No. 742,612. PATENTED OCT. 27, 1903.

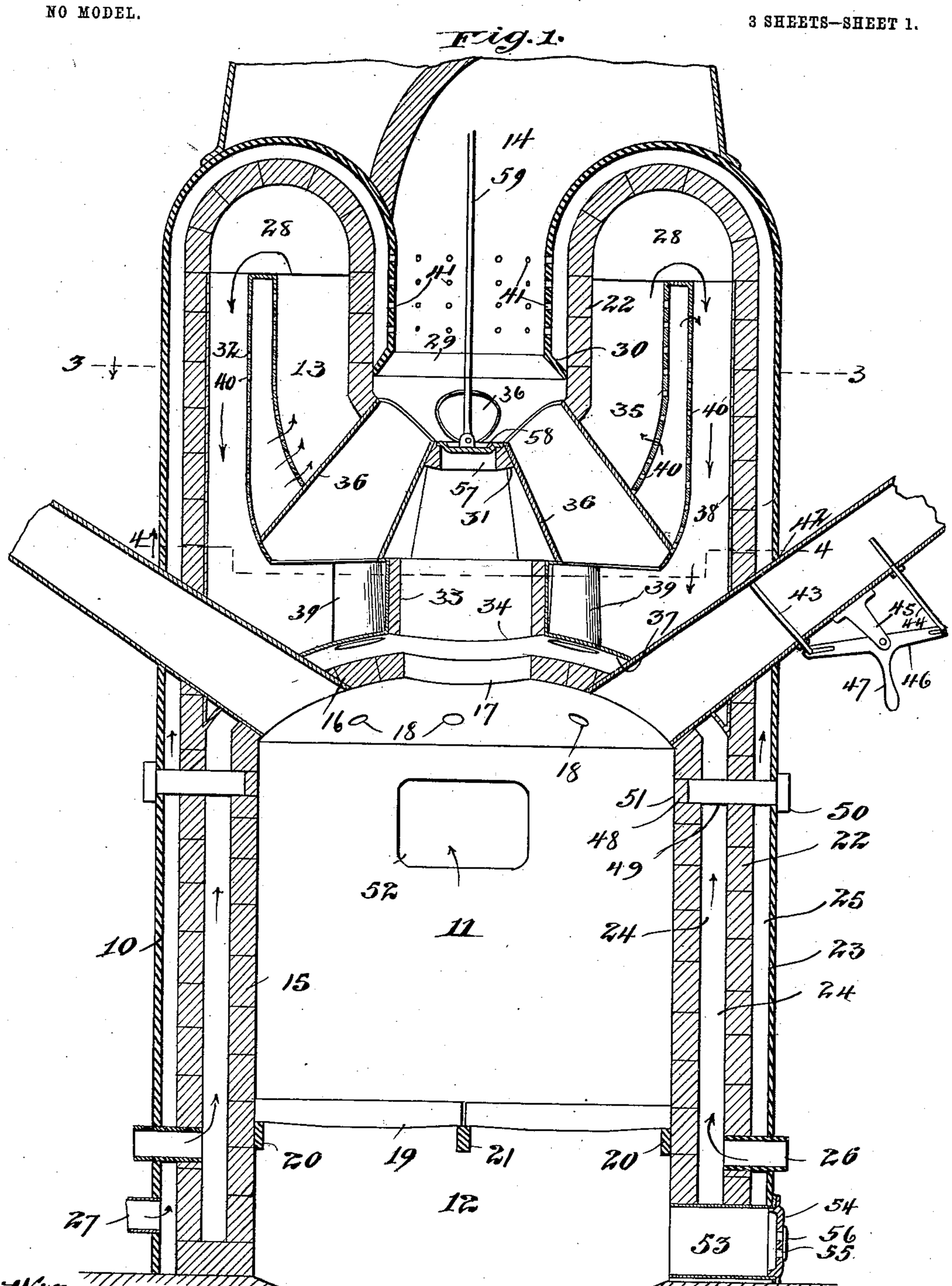
F. J. DOYLE.

FURNACE.

APPLICATION FILED MAR. 5, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.

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NO MODEL. 3 SHEETS—SHEET 2.

