

No. 749,850.

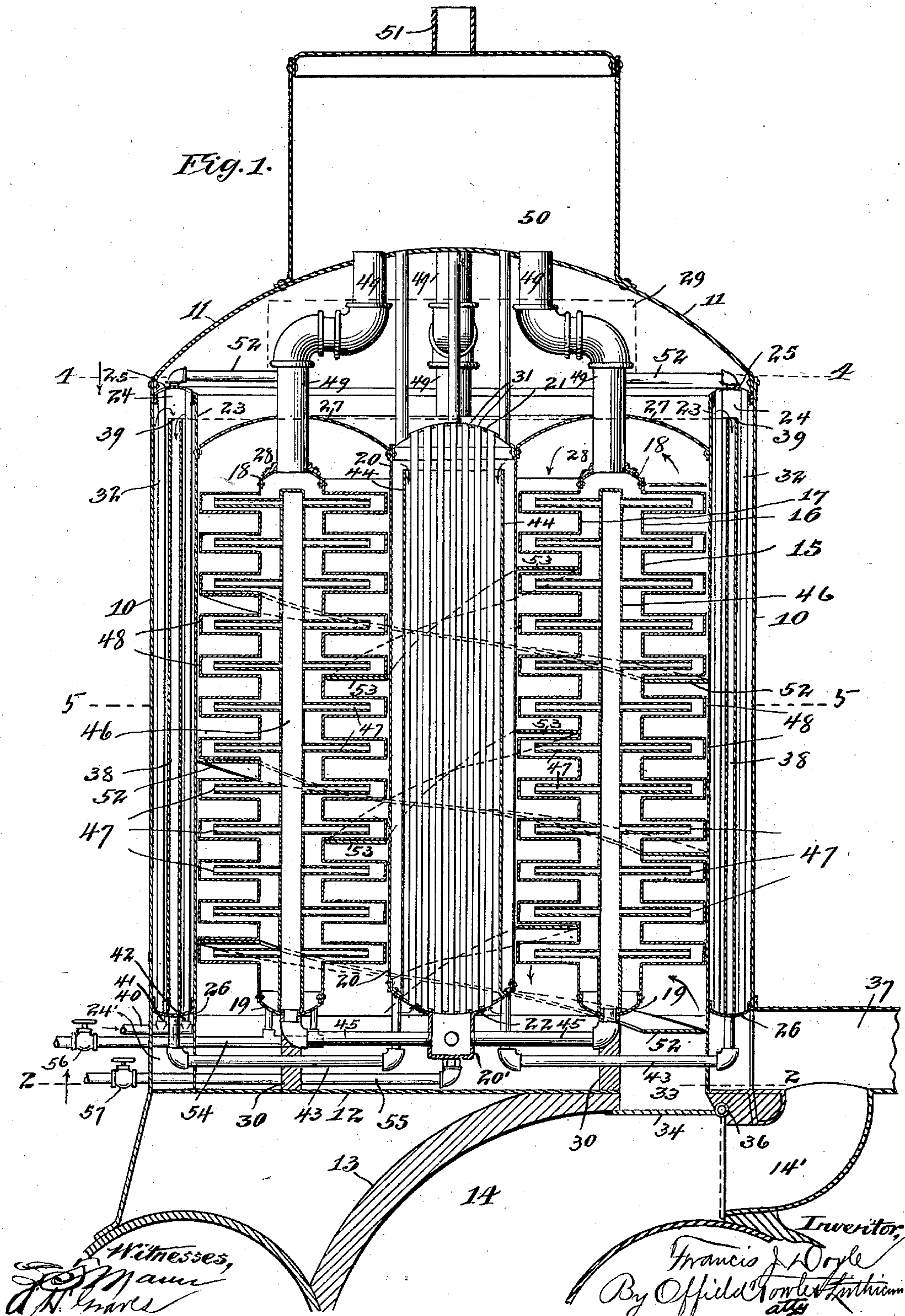
PATENTED JAN. 19, 1904.

F. J. DOYLE.
STEAM BOILER.

APPLICATION FILED MAR. 5, 1903.

NO MODEL.

3 SHEETS—SHEET 1.



No. 749,850.

