No. 742,613. PATENTED OCT. 27, 1903.

F. J. DOYLE.

STEAM BOILER AND FURNACE.

APPLICATION FILED MAR. 7, 1903.

NO MODEL. 6 SHEETS—SHEET 1.

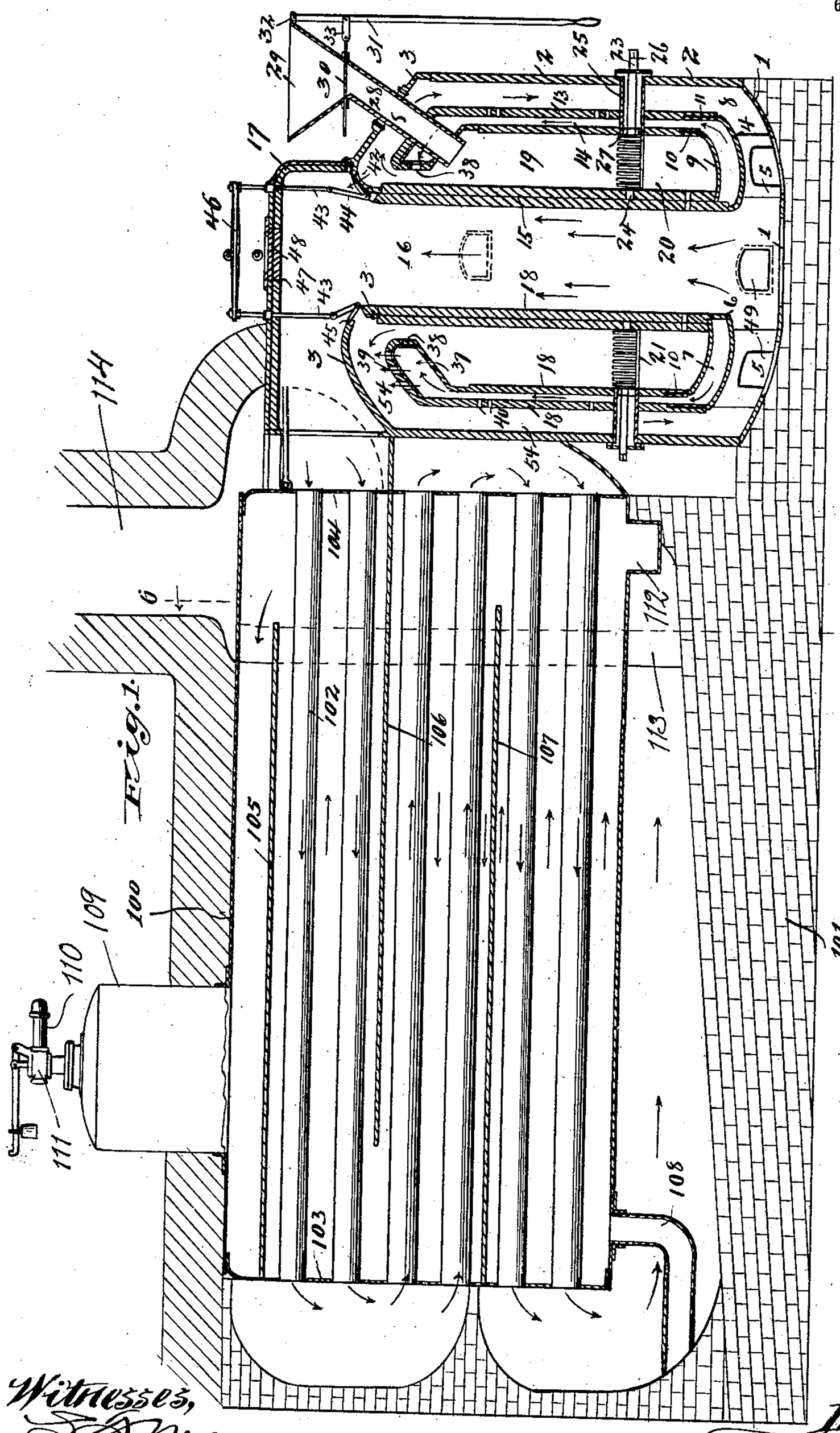

Fig. 1.

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

Inventor,
Francis J. Doyle.
By Offield Towle & Linthicum,
Attys.