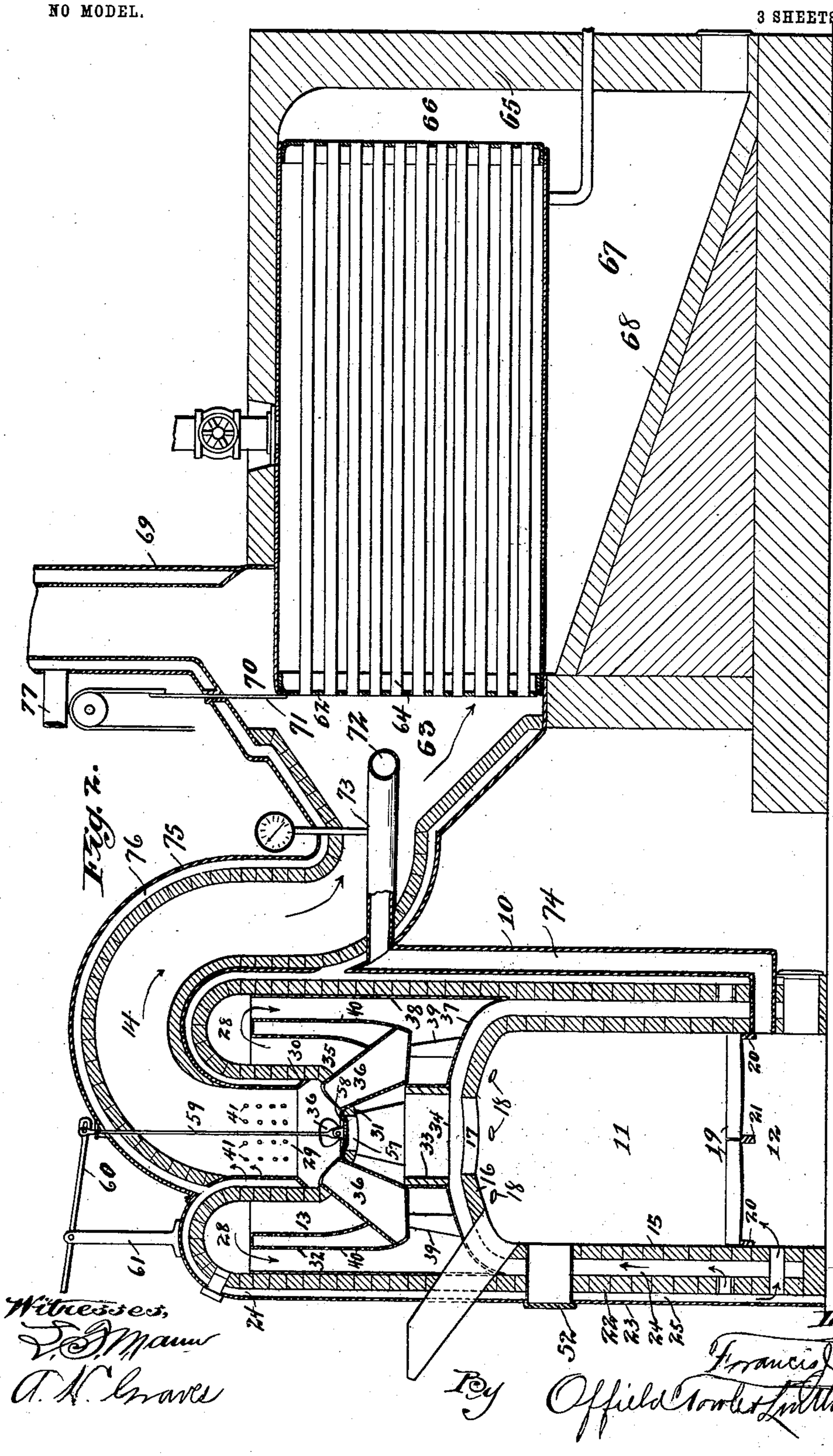


Fig. 2.

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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 3.

