

1,044,559.

Patented Nov. 19, 1912.

4 SHEETS—SHEET 1.

FIG. 1.

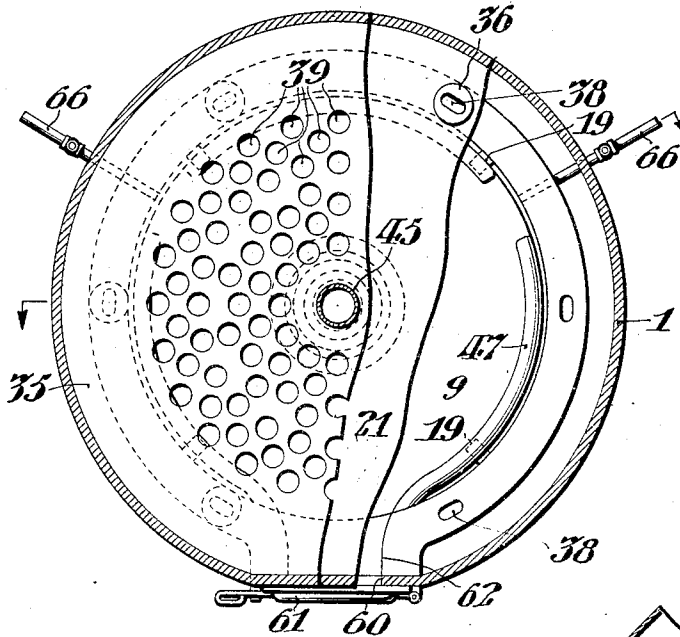
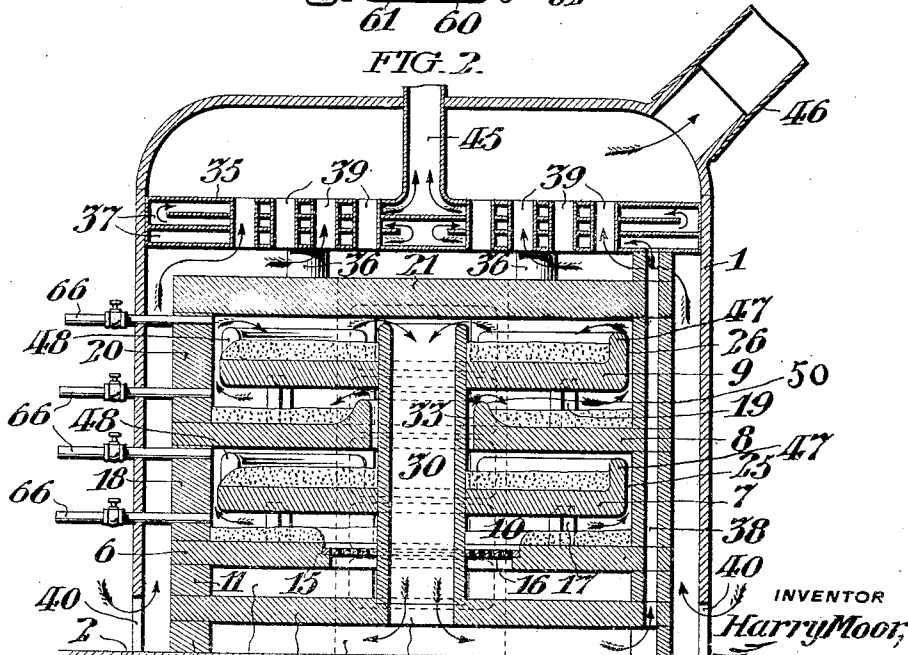


FIG. 2.



