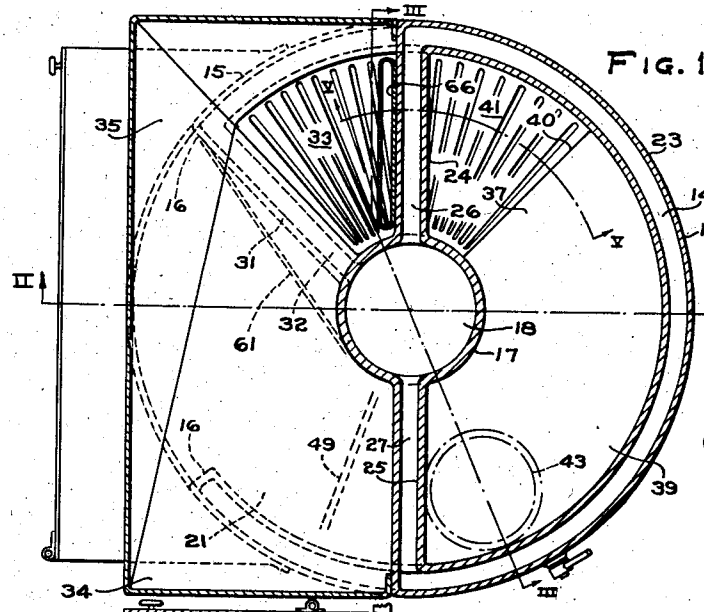
Dec. 20, 1938. R. A. FORESMAN 2,140,522

COMBUSTION APPARATUS

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FIG. 1.



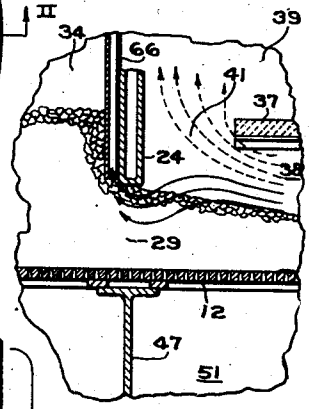


FIG. 5.

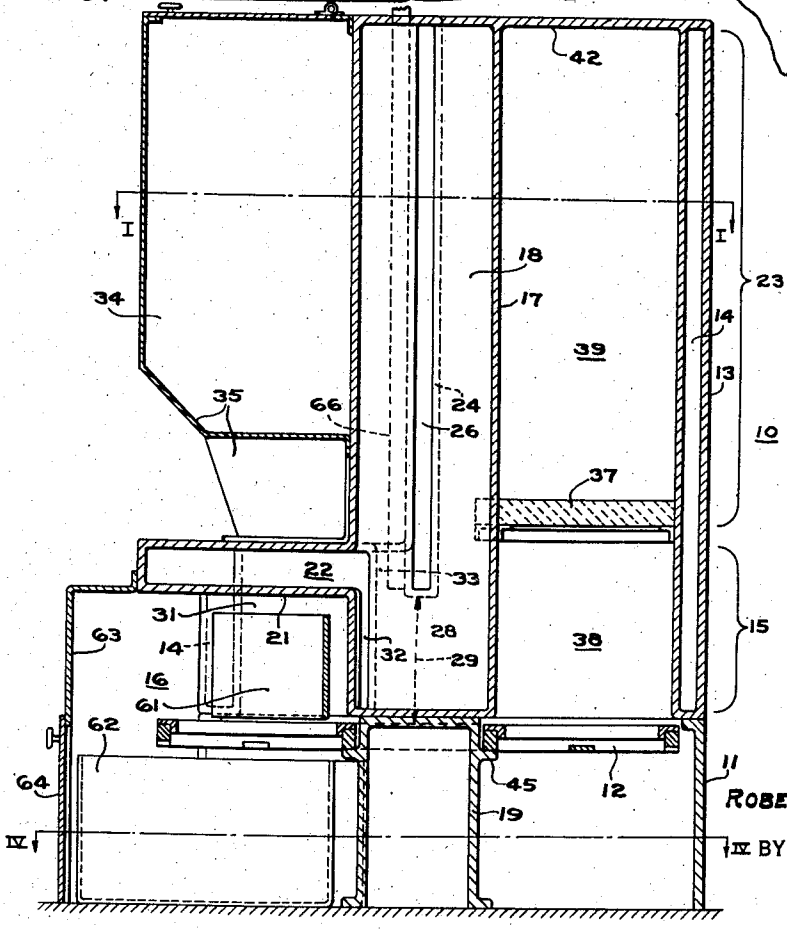


FIG. 2.