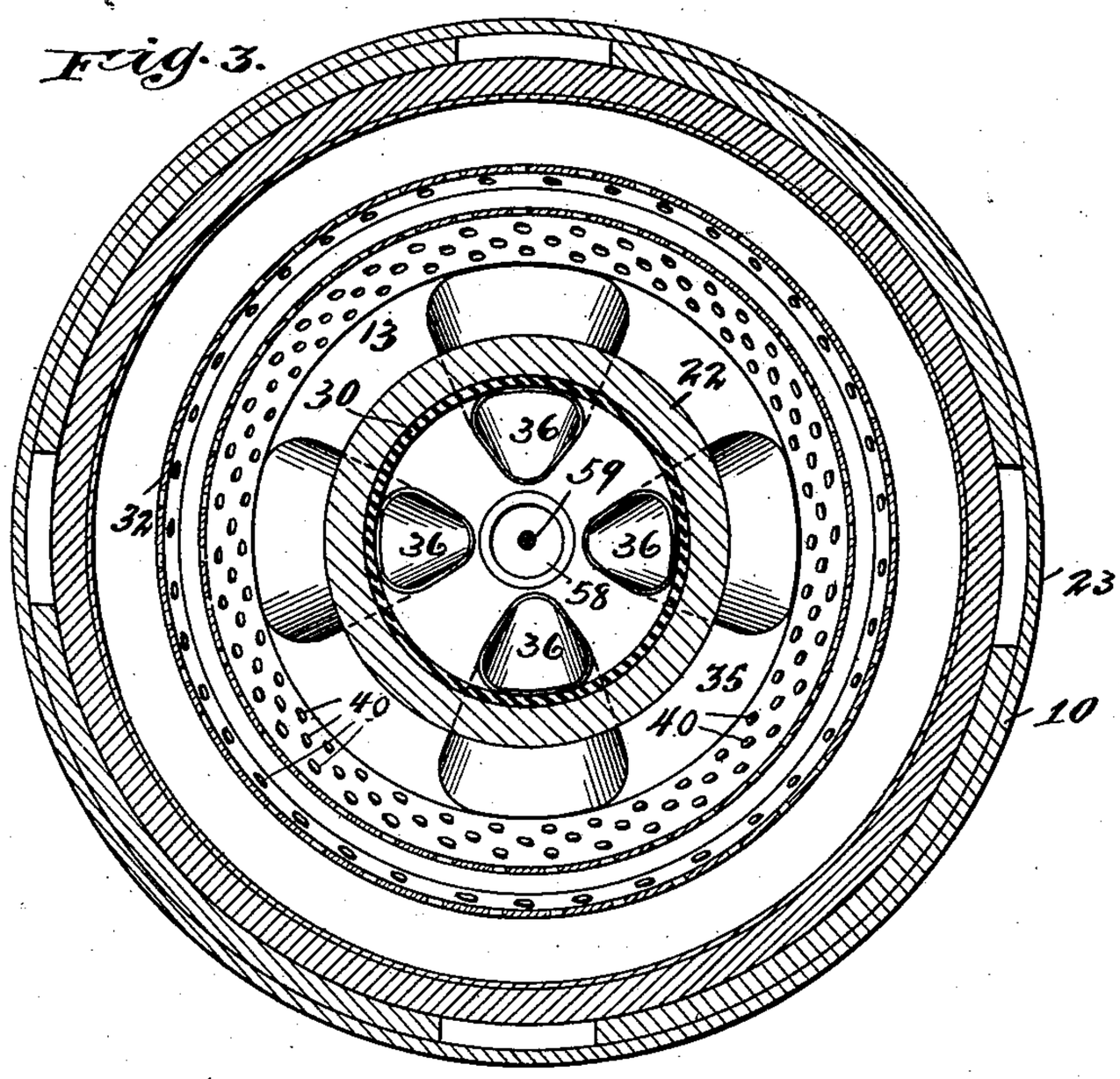
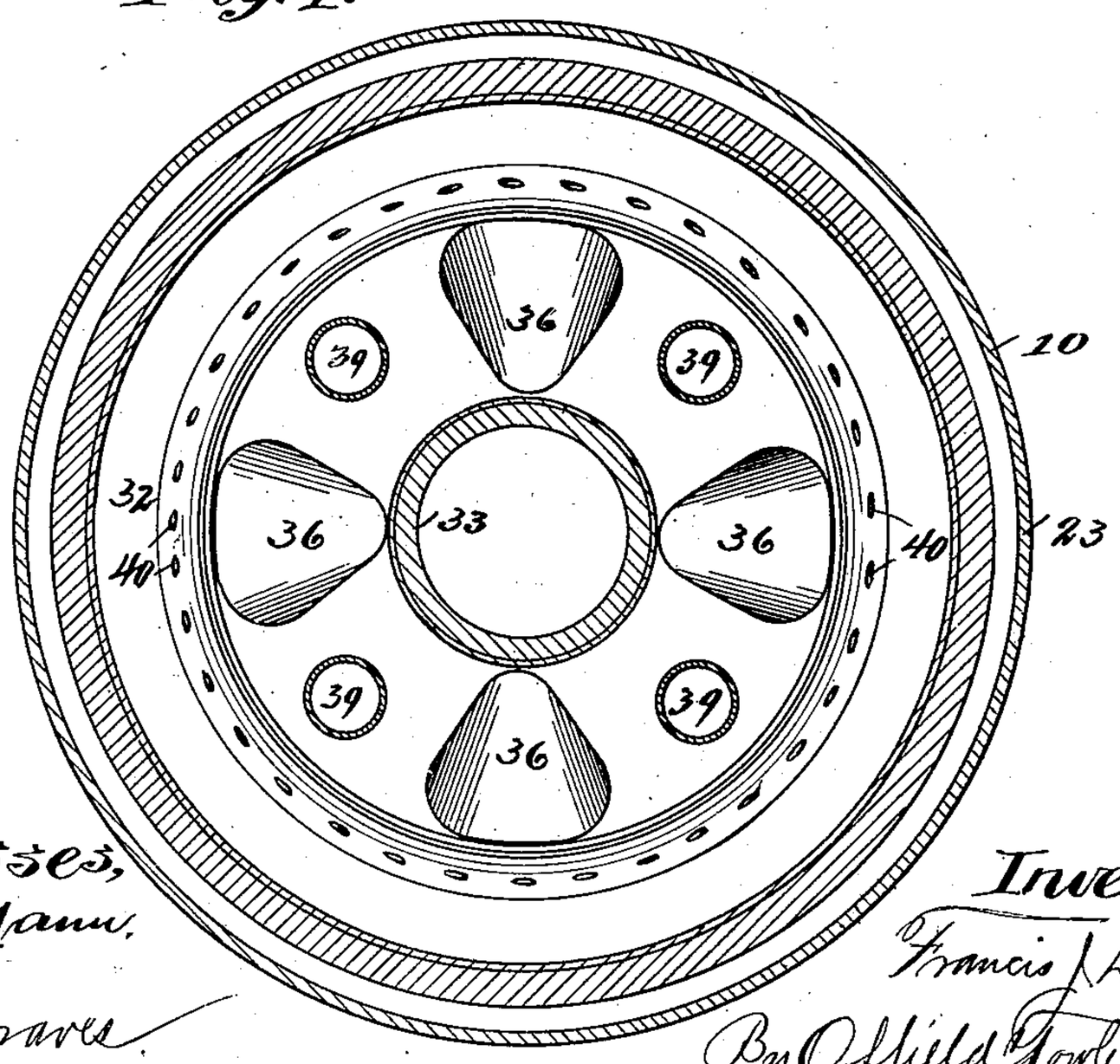