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BY

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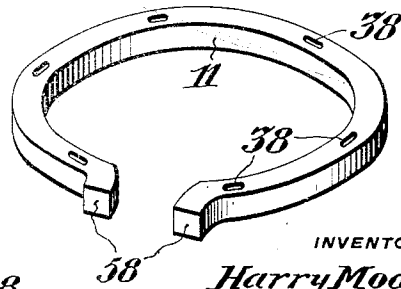
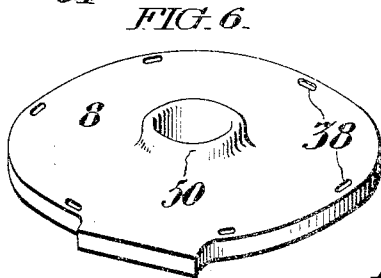
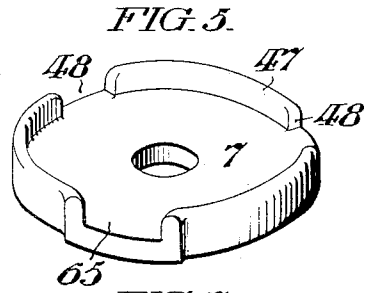
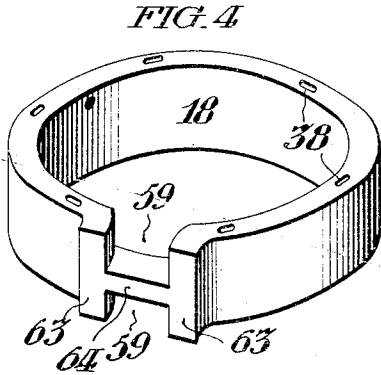
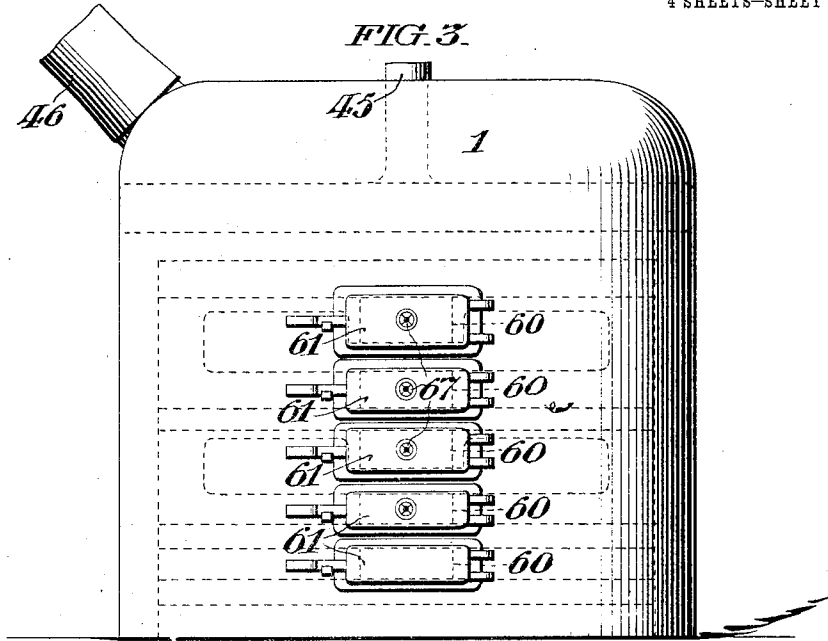
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APPLICATION FILED AUG. 30, 1909.

1,044,559.

Patented Nov. 19, 1912.

4 SHEETS—SHEET 2.



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4 SHEETS-SHEET 3.

FIG. 9.

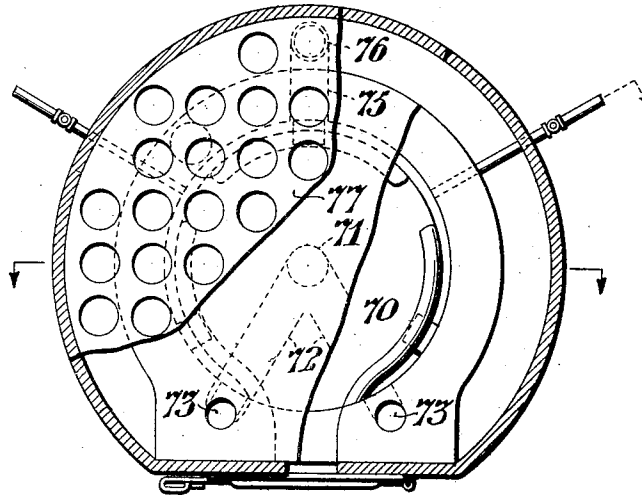
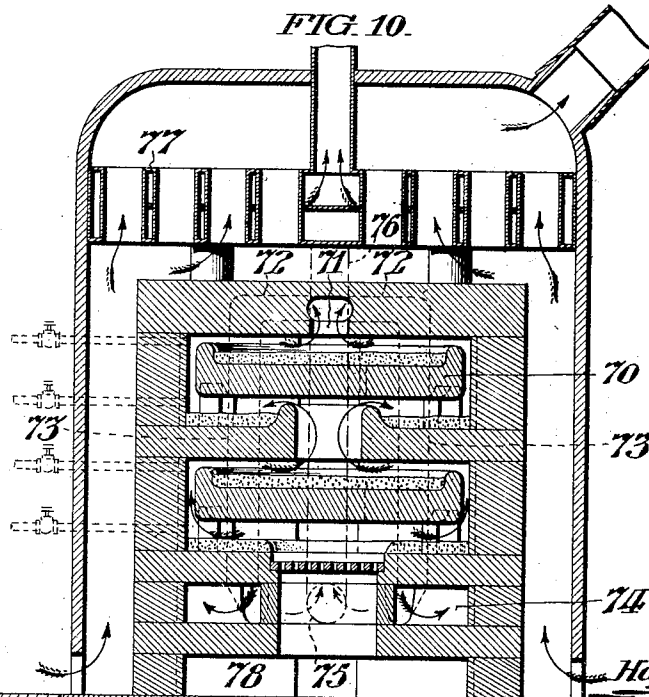