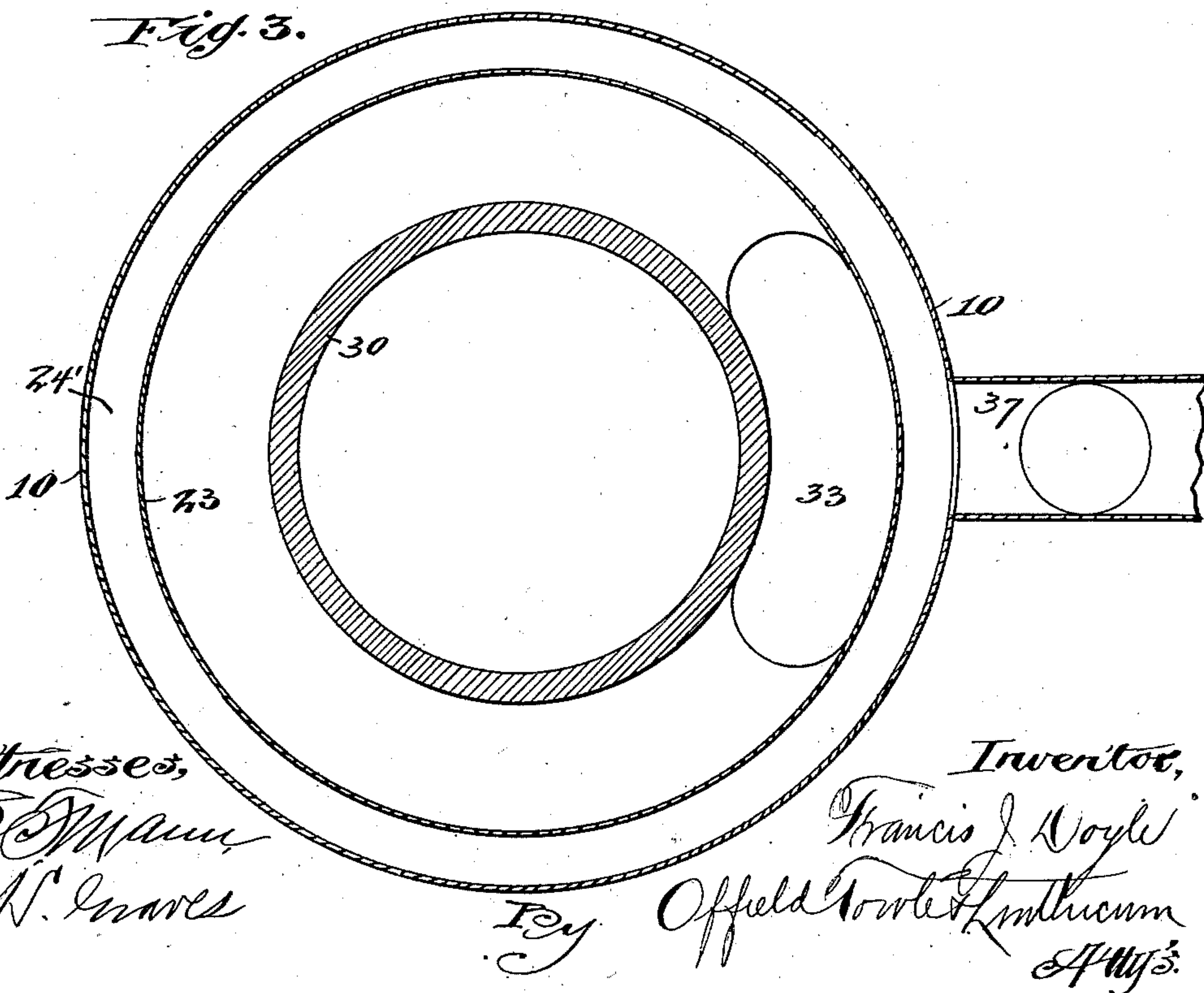
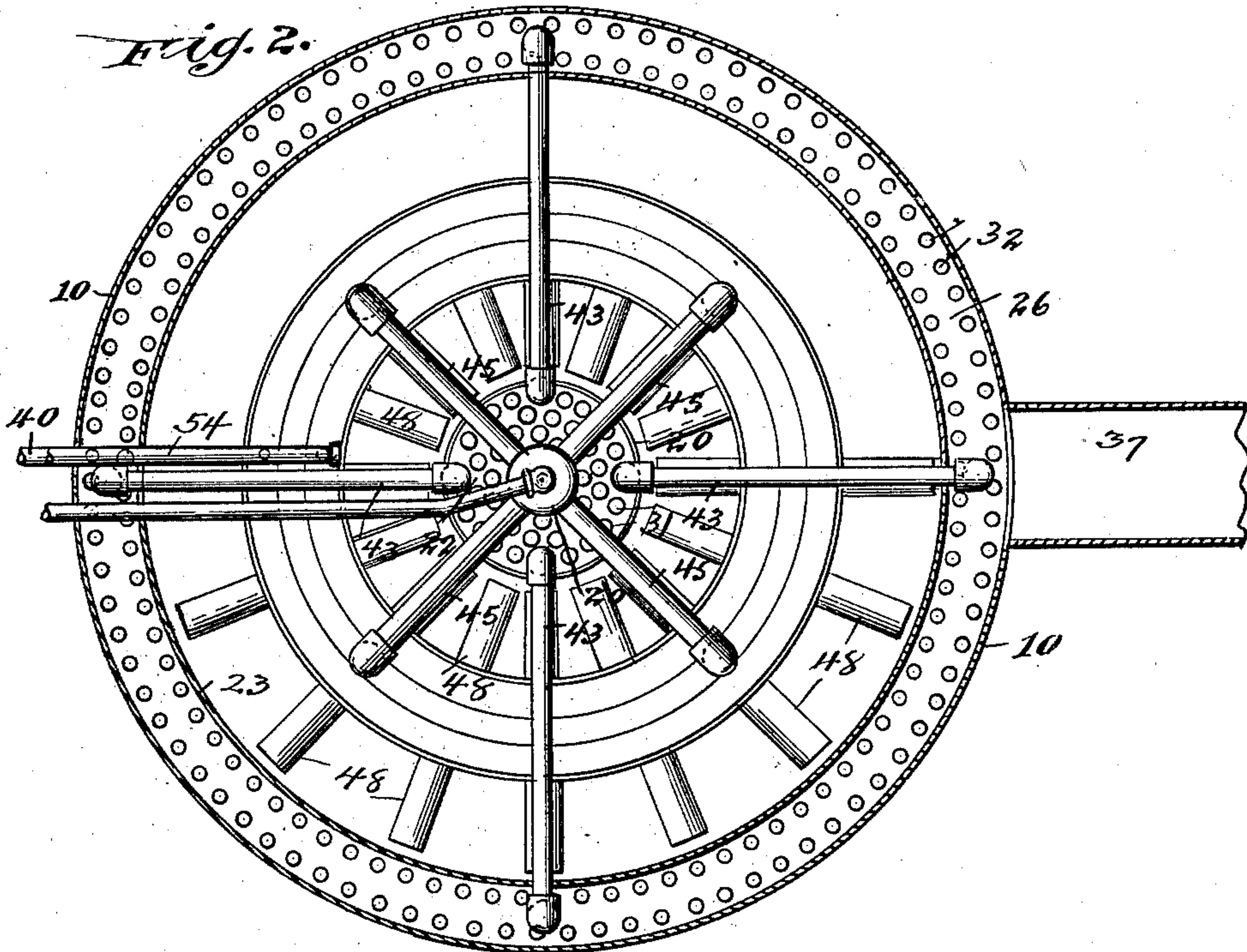
PATENTED JAN. 19, 1904.