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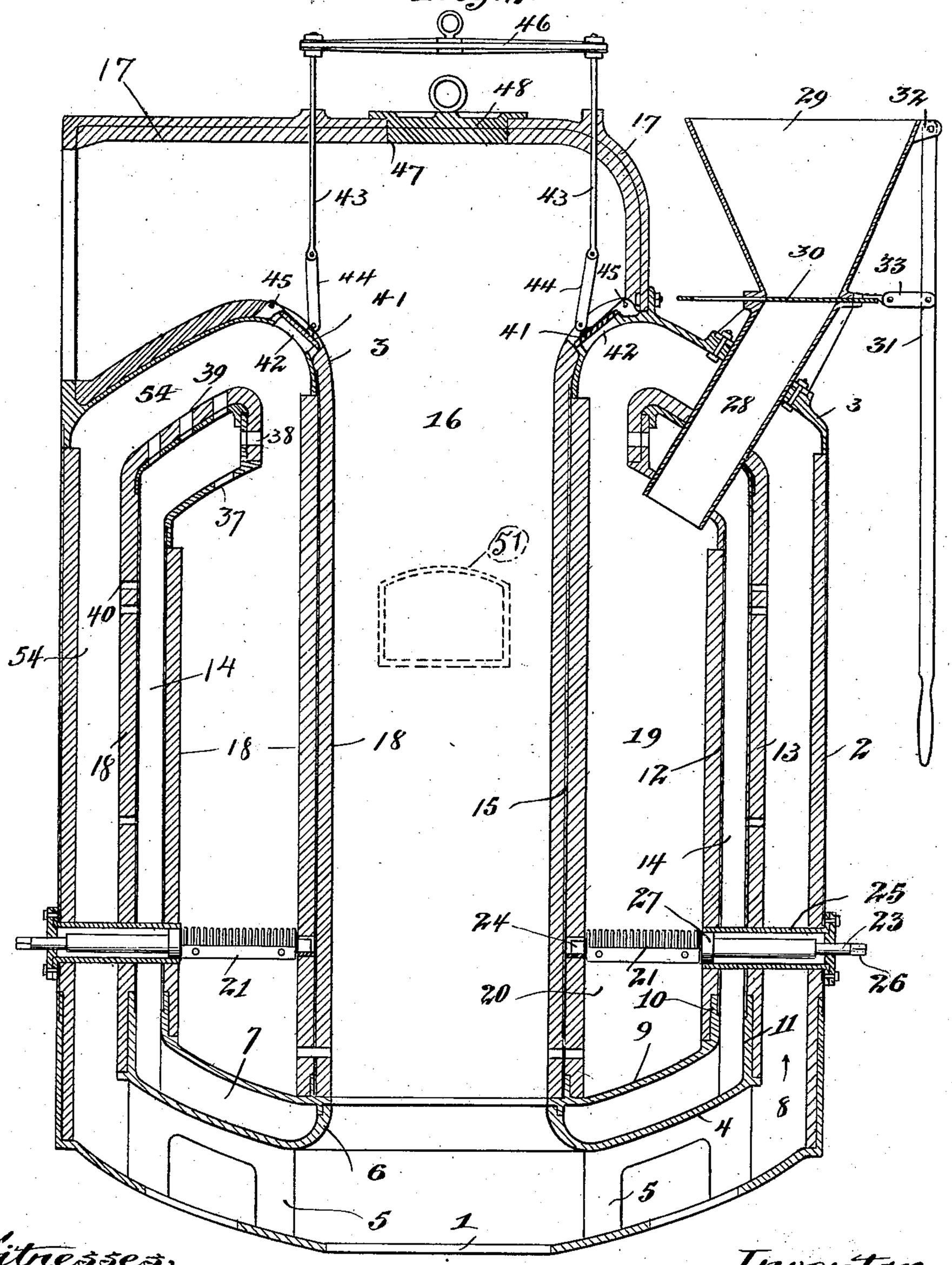
NO MODEL. 6 SHEETS—SHEET 2.

Fig. 2.



Witnesses,
D. D. Mann.
A. D. Graves.

Inventor,
Frances J. Doyle,
By Offield Towle & Linthicum.
Attys.

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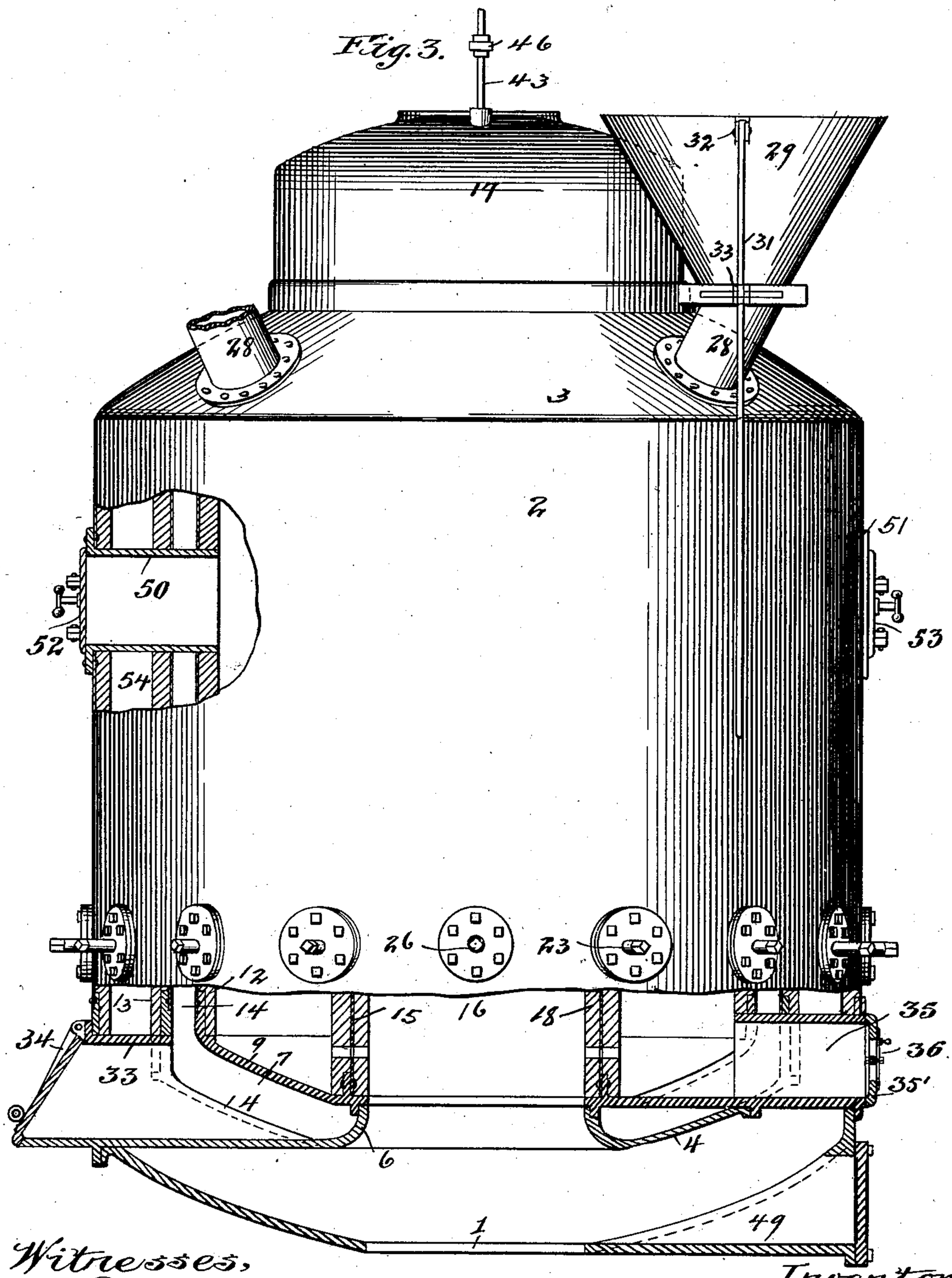
NO MODEL. 6 SHEETS—SHEET 3.