FIG. 10.



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4 SHEETS-SHEET 4.

FIG. 11.

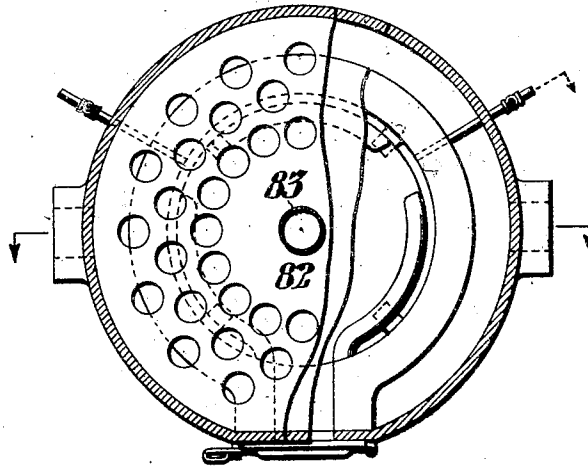
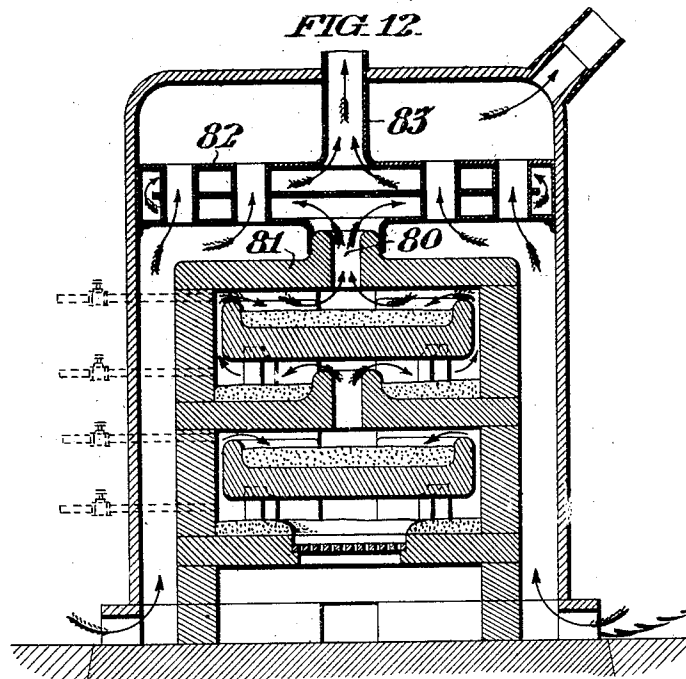


FIG. 12.



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UNITED STATES PATENT OFFICE.

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FURNACE.

1,044,559.

Specification of Letters Patent.

Patented Nov. 19, 1912.

Application filed August 30, 1909. Serial No. 515,192.

To all whom it may concern:

Be it known that I, HARRY MOOR, a subject of the King of Great Britain, residing at Philadelphia, county of Philadelphia, and State of Pennsylvania, have invented certain new and useful Improvements in Furnaces, of which the following is a specification.

The main objects of this invention are to provide an improved furnace for the slow combustion on a natural draft of fine fuel, such as culm, fine soft coal, peat, coke, saw dust, or other fine fuel; to provide a furnace of the class described that may be built and that will operate with great efficiency either in large sizes or in comparatively small sizes adapted for use in heating houses or for other purposes requiring small heating plants; to provide a compact furnace of simple and inexpensive construction that may be easily operated and that will maintain a comparatively constant temperature with little and infrequent attention from the operator; to provide a furnace having a plurality of circular fuel trays arranged in vertical series and having means for conducting the gases of combustion from the top tray downwardly to raise the temperature of the fuel on the bottom tray; to provide a furnace having an improved combustion chamber; and to provide other improvements as will appear hereinafter.