F. J. DOYLE.
STEAM BOILER.

APPLICATION FILED MAR. 5, 1903.

NO MODEL.

3 SHEETS—SHEET 2.



Witnesses,
J. M. Mann
A. N. Innes

Inventor,
Francis J. Doyle
By *Offield Towle & Lathrop*
Attys.

No. 749,850.

PATENTED JAN. 19, 1904.

F. J. DOYLE.
STEAM BOILER.

APPLICATION FILED MAR. 5, 1903.

NO MODEL.

3 SHEETS—SHEET 3.

Fig. 4.

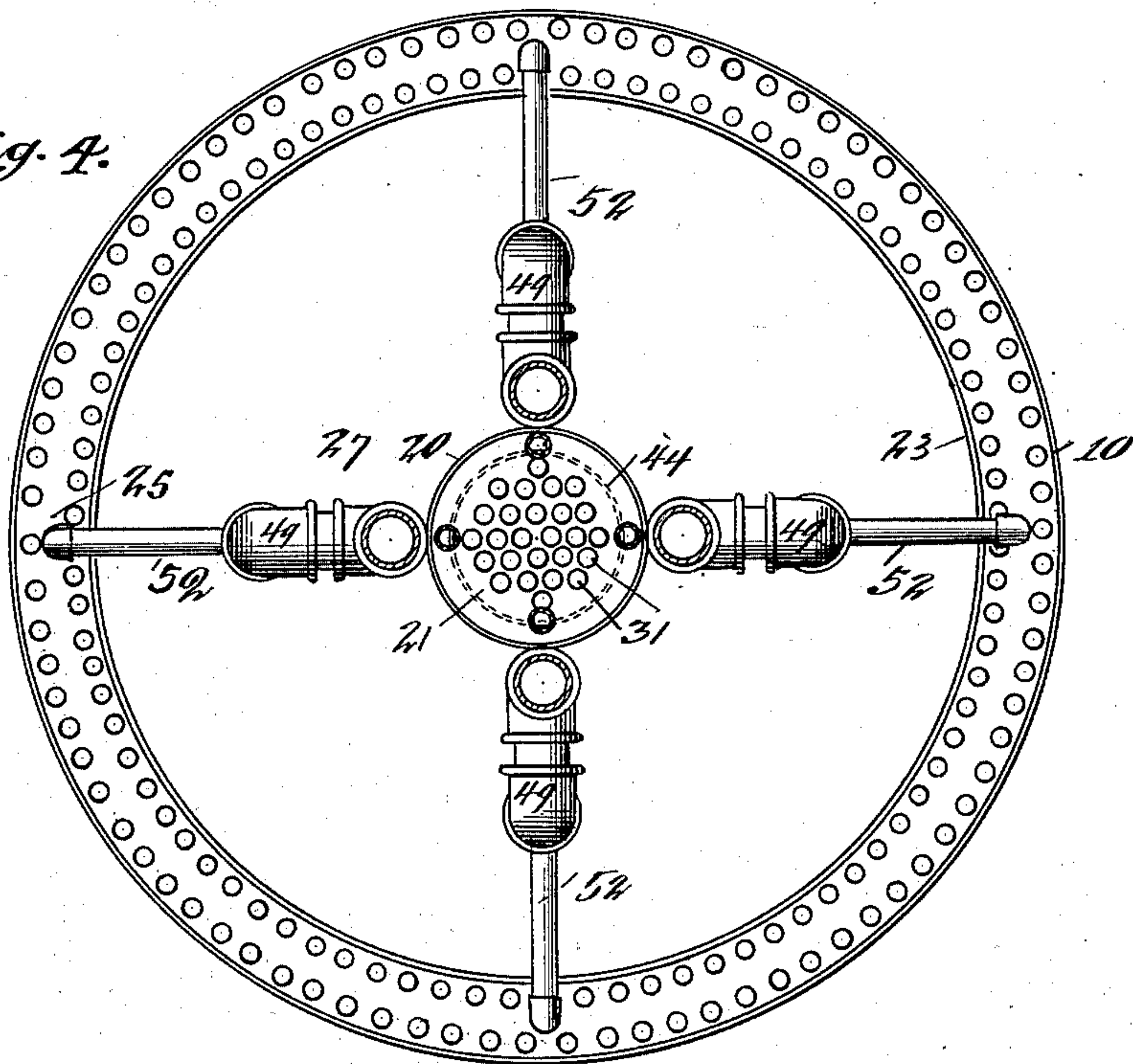
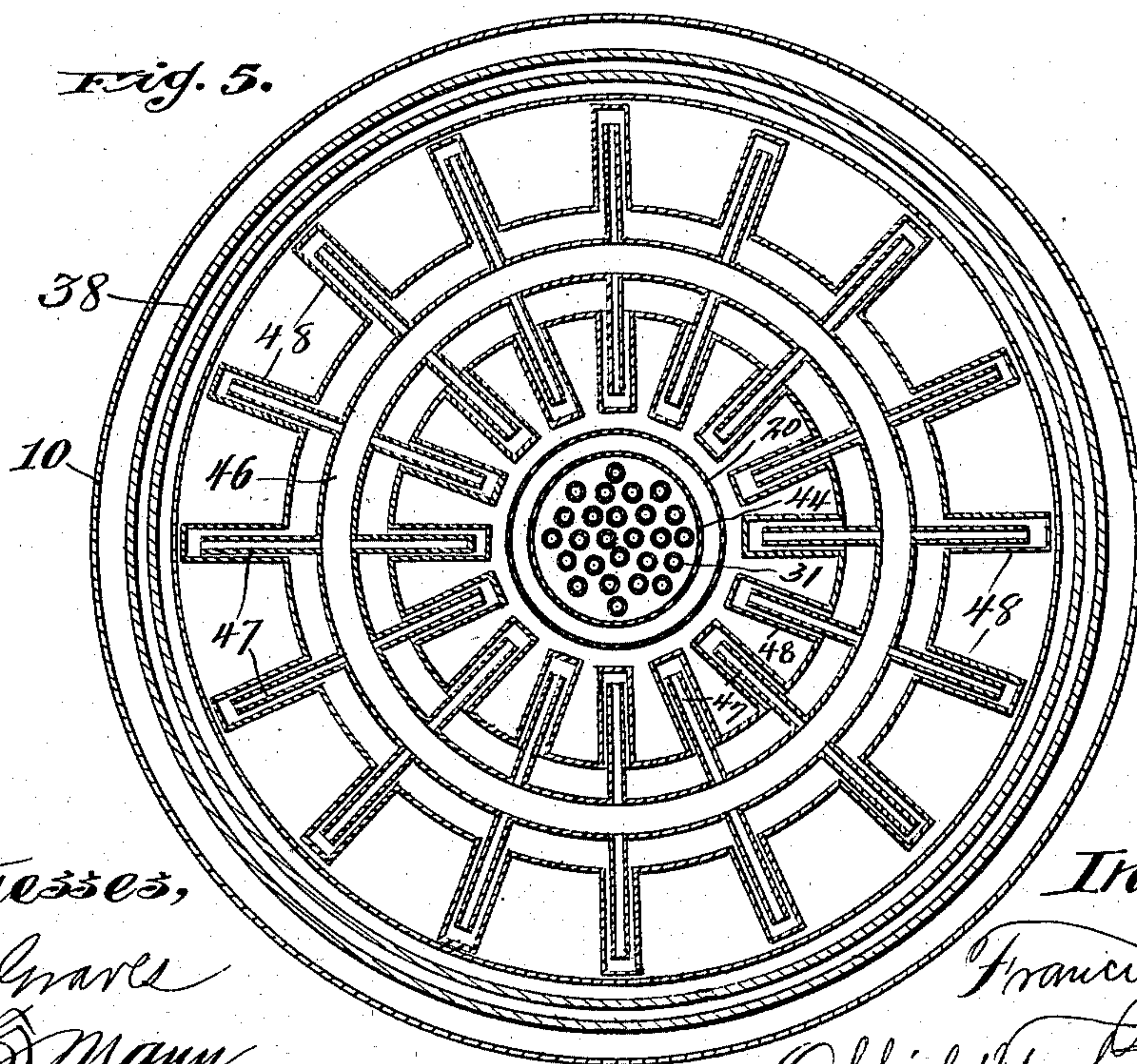


Fig. 5.