Fig. 4.

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# UNITED STATES PATENT OFFICE.

FRANCIS J. DOYLE, OF CHICAGO, ILLINOIS.

## FURNACE.

SPECIFICATION forming part of Letters Patent No. 742,612, dated October 27, 1903.

Application filed March 5, 1903. Serial No. 146,312. (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 Improvements in Furnaces, of which the following is a specification.

This invention relates to improvements in furnaces, and refers more specifically to an improved furnace particularly adapted for economically converting fuel into heat for the purpose of generating steam, the furnace being of that type wherein the products of combustion are circulated progressively through circulating-passages and are successively supplied with quantities of heated air to promote the combustion.

The object of the invention is to provide a simple, compact, and cheap construction capable of effecting the most perfect combustion of the fuel and so constructed and arranged as to produce a most intense combustion and to prevent to the greatest possible extent a loss of heat by radiation.

To this end 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, reference being had to the accompanying drawings, wherein—

Figure 1 is a vertical axial sectional view of a furnace constituting a preferred embodiment of my invention. Fig. 2 is a similar view showing the furnace adapted to a horizontal boiler. Fig. 3 is a sectional view taken on line 3 3 of Fig. 1 and looking in the direction of the arrows. Fig. 4 is a sectional view taken on line 4 4 of Fig. 1 and looking in the direction of the arrows.

Referring to said drawings, 10 designates as a whole the furnace, so constructed as to form two main chambers, the lower chamber constituting the fire-box 11 and ash-pit 12, and the upper chamber (designated as a whole 13) constituting the combustion-chamber, within which the products of combustion are circulated and then discharged to the main flue 14, leading to the boiler.