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COMBUSTION APPARATUS

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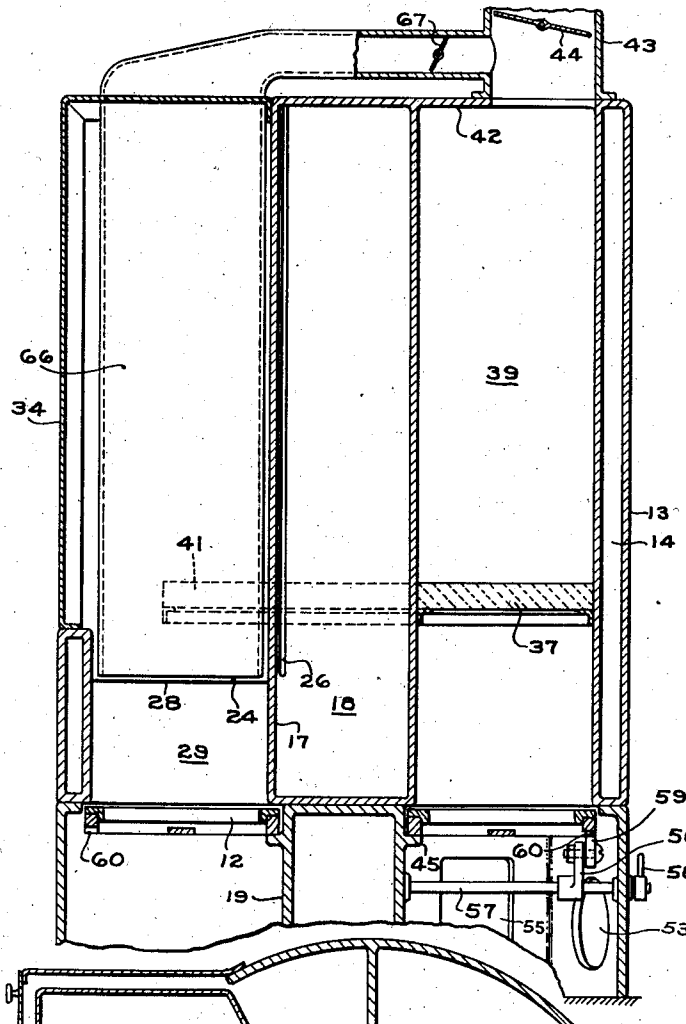


FIG. 3.

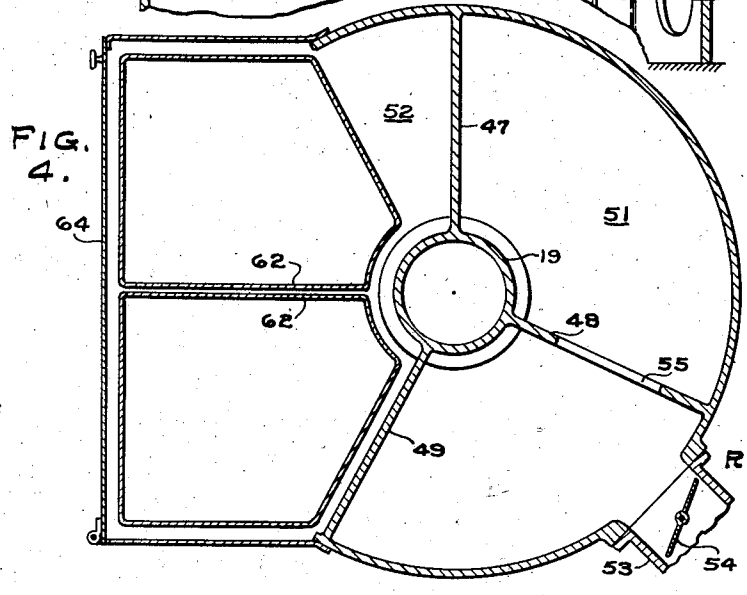


FIG. 4.