Witnesses,
A. N. Graves
F. D. Mann,

Inventor,
Francis J. Doyle,
By Offield T. Smith
Attys.

UNITED STATES PATENT OFFICE.

FRANCIS J. DOYLE, OF CHICAGO, ILLINOIS.

STEAM-BOILER.

SPECIFICATION forming part of Letters Patent No. 749,850, dated January 19, 1904.

Application filed March 5, 1903. Serial No. 146,311. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS J. DOYLE, of the city of Chicago, county of Cook, and State of Illinois, have invented certain new and useful
 5 Improvements in Steam-Boilers, of which the following is a full description.

This invention relates to improvements in steam-boilers, and refers more specifically to boilers of the tubulous type.

10 Among the salient objects of the invention are to provide an improved construction and arrangement wherein the heated gases and products of combustion are caused to so circulate through the boiler as to impart a maxi-
 15 mum proportion of their heat units to the steam-generating liquid before escaping to the chimney or other outlet; to provide a construction wherein the hot gases are circulated through successively cooler parts of the boiler
 20 and the steam-generating liquid is likewise circulated through successively hotter parts or zones of the boiler, the hottest gases being first circulated through those portions of the boiler wherein the steam has been brought to
 25 its highest temperature and then passed successively through zones or portions of the boiler containing steam or liquid of lower and lower temperatures, so that the heated gases are finally circulated through the coolest parts
 30 of the boiler, or those parts wherein the steam-generating liquid is initially heated before escaping to the chimney, and, in general, to provide in a boiler of the character above referred to improved details of construction
 35 and arrangement contributing to the economical manufacture of the boiler, to its efficiency, and to the readiness with which it may be cleaned and operated.

To the above ends the invention consists in
 40 the matters hereinafter described, and more particularly pointed out in the appended claims, and will be readily understood from the following description, reference being had to the accompanying drawings, wherein—

45 Figure 1 is a view in axial vertical section of a boiler embodying a preferred form of my invention. Fig. 2 is a transverse or horizontal sectional view taken on line 2 2 of Fig. 1 and looking upwardly. Fig. 3 is a similar
 50 sectional view taken on the same line 2 2 of

Fig. 1, but looking downwardly. Fig. 4 is a horizontal sectional view taken on line 4 4 of Fig. 1 and looking downwardly, and Fig 5 is a similar sectional view taken on line 5 5 of said Fig. 1.

Referring to said drawings, 10 designates as a whole an outer shell or boiler-casing, shown in the present instance as cylindric and provided with a convex or dome-shaped
 55 upper end wall 11 and a horizontal or flat lower end wall 12, arranged to rest in the present instance upon a support 13, forming a part of the outlet-flue 14, communicating with a furnace or other suitable source of
 60 heated gases. Within the outer shell is arranged a hollow cylindric or annular vessel (designated as a whole 15) of considerably smaller external diameter than the internal diameter of the boiler-shell, its outer and in-
 65 ner walls being respectively designated 16 and 17 and having closed top and bottom end walls 18 and 19, respectively, whereby its interior is completely separated from that part of the interior of the boiler exterior thereto.

20 designates as a whole a centrally-dis- 75 posed cylindric chamber having an external diameter considerably less than the internal diameter of the hollow member 15 last above described, said central member being provided with convex top and bottom end walls 21 and
 80 22, respectively, and being arranged to extend somewhat above the upper end of the member 15, as indicated clearly in Fig. 1.

23 designates an inner cylindric shell arranged concentrically within the outer shell of
 85 the boiler and of somewhat less diameter than the latter, so as to provide therewith an outer annular chamber 24, extending throughout practically the full height of the boiler and having closed top and bottom walls 25 and 26,
 90 respectively. The lower wall 26 is, however, located some distance above the base-wall 12 of the boiler, so that a secondary annular space or chamber 24' is formed immediately below the chamber 24.

27 designates an annular convex partition-wall extending from the inner surface of the
 95 cylindric shell 23 inwardly to the upper end of the central chamber 20 and forming a circulating-space 28 above the upper end of the 100

annular member 15, which affords communication between the spaces inside and outside of said annular member 15, while at the same time separating that part of the boiler which
5 contains said annular member 15 from the upper part or chamber 29 in the top of the boiler.

30 designates an annular base-wall upon which the annular member 15 rests, said wall forming, in conjunction with said annular
10 member, an annular partition which completely separates that part of the boiler within the annular member from that part exterior thereto except as communication is afforded between said parts through the circulating-
15 space 18 over the upper end of the annular partition.

31 designates a series of fire tubes or flues arranged to extend through the central chamber 20 from end to end thereof and opening
20 into the spaces above and below said chamber, and 32 designates similar fire tubes or flues extending through the chamber 24 from end to end thereof and opening into the space 29 above said chamber and into the secondary
25 chamber 24' below the same.