In the preferred embodiment shown herein the furnace has cylindric side walls, the fire-box being formed by an inner wall 15, which extends across the interior of the furnace, as at 16, to form the top wall of the fire-box and is provided in said top wall with a main outlet-aperture 17 and a plurality of smaller air-inlets 18, dispersed circumferentially around the main outlet 17. The grate 19 is arranged to extend across the interior of the furnace at the lower end of the fire-box, as usual, the several grate-bars thereof being supported in any suitable manner—as, for example, by cross-bars 20 and 21. The lower part of the furnace, within which the fire-box and ash-pit are located, is constructed of three separate walls, as 15, 22, and 23, arranged concentrically with each other and spaced apart, so as to provide intervening air-spaces 24 and 25, the two outer walls 22 and 23 being continued up through the full height of the furnace, over the top of the same, and returned a short distance, as will be hereinafter more fully described. Preferably, and as shown herein, the two inner walls 15 and 22 will be constructed of fire-brick or other suitable refractory material, so as to be capable of suitably withstanding the heat of the furnace, while the outer wall may be constructed of sheet or plate iron.

26 and 27 designate air-inlet flues arranged to communicate with the spaces 24 and 25, respectively, near the bottom of the furnace, a plurality of such inlet-flues being provided, leading into said spaces at intervals apart around the circumference of the furnace.

The walls 22 and 23 at the top of the furnace are curved inwardly and returned downwardly to form an annular space 28, surrounding a central, circular, and extending or tube-like outlet-flue 29, of which the flue 14 forms a continuation. The central returned portion 29 extends downwardly somewhat less than one-half the height or depth of the combustion-chamber, and at the lower end of said extension the outer wall 23 is deflected outwardly, so as to cross the end of the annular air-space 25, extending between said outer wall and the adjacent inner wall, as indicated at 30. The wall 22 is, however, continued some distance beyond the termination of the outer wall and then across the central part of the furnace to form a partition 31, concave above and convex beneath.

Within the irregularly-shaped combustion-chamber 13 thus formed is arranged a hollow annulus 32, the upper part of which extends upwardly within the annular part 28 of the combustion-chamber and the lower part of which is located within the central lower part of the combustion-chamber, said annulus being conveniently supported in part by means of a cylindric wall 33, forming a flue or passage 34, concentric and in continuation of the outlet-passage 17 of the fire-box. The cross-sectional space of said annulus is such as to divide the interior of the combustion-chamber into annular circulating-passages which extend completely around said annulus, the flue or passage 34 discharging into the circulating-passage 35, intervening between the upper and inner surface of the annulus and the opposite wall portions 31 and 22 of the furnace.

36 designates a plurality of intersecting flues arranged to extend obliquely upwardly and inwardly from the lower outer portions of the combustion-chamber through the lower parts of the annulus and through the partition-wall 31, thereby affording communication between said lower part of the combustion-chamber and the space immediately below and communicating with the main outlet-flue 29. A partition-wall 37 is provided arranged to extend over and parallel to the top wall 16 of the fire-box from the wall 22 to the flue-wall 33, so as to provide an extension or continuation of the air-space 24 over the top of the fire-box, and preferably said wall 37 is extended upwardly around the flue-wall 33 to the bottom of the annulus 32. Preferably also that part of the wall 22 which incloses the lower part of the combustion-chamber is provided with a lining 38, of metal, said lining in the present instance extending from the wall 37 upwardly to a point coextensive with the top of the annulus, as indicated clearly in the drawings.

In order to supply the hollow annulus with heated air, a plurality of flues 39 are arranged to extend from the wall 37 upwardly to and through the bottom of the annulus, said flues being spaced at intervals around the furnace and arranged to communicate with the air-space 24, as indicated clearly in the drawings. In this connection it is to be noted that the flues 39 will be so located as to communicate with the annulus at points between the several intersecting flues 36, hereinbefore described, which latter, it will be understood, have no communication with the interior of the annulus. The side walls of the annulus are provided with numerous outlet-apertures 40, through which the heated air is discharged through the circulating-passages 35, hereinbefore described.

In order to provide a final supply of heated air to the products of combustion after they have passed through the circulating-passages and entered the discharge-flue 29, the side walls of the latter are provided with apertures 41, communicating with the annular air-space 25 between the outer and inner walls of the furnace.