Fig. 3.



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A. N. Graves.

Inventor,
Francis J. Doyle,
By Offield Towle & Linthicum
Attys.

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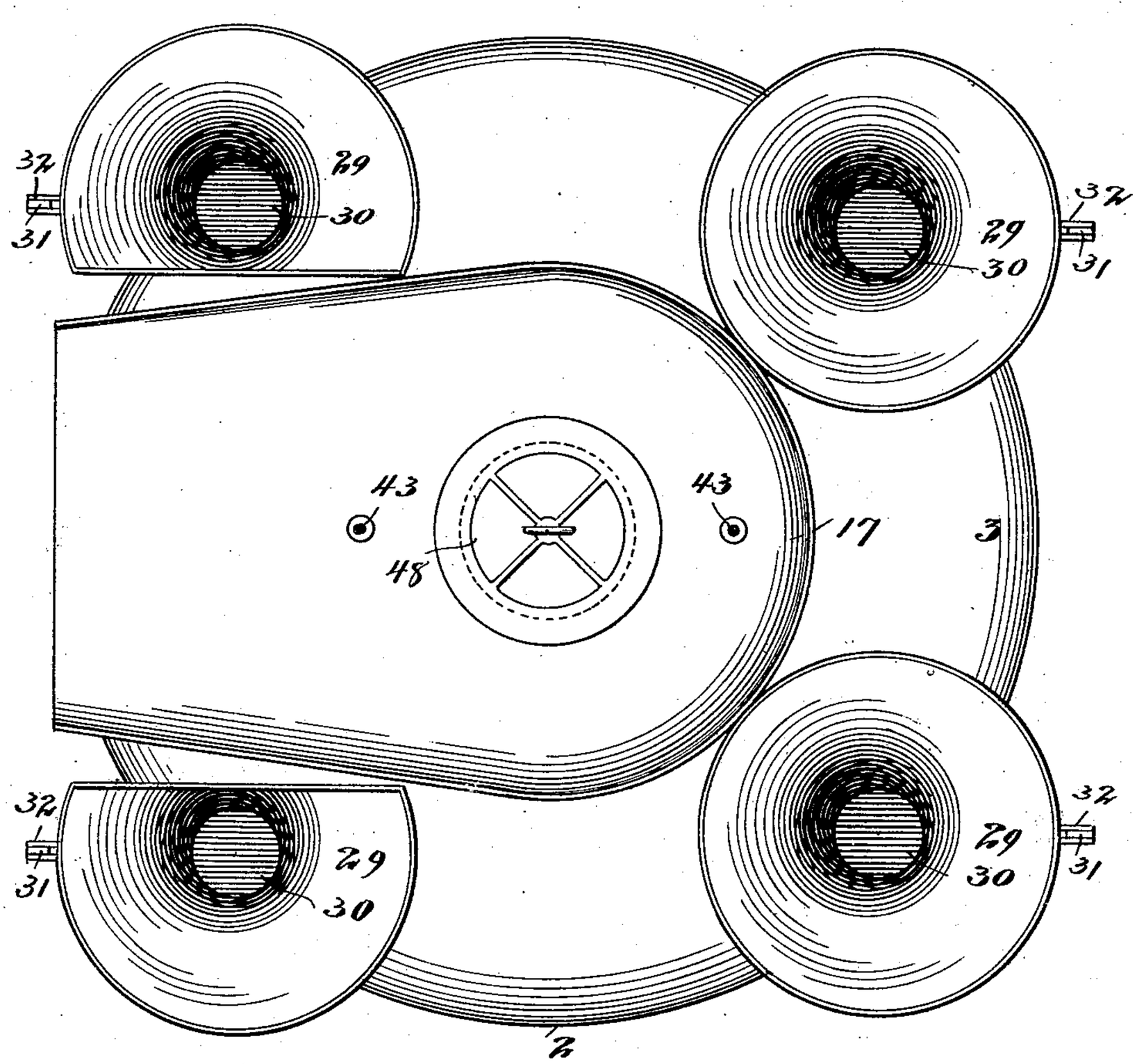
NO MODEL. 6 SHEETS—SHEET 4.

Fig. 4.



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A. N. Graves.

Inventor,
Francis J. Doyle,
By Offield Towle & Linthicum,
Attys.