From the furnace-flue 14 a passage 33 (see Fig. 3) leads upwardly into the annular space between the outer chamber 23 and the annular member 15, this passage being controlled
30 by means of a damper 34, which is pivoted at one side, as at 36, so as to be capable of being swung downwardly into position to close the extension 14' of the main flue which communicates directly with the main outlet 37 of the
35 boiler, the latter leading to the chimney or other outlet.

It will be seen from the foregoing that the products of combustion rising through the passage 33 will be caused to ascend through the
40 annular space exterior to the annular member 15, will pass over the upper end of said hollow partition inwardly through the space 18, and down between the interior of the hollow member and the exterior of the central chamber 20 to the space below the latter, then circulate up through the fire-tubes 31 of said central chamber to the space 29 in the upper part of the boiler, pass radially outward therein, and then return downwardly through the fire-
50 tubes of the outer annular chamber 24 and escape into the secondary chamber 24', which, as shown clearly in the drawings, communicates directly with the flue 37, leading to the chimney.

Describing now the water and steam system of the boiler, 38 designates a hollow annular and cylindric vessel disposed concentrically within the outer chamber 24, so as to divide the interior thereof, its lower end being closed by the end wall 26 of said chamber and its upper end 39 being in open communication with the interior of said chamber.
60

40 designates a water-supply pipe leading in through the outer shell of the boiler into the chamber 24' and communicating with the
65

interior of the chamber 24 through branch pipes 41 and 42. The water admitted through said pipe 40 rises within the chamber 24 and passes into the open upper end of the annular receptacle 38 therein, from the lower end of
70 which it is conducted to the interior of the central chamber 20 through a plurality of pipes 43. The central chamber 20 is provided with an annular or cylindric shell 44, arranged concentrically therein and rising from the bottom
75 wall to a point near the upper end thereof, thus dividing said chamber into inner and outer spaces. The pipe 43 communicates with the outer space of said chamber, and the liquid rising through this space enters the space
80 within the shell 44 and passing downwardly escapes from the lower end of said chamber through a plurality of radially-disposed pipes 45.

Within the annular hollow partition 15 is
85 arranged a second hollow annular member, (designated as a whole 46,) smaller in all its dimensions than the interior of the member 15 and provided both internally and externally
90 with a series of radiating tubes 47, which communicate with the interior of the vessel 46 and are open at their outer ends. The inner and outer surfaces of the member 15 are likewise provided with tubular or porcupine-like
95 projections 48, which inclose the several radiating tubes of the inner member, the projections 48 being of larger dimensions than the radiating tubes, so as to form therewith inclosing spaces. The several radial pipes 45
100 communicate at their outer ends with the lower end of the inner annular hollow member 46, the liquid rising through this member escaping through the several radiating tubes into the member 15. From the upper end of the
105 member 15 lead off a plurality of steam-pipes 49, which extend upwardly through the top wall 11 of the boiler-shell and open into a steam dome or chamber 50, formed upon the upper end of the boiler, from which steam-dome the steam is conducted to any required
110 source of consumption through an outlet-pipe 51. Preferably a series of pipes 52 are arranged to connect the upper end of the chamber 24 with the several steam-pipes 49, the object of this arrangement being to provide
115 escape for any steam which may be formed within the chamber 24.

In order that the products of combustion may be compelled to take a more tortuous course in circulating through the passages of
120 the boiler, the exterior of the annular member 15 is provided with a helical flange or partition 52, extending from top to bottom thereof, so as to divide the space intervening between the exterior of the annular member and
125 the interior of the cylindric shell 23 and compel the products of combustion to circulate circumferentially as they rise. For the same purpose a similar flange or helical partition 53 is arranged upon the interior of the annular
130

member 15 and extending between the latter and the exterior of the central chamber 20, as indicated clearly in the drawings.

In order to facilitate the "blowing out" or cleansing of the boiler, outlet-pipes 54 and 55 are provided, communicating with the bottom of the annular member 15 and the central chamber 20, respectively, the latter chamber being provided at its center with a downwardly-extending extension 20' to facilitate the collection of the sediment and also in order to afford a more convenient means of uniting the pipes 45 therewith. Each of the blow-out pipes 54 and 55 is provided with a suitable controlling-cock, as 56 and 57, respectively.