In the accompanying drawings, Figure 1 is a fragmentary top plan view, partly in transverse section of a furnace constructed in accordance with this invention; Fig. 2 a vertical central section of the same; Fig. 3 a front elevation of the same; Figs. 4, 5, 6, 7 and 8 are perspective views of details of the same; Figs. 9 and 10 are fragmentary top plan and vertical sectional views respectively of a modified form of this invention; and Figs. 11 and 12 are a fragmentary top plan view partially in transverse section and a vertical central section respectively of a second modified form of this invention.

Referring to the drawings, particularly to Figs. 1 to 8, one embodiment of this invention comprises a substantially cylindrical outer shell or jacket 1 made of sheet steel or other suitable material, and resting upon a suitable flat base or foundation 2 and forming the exterior of the furnace. Within this

shell and spaced slightly above the base 2 of the furnace is an annular plate or tray 3 of fire brick, or other suitable material, less in diameter than the interior diameter of the outer shell of the furnace, supported upon a ring 4 of the same material and of the same diameter, which rests in turn upon the base 2 of the furnace. This plate forms the floor of the ash pit 5 of the furnace. Arranged above the plate 3 or floor of the ash pit of the furnace, one above the other or in vertical series, is a plurality of substantially horizontal and circular vertically spaced trays, or fuel supports, 6, 7, 8 and 9, made of fire brick or other suitable material, and of less diameter than the interior diameter of the outer shell of the furnace. The lowest one, 6, of these trays forms the bottom of the combustion chamber 10 of the furnace, and is provided with a circular central opening 15 containing an annular grate 16, adapted to be used in starting the fire. This lowest fuel tray 6 is substantially flat and is of the same diameter as the plate 3 forming the floor of the ash pit, and is supported from the latter plate by means of a ring 11 of fire brick of equal diameter. The bottom tray 6 is substantially flat and supports the tray 7 next above by means of blocks 17 of fire brick, arranged between the two trays. The second tray 8, above the bottom tray, is of substantially the same diameter as the bottom tray, and is supported therefrom by means of a ring or peripheral wall 18 of fire brick of the same exterior diameter as the trays and located between the trays. The third tray 9, above the bottom tray, is supported from the tray beneath by means of blocks of fire brick 19 similar to the blocks 17 between the lower two trays, and this upper tray is surrounded by a ring or peripheral wall 20 of fire brick which rests upon the tray 8 beneath, and which is substantially identical in construction with the ring 18 between the bottom tray and the second tray above. This upper ring 20 supports a flat circular plate 21 of fire brick of the same diameter as the diameter of the bottom tray and which forms the top of the combustion chamber. The second and fourth or top trays are smaller in diameter than the rings 18 and 20 which surround them, leaving annular channels 25, and 26, surround-

ing the trays for the passage of the gases of combustion around the peripheries of the trays.

For conducting the gases of combustion downwardly from above the top tray 9, a vertical tube 30 extends centrally from a point above the level of the top tray but below the top wall of the combustion chamber through the top tray 9 and downwardly through the trays beneath, projecting through the annular grate 16 and into the floor 3 of the ash pit through which it communicates by means of a circular opening 31 with the space 32 beneath the floor of the pit. The first and third trays 7 and 9 above the floor 6 of the combustion chamber, fit snugly around the central tube 30, but the next tray 8 above is provided with an annular recess 33 between the tray and the central tube to permit of the passage of the gases of combustion between the tray and the tube. Within the outer shell 1, spaced above the top plate 21 of the combustion chamber, is located a substantially flat circular heating drum 35 forming a partition between the upper and lower portions of the interior of the shell 1 and supported upon the top plate 21 of the combustion chamber by means of blocks 36 arranged uniformly in spaced relationship around the periphery of the plate 21. The interior of this heating drum 35, is subdivided into tortuous passages 37, which communicate by means of vertical passages 38 through the blocks 36 and peripheral walls of the combustion chamber, with the space 32 beneath the floor of the ash pit. The heating drum 35 is provided with vertical passages 39 which permit communication between the spaces above and below the drum in the interior of the outer shell 1 of the furnace, and the outer shell is provided adjacent its lower end with oppositely disposed apertures 40 for the admission of air into the space between the shell and the outer walls of the combustion chamber. A smoke stack 45 leads upwardly centrally from the heater 35 and through the outer shell 1 of the furnace to conduct the gases of combustion from the furnace into the atmosphere, and the usual heating pipe 46 leads from the upper portion of the outer shell 1 to conduct the heat from the interior of the shell. The second and fourth fuel trays 7 and 9 above the bottom tray 6 are preferably provided with peripheral rims 47 which are recessed at suitable intervals as at 48 to permit of the removal of the fuel from the trays, and the second tray 8 from the bottom tray 6 is provided with a similar rim 50 surrounding its central aperture which may be provided with similar recesses to permit the fuel to be removed centrally from the tray.