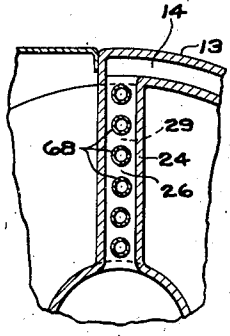


FIG. 6.

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2,140,522

COMBUSTION APPARATUS

Robert A. Foresman, Prospect Park, Pa., assignor to Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., a corporation of Pennsylvania

Application June 18, 1936, Serial No. 85,851

10 Claims. (Cl. 110—36)

My invention relates to furnaces of the type in which fuel is admitted to one end of the combustion chamber upon a travelling grate and passes through successive stages of combustion as it is conveyed through the chamber by the grate. An object of my invention is to provide an improved furnace of this kind.

Further objects of my invention are to assist ignition of the fuel as it enters the combustion chamber during operation and to maintain combustion of the fuel adjacent the fuel admission end of the bed during periods when the furnace is shut down.

These and other objects are effected by my invention as will be apparent from the following description and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a sectional plan view of a boiler furnace arranged in accordance with my invention and is taken along the line I—I of Fig. 2;

Figs. 2 and 3 are sectional views of the apparatus and are taken, respectively, along the lines II—II and III—III of Fig. 1;

Fig. 4 is a sectional view taken along the line IV—IV of Fig. 2;

Fig. 5 is a sectional developed view taken along the line V—V of Fig. 1; and,

Fig. 6 is a partial view of a boiler furnace similar to that of Fig. 1 having a second embodiment of my invention applied thereto.

In practicing my invention, I provide a travelling grate stoker having a fuel magazine so disposed that it deposits fuel thereon by gravity. A wall member is spaced above the grate for defining therewith a fuel discharge opening through which fuel from the magazine passes as the grate is advanced. The fuel is levelled off by the wall and a bed of fuel of predetermined depth is carried by the grate into a combustion chamber where it passes through successive stages of combustion. Refuse of combustion or ash is removed from the grate in any suitable manner.

With this type of furnace, difficulty may arise in maintaining combustion adjacent the fuel discharge opening, particularly during heavy loads when fuel is being fed to the combustion chamber at a high rate. At this time, the zone of ignition tends to move away from the fuel opening due to the rapid feeding of fuel. During shut-down periods, this undesirable condition may also prevail, as the supply of air to the grate is substantially reduced and tends to pass through relatively thin portions of the fuel bed, whereby insufficient air passes through the thick end of the bed where it enters the combustion chamber to sustain combustion at this point. Accordingly, when operation of the furnace is initiated after a shut-down period, difficulty arises in effecting combustion of the relatively thick end of the bed and, if the grate is started, simultaneously, with the flow of air, fuel may be carried to the ash removal zone only partly consumed. This, of course, represents inefficient operation.

In accordance with my invention, I propose to effect a relatively small flow of heated gas from the combustion chamber through a portion of the thick end of the fuel bed within the fuel discharge opening at all times, so that ignition of the fuel therein is assisted during operation and combustion is slowly effected during shut-down periods. A conduit that communicates with the fuel bed in or adjacent to the fuel discharge opening may be provided for effecting this flow of gas, which conduit connects with a zone of relatively low pressure in the gas offtake. Means are provided for adjusting the flow of gas through the conduit to the desired value. With this arrangement, the furnace may be operated at a high rate of combustion and ignition of the fuel in the thick end of the bed within the fuel opening is readily effected by the flow of hot gases therethrough.