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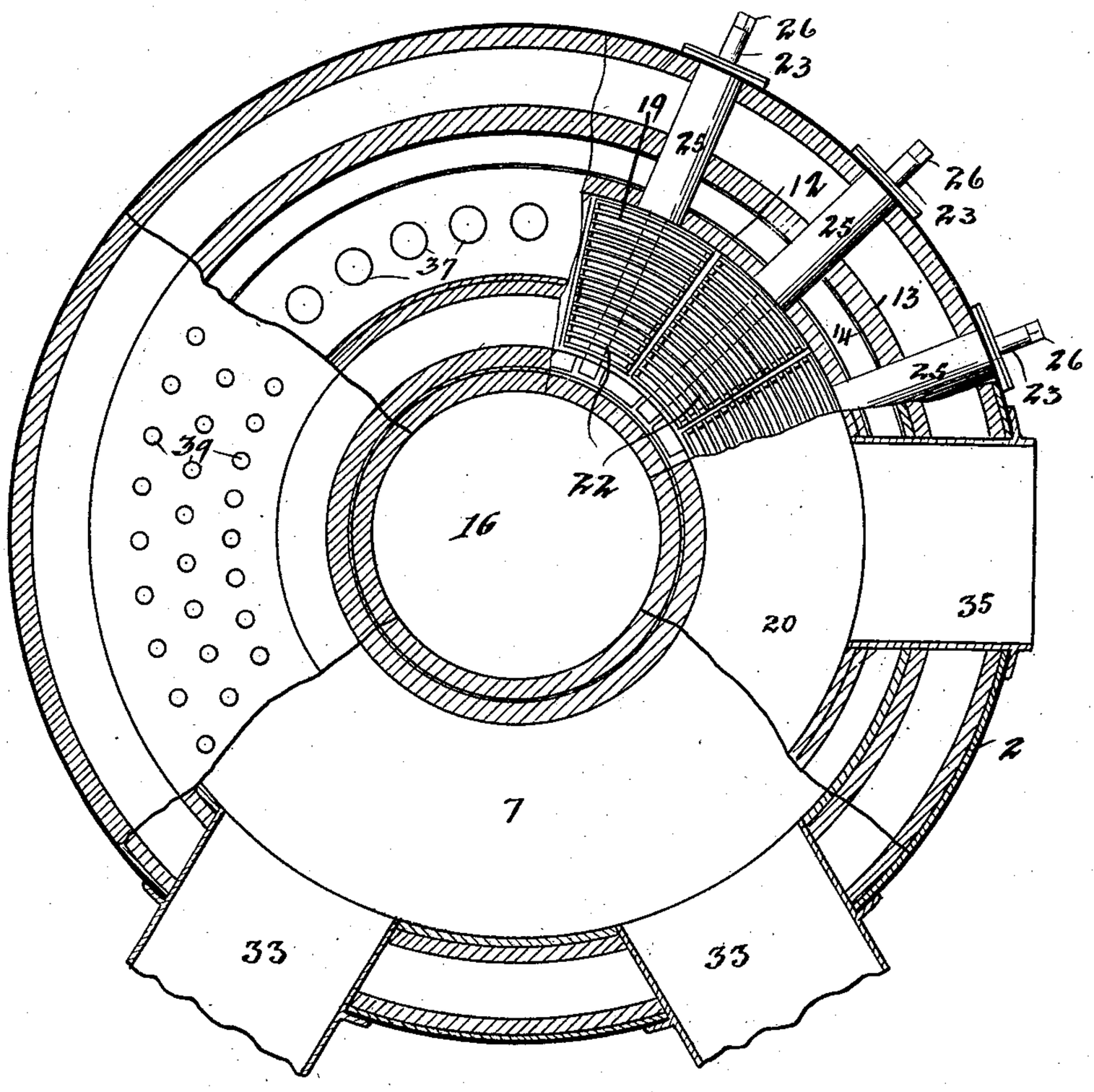
NO MODEL. 6 SHEETS—SHEET 5.

Fig. 5.



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

Inventor,
Francis J. Doyle.
By Offield Towler & Linthicum,
Attys.

