Dec. 3, 1935. H. A. GRINE ET AL 2,022,716

AUTOMATIC FURNACE

Filed Feb. 20, 1933 4 Sheets-Sheet 1

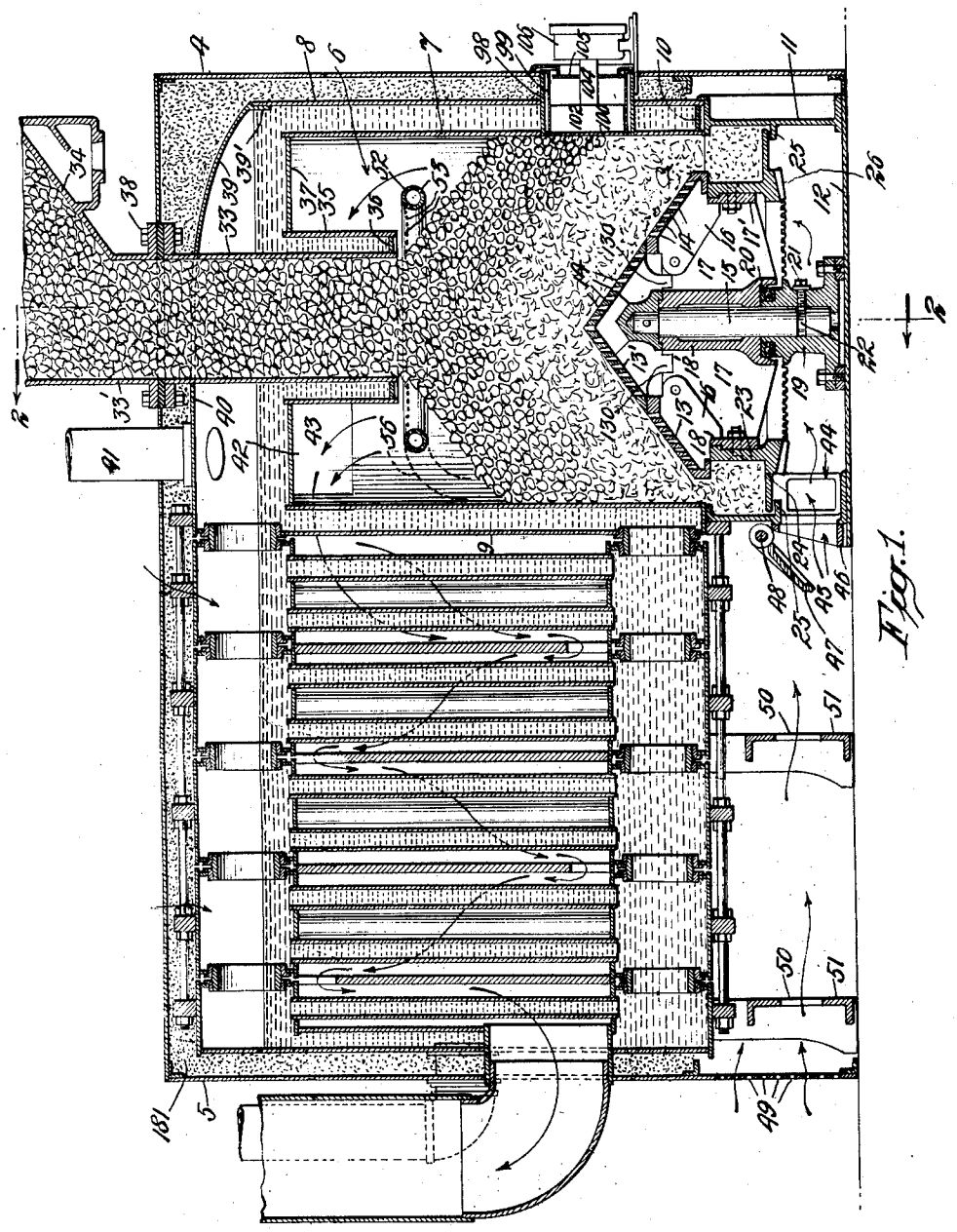


Fig. 1.