The front of the outer shell 1 of the fur-

nace is provided with a plurality, in this instance 5, of openings 60 closed by doors 61 arranged in vertical series and hinged to the outer shell to permit of the introduction of fuel into and the removal of ash from the furnace, and the usual manipulation of the furnace. These doors are preferably arranged so that one door will be opposite each fuel tray.

To form a suitable foundation for the doors 61 and to provide suitable openings into the furnace, the front walls of the combustion chamber and of the ash pit are extended forwardly and are flattened externally to form a seat for the doors and through this seat suitable apertures 62 are provided at convenient levels for the operation of the furnace. This is accomplished by dividing the ring 11 next to the lowest ring and extending its ends 58 forwardly as shown in Fig. 7, by providing each ring 18 and 20 above with oppositely disposed recesses 59, and by extending the adjacent portions 63 of the ring forwardly as shown in Fig. 4, the portion 64 of the ring between the recesses being also extended forwardly and being centrally located between the upper and lower planes of the ring and of substantially the same thickness as the thickness of the adjacent fuel tray 7. The front portion of each fuel tray and of the floor 3 of the ash pit is also extended forwardly to conform to the front contour of the furnace and the peripheral rims of the trays 7 and 9 are recessed as at 65 and extended forwardly accordingly.

For admitting a supply of oxygen into the space above each fuel tray, one or more air inlets 66 are provided leading through the wall of the combustion chamber above each tray and also in each door. These inlets are covered by suitable adjustable closures 67 whereby the amount of air passing through the inlets may be regulated.

In the operation of this furnace the culm or other fine fuel is evenly arranged upon each of the fuel trays 6, 7, 8 and 9, through the doors 61, and the fire is started upon the grate 16 in the usual manner by means of shavings or other light kindlings. The gases of combustion from the fire pass radially outwardly from the grate over the fuel upon the lowest tray and then upwardly around the outer periphery of the first tray 7 above and radially inwardly over the fuel upon this latter tray, then through the central annular opening 33 of the tray 8 above and radially outwardly over this latter tray, then upwardly around the outer edge of the topmost tray 9 and radially inwardly over the fuel upon this tray, then pass downwardly through the central combustion tube 30 into the space at the lower end of the furnace, then upwardly through the vertical passages 38 in

the side walls of the heating chamber and into the heater 35, and finally pass out through the smoke stack 45. The heat from the fire on the grate gradually ignites the fuel on all of the trays, so that after a short time the fuel on each tray will be in an incandescent state, and the central tube 30 will also be highly incandescent. This central chamber being thus maintained at a very high temperature, the smoke and unburnt gases passing off from the fuel into the tube will be oxidized and completely consumed in the tube before being permitted to pass out of the smoke stack 45, thus avoiding the usual smoke and waste incident to furnaces which are not provided with this improved combustion chamber.

In this furnace the combustion of the fuel on the tray takes place primarily at the upper surface of the fuel, gradually extending downward, the rate of combustion decreasing slightly as the ash is formed upon the upper surface, as the ash protects the fuel beneath from the action of the oxygen in the air. After the fuel has been thus burning a considerable time, for instance for 24 hours or longer, the fire is cleaned by raking the fuel from the lowest tray into the ash pit, then raking the fuel from each of the trays above to the tray immediately beneath, beginning with the lowest tray. After this has been done, the top tray is filled with fresh fuel and the furnace is then in condition to burn another equal period of time. By raking the fuel from one tray to the tray beneath, the unburnt carbon is mixed with the ash, and when leveled off a new surface of unburnt carbon is exposed to the oxygen admitted and combustion proceeds until the ash forms of such a thickness as to require further cleaning. The new fuel is only introduced on the top tray where it is partially consumed and as already described is then moved to the tray beneath, and so on downwardly at each cleaning of the furnace until it reaches the lowest tray, where it is finally and completely consumed, leaving only a very fine and practically pure ash to be raked into the ash pit.

It is obvious that any other form of heater other than that shown at 35 may be used with this furnace, for instance, hot water coils or steam coils might be substituted or hot air coils might be arranged in the annular space between the heating chamber and the outer shell 1 of the furnace or any other suitable means might be employed for utilizing the heat from the furnace.

