floor or other foundation prepared to receive it or upon a stand or support H the fire-box F is separated from the ash-pit F' by the grate-bars F², which in the former construction rests at their opposite ends upon suitable girders i , that in turn are supported at their opposite ends upon brackets i' , which are secured to the inner faces of the downwardly-extending portions of cer-

tain of the respective headers B and B³, as shown in Figs. 1 and 2, while in the latter construction the opposite ends of these grate-bars are supported upon inwardly-extending flanges i^2 , formed on the inner side of the stand or support H, as shown in Figs. 3 and 4.

In effecting the securement of the ends of the various tubes and nipples in the respective orifices in which they enter any of the ordinary and well-known expedients usually adopted for that purpose may be employed. I prefer, however, to accomplish that result by expanding the portion of the tube or nipple which enters the orifice until it completely fills the same and has its own extremity made somewhat larger than the latter, as is now common to boilers of this class as at present constructed, and in order to provide for the expansion of these ends the various headers, tubes, and other members in which they are expanded, outside of the steam and water drums, are severally provided in the sides opposite to them with suitable hand-holes l , through which access may be had to them for that purpose and which may be closed by any appropriate means, such as screw plugs or caps. In the form of the construction which has been selected for illustration these means consist of a cup-shaped stopper l' , which is preferably constructed of ductile sheet metal, with cylindrical side walls l^2 , a spherical bottom l^3 , and an outwardly-extending flange l^4 around its upper edge, as shown in the lower portion of Fig. 7. As thus constructed this stopper is inserted in the hand-hole to be closed and expanded therein until a bead l^5 is formed in it on the inside of the member in which it is employed, as shown at the top in such figure, forming thereby a simple and efficient closing device for the hand-hole, which may be readily removed therefrom when desired by simply cutting through its bottom l^3 with a chisel or otherwise for a sufficient distance around its outer edge to permit of the part detached being forced inward, as shown in Fig. 8, when the cylindrical side walls l^2 may be bent inward or distorted, as illustrated by the dotted lines in that figure, and the stopper then easily withdrawn from the hole in which it is inserted. For expanding the stopper thus described in a hand or other hole when it is desired to close the latter various means may be adopted. In Figs. 9 and 10, however, is shown a device which may be employed for that purpose, the same comprising a round body portion K, that is threaded upon a shaft K' by appropriate threads k and is provided in its lower portion with a plurality of radially-disposed recesses or chambers k' , in which are located cylindrical rolls k^2 , that cooperate with the conical lower portions k^3 of such shaft and are held in their respective recesses or chambers k' by a cap k^4 , that is secured to the lower end of the body k by appropriate screws k^5 , as shown. As thus con-

5 constructed when a stopper is to be expanded
 within a hand or other hole the lower end of
 the expanding device is inserted within it and
 the shaft rotated in the proper direction with-
 in the body K, the result of which will be that
 the conical lower portion k^3 of such shaft will
 be drawn upward in rear of the rolls k^2 , forc-
 ing them outward against the interior of the
 side walls of the stopper, while at the same
 10 time rotating those rolls, and thereby expand-
 ing the stopper within the hole, as more fully
 shown and described in the application for
 Letters Patent filed by me in the United States
 Patent Office June 13, 1900, Serial No. 20,406,
 15 to which reference may be had.

The boiler being constructed as above de-
 scribed may be inclosed within an ordinary
 brick or other masonry setting. It is pre-
 ferred, however, to inclose it within a casing
 20 that is composed of plates which may be
 formed either from cement, magnesia, or fire-
 felt properly treated and firmly packed and
 solidified in pan-shaped backs m , that are
 constructed of sheet metal with laterally-ex-
 25 tending ribs and flanges m' formed on their
 inner sides around their edges and elsewhere
 by securing angle-irons to them by rivets and
 otherwise, or some of the plates may be formed
 from those materials and the other from cast
 30 metal. As thus constructed from any one of
 the materials specified the plates may be made
 either of a size to cover the entire front, side,
 back, or top of the boiler, or they may be
 made up from a number of constituent sec-
 35 tions or panels and secured together as pre-
 ferred; but in whichever of the ways they
 may be thus constructed they will preferably
 be provided around the edges that are to be
 joined to others with appropriate flanges,
 40 which may be formed either by extending the
 back m beyond the lateral flanges m' thereon,
 as shown at m^2 in Fig. 6, or by securing an-
 gle-irons to their outer faces near their edges,
 as shown at m^3 in Figs. 1 and 3, accordingly
 45 as the edges are to be lapped upon or abutted
 against the edges of others.