Referring now to Figs. 1 to 4, inclusive, of the drawings, I show my invention applied to a boiler furnace of the type disclosed in my copending application, Serial No. 658,334, filed February 24, 1933, although it may be applied equally well to other forms of furnace structure employing either water-cooled or refractory walls.

In the drawings, a boiler structure, indicated generally at 10, is carried by a base 11 that provides a support for a rotatable annular grate 12. The boiler 10 includes an outer wall 13 having a water space 14 formed therein, the lower portion 15 of the wall 13 being substantially cylindrical in form and disposed above the outer periphery of the grate 12. An upper portion 23 of the wall 13 is substantially semi-circular in shape to provide space for the fuel magazine as will be described later. The lower circular portion 15 of the wall 13 is cut away to define an opening 16 for the discharge of ash from the grate as best shown in Figs. 1 and 2. Further reference to the discharge of ash will be made hereinafter.

The structure 10 includes a central wall member or column 17 having a water space 18 and supported by a center wall 19 formed in the base 11. Between the semi-cylindrical upper portion 23 and the lower cylindrical portion 15 is a substantially semi-circular horizontal wall 21 ex-

tending from the outer wall 13 inwardly as best shown in Fig. 2. A water space 22 is formed in the horizontal wall 21 and communicates with the spaces 14 and 18 for the circulation of water therebetween.

The upper semi-cylindrical portion 23 of the outer wall 13 has its end portions connected to the center column 17 by means of radial walls 24 and 25 having water spaces 26 and 27, respectively, that provide communication between the spaces 14 and 18. The lower end of the radial wall 25 connects with the horizontal wall 21, the water spaces 27 and 22 thereof being in communication. The lower edge 28 of the radial wall 24 is disposed in spaced relation with the grate 12 for defining an opening 29 which determines the depth of fuel carried by the grate 12. This function will be referred to hereinafter.

Arranged beneath the horizontal wall 21 and transversely of the grate 12 is a vertical wall 31 extending horizontally from the outer wall to the inner column 17 and extending vertically from the horizontal wall 21 downwardly towards the grate and terminates adjacent to the latter (Fig. 2). A water space 32 may be provided in the wall 31 which affords communication between the lower portions of the space 14, the space 18 and the space 22. A vertically-extending opening or passage 33 is formed in the horizontal wall 21 between radial walls 24 and 31 for the passage of fuel to the grate. A fuel magazine 34 is disposed above the horizontal wall 21 and adjacent to the radial walls 24 and 25 for the gravitational feeding of fuel through the opening 33 to the grate. This arrangement of the magazine 34 and boiler structure 10 is disclosed in my copending application, Serial No. 57,332, filed January 3, 1936, and assigned to the Westinghouse Electric & Manufacturing Company. The bottom 35 of the magazine 34 is sloped toward the opening 33 for facilitating movement of fuel thereto.

An arcuate space 36 is defined by the wall 13 and the column 17, within which a combustion arch 37 is disposed as best shown in Figs. 2 and 3. The arch 37 divides the space 36, vertically, into a combustion chamber 38 and a gas passage 39. The arch 37 extends from the radial wall 25 toward the wall 24 but terminates at 40 (Fig. 1) in spaced relation with the wall 24 to define a passage 41 for the flow of gas from the combustion chamber 38 to the gas passage 39. A top wall 42 covers the gas passage 39 and is provided with an outlet 43 for the products of combustion (Figs. 1 and 3). A damper 44 may be arranged in the outlet 43 for regulating the draft through the furnace.

As best shown in Fig. 3, a support for the grate may be provided by an annular flange 45 formed on the inner ring 19 of the base 11, and by a plurality of radial walls 47 to 49, inclusive, (Fig. 4) formed in the base 11. The walls 47 and 49 divide the base into a windbox 51 and an ash receiving chamber 52, the former being disposed beneath the combustion chamber 38 and determines the length of the grate receiving air. A portion of the wall 49 is shown in dotted lines in Fig. 1 and indicates the portion of the combustion chamber where combustion of the fuel on the grate is substantially complete. The wall 47 of the windbox 51 lies beneath the radial wall 24 of the boiler where combustion of the fuel is initiated. Air may be admitted to the windbox through an opening 53 (Figs. 3 and 4) having an air controlling device such as, for example, a damper 54 disposed therein. It will be understood that, where forced draft is employed, a suitable blower (not shown) may be connected to the windbox. An opening 55 is provided in the wall 48 for providing continuity of the windbox.