In order to provide means for supplying the fire-box with fuel, a plurality of feed-chutes 42 are provided at intervals around the circumference of the furnace, these chutes being arranged to extend from the upper part of the fire-box obliquely upwardly and radially outward through the several walls of the furnace and being extended beyond the latter sufficiently to contain a pair of feed-controlling slides 43 44, which are capable of being operated in such manner as to feed the fuel into the furnace in successive measured quantities or charges. As a convenient means of thus operating said slides a bracket-support 45 is mounted upon the lower side of each chute, beyond the outer end of which is pivotally mounted a lever 46 at a point intermediate of its length, the ends of said lever having slot-and-pin connections with the ends of the respective slides 43 44, so that the latter will be projected and retracted from the chute alternately as the lever is oscillated. Any suitable means may be employed for actuating the lever 46—as, for example, by means of a suitable handle 47—or mechanism may be supplied for actuating these levers automatically from any suitable motor.

In order that the condition of the fire within the fire-box may be inspected, a plurality of peep-holes 48 are provided, arranged to extend through the several walls of the furnace and opening into the upper part of said fire-box, said peep-holes being conveniently formed by means of tube-sections 49, inserted through suitable apertures in the several walls and normally closed by means of plugs 50, provided at their inner ends with refractory portions 51, which serve to protect both the tube-sections and the plugs from destruction by the intense heat.

In addition to the feed-chutes the fire-box is desirably provided with a door 52, through which access may be had to its interior for the purpose of inspection, stoking, and repair, and likewise the ash-pit is provided with a suitable opening 53, leading out through the side walls of the furnace and closed by means of an ordinary door 54. The door 54 is provided with the usual air-inlets 55, controlled by means of a slide-damper 56, whereby air may be admitted to a space below the grate in controlled quantities.

Inasmuch as it is desirable to provide for a direct draft from the fire-box or initial combustion-chamber to the main flue during the time the fire in the furnace is being started, a passage 57 is formed through the wall 31 in alinement with the passages 17 and 34, which passage 57 is controlled by a damper 58, operable by means of a rod 59, connected with its upper side and extending upwardly through the flue 29 and out through the top wall of the furnace. The rod 59 may be reciprocated by any suitable means—as, for

example, by means of a hand-lever 60—connected therewith and pivotally mounted upon a support 61. (See Fig. 2.)

The operation of the furnace constructed and arranged as thus described may be briefly detailed as follows: After the fire has been suitably started in the fire-box and the damper 57 closed the air-inlets communicating with the space below the grate are so adjusted as to admit a restricted supply of air, and a sufficient quantity of fuel is charged into the fire-box to produce a restricted combustion, which results in distilling and throwing off the combustible gases, but does not produce a free combustion within the fire-box. The gases and products of combustion rise from the fire-box through the main outlet 17 and communicating passages 34 and pass into the circulating-passages 35, an initial supply of air being entrained through the several inlets 18 in the top wall of the furnace and a further supply of air being added to the gases directly from the annular air-space 24, where the latter intersects the passages 17 and 34. The products of combustion are deflected radially outwardly and upwardly by means of the convex lower surface of the wall 31 and pass upwardly within the circulating-passages 35, around the hollow annulus, receiving additional supplies of heated air throughout practically their entire course of progress through the circulating-passages 35. From the lower portions of the combustible chamber the gases pass upwardly through the flues 36 into the space immediately above the partition 31, and thence into the main outlet-flues 29 and 14, receiving an additional supply of heated air while passing through the flue portion 29.

It will be seen that the air supplied from the annular space 24 is heated during its passage upwardly adjacent to the walls of the fire-box, so that the air supplied to the products of combustion both in the upper part of the fire-box and at the entrance to the combustion-chamber is in heated condition. Inasmuch also as the air supplied to the hollow annulus is from the same source, this air reaches the annulus in heated condition; but in view of the fact that the latter is completely enveloped by the circulating-passages within which the combustion is taking place the air within the annulus will be raised to a substantially higher temperature before it escapes into said circulating-passages. The result is that the free combustion which is inaugurated at the entrance to the combustion-chamber is intensified progressively as the gases circulate through the combustion-chamber. The final supply of air added to the products of combustion at the entrance to the discharge-flue 29 is likewise heated to an intense temperature, since this air passes upwardly between the walls of the furnace throughout the entire height of the latter, passing lastly through that part of the hollow furnace-wall which incloses the combustion-chamber and the inner side of which is obviously at a very high temperature, so that this final supply of air is even hotter than that supplied from the hollow annulus. From the main discharge-flue 14 the products of combustion are conveyed to the device wherein the heat is to be utilized.