INVENTORS
HARRY A. GRINE
JOHN G. REID
HARR A. WAGNER

BY E. C. Sanborn
ATTORNEY

Dec. 3, 1935. H. A. GRINE ET AL 2,022,716

AUTOMATIC FURNACE

Filed Feb. 20, 1933 4 Sheets-Sheet 2

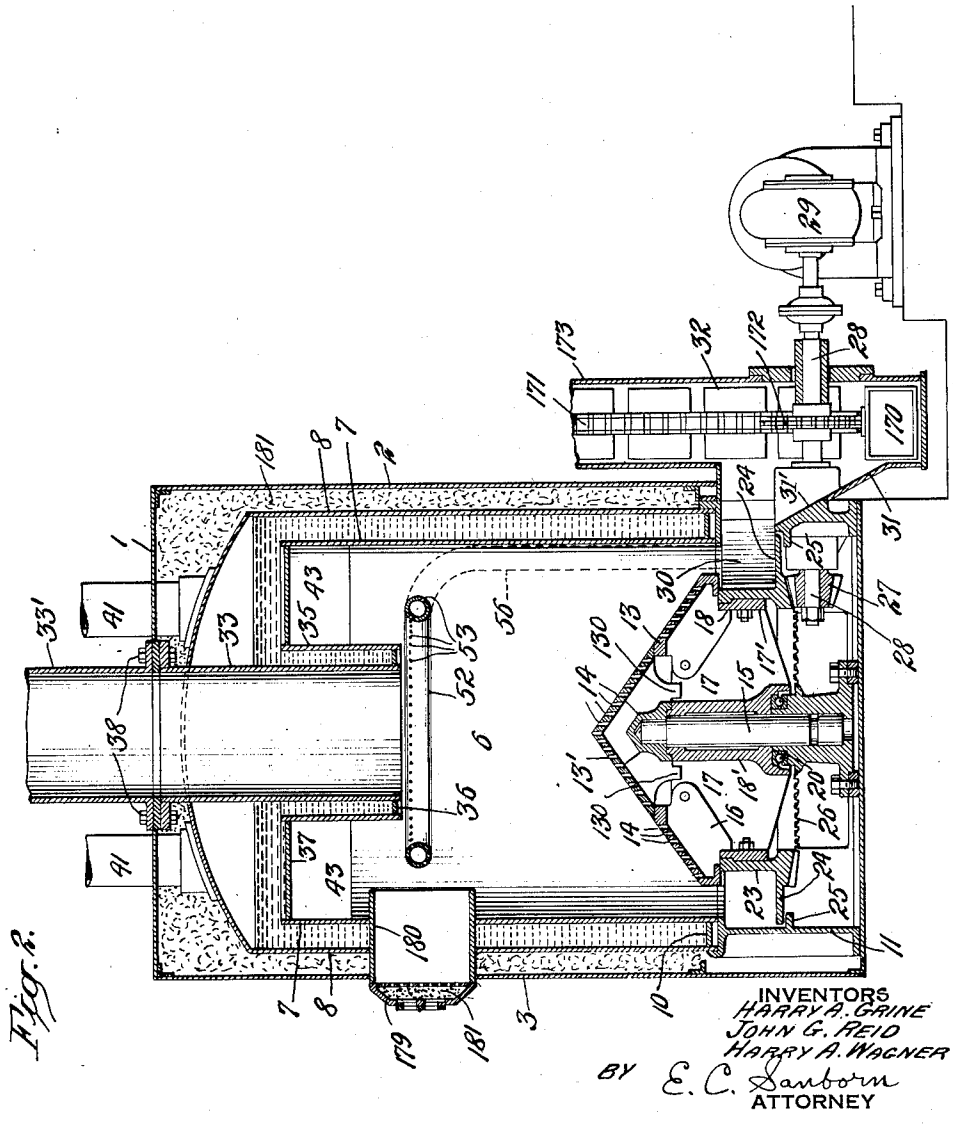


Fig. 2.

INVENTORS
HARRY A. GRINE
JOHN G. REID
HARRY A. WAGNER

BY E. C. Sanborn
ATTORNEY

Dec. 3, 1935. H. A. GRINE ET AL 2,022,716

AUTOMATIC FURNACE

Filed Feb. 20, 1933 4 Sheets-Sheet 3

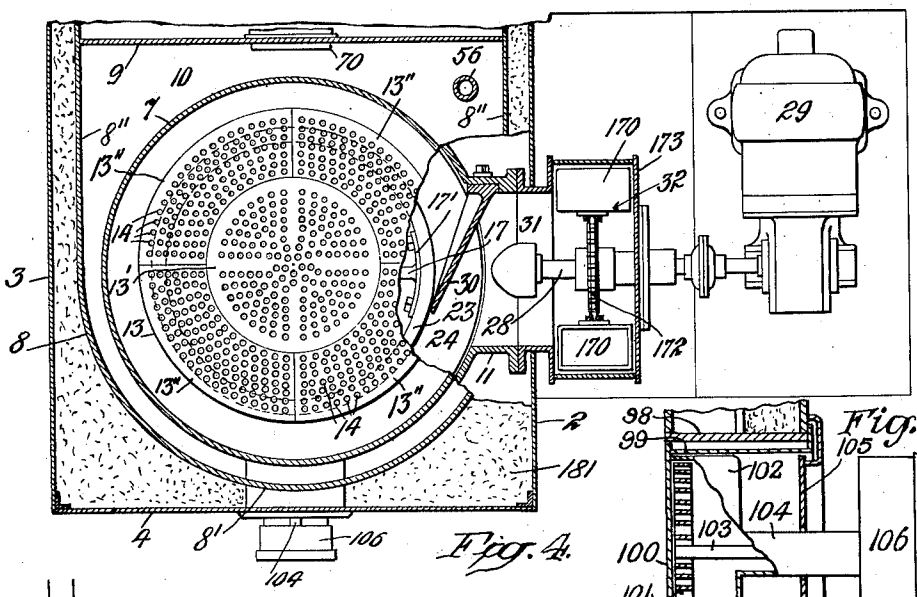


Fig. 4.

Fig. 3.