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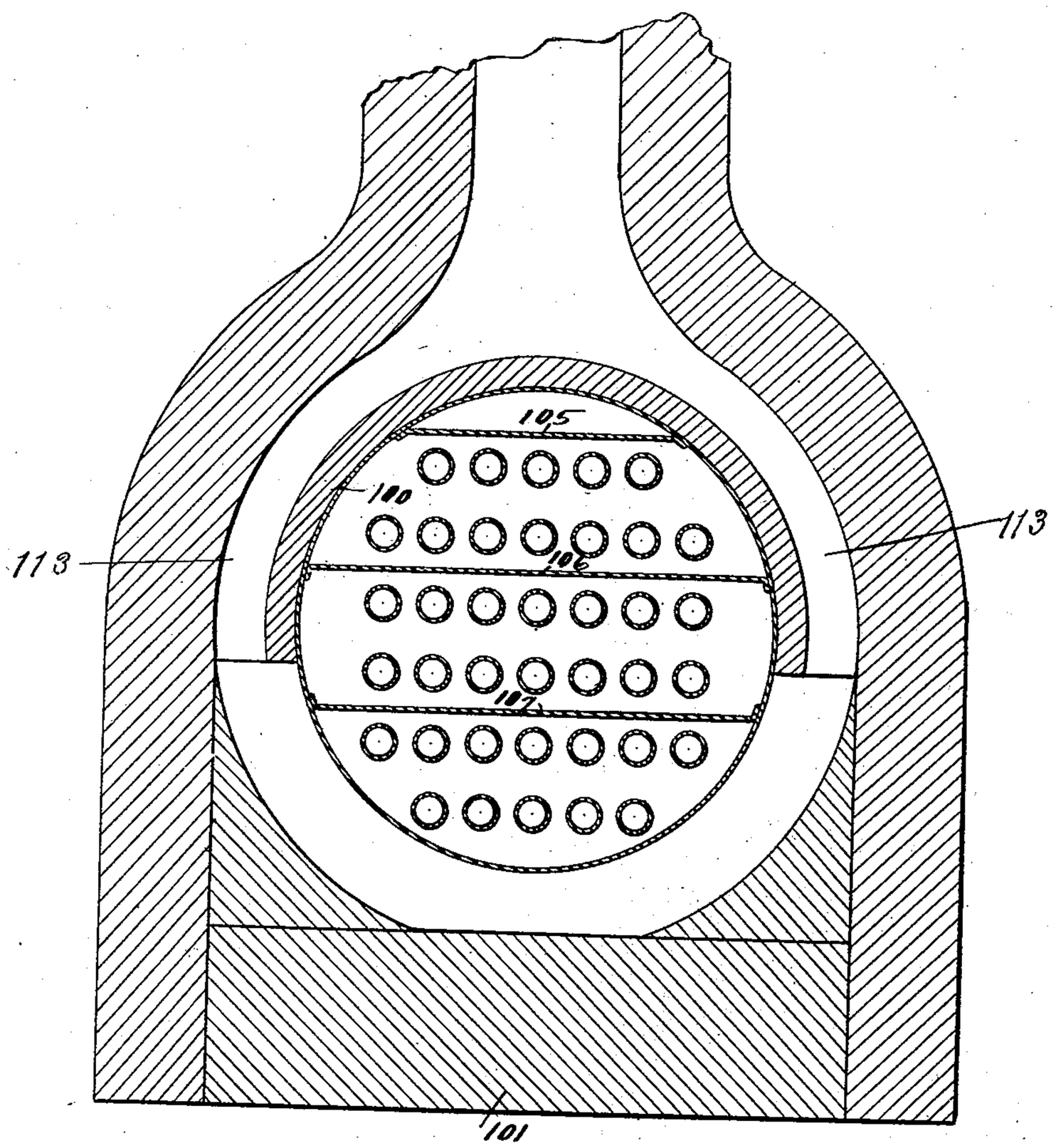
NO MODEL. 6 SHEETS—SHEET 6.

Fig. 6.



Witnesses,
F. F. Mann,
A. N. Spares.

Inventor,
Francis J. Doyle.
By Offield Towler & Linthicum,
Attys.

No. 742,613. Patented October 27, 1903.

UNITED STATES PATENT OFFICE.

FRANCIS J. DOYLE, OF CHICAGO, ILLINOIS.

STEAM-BOILER AND FURNACE.

SPECIFICATION forming part of Letters Patent No. 742,613, dated October 27, 1903.

Application filed March 7, 1903. Serial No. 146,682. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS J. DOYLE, of Chicago, Illinois, have invented certain new and useful Improvements in Steam-Boilers and Furnaces, of which the following is a specification.

This invention relates to improvements in steam-boilers and furnaces therefor, and refers more specifically to a construction in which the fuel is converted into heat within a furnace of novel and peculiar construction and thereafter conveyed to and through the steam-boiler, which is also of peculiar and novel construction, the furnace being substantially complete in itself and located contiguous to the boiler.

The salient object of the invention is to achieve greater economy in the production of steam, the secondary objects being to provide a furnace construction which produces a more perfect, and therefore a more economical, combustion of the fuel and to provide a boiler construction which applies the heat to the production of steam in an improved and more economical manner.

The invention also has for its object to provide a generally improved, practical, and efficient apparatus of the character referred to.

The invention consists in the matters hereinafter described, and more particularly pointed out in the appended claims, and the same will be more readily understood from the following description by reference to the accompanying drawings, forming a part thereof, and in which—

Figure 1 is a vertical sectional view taken longitudinally through the boiler and axially through the furnace. Fig. 2 is an axial sectional view, similar to that shown in Fig. 1, of the furnace detached. Fig. 3 is an elevation of the furnace. Fig. 4 is a top plan view of the same; Fig. 5, a horizontal sectional view taken on five different horizontal planes, broken away to expose subjacent mechanism; and Fig. 6 is a transverse vertical sectional view taken on the dotted line 6 6 of Fig. 1 and looking in the direction of the arrows.

Describing first the construction of the furnace, 1 designates as a whole a lower end or base member, which is preferably somewhat concave and circular in its plan, this member being conveniently seated or mounted in a suitable masonry structure, as indicated in Fig. 1. With the outer periphery of the base member 1 is connected the lower end of a cylindric outer shell 2, upon the upper end of which is mounted an annular top wall member or cap 3. Within the lower part of the main furnace-body is arranged a horizontally-disposed intermediate partition member 4, which is desirably also made slightly concave, so as to extend substantially parallel with the bottom wall 1 and is supported at a distance above the latter conveniently by means of radially-disposed skeleton plates or legs 5. The member 4 is of annular form, being provided at its center with a relatively large opening surrounded by an annular upstanding flange 6, which flange forms the inner side wall of an intermediate chamber 7, hereinafter more fully described. The intermediate member 4 is of less diameter than the interior of the main outer shell 2, its periphery terminating at a sufficient distance from said outer shell to provide an annular passage 8, the function of which will hereinafter appear.