In Figs. 1, 2, and 5 is shown a casing in
 which the top, sides, and back are constructed
 of plates that are formed from cement, mag-
 50 nesia, or fire-felt, as above explained, and the
 front from plates that are formed from cast
 metal. In this construction the plates L, L',
 and L², either as integral wholes or as made
 up from constituent sections or panels, will
 55 be made of the proper sizes and shapes to
 cover the respective top, sides, and back of
 the boiler, including the steam and water
 drums D and D', and will be united at their
 adjoining edges by appropriate screws and
 60 bolts passing through their respective flanges
 m^2 and m^3 , as above explained. In like man-
 ner the plate for the front of the boiler will
 be made of the proper size and shape for that
 purpose; but instead of being constructed as
 65 an integral whole it is preferably constructed

in two sections L³ and L⁴, which are secured
 together by appropriate flanges and bolts m^4
 and m^5 . As thus constructed this plate is re-
 ceived within the front end of the casing and
 the projecting flanges m^2 of the top and side 70
 plates L and L' lapped over its top and side
 edges and secured to it by bolts m^5 , as shown.
 In Figs. 3, 4, and 6, on the other hand, is
 shown a casing in which the top and sides are
 constructed of plates that are formed from 75
 cement, magnesia, or fire-felt and the por-
 tions answering to the front and back con-
 structed of plates that are formed from cast-
 iron. In this construction, as in the former,
 the plates L and L', either as integral wholes 80
 or as made up from constituent sections or
 panels, are constructed of the proper sizes and
 shapes to cover the respective top and sides
 of the boiler with the steam and water drums.
 The same is also true respecting the plates L⁵ 85
 and L⁶; but instead of these plates being
 made up from parts they are shown as con-
 structed as integral wholes and are received
 within the opposite ends of the casings with
 the projecting flanges m^2 on the ends of the 90
 top and side plates L and L' lapped over
 their respective edges and secured thereto by
 bolts m^5 .

When the doors f and f' of the respective
 fire-box and ash-pit are located in the end of 95
 the boiler and the boiler rests upon the floor
 or foundation prepared to receive it, the re-
 spective frames f^2 and f^3 for those doors will
 be secured in the plate L⁴, as shown in Figs.
 1, 2, and 5. In like manner when these doors 100
 are located upon the side of the boiler and
 the boiler similarly rests upon the floor or
 foundation prepared for it the frames for
 these doors will be secured in either of the
 side plates L' that may be desired and in some 105
 instances may extend inward between and be
 secured to the downwardly-extending por-
 tions of the headers B' or B³, that may be dis-
 posed on opposite sides of them. On the
 other hand, when the boiler rests upon a stand 110
 or support the frame f^2 for the door f of the
 fire-box will be located in either the plates L⁵
 or L⁶, and the frame f^4 for the door of the
 ash-pit will be formed in the stand or support
 H. So, too, when these doors are arranged 115
 upon the side of the boiler and the boiler
 similarly rests upon a stand or support the
 frame f^2 for the door of the fire-box will be
 secured in either of the plates L' and may
 likewise extend inward between and be se- 120
 cured to the downwardly-extending portion
 of the headers B' or B³, that may be disposed
 on opposite sides of it, while the frame for
 the door f^4 of the ash-pit will be formed in
 the stand or support H, as above explained. 125

With the frames for the doors disposed un-
 der any of the arrangements specified the
 door f to the fire-box F will be preferably
 jointed to its respective frame by hinges f^5
 and will be provided with a suitable latch f^6 130

for coöperation with a catch f^7 . The door f' to the ash-pit F' , on the other hand, instead of being hinged to its respective frame will be provided with a suitable base and handle f^8 , whereby it may be set in front of the aperture through the door-frame and be held in that position or removed wholly therefrom when desired.