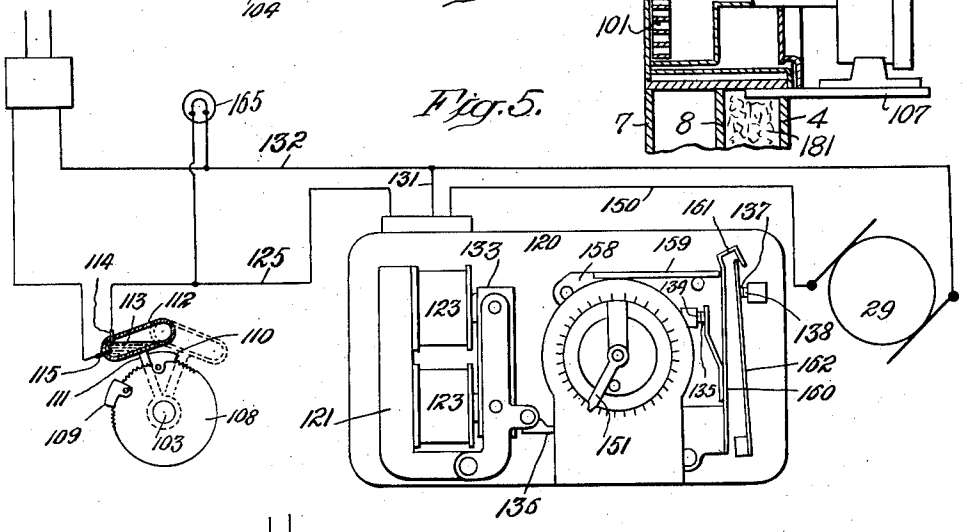


Fig. 5.

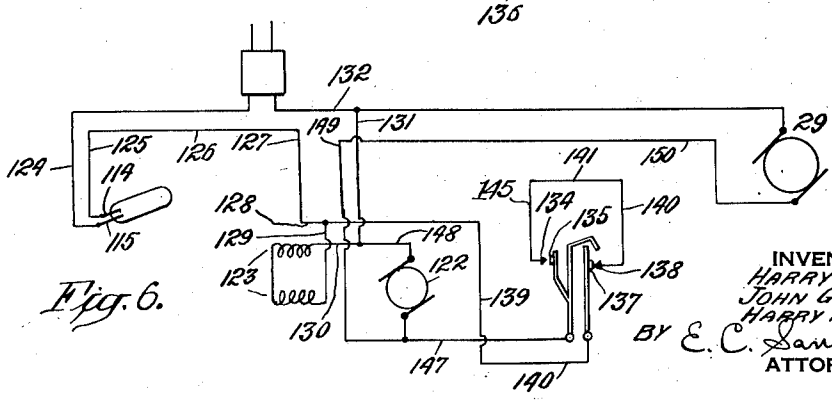


Fig. 6.

INVENTORS
HARRY A. GRINE
JOHN G. REID
HARRY A. WAGNER
BY E. C. Sanborn
ATTORNEY

Dec. 3, 1935. H. A. GRINE ET AL 2,022,716

AUTOMATIC FURNACE

Filed Feb. 20, 1933 4 Sheets-Sheet 4

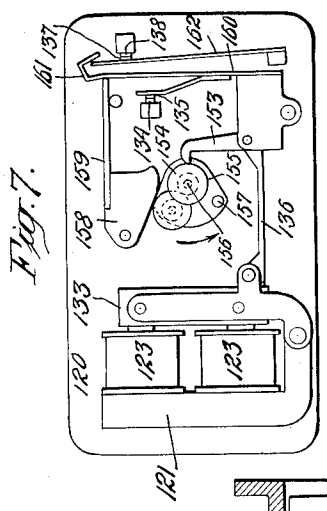


Fig. 7.

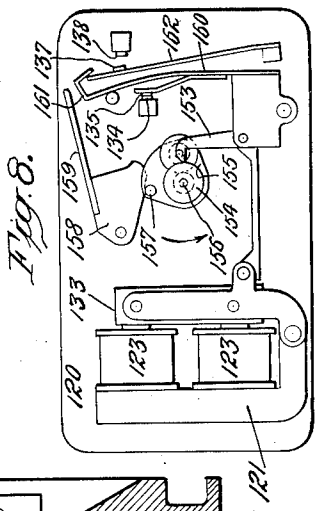


Fig. 8.

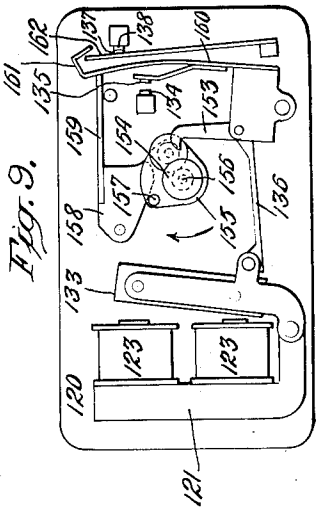


Fig. 9.