Upon the intermediate member 4 is superposed an upper member 9, likewise made convex and of smaller diameter than the intermediate member, said upper member being conveniently, and as shown herein, supported upon the annular flange 6 and being provided at its periphery with an upstanding flange 10. The outer periphery of the member 4 is likewise provided with an upstanding flange 11, and upon these two flanges 10 and 11 are respectively mounted inner and outer annular partition members 12 and 13, which are brought together at their upper ends at a point some distance below the top wall 3 and form, in conjunction with the space or chamber 7, intervening between the horizontal partition members 4 and 9, an air-heating chamber, (designated as a whole 14.)

Upon the central portion of the upper member 9 is mounted a tubular partition member 15, which is of an internal diameter substantially the same as the central opening of the lower member 4 and which extends from said upper member 9 upwardly to and is connected with the top cap member 3, thus forming a central passage 16 from bottom to top of the furnace. In the present instance the furnace is arranged to discharge laterally into a boiler,

as seen in Fig. 1, and accordingly the top member or cap 3 of the furnace is provided with a laterally-extending discharge-trunk 17, which is fitted upon the upper end of the furnace, so as to communicate with the central discharge-passage 16, and extends to a point flush with the side wall of the furnace.

The interior of the furnace is provided throughout with refractory lining, as indicated at 18, except as to the bottom walls of the several chambers, which are sufficiently protected by the ashes, but may also be lined, if found desirable or necessary.

The space intervening between the inner annular partition 12 and the central tubular partition 15 constitutes the fuel or primary combustion-chamber and ash-pit, the former being designated 19 and the latter 20. The fuel-chamber and ash-pit are separated from each other, as usual, by means of a horizontal annular grate, (desiguated as a whole 21,) said grate being conveniently, and as shown herein, formed of a series of segmental sections, as 22, (see Fig. 5,) each of which is mounted upon a trunnion rod or shaft 23, the inner end, as 24, of which is seated in a suitable bearing-aperture in the tubular partition-wall 15, while the outer end is arranged to extend outwardly through a tubular partition 25, which extends through the outer wall and the two intermediate annular partition-walls 12 and 13, thus enabling the grate to be manipulated from the exterior. The end of each trunnion-shaft 23 is provided with a suitable spanner-hold, as indicated at 26. A bearing is provided for the trunnion-shaft at a point adjacent to the outer edge of the grate, which bearing, as indicated at 27, conveniently takes the form of a disk, which fits within the tubular partition 25, thereby serving both as a bearing-support for the shaft and as a closure for the tubular opening.

As a means of feeding fuel intermittently to the fuel-chamber I provide a plurality of inlet-chutes 28, arranged at intervals apart around the top of the furnace and each constructed to extend obliquely inwardly and downwardly through the top cap 3 and the air-chamber partitions 12 and 13 and discharging into the upper end of the fuel-chamber, as indicated clearly in the drawings. The outer end of each chute desirably terminates in a hopper 29, and in order to control the feed of fuel each chute is provided with a slide valve or gate 30, which extends through the chute at a point outside of the furnace and is conveniently manipulated by means of a hand-lever 31, pivoted at one end to the hopper, as indicated at 32, and connected intermediate its length with the gate by means of a link 33.

The principal supply of air for combustion is primarily admitted to the space or chamber at the lower part of the furnace (designated 7) and which for convenience of description will be designated the "air-inlet" chamber. To this end a tubular partition 33 is arranged to extend inwardly through the outer wall of the furnace at a point horizontally opposite said inlet-chamber, as best indicated in Fig. 3, which tubular partition connects at its inner end with said air-inlet chamber and is closed at its outer end by means of a suitable damper-door 34.

In order to provide for the withdrawal of the ashes, a horizontally-disposed tubular partition 35 is arranged to extend inwardly through the outer wall of the furnace and the two intermediate partitions 12 and 13 at a point horizontally opposite the lower end of the ash-chamber, the outer end of the tubular passage thus formed being closed by means of a suitable door 35'. This door is also provided with a damper 36, through which a controlled quantity of air may be admitted to the ash-pit below the grate.

The air which is admitted to the air-inlet chamber 7 and passes thence into the air-heating chamber or space 14 is admitted to the products of combustion at various points along the path of circulation of said products of combustion, but after they have passed out of the fuel or primary combustion-chamber. To this end the upper end of the inner annular partition 12 and the upper end portion and sides of the partition member 13 are provided with numerous perforations or air-passages, as indicated at 37, 38, 39, and 40, through which the air passes from the air-heating chamber into the surrounding circulating-passages.

At times—as, for example, in starting the fire in the furnace—it is desirable to place the fuel-chamber in direct communication with the main outlet of the furnace, and to this end I provide a plurality of damper-doors 41, arranged at intervals apart around the receiving end of the outlet-trunk 17, and several controlling-passages 42, which afford communication between the upper end of the fuel-chamber and said trunk. These damper-doors are conveniently manipulated by means of operating-rods 43, arranged to extend vertically down through the upper wall of the trunk and severally connected with the doors by means of links 44, the doors being severally hinged at their upper sides, as indicated at 45, so as to be capable of being lifted upwardly to open them and closing by gravity. Conveniently the operating-rods 43, of which there are two in the present instance, are connected by means of a cross-bar 46, so that the damper-doors may be opened together and to an equal extent.