When the doors for the fire-box and ash-pit are located upon the side of the boiler, it is sometimes found desirable to protect the plates L^5 at the ends of the boiler and prevent the escape of heat through them. To accomplish this, a lining of fire-brick F^3 on the inside of each of the plates is employed, which, constructed in the form of a thin wall, extends the entire length of the fire-box and from the foundation of the boiler upward to the under side of the water-tubes A and A' , as illustrated in Figs. 3 and 4. On the other hand, when these doors are disposed at the end of the boiler it is likewise found desirable to close the spaces between the lowest water-tubes A and A' from the front of the boiler toward its rear for approximately two-thirds of its length by fire-bricks F^4 or other heat-resisting material, as well as the spaces between the tubes d^4 from the rear of the boiler forward for approximately the same distance by similar bricks or material F^5 ; whereby to form a sinuous flue for the passage of the heat and other products of the combustion through the various series of water-tubes in their travel from the fire-box to the uptake M , which latter is preferably located in the top of the casing between the steam and water drums D and D' , as shown in Figs. 1 and 2.

For removing the ashes and other refuse from the ash-pit the ash-pan N is employed, which is preferably constructed of a width to enter the aperture in door-frame f^2 , and in order to insure the ashes and other materials falling through between the grate-bars F^2 on opposite sides of this pan reaching it the deflectors f^9 are employed, which, secured at their upper edges either to the inner faces of the downwardly-extended portion of the respective headers B' and B^2 or to the interior of the stand or support H , incline inward and downward with their respective lower edges resting over such pan.

With a view to removing the ashes and soot from the tops of the water-tubes when the forms of boiler and casing shown in Figs. 1 and 5 are employed the orifices n are provided, which are so disposed in the plate L^3 as to permit of a jet of steam or compressed air being introduced into the casing at the points where required by an appropriate nozzle. On the other hand, when the forms of boiler and setting shown in Figs. 3 and 6 are made use of, these orifices will be disposed in a row along the plate L' opposite the space between the upper and under headers, and in order to

permit of their being closed when their use is not required, while yet allowing of their being opened when the jet of steam or air is to be introduced the plate n' is employed, which, fitted to slide longitudinally in suitable guideways n^2 , secured to the casing, is provided with orifices n^3 , corresponding to those in the plate L' , and which when the sliding plate is moved in one direction will be brought into registry with those in the plate L' and be carried to one side of them and the orifices in that plate thereby closed when the sliding plate is moved in the other direction as will be readily understood.

The boiler and setting being constructed as above described may be firmly secured to its foundation, as when used on shipboard or otherwise, by any convenient means. In the drawings, however, this is shown accomplished by the rods P , which, secured at their upper ends to the ends of the steam and water drums D and D' by screws p , extend downward through the foundation for the boiler and are provided on their lower ends, on the under side thereof, with suitable nuts p' or other appropriate fastening devices, as preferred.

It will thus be seen that I produce a boiler of the class in which the alternate series of water-tubes are inclined in opposite directions that is not only simple and compact in construction, but one in which the vertical walls of either the sides or the front and rear of the fire-box are formed by downwardly-extended portions of the headers at the lowermost ends of the various series of water-tubes, whereby the radiated heat from the fuel combustion heretofore absorbed by the boiler casing or setting is made available for converting the water into steam, and thereby attain greater efficiency and economy in the use of fuel than has been possible with this class of boilers as heretofore constructed.

Although in the foregoing I have described the best means contemplated by me for carrying my invention into practice, I wish it distinctly understood that I do not limit myself strictly thereto, as it is obvious that I may modify the same in various ways without departing from the spirit thereof.

Having now described my invention and specified certain of the ways in which it is or may be carried into effect, I claim and desire to secure by Letters Patent of the United States—

1. The combination, with a plurality of series of oppositely-inclined water-tubes, a fire-box for coöperating with them, and a plurality of connected steam and water drums, of mud-drums, headers for the opposite ends of the water-tubes, the under of which are provided with downwardly-extended portions to form a portion of the vertical walls of the fire-box and connect with the mud-drums, and tubes and nipples whereby the water-drums are con-

nected and the various headers likewise connected with them, substantially as described.

2. The combination, with a plurality of series of oppositely-inclined water-tubes, a steam and water drum arranged over each of the ends of these series, tubes for connecting these steam and water drums, and a fire-box for coöperating with the water-tubes, of mud-drums, headers for the opposite ends of such series of water-tubes, the under of which are provided with downwardly-extended portions to form a portion of the vertical walls of the fire-box and connect with the mud-drums, nipples for connecting the upper ends of the upper headers with their respective steam and water drums, and tubes for connecting the under headers with the oppositely-arranged steam and water drums, extending across from the upper portions of such headers to said drums, substantially as described.