The grate 12 is rotated in any suitable manner as by a pawl and ratchet mechanism 56 which may include a shaft 57 journalled in the base 11 and oscillated by a crank 58. A pawl 59 which oscillates with the shaft 57 engages ratchet teeth 60 formed in an under surface of the grate 12 and effects step by step rotation of the grate 12 as the shaft is oscillated. The grate moves in clockwise direction as viewed in Fig. 1.

Suitable means may be provided for removing ash from the grate adjacent the opening 16. Accordingly, a plate 61 may be tangentially disposed with respect to the grate and having its lower edge contiguous thereto whereby ash is moved radially of the grate as the latter passes beneath the plate 61. The removed ash passes through opening 16 and drops into the ash receiving chamber 52. Suitable containers 62 may be disposed in the chamber 52 for receiving the ash. The chamber 52 may be provided with a dust-tight housing 63 having a door 64 for providing access to the containers 62.

Referring now to the operation of such a fluid heater, assume that the magazine 34 is filled with coal and that the grate is rotated by the mechanism 56. Fuel passes by gravity from the magazine 34 through the opening 33 upon the grate and is leveled off to a predetermined depth by the bottom edge 28 of the wall 24. The fuel on the grate 12 is progressively burned as it passes through the combustion chamber 38 and combustion is substantially complete as it passes the region of the combustion chamber over the wall 49 of the windbox. Ash is removed by the plate 61 and deposited in the containers 62. Products of combustion pass in a direction counter to the movement of the grate 12 and pass through the opening 41 into the gas passage 39 and thence to the gas offtake 43.

In a furnace of this type, it may be difficult, during period of high load, to effect ignition of the green fuel being fed to the combustion chamber at a relatively high rate through the fuel discharge opening 29 because, as shown in Fig. 5, a substantial portion of the hot gases passing from beneath the arch 37 into the opening 41 flow adjacent to the end of the arch 37 and out of contact with the surface of the fuel as it emerges from beneath the wall 24. The igniting effect of these gases is, therefore, lost. Fig. 5 discloses in dotted arrows the normal path of the gases flowing from the combustion chamber to the opening 41. Furthermore, during shut down periods or periods when the grate is stationary and the supply of air to the windbox is substantially reduced, the fire burns away from the thick portion of the fuel bed or wall 24 within the opening 29 toward thinner portions of the bed, that is, in the direction of the wall 25. This is due to the aforementioned condition and to the fact that air will flow through a thinner portion or more consumed portion of the fuel bed than through a thicker or less consumed portion of the fuel bed. Accordingly, when operation of the grate is initiated and the supply of air increased, ignition of the fuel in the thick portion of the bed is difficult and fuel may be carried to the ash removal end of the combustion chamber prior to its complete combustion.

In accordance with my invention, I obviate this

condition by inducing a flow of hot gases from the combustion chamber through the thick portion of the bed of fuel in or adjacent to the fuel discharge opening 29, as best shown by the solid arrows of Fig. 5. Ignition of the fuel is, therefore, assisted during operation and, during shut down periods, combustion is slowly effected in the fuel bed within the opening 29. Accordingly, when operation is initiated after a shut down period, ignition of the fuel entering the opening 29 is readily effected by the relatively hot coals therein and by the hot gases from the combustion chamber.

One form of effecting the flow of hot gases from the combustion chamber 38 is shown in Figs. 1 to 3 and 5. A conduit 66 is disposed on the side of the wall 24 adjacent to the fuel in the magazine 34. This conduit terminates in the bed of fuel adjacent to the opening 29, as best shown in Figs. 2 and 5. Preferably, the conduit is made flat and substantially coextensive with the width of the wall 24. The other end of the conduit terminates in a region of relatively low pressure, such as, for example, in the gas offtake 43 for inducing a flow of heated gases from the combustion chamber through the fuel in the opening 29 as shown by solid arrows in Fig. 5. A damper 67 may be employed for regulating the flow of gas through the conduit 66.