For the purposes of inspection and the like a manhole is conveniently provided in the upper side of the discharge-trunk 17, conveniently located vertically above the central passage 16 of the furnace, as indicated at 47, and normally closed by means of a manhole-cover 48. The lowermost chamber of the furnace is desirably provided with a lateral inlet, as indicated at 49, normally closed by means of a suitable door and through which

the accumulation of soot may be removed from time to time. Desirably also peep-openings are arranged at points intermediate the height of the furnace through which the character of the combustion taking place within the fuel-chamber and the outer circulating-passages may be viewed, one of these peep-openings being formed by means of a tubular passage 50 (see Fig. 3) to extend inwardly through the outer wall and two intermediate walls and communicating at its inner end with the fuel-chamber and the other simply opening through the outer wall of the furnace into the outer circulating-passage, as indicated at 51. Each of these peep-openings is normally closed by means of a door, as 52 and 53.

The operation of the furnace will now be briefly described and is as follows: The fuel fed in through the several chutes 28 rests upon the grate in the fuel-chamber, ordinarily occupying a substantial part of the depth of the fuel-chamber. The supply of air for initial combustion is admitted to the ash-pit through the passage formed by the tubular partition 35. The products of combustion escaping from the fuel-chamber pass upwardly into the annular circulating-passage 54, formed between the air-heating chamber and the outer walls of the furnace, receiving supplies of heated air through the openings 37, 38, 39, and 40 as the products of combustion circulate outwardly and downwardly through said circulating-passage. The products of combustion pass downwardly entirely around the air-heating chamber and into the lowermost space or chamber of the furnace and thence into the central tubular passage 16, and so out through the main discharge-trunk. It will be seen from the foregoing that the air-heating chamber 14 is completely enveloped by the combustion which is taking place in the fuel-chamber and the circulating-passages 54, and it will further be noted that inasmuch as the products of combustion which are dispersed as they leave the fuel-chamber are again collected in the central uptake-passage the latter serves as a mixing-chamber, so that the heated gases are thoroughly commingled and leave the furnace in a body of practically uniform temperature. The manipulation of the various draft-controlling doors and fuel-supplying mechanism, as well as the operation of the several dampers and grates, is entirely obvious and need not, therefore, be explained in detail.

Describing now the construction of the boiler in which I utilize the products of combustion from my improved furnace and which boiler is also of novel and improved construction, 100 designates as a whole an outer boiler-shell, which may conveniently be of the usual cylindric horizontal type and mounted in suitable masonry, whereby it is supported at each end, as indicated at 101. The boiler is of the fire-tube type, and to this end is provided with a series of horizontally-extending fire-tubes 102, extending from end to end and having their ends opening out through the end walls 103 and 104 of the boiler in the usual manner. The fire-tubes are arranged in such manner as to provide horizontally-disposed intervening spaces within which are arranged a series of baffle-plates, as indicated at 105, 106, and 107. These baffle-plates are arranged to extend alternately from opposite ends of the boiler and are somewhat shorter than the full length of the boiler and are of a width sufficient to completely partition the interior of the water-space of the boiler, as indicated clearly in the cross-sectional view Fig. 6. In the present instance the uppermost baffle-plate 105 extends from the rear end wall forwardly to a point near the front end of the furnace, this baffle-plate being arranged immediately above the uppermost series of fire-tubes. The next lower baffle-plate 106 extends similarly from the opposite or front wall rearwardly to the point near the rear end of the boiler between the second and third horizontal series of fire-tubes, and the third or lowermost baffle-plate extends from the rear wall forwardly between the second and third tiers of tubes from the bottom.

108 designates the water-inlet, which, it will be noted, is arranged to communicate with the lower side of the boiler, near that end of the latter remote from the point where it passes upwardly around the first or lowermost baffle-plate. The water entering through inlet-pipe 108 passes forwardly and upwardly around the end of baffle-plate 107, thence rearwardly and upwardly around the end of baffle-plate 106 and back around baffle-plate 105, and finally passing to the steam-dome 109, by which time the liquid will have been entirely converted into steam. The steam-dome may be of any usual construction, that shown in the present instance being provided with an outlet trunk or pipe 110 and also with a safety-valve 111.

Desirably a sediment trough or recess 112 is provided, arranged to extend across the bottom side of the boiler, at that end of the latter remote from its receiving end, so that whatever sediment is precipitated will by the force of the inlet-current be swept into said trough.

The heater-gases pass from the trunk of the furnace longitudinally through the two uppermost series of fire-tubes, then return through the next two lower series and again pass outwardly through the next two lower series, and finally return toward the furnace beneath the lower side of the latter, as indicated clearly by the current-arrows indicated in Fig. 1. The products of combustion finally divide and pass laterally outwardly and upwardly through passages 113 to the chimney-stack 114.

It will be seen from the foregoing description that the circulation of the hot gases is exactly the reverse of the circulation of liquid steam—that is to say, the hottest gases or those just emerged from the furnace will pass

through those fire-tubes surrounded by steam in the upper part of the boiler, thus producing superheated steam and at the same time giving up a certain proportion of their heat. The partially-cooled gases then pass downwardly and return through tubes submerged in liquid or steam of a lower temperature, and so on progressively and downwardly through the boiler, constantly giving up their heat and imparting such heat to successively cooler portions of the liquid. The result of the arrangement is that the gases have almost completely yielded up their caloric before they pass out to the chimney-stack, and what is more important the steam which passes to the steam-dome is of the highest temperature, because it is subject to the hottest gases received from the furnace. This method of so intercirculating the heated gases and steam-producing medium that the steam is subjected in its final stage of production to the action of the hottest gases is not made the subject of claims herein, but is described and claimed in another application heretofore filed by me, Serial No. 146,312, filed March 5, 1903.

While I have herein shown and described a practical and preferred embodiment of my present invention, yet I do not wish to be understood as limiting myself to the precise details of construction and arrangement shown except in so far as these details are made the subject of specific claims.