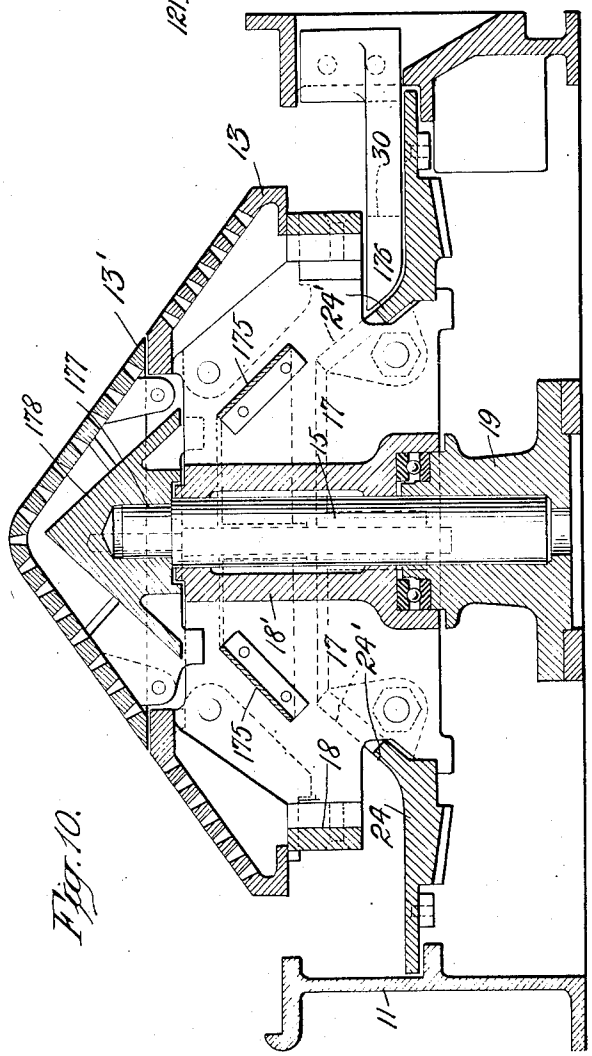


Fig. 10.

INVENTORS
HARRY A. GRINE
JOHN G. REID
HARRY A. WAGNER

BY E. C. Sanborn
ATTORNEY

Patented Dec. 3, 1935 2,022,716

UNITED STATES PATENT OFFICE

2,022,716

AUTOMATIC FURNACE

Harry A. Grine, White Plains, N. Y., and John G. Reid and Harry A. Wagner, Pottsville, Pa., assignors to The Philadelphia and Reading Coal and Iron Company, Philadelphia, Pa., a corporation of Pennsylvania

Application February 20, 1933, Serial No. 657,538

7 Claims. (Cl. 110—165)

This invention comprises a novel method of and apparatus for burning solid fuel for the heating of buildings and the like. The invention comprises new and effective provisions enabling the attainment of improved domestic furnace operation including increased efficiency of combustion. An outstanding feature of the invention resides in novel provisions for maintaining predetermined fuel and ash bed depths, in which connection the invention provides novel automatic means for controlling the removal of ashes whereby ash accumulations are prevented from exceeding a given amount in the combustion chamber and on the other hand the ash removal is effectively precluded from continuing to an undesirable extent.

In current methods and apparatus for burning solid fuels, the distribution of fuel on the grate and the method of admitting air to the fire are such as to cause uneven distribution of air in the fuel bed and consequent uneven burning of the fuel, thus resulting in the passage of excess air through some portions of the fire, causing excessively high rates of combustion in these sections and producing clinkering. Other portions may not have sufficient air for combustion of the fuel, resulting in unburned fuel passing through the fire and out of the combustion chamber. Through the present invention the factors of unequal fuel distribution and unequal air distribution through the fuel bed are obviated, thus eliminating the tendency to form clinkers or the passage of unburned fuel from the combustion chamber and facilitating the automatic removal of ash from the furnace. The automatic maintenance of predetermined fuel bed depth and equalized distribution of air in the fuel bed provided by our invention have a further effect of minimizing the loss of efficiency in burning of fuel common to present furnaces by reason of diluting gases from combustion with excess uncombined oxygen passing through the fuel bed.

In current types of furnaces in which it is common practice to intermittently charge a considerable amount of fuel, there is produced a wide variation in fuel bed depth and temperature, as well as a temperature on the upper surface of the fuel which is too low to ignite combustible gases evolved from the fresh coal and there is a considerable loss of efficiency due to the escape of these gases from the fuel. With our improved method of burning, the coal is constantly fed to the top central portion of the fuel bed as needed and the incoming coal is surrounded by an incandescent surface of burning coal at the top of the fuel bed which ignites combustible gases evolved from the fuel bed and causes them to burn, particularly when supplied with secondary air admitted over the fuel bed. Maintaining the upper surface of the fire sufficiently hot to ignite gases evolved in the fuel bed is further facilitated by the fact that the coal is preheated in the lower end of the magazine feed.

In conjunction with the feeding of the fuel to the top central portion of the combustion chamber, whereby the top of the fuel bed in the combustion chamber assumes a conical shape sloping downward from the coal feed pipe to the wall, there is provided in this improved apparatus a conical shaped rotatable grate with air passages on its surface, thus giving to the bottom of the fuel bed a conical form and assuring an even depth of fuel bed over the grate and proper distribution and diffusion of the primary air in the fuel bed. This conical grate is of smaller base diameter than that of the combustion chamber, allowing for passage of ash between it and the walls of the combustion chamber. The grate is further mounted eccentrically on its supporting shaft for the purpose of giving a slight crushing action on the ash, as the grate rotates, causing the ashes to come down more freely.

Also, in current domestic furnaces the shaking down and removal of ashes involves periodical manual attention. In this improved furnace motorized mechanical means for removal of ashes is provided and is automatically controlled by means of a thermostat placed in the bottom zone of the combustion chamber and operated by means of varying temperatures in this zone.

Other objects and advantages of the invention will become apparent from the ensuing description and claims.

In the accompanying drawings:

Fig. 1 is a vertical longitudinal sectional view of apparatus constituting a preferred embodiment for the carrying out of our invention.

Fig. 2 is a vertical transverse section on line 2—2 of Fig. 1.

Fig. 3 is a detail view partly in vertical section, illustrating the thermostat and associated parts.

Fig. 4 is a detail horizontal sectional view, with parts broken away, showing more particularly the grate and associated ash removing mechanism.

Fig. 5 is a diagrammatic view illustrating electrical connections including a time limit switch between the thermostat and the ash removing motor.

Fig. 6 is a wiring diagram further illustrating said connections.

Figs. 7, 8, and 9 are views illustrating the operation of the time limit switch mechanism.