In Fig. 2 I have shown the application of a furnace constructed substantially like that hereinbefore described to a horizontal tubular boiler. In said figure the discharge-flue 14 is shown as extended from the top of the furnace downwardly to a point on a level with the main body of the boiler, (designated as a whole 62,) at which point it communicates with a chamber 63, formed at the front end of the boiler, with which the several horizontal fire-tubes 64 of the boiler communicate. The boiler is inclosed in a suitable casing 65, so constructed as to provide the chamber 63, hereinbefore referred to, at the front end of the boiler, a corresponding chamber 66 at the opposite end of the boiler, and a lower chamber 67 beneath the boiler, desirably provided with a floor-wall 68, inclined from the rear end of the boiler obliquely forwardly and upwardly to a point adjacent to the lower side of the boiler proper. A smoke-stack or chimney 69 is arranged to communicate with the intertubular space of the boiler at the upper side thereof, this smoke-stack being desirably located at the front of said boiler and arranged to communicate when desired with the front chamber 63 through a passage 70, normally closed by means of a damper 71.

The circulation of the heated gases through the boiler is as follows: From the chamber 63 the gases pass rearwardly through the several fire-tubes of the boiler to the chamber 66, thence downwardly to the chamber 67, and up through the intertubular space of the boiler to the smoke-stack. In case it be desired to cut out the circulation through the boiler and provide a direct draft to the chimney the damper 71 may be simply raised, thus throwing the chamber 63 into direct communication with the smoke-stack.

In the present instance means are provided for heating the supply of air which is admitted to the fuel through the grate. To this end the air tube or trunk 72 is arranged to extend through the chamber 63, preferably arranged horizontally, the ends thereof being open to the external air. From this trunk a pipe 73 extends forwardly and out through the side wall of the flue 14 and is there connected with a downtake-flue 74, which extends downwardly to a point opposite the ash-pit, and is then extended inwardly through the walls of the furnace and opens into said ash-pit.

The operation of the furnace shown in said Fig. 2 is obviously the same as that previously described and need not, therefore, be repeated. In this connection, however, it will be noted that the main flue 14, as well also as that part of the boiler-setting which incloses the chamber 63, is inclosed within an outer wall 75,

which forms therewith an air-space 76, communicating at the juncture of the flue 14 with the top of the furnace, with the air-space 24 of the latter. If desired, a blower-pipe, as indicated at 77, may be arranged to communicate with the annular space 76 thus provided, whereby the final supply of air admitted through the inlets 41 may be admitted under pressure. Obviously in view of the fact that this air is passed through the annular space inclosing the entire length of the outlet-flue 14 it will be brought to a high temperature before being discharged.

While I have herein shown and described what I deem to be preferred embodiments of my invention, yet it will be understood that the details thereof may be modified without departing from the spirit of the invention, and I do not, therefore, wish to be limited to these details except to the extent that they are made the subject of specific claims.

I claim as my invention—

1. A furnace provided with a centrally-depressed top wall portion constituting an outlet-flue, a combustion-chamber immediately beneath said top wall portion and having its upper portion surrounding the centrally-depressed top wall portion, an annulus supported within said combustion-chamber and dividing the interior thereof into annular circulating-passages, a partition-wall extending across beneath the receiving end of said outlet-flue and separating the latter from the combustion-chamber, intersecting flues extending from the circulating-passages exterior to the annulus, through said partition-wall and discharging into the receiving end of said outlet-flue and a fire-box provided with a restricted outlet discharging into the circulating-passages of the combustion-chamber at a point inside of said annulus.

2. A furnace provided with a centrally-depressed top wall portion constituting an outlet-flue, a combustion-chamber immediately beneath said top wall portion and having its upper portion surrounding the centrally-depressed top wall portion, an annulus supported within said combustion-chamber and dividing the interior thereof into annular circulating-passages, a partition-wall extending across beneath the receiving end of said outlet-flue and separating the latter from the combustion-chamber, intersecting flues extending from the circulating-passages exterior to the annulus, through said partition-wall and discharging into the receiving end of said outlet-flue, a fire-box provided with a restricted outlet discharging into the circulating-passages of the combustion-chamber at a point inside of said annulus, and means for supplying heated air to the products of combustion at the entrance to the combustion-chamber and from the annulus.