Preferably, the conduit is disposed in heat exchanging relation with the wall 24 so that the heat abstracted from the gas conveyed thereby is conducted to the wall 24. This conduit 66 radiates some heat also to the fuel in the magazine 34 whereby some advantageous preheating of the fuel is obtained, but the quantity of heat radiated is relatively small.

Fig. 6 discloses a second embodiment of my invention and shows a portion of the walls 13 and 24 of Fig. 1. The conduit 66 of Fig. 1 is dispensed with in this embodiment and a plurality of tubes 68 are employed for conducting the gases from the combustion chamber. It will be understood that the tubes 68 terminate at one end in the bed of fuel lying within the opening 29 beneath the wall 24 and, at their other ends, in a region of low pressure as described in connection with the prior embodiment. In this embodiment, heat is abstracted from the tubes directly by the water in the space 26.

From the foregoing, it will be apparent that I have provided improved operation of a furnace having a travelling grate, upon which a bed of fuel is deposited for progressive combustion as it passes through a combustion chamber. While I have shown my invention applied to a furnace of the rotating grate type, it will be understood that it may be applied to other forms of furnace structure. Furthermore, my invention is disclosed applied to a boiler furnace having water walls, but it is applicable also to furnaces for other purposes employing other forms of wall structure.

While I have shown my invention in two forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. In combustion apparatus, the combination of a furnace structure having a combustion chamber therein, a movable grate defining, at least in part, the bottom of the combustion chamber, means for depositing fuel upon a portion of said grate, a wall member having a fluid space formed therein and disposed transversely of the grate, said wall member having its bottom edge spaced above the grate for leveling the fuel and determining the depth thereof as it is carried by the grate into the combustion chamber, means for supplying air to the underside of said grate, means for conveying gases of combustion from the combustion chamber, and conduit means communicating with said gas-conveying means and with the fuel bed for withdrawing heated gases from the combustion chamber beneath the bottom edge of said wall member and conveying the same in heat exchanging relation with the wall member.

2. In combustion apparatus, the combination of a furnace structure having spaced inner and outer substantially concentric wall members defining an annular space therebetween, a rotatable annular grate disposed at the bottom of said space, a wall member extending transversely of the grate and dividing said space into a combustion zone and a fuel receiving zone, said wall member being spaced above the grate for defining therewith an opening for the discharge of fuel to the combustion zone as the grate is rotated, means for passing air through the bed of fuel in the combustion zone, and means for passing heated gases from the combustion zone through a portion of the bed of fuel in said fuel receiving zone.

3. In combustion apparatus, the combination of a furnace structure having spaced inner and outer substantially concentric wall members defining an annular space therebetween, a rotatable annular grate disposed at the bottom of said space, wall members extending transversely of the grate and dividing said space into a combustion chamber and a fuel receiving chamber, one of said transversely extending walls being spaced above the grate for defining an opening through which fuel is carried into the combustion chamber as the grate is rotated, means for passing air through the portion of the fuel bed within the combustion chamber for effecting combustion thereof, means for passing heated gas from the combustion chamber through a portion of the fuel in the fuel receiving chamber, and means for adjusting the amount of gas passed through the fuel in the fuel receiving chamber.

4. In combustion apparatus, the combination of a furnace structure having spaced inner and outer substantially concentric wall members defining an annular space therebetween, a rotatable annular grate disposed at the bottom of said space, first and second wall members extending transversely of the grate for dividing said space into a combustion chamber and a fuel magazine, said first wall member having a portion thereof spaced above the grate for defining therewith an opening of predetermined height and through which fuel is carried into the combustion chamber as the grate is rotated, means disposed adjacent the second transversely extending wall member for deflecting ash from the grate, means for supplying air to the under side of the grate, means defining a passage communicating with the combustion chamber for removing gases therefrom, a conduit communicating with the bed of fuel disposed in said fuel discharge opening and with said gas removing passage for promoting a flow of heated gas through a portion of the fuel in the opening and means for adjusting the amount of heated gas flowing through the opening to said conduit.