Fig. 10 is a vertical sectional detail view showing a modified form of grate.

Referring to the drawings, the furnace is shown enclosed within a casing comprising a top plate 1, side plates 2, 3, and end plates 4, 5. The furnace includes a combustion chamber 6 bounded by a cylindrical shell 7, which, in turn, is positioned within and spaced from a shell 8. The latter comprises a curved forward end portion 8' (Fig. 4) and parallel side portions 8''. Extending across said side portions is a vertical plate or partition 9. A bottom plate 10 extends across the space between said shell 7 and 8 and plate 9; the space between said shells and said plates 9 and 10 constituting a chamber surrounding the combustion chamber 6 and adapted to receive water or other fluid medium. The shells 7, 8, may be supported on a base member 11 of any suitable construction mounted upon the base plate 12.

In the bottom portion of the combustion chamber there is mounted a rotatable grate 13, the latter being shown as of conical formation and provided with perforations 14 for admitting air to the fuel bed. The grate may conveniently comprise a top section 13' and four lower segmental sections 13''; the top section being mounted on a vertical shaft 15, and the lower sections having arms 16 pinned to the arms 17 of a spider 18. The latter has a central tubular portion 18' journaled on the shaft 15, and supported on a pedestal base member 19. Lugs 130 depending from the top section 13' of the grate extend into the spaces between adjacent arms 17 of the spider whereby rotation of the latter causes rotation not only of the lower grate segments 13'', but also of the top segment 13'. An anti-friction thrust bearing unit 20 may be interposed between said member 19 and portion 18' of spider 18 as shown. A screw 21 in the pedestal 19 engages a groove 22 in the shaft 15 for maintaining the latter in a definite vertical position with respect to said pedestal and thus to the furnace. The spider arms 17 have arcuate flanges 17' at their ends. The grate is mounted eccentrically with respect to the combustion chamber, for a purpose which will hereinafter appear more specifically. This may be conveniently accomplished by so constructing the top grate section that the vertical axis through the apex thereof is slightly off-set with respect to the vertical axis of the shaft 15, and by constructing the spider 18 so that the vertical axis through the intersection of the center lines of the arms 17 is similarly off-set with respect to the vertical axis of said shaft. In short, the vertical axis of the spider 18 and of the cone shaped grate comprising the sections 13', 13'', is off-set with respect to the vertical axis of shaft 15.

Secured to the flanges 17' of the spider arms 17 is a ring 23 having a horizontal and circumferential flange 24 adapted to receive ashes from the combustion chamber. Said flange 24 overlies an inwardly extending circumferential flange 25 on the base member 11. The ash ring flange 24 has formed on its underside a beveled annular gear 26 with which meshes a beveled pinion 27 on a shaft 28 driven by an electric motor 29. Secured to the base member 11 and projecting obliquely across the ash ring flange 24 is an ash deflecting arm 30 (Figs. 2 and 4), whereby, as the ash ring rotates, the ashes thereon are scraped laterally off the flange 24 and thence passed downwardly into a well or casing 31 from which they are removed by an elevator 32. The base member 11 may, as shown in Figures 2 and 4, be provided with a downwardly and laterally inclined portion 31' for facilitating the discharge of ashes into the receptacle 31.

Extending through the top plate 1 and thence downwardly into the combustion chamber is a coal chute or magazine, which may comprise sections 33, 33'. Said chute may also include at its upper end an inclined hopper portion 34, communicating with a coal bin (not shown).

A water jacket is provided around the lower portion of the magazine 33 by a tube 35 and bottom ring 36. Extending between the tube 35 and the shell 7 is a ring 37 forming a top plate for the combustion chamber. The rings or plates 36, 37, magazine section 33, and shells 7 and 35 may conveniently be welded together; as may also the bottom ring 10 and the shells 7 and 8. The sections 33, 33' of the coal chute may be bolted together as shown at 38.

It will be seen that by feeding the coal into the top central portion of the combustion chamber 6, the upper surface of the fuel bed slopes downwardly from the magazine to the sides of the combustion chamber, thereby assuming a conical formation. Through the conical grate 13 a conical form is also given to the bottom of the fuel bed. Thus, through the provision of said grate in conjunction with the overhead feeding of the coal to the chamber 6, there is assured a substantially uniform depth of fuel bed together with equalized distribution of air therethrough. As shown, the grate is of less diameter than the combustion chamber, thus allowing the ashes to pass downwardly between said grate and the combustion chamber. By virtue of the eccentric mounting of said grate on the shaft 15 the rotation of the grate imparts a slight crushing action to the ashes, causing them to move downwardly more freely on to the ash ring flange 24.

If desired, the lugs 130 of the top section of the grate may be omitted so that said section will remain stationary during rotation of the lower sections 13'' with the spider 18 and ash ring 23.

The space at the top of the shell 8 may be covered by the dished plate 39 and the concave plate 40, the latter resting at one end on the top edge of the vertical plate 9 and at its edges on the top edges of the legs 8'' of the shell 8. The plate 39 has a flange 39' fitting within the curved portion 8' of said shell. Said plates 9, 39, and 40, and shell 8 may be secured together in any suitable way, as by welding. Openings in the adjoining portions of the plates 39 and 40 provide for the passage of the magazine section 33. Plate 40 is further provided with openings communicating with outlet pipes 41, 41, for conducting steam from the water to the customary radiators or other heating units (not shown).