3. A furnace provided with a centrally-depressed top wall portion constituting an outlet-flue, a combustion-chamber immediately beneath said top wall portion and having its upper portion surrounding the centrally-depressed top wall portion, an annulus supported within said combustion-chamber and dividing the interior thereof into annular circulating-passages, a partition-wall extending across beneath the receiving end of said outlet-flue and separating the latter from the combustion-chamber, intersecting flues extending from the circulating-passages exterior to the annulus, through said partition-wall and discharging into the receiving end of said outlet-flue, a fire-box provided with a restricted outlet discharging into the circulating-passages of the combustion-chamber at a point inside of said annulus, and means for supplying heated air to the products of combustion at the entrance to the combustion-chamber, from the hollow annulus at points throughout the circulating-passages and at the receiving end of the main outlet-flue.

4. A furnace provided with a centrally-depressed top wall portion constituting an outlet-flue, a combustion-chamber immediately beneath said top wall portion and having its upper portion surrounding the centrally-depressed top wall portion, a hollow annulus supported within said combustion-chamber and dividing the interior thereof into annular circulating-passages, a partition-wall extending across beneath the receiving end of said outlet-flue and separating the latter from the combustion-chamber, intersecting flues extending from the circulating-passages exterior to the annulus, through said partition-wall and discharging into the receiving end of said outlet-flue, a fire-box provided with a restricted outlet discharging into the circulating-passages of the combustion-chamber at a point inside of said annulus, and an annular conduit surrounding said fire-box, provided with an air-inlet near its lower end and with discharge-outlets communicating with the discharge-outlet of the fire-box and with the hollow annulus respectively.

5. A furnace provided with a centrally-depressed top wall portion constituting an outlet-flue, a combustion-chamber immediately beneath said top wall portion and having its upper portion surrounding the centrally-depressed top wall portion, a hollow annulus supported within said combustion-chamber and dividing the interior thereof into annular circulating-passages, a partition-wall extending across beneath the receiving end of said outlet-flue and formed in continuation of the depressed central wall portion of the furnace, intersecting flues extending from portions of the circulating-passages exterior to the annulus through portions of the circulating-passages inside said annulus and discharging into said outlet-flue, a fire-box provided with a restricted outlet discharging into the circulating-passages of the combustion-chamber at a point inside of said annulus, the outer walls of said furnace comprising two concen-

tric wall members spaced at an interval apart whereby an intervening air-heating conduit is formed, provided at its lower end with one or more inlets and provided in its portions which form the outlet-flue with discharge-openings communicating with said flue, substantially as described.

6. A furnace provided with a centrally-depressed top wall portion constituting an outlet-flue, a combustion-chamber immediately beneath said top wall portion and having its upper portion surrounding the centrally-depressed top wall portion, a hollow annulus supported within said combustion-chamber and dividing the interior thereof into annular circulating-passages, a partition-wall extending across beneath the receiving end of said outlet-flue and formed in continuation of the depressed central wall portion of the furnace, intersecting flues extending from portions of the circulating-passages exterior to the annulus through portions of the circulating-passages inside said annulus and discharging into said outlet-flue, a fire-box provided with a restricted outlet discharging into the circulating-passages of the combustion-chamber at a point inside of said annulus, the outer walls of said furnace being of double construction separated by an air-heating space, and the walls of the fire-pot portion of the furnace being of three-part construction, the inner wall member separated from the adjacent wall member by an annular air-space provided with one or more outlets at its lower end and arranged to discharge into the passage connecting the fire-pot with the combustion-chamber, substantially as described.

7. In combination, a furnace provided at its top with a centrally-disposed outlet-flue, the inlet end whereof is located at a point below the top of the furnace, a combustion-chamber arranged in the upper part of said furnace and having its upper portion surrounding the inlet end portion of the outlet-flue, a partition-wall extending across beneath the receiving end of said outlet-flue and separating the latter from the combustion-chamber, an annulus supported within said combustion-chamber and dividing the interior thereof into annular circulating-passages, intersecting flues extending from portions of the circulating-passages exterior to the annulus, through said partition-wall and discharging into the receiving end of said outlet-flue, a fire-box provided with a restricted outlet discharging into the circulating-passages of the chamber at a point within the annulus and a passage through said partition-wall whereby the products of combustion may be passed directly through the combustion-chamber to a main outlet-flue without passing through the circulating-passages of the combustion-chamber, and a damper arranged to control said direct passage, substantially as described.

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