The embodiment of this invention described above may be modified in various ways, for instance, as shown in Figs. 9 and 10 instead of having the central tube to form a down draft in the center of the combustion chamber as above described, the

gases of combustion may be carried from above the upper tray 70 upwardly through a central recess 71 in the top wall of the combustion chamber and then radially outwardly through ducts 72 in the top wall and then downwardly through vertical ducts 73 in the side walls of the combustion chamber and into the annular space 74 beneath the lowest fuel tray whence the gases pass rearwardly through a duct 75 and then upwardly through a vertical duct 76 into the heating drum 77. The ash pit 78 in this case is situated at the bottom of the furnace. In other respects, the construction of this modification is similar to the first form described.

A further modification of the invention, shown in Figs. 11 and 12, consists in omitting the down draft heretofore described and permitting the gases of combustion to pass out from the combustion chamber through a central aperture 80 in the top wall 81 of the combustion chamber and through a heating drum 82 and into the smoke stack 83.

Although only a few of the forms in which this invention may be embodied have been described, it is obvious that many changes might be made in the construction set forth without departing from the spirit of this invention or the scope of the appended claims.

Having thus fully described my invention, I claim and desire to protect by Letters Patent of the United States:—

1. A furnace comprising a plurality of vertically spaced fuel trays, and having a passage for conducting gases of combustion from the bottom tray to the top tray, and a passage provided with an inlet leading from the space above the top tray and with an outlet opening into the furnace adjacent to and beneath the bottom tray, whereby the gases of combustion are constrained to move downwardly from above the top tray and through said outlet.

2. A furnace having a combustion chamber provided with a plurality of vertically spaced substantially circular fuel trays located therein and provided with conduits arranged to constrain the gases of combustion to move inwardly in opposite directions over one of said trays from opposite portions of the periphery thereof, and radially outwardly in opposite directions over another of said trays from the central portion thereof.

3. A furnace having a combustion chamber provided with a fuel tray and provided with conduits arranged to constrain the gases of combustion to move from beneath said tray over said tray in opposite directions from opposite portions of the periphery thereof and toward the central portion thereof, and having a fuel tray spaced above

- said first mentioned tray and arranged to hold a mass of incandescent fuel in said chamber, and said second mentioned tray being provided with a central aperture through which the gaseous products of combustion from said first mentioned tray are constrained to flow.
4. In a furnace, the combination with a plurality of vertically spaced fuel trays, of a tube extending through all of said trays and communicating with the space above the top tray for conducting gases of combustion downwardly from above the top tray to the plane of the lower end of the tube.
5. A furnace comprising an annular fuel tray provided with a centrally arranged aperture, said furnace being provided with conduits arranged to constrain the gases of combustion to flow from beneath said tray upwardly and over said tray from opposite portions of the periphery thereof and downwardly through said opening in the tray.
6. A furnace having a combustion chamber provided with two vertically spaced coaxial annular fuel trays and an annular wall spacing said trays apart, a fuel tray located between said first mentioned trays and having substantially its entire periphery spaced from and within said wall, and a tube extending snugly through said intermediate tray and projecting through said first mentioned two trays and spaced from the walls thereof, forming annular passages therewith, the gases of combustion being constrained to flow in one direction through said annular passages and in an opposite direction through said tube.
7. A furnace comprising a combustion chamber having two vertically spaced fuel trays, each arranged to hold a separate mass of fuel in a state of incandescence in said chamber, and a peripheral wall surrounding and spaced from the entire outer periphery of one of said trays and supported from the other of said trays, providing an annular passage between the space between the trays and the space above one of said trays.
8. A furnace having a combustion chamber provided with a plurality of vertically spaced substantially circular and horizontal fuel trays located therein and provided with conduits arranged to constrain the gases of combustion to move inwardly in opposite directions over one of said trays from opposite portions of the periphery thereof, and radially outwardly in opposite directions over another of said trays from the central portion thereof.
9. A furnace comprising a plurality of substantially horizontal and circular fuel trays arranged in vertical series, and means for conducting the gases of combustion radially outwardly from one of said trays and radially inwardly from an adjacent tray, upwardly from the bottom tray consecutively over said trays to the top tray, and then downwardly from above the top tray into proximity to the bottom tray.
10. A furnace comprising a plurality of fuel trays arranged one above another, and provided with a duct for conducting the gases of combustion from the bottom tray to the top tray, and a tube extending through the trays for conducting said gases from the top tray through the bottom tray.
11. A furnace comprising a plurality of fuel trays arranged one above another, and provided with a duct for conducting the gases of combustion from the bottom tray to the top tray, and a tube extending through the trays for conducting said gases from the top tray through the bottom tray, and having a duct for conducting said gases upwardly from the bottom of said tube to the upper part of said furnace.
12. A furnace comprising a substantially circular tray forming the floor of the ash pit of the furnace, a peripheral ring supporting said tray and adapted to form with the foundation of said furnace an inclosed space beneath said tray, a plurality of vertically spaced fuel trays arranged above said first mentioned tray, the lowest of said fuel trays being provided centrally with an annular grate, and a combustion tube extending downwardly through said fuel trays and into said first mentioned tray and communicating with the space below said first mentioned tray.
13. A furnace comprising a substantially circular tray forming the floor of the ash pit of the furnace, a peripheral ring supporting said tray and adapted to form with the foundation of said furnace an inclosed space beneath said tray, a plurality of vertically spaced fuel trays arranged above said first mentioned tray, the lowest of said fuel trays being provided centrally with an annular grate, a combustion tube extending downwardly through said fuel trays and into said first mentioned tray and communicating with the space below said first mentioned tray, and an outer jacket surrounding said trays and spaced from the peripheries thereof forming an annular heating chamber around said furnace.
14. A furnace comprising a plurality of vertically spaced fuel trays and having a passage leading from the space above each tray to the space above the next tray above, and having a passage leading from the space above the top tray downwardly into proximity to the bottom tray, a wall surrounding said trays, and having a passage leading upwardly therethrough and communicating with the lower end of said downwardly extending passage, whereby the gases of combustion are constrained to move from the lowermost of said fuel trays over the upper side of each other tray, and then down-