I claim as my invention—

1. A furnace comprising an upright outer shell, a centrally-disposed upright tubular member arranged within said shell, an annular top member extending from the outer shell to the central tubular member, an annular air-heating chamber interspaced between said outer shell and the central tubular member and dividing the space inside of, and outside of said air-heating chamber into a fuel-chamber and a downtake circulating-passage respectively, a grate arranged in the lower part of said fuel-chamber and separating the latter horizontally, a plurality of fuel-chutes arranged to extend obliquely downwardly and inwardly through the walls of said furnace and communicating with the upper portion of said fuel-chamber, a horizontally-extending passage affording communication between the lower end of said downtake circulating-passage and the lower end of the inner tubular member, an outlet-trunk connected with the upper end of said inner tubular member, means for supplying air to the space below the grate in the fuel-chamber, means for supplying air to the annular air-chamber, and outlets affording communication between said air-chamber and said circulating-passage.

2. A furnace comprising an outer shell, a concentrically-disposed tubular member arranged within said shell, an annular end member extending from the outer shell to the central tubular member and forming in conjunction with the latter an inclosed annular space, an outlet-trunk connected with the central portion of said end member communicating with the interior of the central tubular member, an annular air-heating chamber interspaced between said outer shell and the central tubular member and dividing the space inside of, and outside of the air-heating chamber into a fuel-chamber and a circulating-passage respectively, a fuel-burning device arranged in the lower part of said fuel-chamber, a second end member opposite that with which the outlet-trunk is connected, closing the entire end of the outer shell and spaced at a distance from the proximate end of the central tubular member, an annular air-inlet chamber interspaced between the fuel-chamber and said last-mentioned end wall member, said air-inlet chamber arranged in communication with said air-heating chamber, a radially-disposed tubular passage affording communication between the exterior of the furnace and said air-inlet chamber, and a series of outlet-passages in said air-heating chamber affording communication between the latter and said circulating-passage at intervals throughout the length of the latter.

3. In a furnace of the character described, the combination of an outer upright shell closed at its lower end, a concentrically-disposed upright tubular member arranged within said shell, an annular top member extending from the outer shell to the central tubular member, an annular air-heating chamber concentrically arranged and interspaced between the walls of the outer shell and central tubular member, an extension at the lower end of said air-heating chamber extending inwardly to and connected with the lower end of the central tubular member and forming an air-inlet chamber, an extension connected with the upper end of said air-heating chamber and extending inwardly toward the upper end of the central tubular member to form a restricted annular passage from the space inside of said air-heating chamber to the circulating-space outside of the latter, a controlled inlet-passage from the exterior of the furnace to, and communicating with said air-inlet chamber, a plurality of restricted outlets affording communication between the air-heating chamber and the circulating-space, exterior to said air-heating chamber, a controlled air-inlet passage affording communication between the exterior of the furnace and the lower part of the initial combustion-chamber formed inside of said annular air-heating chamber, and controlled inlets for feeding fuel into said combustion-chamber, substantially as described.

4. In a furnace of the character described, the combination of an outer upright shell closed at its lower end, a concentrically-disposed upright tubular member arranged within said shell, an annular top member extending from the outer shell to the central tubular member, an annular air-heating chamber concentrically arranged and interspaced between the walls of the outer shell and cen-

tral tubular member, an extension at the lower end of said air-heating chamber extending inwardly to, and connected with the lower end of the central tubular member and forming an air-inlet chamber, an extension connected with the upper end of said air-heating chamber and extending inwardly toward the upper end of the central tubular member to form a restricted annular passage from the space inside of said air-heating chamber to the circulating-space outside of the latter, a controlled inlet-passage from the exterior of the furnace to, and communicating with said air-inlet chamber, a plurality of restricted outlets affording communication between the air-heating chamber and the circulating-space, exterior to said air-heating chamber, a controlled air-inlet passage affording communication between the exterior of the furnace and the lower part of the initial combustion-chamber formed inside of said annular air-heating chamber, controlled inlets for feeding fuel into said combustion-chamber, and one or more direct-draft, damper-controlled, passages affording communication between the receiving end of the circulating-passage and the main outlet-trunk, substantially as described.

5. In a furnace of the character described, the combination with an upright outer shell, an inner concentrically-arranged tubular member, and an annular air-chamber interspaced between the outer shell and inner tubular member and forming a combustion-chamber inside of, and a circulating-passage outside of, said air-heating chamber, of a plurality of segmental grate-sections arranged in a horizontal series within said combustion-chamber, each grate-section mounted to oscillate on a radial axis and provided with an axial shaft extending radially out through the walls of the furnace, substantially as described.

6. A furnace comprising an upright outer shell, a centrally-disposed upright tubular member arranged within said shell and extending from top to bottom thereof, an annular top member extending from said outer shell to the central tubular member, a vertically-disposed annular air-heating chamber interspaced between the outer shell and the central tubular member, and dividing the space between said air-heating chamber and the inner tubular member and outer shell respectively into a fuel-chamber and a down-take circulating-passage, a grate arranged in the lower part of said fuel-chamber, means for feeding fuel into the upper part of said fuel-chamber, an air-inlet passage admitting air to the lower part of said air-heating chamber, an air-inlet passage admitting air to the space beneath the grate, air-passages affording communication between the air-heating chamber and said circulating-passage at various points along the path of circulation of the products of combustion, and a discharge-trunk into which the upper end of said central tubular member discharges, substantially as described.

FRANCIS J. DOYLE.

Witnesses:
ALBERT H. GRAVES,
FREDERICK C. GOODWIN.