Mounted in openings in the shell 7 and in corresponding openings in the plate 9 are flue members 42 having passages 43 (Fig. 1) therethrough for enabling the gases of combustion to flow from the combustion chamber 6 into the space to the rear of said plate.

The rear end of the base member 11 is provided with an opening 44 therethrough for admitting air to the underside of the grate. This opening is in registry with an opening 45 in a

frame member 46 secured to said base member 11 and adapted to be closed by a door 47 secured to a shaft 48 rotatably mounted in suitable bearings. Said shaft extends through the side wall 3 of the casing and has attached thereto a handle 48' whereby the door 46 may be readily adjusted to regulate the draft of air passing through said openings. To facilitate the passage of air to the combustion chamber the end plate 5 of the furnace casing is provided with perforations 49. Openings 50 are also provided in the supporting standards 51 for the rear or heat absorbing portion of the furnace.

Positioned below the coal magazine and surrounding the top portion of the fuel bed is a secondary air ring 52 having perforations 53 whereby combustion of the combustible gas evolved from the bed of fuel is expedited. This ring is supported in any suitable way. An air supply pipe 56 extends upwardly from a point below the bottom plate 10 (Fig. 4) and thence through the water in the chamber formed between the shells 7 and 8, said pipe then projecting through the upper part of shell 7 into a coupling 57 communicating with the interior of the air ring 52. Air is thus continuously supplied to said ring and is preheated by the water surrounding the combustion chamber. The lower end of the pipe 56 below the plate 10 may terminate within the base member 11 and thus receive air from within said base member, or it may extend into the atmosphere at any other point. The rear or boiler portion of the furnace may be of any suitable type, the particular construction thereof being immaterial to the invention herein claimed.

It has been noted that the lower portion of the fuel magazine 33 is surrounded by a water jacket. The hot water therein heats the fuel preliminarily to the entry of the fuel into the combustion chamber, thereby assisting in maintaining the upper surface of the fire bed sufficiently hot to ignite the gases evolved. In addition to this, the water jacket aforesaid prevents the fuel in the magazine 33 from reaching so high a temperature as to burn in the magazine.

As combustion of the fuel in the combustion chamber proceeds, ashes will, of course, collect on the grate 13 and, as hereinbefore noted, will be removed from time to time by rotation of the grate 13 and ash ring 23 through the motor 29. We have provided for the control of said motor in response to temperature conditions at a predetermined point in the combustion chamber. More particularly, we provide a thermostat in a chamber or housing mounted in a wall of the combustion chamber for subjecting the thermostat to temperature changes in the bed of ash and fuel on the grate 13.

Through our thermostatic control provisions, including the location of the thermostat and the predetermined length and diameter of the fuel feed tube 33, substantially uniform depths of fuel bed and ash bed are maintained.

Preferably the top of said ash bed is maintained substantially on a level with the apex of the conical grate but the top of ash bed may be maintained at any desired level with relation to the grate.

For this purpose we provide a thermostat mounted in a housing 98 inserted in the front wall of the furnace, said housing extending through openings in the front end plate 4, the shell 7, and the shell 8. A casing 99 within said housing surrounds the thermostat, the end wall 100 of which casing is engageable by the material in the lower part of the combustion chamber, as shown in Figure 1. The thermostat may be of any well-known type, that shown comprising a heat-responsive coiled element 101 (Fig. 3) secured at one end to the interior of a shell or casing 102 within the casing 99 and at its other end to a rotatable shaft 103. Change of temperature in the bed of ash and fuel adjacent the plate 100 results in expansion or contraction of the element 101 and in rotation of shaft 103 in one direction or the other. The parts are shown so located with respect to the grate 13 that the axis of the thermostat and of the chamber in which it is mounted are substantially on a level with the apex of the grate, but this relation may be varied if desired. A tubular extension 104 of casing 102 surrounds the shaft 103 and extends through end plate 105 at the front end of the casing 99, said extension 104 joining a casing 106 mounted on a bracket 107 projecting from the front wall of the furnace. The end plate 100 may be of any material capable of withstanding the temperatures in the fuel bed, and at the same time of the desired heat conductivity for transmitting the temperatures from the fuel bed into the thermostat housing. We have found the metal known to the trade by the name "Ascaloy" to be highly satisfactory in this connection, although any other suitable material may be employed in the plate 100.

The connections whereby the thermostat controls the motor 29 may be of any suitable or conventional type. In the embodiment shown there is provided in the casing 106 a so-called "Mercoid" switch of well-known type and shown diagrammatically in Figure 5. This switch comprises a toothed wheel 108 secured to the thermostat shaft 103. A pair of spaced lugs 109, 110 are carried by said wheel and engage the teeth thereof. Journaled on said shaft 103 is an arm 111 carrying at its upper end a chamber 112 containing mercury or other suitable conducting liquid 113. Said chamber 112 also contains a pair of spaced contacts 114, 115. These contacts are suitably insulated from each other. When the arm 111 and chamber 112 are shifted by lug 110 into the position shown in full lines in Fig. 5, the contacts 114, 115 are bridged by the mercury 113, whereby a circuit is closed through the motor 29; and when, on the other hand, the arm 111 and chamber 112 are moved by lug 109 into the dotted line position of Fig. 5, the mercury moves out of engagement with said contacts. More specifically, when due to accumulation of ashes in the lower part of the combustion chamber, the temperature in the thermostat casing is lowered to a certain point, the resulting contraction of the thermostat and rotation of the shaft 103 causes the rotation of wheel 108 and shifting of arm 111 by lug 110 to bring the chamber 112 into the full line position shown in Figure 5, whereupon the motor circuit is closed. The motor 29 thus comes into operation and rotates the ash receiving ring 23 and grate 13. As noted previously herein, the eccentric mounting of the grate 13 imparts a crushing action to the ashes between said grate and the combustion chamber walls, whereby the passage of the ashes from the grate into the ash receiving ring is expedited. As the ring 23 rotates, the arm 30 deflects the ashes from the flange 24 of said ring and causes them to pass into the ash lifter well 31. The withdrawal of ashes from the combustion chamber results in lowering of the coal above the ashes with corresponding increase of tem-