wardly from the top tray into proximity to the bottom tray, and then upwardly through the passage in said wall.

15. A furnace comprising a plurality of 5 vertically spaced fuel trays and having a passage leading from the space above each tray to the space above the next tray above, and having a passage leading from the space above the top tray downwardly into 10 proximity to the bottom tray, a wall surrounding said trays and having a passage leading upwardly therethrough and communicating with the lower end of said downwardly extending passage, and a heating 15 drum communicating with the upper end of said passage through said wall.

16. A furnace comprising two vertically spaced solid trays each provided with a central opening only, a peripheral wall inclosing 20 the space between said trays, a third solid tray located between said first mentioned trays and spaced therefrom, a centrally arranged tube extending snugly through said last mentioned tray and projecting through the openings in said first 25 mentioned two trays and spaced from the walls of said openings, and an annular grate surrounding said tube and located in the annular opening between said tube and the lowermost of said trays. 30

17. A furnace comprising a plurality of vertically spaced trays, and having conduits arranged to constrain the gases of combustion to flow radially outwardly over 35 one of said trays from its central portion, and radially inwardly from an adjacent tray and toward its central portion, upwardly from the bottom tray consecutively over said trays to the top tray, and then downwardly from above the top tray and into 40 proximity to the bottom tray.

18. A furnace comprising a plurality of fuel trays arranged one above the other, one of said trays being provided with a centrally arranged annular grate, another one 45 of said trays being above said grate and surrounded by a peripheral channel, and said furnace being provided with conduits arranged to constrain the gases of combustion 50 to flow from said grate radially outwardly over the tray supporting said grate and around the periphery of the tray above said grate, and radially inwardly over the upper side of said tray above said grate.

19. A furnace having a combustion chamber provided with vertically spaced fuel trays located therein, all of the fuel trays of said furnace being coaxial, and said furnace 60 having passages arranged to constrain the gases of combustion to flow radially outward from the central portion of one tray toward substantially all portions of the periphery thereof, and radially inward over a second tray from substantially every portion 65 of the periphery thereof.

20. A furnace comprising a combustion chamber having an annular fuel tray, a tube surrounded by but spaced from said tray, said furnace having passages arranged to constrain the gaseous products of combustion 70 to flow in one direction through the space between said tube and said tray and in the opposite direction through said tube.

21. A furnace comprising a combustion chamber having an annular, substantially 75 circular and horizontal fuel tray, a tube surrounded by but spaced from said tray and projecting therethrough, forming therewith a substantially annular passage, said furnace having passages arranged to constrain 80 the gases of combustion to flow in one direction through said annular passage, and in the opposite direction through said tube.

22. A furnace having a combustion chamber provided with a plurality of solid vertically 85 spaced circular coaxial fuel trays, located therein and having passages arranged to constrain the gases of combustion to flow outwardly in various directions from the central portion of one tray and inwardly in 90 various directions over a second tray and toward the central portion thereof.