The operation of the boiler constructed as above described may be briefly detailed as follows: During the starting of the fire the damper 34 of the outlet-flue 14 of the furnace is turned up into horizontal position, as shown in full lines in Fig. 1 of the drawings, so as to afford a direct draft to the chimney. When the boiler is to be brought into operation, however, the damper 34 is turned down into the position indicated in dotted lines, so as to compel the products of combustion to circulate through the boiler. The hot gases entering through the passage 33 pass upwardly through the helical passage between the inner surface of the outer chamber 24 and the outer surface of the annular chamber 15 to the upper end of the latter, thence passing through the space 18 to the annular space between the central chamber and the inner surface of the chamber 15 and downwardly through the helical passage formed by the inner flange or partition 53. It will be understood that in circulating through the passages referred to the gases circulate all around the several porcupine-like projections 48 upon the outer surfaces of the member 15. At the lower end of the inner helical passage the products of combustion enter the space which communicates with the fire-tubes of the central chamber 20, passing up through these latter to the upper space 29 of the boiler, and then passing radially outward to the inlet ends of the fire-tubes of the outer annular chamber 24. From the lower ends of the fire-tubes of the outer chamber the products of combustion escape into the secondary chamber 24' and from thence pass into the main outlet or flue 37, leading to the chimney. The water and steam after the water has been converted into steam is circulated through the boiler in a manner which is substantially the reverse of the circulation of the hot gases—that is to say, the water is first admitted to the foot of the outer annular chamber 24 through the inlet-pipe 40, rises through said chamber to its upper part and then passes downwardly through the hollow annular space 38, from which it is conducted to the outer space of the central chamber 20 through the several pipes 43, rises through said outer space to the upper part of the chamber, then returns

downwardly through the central portion thereof, and is conveyed to the foot of the annular member 46 through the pipes 43, rising within said annular member and escaping through the several radiating tubes of the latter, and finally passing off in the form of superheated steam through the steam-pipes 49 to the dome 50. It will be observed that the water in its coolest condition is first introduced to the outer chamber 24, through which the hot gases are performing their final circulation and wherein they have reached their lowest temperature before escaping to the chimney. Likewise the water is transferred from the outer chamber 24 to the central chamber in its second stage of heating, through which the gases are circulated just previously to their passage to the outer chamber, and are therefore at a temperature next higher to that which obtains in the outer chamber, and finally the water and steam are circulated through the interior of the hollow member 15, which is enveloped with the gases just received from the furnace, and therefore having the highest temperature which obtains in the boiler. The result of this construction and arrangement is that the gases impart a maximum portion of their heat units to the liquid, that the steam generated is brought to an extremely high temperature, and that the amount of heat lost by radiation is reduced to a maximum, since the outer parts of the boiler which are exposed to the external cooling effects contain the liquid and gases of the lowest temperature. It will be seen, therefore, that I attain the several objects of my invention and at the same time provide an extremely compact and comparatively cheap construction, it being noted that the several annular elements may be very cheaply constructed and assembled, while the tubular parts are all composed of straight tube-sections which are obviously also capable of very economical construction. It will of course be understood that the details of construction may be modified without departing from the invention—as, for example, the boiler would be entirely practicable if the helical partition webs or flanges were omitted and likewise the construction would be operative, although less economical, were the radiating tubes and corresponding inclosing projections omitted. I do not, therefore, wish to be limited to the details of construction shown and described herein except to such extent as said details are made the subject of specific claims.

I claim as my invention—

1. In a boiler the combination with an outer shell, of a hollow annular water-chamber disposed within said shell, to provide a surrounding gas-circulating space, a central chamber of less external diameter than the interior of said annular water-chamber, providing therewith an inner annular gas-circulating space, a plurality of gas-passages within and extend-

ing longitudinally throughout the length of said central chamber, an outer chamber surrounding the said annular water-chamber and likewise provided with gas-passages within
 5 and extending longitudinally throughout the length thereof and communicating passages or spaces at the ends of said several chambers.

2. In a steam-boiler the combination with an outer shell, of a hollow annular water-chamber of less dimensions than the interior of the boiler-shell and disposed therein to provide
 10 a surrounding gas-circulating space, an inner chamber of less external diameter than the interior of said annular water-chamber, and disposed within the latter to provide a second annular gas-circulating space, fire-tubes extending from end to end through said central
 15 chamber and opening into gas-spaces at the ends thereof, an outer annular chamber surrounding the said annular water-chamber, and likewise provided with fire-tubes extending longitudinally therethrough and opening into gas-spaces at the respective ends of the boiler,
 20 an annular partition separating the space within which the annular water-chamber is arranged, from the end space of the boiler into which the fire-tubes of the central and outer chambers open, a gas-inlet communicating with the circulating-space exterior to the annular water-chamber, and an outlet-flue communicating with the end space of the boiler
 25 into which the fire-tubes of the outer chamber discharge, substantially as described.

3. In a boiler the combination with an outer
 35 shell, of a hollow annular water-chamber of less external dimensions than the interior of the boiler-shell and disposed thereon to provide a surrounding gas-circulating space, said annular chamber forming in conjunction with
 40 its support a substantially complete annular partition, extending from one end of the boiler to a point near the opposite end thereof, a central chamber of less external dimensions than the interior of the annular water-chamber and
 45 disposed therein to provide a surrounding annular gas-circulating space, said central chamber terminating at each end short of the end walls of the boiler-shell and having fire-tubes extending longitudinally therethrough and
 50 opening into the end spaces of the boiler at the respective ends thereof, an outer annular chamber of larger internal dimensions than the annular water-chamber and arranged concentrically therewith, said outer chamber being
 55 likewise provided with fire-tubes and terminating short of the end walls of the boiler so that said fire-tubes open into the end spaces at the respective ends of the boiler, a partition extending between said outer and central
 60 chambers at a point between the upper end of the annular water-chamber and the adjacent end of the boiler, an annular chamber immediately below the end of the said outer chamber into which the fire-tubes of the latter discharge, an inlet-passage communicating with

the circulating-space exterior to the annular water-chamber at the lower end thereof, an outlet passage or flue communicating with the annular chamber into which the fire-tubes of the outer chamber discharge, one or more
 70 steam-pipes communicating with the upper end of said annular water-chamber, means for supplying said outer annular chamber with water, communicating passages between the outer chamber and the central chamber and
 75 communicating passages between the central chamber and the annular water-chamber, as and for the purpose set forth.