perature adjacent the thermostat. Upon sufficient increase of said temperature, the shaft 103 is rotated sufficiently to cause lug 109 to move arm 111 and chamber 112 into the dotted line position of Figure 5 with resultant disengagement of the mercury in said chamber from the contacts 114, 115. If desired, this shifting of the chamber 112 to remove the mercury from engagement with said contacts may be relied upon to break the motor circuit. In short, the contacts 114, 115 may be connected directly in the motor circuit, whereby the bridging of said contacts energizes the motor directly and the removal of the mercury from engagement with said contacts deenergizes said motor. We have, however, shown in conjunction with the motor control connections provisions for insuring that the motor 29 will not continue in operation beyond a predetermined time following the bridging of contacts 114, 115. Thus the operation of the motor is limited to a definite period in case the thermostat coil 101 takes too long to restore switch arm 111 to the "off" position in response to increase of temperature in the lower part of the fuel bed. For this purpose we employ a safety control limit switch of standard type, designated 120 and comprising a relay 121 and relay motor 122. Since this unit is well known, its operation need not be discussed in detail except to note briefly that when the contacts 114, 115 are bridged by the mercury 113, a circuit is closed through coils 123 of relay 121, by way of wire 124 connected to one pole of a suitable source of electrical energy and thence through contact 115, mercury 113, contact 114, wires 125—129, relay coils 123, wire 130, wire 131, and wire 132 to the opposite pole of said source. Relay 121 is thus energized and armature 133 thereof operated to close contacts 134—135 in the usual manner (said armature being connected with contact 135 by a rod 136, as is well understood). Contacts 137, 138 are normally closed and a circuit is thus established from wire 128 through wires 139, 140, contacts 137, 138, wires 140, 141, 145, contacts 134, 135, wire 147, the relay motor 122, and thence through wires 148 and 131 to wire 132. Also current flows from wire 147 through the furnace motor 29 by way of wires 149 and 150 and thence to wire 132. Thus both the relay motor 122 and the furnace motor 29 are placed in operation.

After a predetermined time, limited by the setting of the relay (for which purpose a pointer 151 is provided) the furnace motor and relay motor circuits are broken by the disengagement of contact 137 from contact 138. To summarize the action of the limit switch relay mechanism upon said contacts, it may be noted that when the relay coils 123 are energized, the operation of armature 133 not only closes the contacts 134, 135 as above pointed out, but also, through link 136, shifts a pawl 153 into engagement with one of the gears 154 of an epicyclic train driven by the relay motor and associated with the disk 155, loosely mounted on the shaft 156. The parts are now in the position shown in Fig. 7. Upon the engagement of pawl 153 with gear 154 the disk 155 is rotated through the actuation of the epicyclic train by the relay motor, and energy is stored in a spring (not shown) to which said disk is connected. Attached to said disk is a stop pin 157 which, at the end of the predetermined time aforesaid, engages and raises an arm 158, lifting bar 159 out of the path of spring element 160. The latter now snaps back, and its upper offset projection 161 engages and retracts the spring member 162 which carries contact 137, thereby disengaging said contact from contact 138, as shown in Fig. 8. The furnace motor, as well as the relay motor, is thus now stopped after a predetermined period of operation. The manner in which the relay motor acts upon the epicyclic gears and disk 155 and the manner in which the time when the pin 157 shall engage member 158 is predetermined are well understood in the art and description thereof is unnecessary to an understanding of our invention.

The furnace motor 29 may now remain inactive until after the relay motor armature 133 returns to its normal position. This occurs when the switch arm 111 is moved to its "off" or dotted line position, breaking the circuit through contacts 114, 115, with consequent deenergization of relay coils 123. Armature 133 now returns to its normal position, under suitable spring action, pushing spring 160 rearwardly permitting bar 159 to drop back into its normal position and contact 137 to return into engagement with contact 138 at the same time, contact 134 is withdrawn from engagement with contact 135, contact 134 being mounted on said spring element 160.

Also, the retraction of said armature disengages pawl 153 from gear 154, whereupon disk 155 is returned to its normal position by its spring previously referred to. The relay mechanism is now again in its normal position (Fig. 9) ready to repeat the cycle aforesaid upon bridging of the contacts 114, 115.

It will be apparent that any suitable time limit switch mechanism other than the conventional one here shown may be employed in connection with the thermostat and furnace motor. The time limit for which the mechanism is set is such that the motor circuit will be broken after a period which will enable the accumulated ashes to be removed from the fuel bed but before burning fuel is removed, and before burning fuel engages the grate.

If the thermostat should shift the switch arm 111 into its "off" position while the relay motor is in operation but before stop pin 157 engages pawl 158, the relay coils 123 will be demagnetized, armature 152 and disk 155 returned to normal position, and contact 134 withdrawn from engagement with contact 135; the circuit through the relay and furnace motors being thus broken and the relay restored to normal.