3. The combination, with a plurality of series of oppositely-inclined water-tubes, a steam and water drum arranged over each of the ends of these series, tubes for connecting these steam and water drums, a fire-box, and an ash-pit, of mud-drums, headers for the opposite ends of such series of water-tubes, the under of which are provided with downwardly-extended portions to form a portion of the vertical walls of the fire-box and ash-pit and connect with the mud-drums, nipples for connecting the upper ends of the upper headers with their respective steam and water drums and the downwardly-extended portions of the under headers with their respective mud-drums, and tubes for connecting the under headers with the oppositely-arranged steam and water drums, extending across from the upper portions of such headers to said steam and water drums, substantially as described.

4. The combination, with a plurality of series of oppositely-inclined water-tubes, a steam and water drum arranged over each of the ends of these series, tubes for connecting these steam and water drums, and a fire-box for coöperating with the water-tubes, of mud-drums, headers for the opposite ends of such series of water-tubes, the under of which are provided with downwardly-extended portions to form a portion of the vertical walls of the fire-box and connect with the mud-drums, nipples for connecting the upper ends of the upper headers with their respective steam and water drums, and tubes for connecting the under headers with the oppositely-arranged steam and water drums extending across from the upper portions of such headers to said drums, substantially as described.

5. The combination, with a plurality of series of oppositely-inclined water-tubes, steam and water drums, tubes by which they are connected, a casing for such parts, a fire-box for coöperating with the water-tubes and mud-

drums, of headers for the opposite ends of such series of water-tubes, the under of which are provided with downwardly-extended portions to form the side walls of the fire-box and connect with the mud-drums, means whereby the various headers are connected with the steam and water drums, a door for the fire-box arranged in the end of the casing, filling means interposed between the lowest tubes of various of the front and middle series of water-tubes and other filling means interposed between the highest tubes of various of the rear and middle series thereof, whereby a sinuous course is imparted to the heat and other products of combustion in traveling from the fire-box to the uptake, substantially as described.

6. The combination, with a plurality of series of oppositely-inclined water-tubes, steam and water drums, tubes by which these drums are connected, a fire-box and mud-drums, of headers for the opposite ends of the water-tubes, the under of which are provided with downwardly-extended portions to form a portion of the vertical walls of the fire-box and connect with the mud-drums, means whereby the various headers are connected with the steam and water drums, and a stand or support upon which these several parts rest and are supported provided with an ash-pit, substantially as described.

7. The combination, with a plurality of series of oppositely-inclined water-tubes, steam and water drums, tubes by which these drums are connected, a fire-box, and mud-drums, of headers for the opposite ends of the water-tubes the under of which are provided with downwardly-extended portions to form a portion of the vertical walls of the fire-box and connect with the mud-drums, means whereby the various headers are connected with the steam and water drums, a stand or support upon which these various parts rest and are supported and a casing inclosing such parts, substantially as described.

8. The combination, with a plurality of series of oppositely-inclined water-tubes, steam and water drums, tubes by which these drums are connected, a fire-box, and mud-drums, of headers for the opposite ends of the water-tubes, the under of which are provided with downwardly-extended portions to form a portion of the vertical walls of the fire-box and connect with the mud-drums, means whereby the various headers are connected with the steam and water drums, a stand or support upon which these various parts rest and are supported, a casing inclosing said parts, and an ash-pit formed within the stand, substantially as described.

9. The combination, with a plurality of series of oppositely-inclined water-tubes, headers for the opposite ends of such tubes, and means whereby these various series of tubes are connected to permit of the circulation of

the water through them, of a casing for said parts provided with orifices for the introduction of a jet of steam or air located opposite the space between the upper and under headers, and a sliding plate provided with orifices corresponding with those in the casing, whereby these orifices in such casing may be opened and closed by moving such sliding plate in

one and the other direction, substantially as described.

In testimony whereof I have hereunto set my hand this 4th day of January, 1901.

AMASA WORTHINGTON.

Witnesses:

WM. H. APPLETON,

FRANK S. OBER.

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