4. In a boiler, the combination with an outer shell, of a hollow annular water-chamber of
 80 less external dimensions than the interior of the boiler-shell and disposed therein to provide a surrounding gas-circulating space, said annular chamber forming in conjunction with its support a substantially complete annular
 85 partition extending from one end of the boiler upwardly toward the opposite end thereof, a centrally-disposed chamber of less external dimensions than the interior of the annular water-chamber and disposed therein to provide
 90 a surrounding gas-circulating space, said central chamber terminating at each end short of the end walls of the boiler-shell and having gas-circulating passages extending longitudinally therethrough, and opening into the end
 95 spaces of the boiler, an outer annular chamber extending around the interior of the boiler-shell, said outer chamber being likewise provided with fire-tubes extending longitudinally therethrough and opening into the end spaces
 100 of the boiler, a partition extending between said outer and central chambers at a point between the upper end of the annular water-chamber and the adjacent end of the boiler, helically-disposed partitions arranged within
 105 the circulating-spaces exterior and interior to the annular water-chamber, inlet and outlet passages communicating with a source of heated gases and with a discharge-flue respectively, means for supplying liquid to said
 110 outer and central chambers and to the annular water-chamber, communicating passages between said chambers and one or more steam-outlet pipes communicating with the steam-space of the boiler, as and for the purposes
 115 set forth.

5. In a boiler, the combination with an outer cylindric shell, of a hollow cylindric annular water-chamber of less external diameter than the interior of the boiler-shell and disposed
 120 concentrically therein, said annular chamber forming in conjunction with its support a substantially complete annular partition extending from the lower end of the boiler upwardly toward the opposite end thereof, a centrally-
 125 disposed cylindric chamber of less diameter than the interior of said annular water-chamber and terminating at each end short of the end walls of the boiler-shell, one or more gas-passages within said central chamber and ex- 130

tending longitudinally throughout the length thereof and opening into the end spaces of the boiler, a helically-disposed partition surrounding the exterior of said annular water-chamber, a partition extending between said 5 central chamber and the surrounding wall which incloses the annular water-chamber at a point above the upper end of said annular chamber and between the latter and the adjacent end wall of the boiler, a gas-inlet passage communicating with the circulating-space exterior to the annular water-chamber at the lower end thereof and a gas-outlet passage from the gas-space at the upper end of said 15 boiler, substantially as described.

6. In a boiler, the combination with an outer cylindric shell, of a hollow cylindric annular water-chamber of less external diameter than the interior of the boiler-shell and disposed 20 concentrically therein, said annular chamber forming in conjunction with its support a substantially complete annular partition extending from the lower end of the boiler upwardly toward the opposite end thereof, a centrally-disposed cylindric chamber of less diameter 25 than the interior of said annular water-chamber but of substantially the same length and both terminating at each end short of the end walls of the boiler-shell, one or more gas-passages within and extending longitudinally throughout the length thereof and opening into the end spaces of the boiler, helically-disposed partition-strips extending around the exterior and interior of said annular water-chamber, a partition extending between said 35 central chamber and the surrounding wall which incloses the annular water-chamber at a point above the upper end of said annular

chamber and between the latter and the adjacent end wall of the boiler, a gas-inlet passage 40 communicating with the circulating-space exterior to the annular water-chamber at the lower end thereof and a gas-outlet passage from the gas-space at the upper end of said boiler, substantially as described. 45

7. In a boiler of the character described, the combination of the outer chamber extending around the cylindric side wall of the boiler, the central chamber, the annular chamber interspaced between the outer and central chambers, of communicating gas-passages, means 50 for supplying water to one end of the outer annular chamber, means within said outer chamber compelling the liquid to perform a longitudinal forth-and-return circulation 55 therein, communicating passages extending between the inlet end of said outer annular chamber and the adjacent end of the central chamber, means within said central chamber for compelling the water to perform a longitudinal forth-and-return circulation therein, 60 an inner annular chamber arranged concentrically within said annular water-chamber, communicating passages extending between the inlet end of said central chamber and the corresponding end of said inner annular chamber, 65 outlet-passages at various points throughout the length of said inner annular chamber and one or more steam-pipes communicating with that end of the interspaced annular chamber 70 remote from the inlets of the latter, as and for the purpose described.

FRANCIS J. DOYLE.

Witnesses:

ALBERT H. GRAVES,
FREDERICK C. GOODWIN.