23. A furnace comprising a plurality of vertically spaced substantially circular horizontal coaxial fuel trays, and a tube extending 95 axially through said trays for conducting gases of combustion from the top tray through the bottom tray.

24. A furnace comprising two vertically spaced trays, each provided with a central 100 opening, a peripheral wall inclosing the space between said trays, a tray located between said first mentioned trays and having its outer periphery spaced from the inner surface of said wall, and a tube communicating 105 with the interior of said furnace extending snugly through the said last mentioned tray, projecting through said openings in said first mentioned two trays, and spaced from the walls of said openings. 110

25. A furnace comprising two vertically spaced trays each provided with an opening, a peripheral wall inclosing the space 115 between said trays, a third tray located between the said first mentioned trays and spaced therefrom, a tube communicating with the interior of said furnace extending snugly through said last mentioned tray, projecting through the openings in said 120 first mentioned two trays, and spaced from the walls of said openings.

26. A furnace comprising two vertically spaced trays each provided with an opening, a peripheral wall inclosing the space 125 between said trays, a third tray located between the said first mentioned trays and spaced therefrom, a tube communicating with the interior of said furnace extending snugly through said last mentioned tray and projecting through the openings in said 130

first mentioned two trays and spaced from the walls of said openings, and an annular grate surrounding said tube and located in the annular opening between said tube and the lowermost of said trays.

27. A furnace comprising a plurality of vertically spaced fuel trays and provided with a duct for conducting gases of combustion downwardly from above the top tray into proximity to and in vertical alinement beneath the bottom tray, to raise the temperature of said tray.

28. A furnace comprising a plurality of vertically spaced fuel trays and provided with ducts for conducting gases of combustion upwardly from the space above the bottom of said trays and over each of the remaining trays in succession, and provided with a duct for conducting gases of combustion downwardly from the space above the uppermost of said trays into proximity to and in vertical alinement beneath the bottom tray, to raise the temperature of said tray.

29. A furnace having a combustion chamber provided with an imperforate fuel tray having a pipe extending therethrough and communicating with said combustion chamber, said pipe being surrounded by an annular passage through said tray, said furnace being provided with passages arranged to constrain the gases of combustion to flow in one direction through said annular passage, and in the opposite direction through said pipe and said tray being provided with an upwardly extending annular rim bordering said annular passage.

30. A furnace having a combustion chamber provided with a plurality of vertically spaced substantially horizontal fuel trays, all of the fuel trays of said furnace being coaxial and said furnace being provided with passages arranged to constrain the gases of combustion to flow radially outward from the central portion of one tray and toward substantially every portion of the periphery thereof, and radially inward over a second tray from substantially every portion of the periphery thereof.

31. A furnace comprising a combustion chamber provided with a plurality of vertically spaced substantially circular horizontal fuel trays, all of the fuel trays of said chamber being coaxial, and said furnace being provided with passages arranged to con-

strain the gases of combustion to flow radially outward from the central portion of one of said trays and toward substantially every portion of the periphery thereof, and radially inward over a second of said trays from substantially every portion of the periphery thereof.

32. A furnace having a combustion chamber provided with a plurality of vertically spaced fuel trays, and provided with conduits arranged to constrain the gases of combustion to move radially inwardly from one of said trays from substantially every portion of the periphery thereof, and radially outwardly over another of said trays from the central portion thereof, toward substantially every portion of the periphery thereof.

33. A furnace having a combustion chamber provided with a plurality of vertically spaced substantially circular fuel trays, and provided with conduits arranged to constrain the gases of combustion to move radially inwardly over one of said trays from substantially every portion of the periphery thereof, and radially outwardly over another of said trays from the center thereof, toward substantially every portion of the periphery thereof.

34. A furnace having a combustion chamber provided with a plurality of vertically spaced substantially circular solid, horizontal fuel trays, and provided with conduits arranged to constrain the gases of combustion to move radially inwardly over one of said trays from substantially every portion of the periphery thereof, and radially outwardly over another of said trays from the center thereof, toward substantially every portion of the periphery thereof.

35. A furnace having a combustion chamber provided with two vertically spaced coaxial annular fuel trays, an annular wall spacing said trays apart, and a fuel tray located between said first mentioned trays and having substantially its entire periphery spaced from and within said wall.

In witness whereof I have hereunto set my hand this 24th day of August, A. D., 1909.

HARRY MOOR.

Witnesses:

T. G. COULTER,
A. I. GARDNER.