5. In combustion apparatus, the combination of a boiler structure having spaced inner and

outer substantially concentric walls defining an annular space therebetween, said walls having spaces therein for fluid to be heated, a rotatable annular grate disposed at the bottom of said space, first and second walls extending transversely of the grate and having fluid spaces therein communicating with the spaces of the inner and outer walls for dividing said annular space into a combustion and a fuel receiving chamber, said first transversely extending wall having its bottom edge spaced above the grate for defining an opening through which fuel of a predetermined thickness passes into the combustion chamber as the grate is rotated, means for removing ash from the grate arranged adjacent said second transversely spaced wall, means for withdrawing gas from the combustion chamber, a windbox for supplying air for combustion beneath the grate, and a conduit communicating with the fuel within said opening and with the gas withdrawing means for promoting a flow of gas through the opening, said conduit being disposed in heat exchanging relation with said first transversely extending wall.

6. In combustion apparatus, the combination of a rotatable circular grate, a furnace structure associated with the grate and defining a combustion chamber above a segment of the grate, means defining a fuel conduit above a second segment of the grate and including members extending transversely of the grate, one of said members being spaced above the grate for defining an opening through which fuel is carried by the grate as it is rotated, means for conveying gases of combustion from the combustion chamber, and means for passing a portion of the combustion gases through the fuel in said opening for preheating the same and thence in heat transfer relation with the fuel in said fuel conduit.

7. In combustion apparatus, the combination of a rotatable circular grate, a furnace structure associated with the grate and defining a combustion chamber above a segment of the grate, means defining a fuel conduit above a second segment of the grate and including members extending transversely of the grate, one of said members being spaced above the grate for defining an opening through which fuel is carried by the grate as it is rotated, means for conveying gases of combustion from the combustion chamber, and means for passing a portion of the combustion gases through the fuel in said opening for preheating the same and thence in heat transfer relation with the fuel in said fuel conduit, and means for adjusting the quantity of gases of combustion that is passed through the fuel in the opening.

8. In combustion apparatus, the combination of a rotatable circular grate, a structure associated with the grate for defining a combustion chamber above a segment of the grate, said structure having a space formed therein for medium to be heated, a conduit for fuel disposed above a second segment of the grate for feeding fuel thereto by gravity, means spaced above the grate for providing an opening through which fuel is carried by the grate to the combustion chamber, means for conveying gases of combustion from the combustion chamber, and second conduit means communicating with the fuel on the grate adjacent said opening for providing flow of a portion of the gases of combustion from the combustion chamber through the fuel in said opening; said second conduit means being disposed in heat transfer relation with the fluid in said space.

9. In combustion apparatus, the combination of a movable grate, a furnace structure associated with the grate for defining a combustion chamber above a segment thereof, a magazine for fuel elevated with respect to the grate for depositing fuel by gravity on a second segment of the grate, means spaced above the grate for defining a fuel orifice through which fuel is passed from the magazine to the combustion chamber as the grate is actuated, means for conveying a portion of the gases of combustion from the combustion chamber and means for passing a second portion of the gases of combustion through the fuel in said orifice for preheating the same and thence in heat transfer relation with the fuel in said magazine.

10. In combustion apparatus, the combination of a movable grate, a boiler associated with the grate and having water cooled walls defining a combustion chamber above a segment of the grate, a magazine for depositing fuel by gravity on a second segment of the grate, means spaced above the grate for defining a fuel orifice through which fuel is passed from the magazine to the combustion chamber as the grate is actuated, means for conveying a portion of the gases of combustion from the combustion chamber and means for passing a second portion of the gases of combustion through the fuel in said orifice for preheating the same and thence in heat transfer relation with one of said water cooled walls.

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