A signal light 165 may be connected across the wires 125, 132 as shown, and may be located at any desired point for giving an indication that the mercoid switch is in its "on" position.

It may be noted that the operation of the switch arm 111 may be regulated as desired by adjusting the lugs 109, 110 to appropriate positions on the toothed wheel 108.

The ashes ejected from the ash ring 23 into the well or casing 31 are removed by the ash elevator 32 comprising a series of buckets 170 on an endless chain 171. Said chain is driven by a sprocket wheel 172 secured to the motor driven shaft 28. The elevator operates in a vertically extended casing 173 provided at its upper end with a suitable opening through which the ashes are discharged into any suitable receptacle. Since ash elevators of this type are known in the art, further description thereof is not essential.

The air ring 52 provides for distributing and diffusing oxygen to the combustible gases immediately above and in the center of the fire

bed to assure their complete combustion. The air supplied to said ring is preheated by passing through the pipe **56** which, as has been noted, extends through the shell **7** and downwardly through the space between said shell and the shell **8**, finally extending through the bottom plate **10**. The space between the shells **6** and **8** being filled with hot water, it will be seen that the air which passes through the pipe **56** to the ring **52** is effectively heated. Preferably the air ring is provided with two rows of holes **53**, one on the inside and the other on the outside of said ring, and at an angle corresponding to that at the top of the fuel bed. In other words, preferably the holes **53** are so arranged that an imaginary surface passed through the two rows thereof assumes an angle corresponding to that of the frusto-conical top portion of the fuel bed.

The furnace herein described has been found particularly effective for burning prepared sizes of anthracite coal, especially those known to the trade as egg, stove, and chestnut. The invention, of course, is not restricted to the burning of any particular coal or size thereof.

In Figure 10 there is shown a modification of the invention wherein deflecting plates **175** extend between the arms **17** of the spider **18** and are secured thereto. These deflecting plates, which are inclined at an angle corresponding to that of the conical grate, receive the small particles of ash which pass through the holes of the grate during the rotation of the latter and deflect said particles on to the ash ring flange **24**. Also, the ash ring flange **24** is formed with upwardly inclined segmental portions **24'** which extend between the spider arms **17** and are secured to said arms by bolts as shown. The inclined segmental portions **24'** aforesaid also receive ash particles from the holes in the lower part of the grate, as well as from the plates **175**. In this form of invention also the deflecting arm **30** has secured thereto and extending therefrom a piece of spring steel **176** for engagement with the segmental extensions **24'** to remove ash therefrom. In this manner the ash which passes through the openings in the grate is effectively collected and passed to the well or boot of the ash removing elevator **32**. It may be noted also that the bearing portion **177** of the top section of the grate has a downwardly flaring extension **178**, thereby insuring that any ashes passing through the top grate section adjacent said bearing portion will be directed on to the plates **175** and thence to the segmental extensions **24'** and the ash ring flange **24**.

A door **179** of conventional type may be provided for opening or closing the interior of a shell or housing **180** extending through the wall **3** and the shells **7** and **8**, whereby access may be gained, when desired, to the combustion chamber. Suitable heat insulating material **181** is provided, as shown, between the outer shell or casing and the inner sections of the furnace.

Coal may be automatically supplied to the magazine **33**, **33'**, either by gravity from an overhead storage bin or by means of an automatically controlled elevator synchronized with the ash removal apparatus.

The terms and expressions which we have employed are used as terms of description and not of limitation, and we have no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described or portions thereof, but recognize that various modifications are possible within the scope of the invention claimed.

We claim:

1. In a furnace, a combustion chamber, a grate for supporting a fuel bed in said chamber, means including said grate for removing ashes from said chamber, a motor for operating said ash removing means, a thermostat positioned to be responsive to temperature conditions in the combustion chamber, a power circuit for said motor including a switch controlled by said thermostat, a relay energized when said switch is in one position and de-energized when said switch is in another position, said relay closing said circuit through said motor when the relay is energized, and means controlled by said relay for breaking the circuit through the motor at the end of a predetermined time following the energization of said motor.

2. In a furnace, a combustion chamber, means positioned to be responsive to temperature conditions in a fuel bed in said chamber, a motor, means operable by said motor for removing ashes from said chamber, a pair of normally open contacts, means controlled by said heat responsive means for closing said contacts to establish a circuit through said motor, a pair of normally closed contacts in said circuit, and time-controlled means for opening the last mentioned contacts for breaking said circuit upon the lapse of a predetermined time while the first-mentioned contacts are closed.

3. In a furnace, a combustion chamber having an opening in a wall thereof, a plate of high-temperature-resistant heat-conductive metal in said opening and positioned to be contacted by burning fuel and ashes in said combustion chamber, a housing rearward of said plate, means for removing ashes from said chamber, and thermostatic means controlled by the temperature in said housing for controlling the operation of said ash removing means.

4. In a furnace, a combustion chamber, a grate for supporting fuel and ash beds in said chamber, said grate having its outer edge spaced from and forming an ash passage with a side wall of said chamber, means including said grate for removing ash from said chamber, a motor for causing operation of said ash removal means, a power circuit for supplying energy to said motor, a thermostat positioned in a side wall of said chamber and above said grate, contacts controlled by said thermostat for controlling the supplying of energy from said power circuit to said motor, said thermostat being adapted to cause opening and closing of said contacts in response to temperature conditions in said chamber, and time limit switch means for breaking said power circuit and deenergizing said motor after a predetermined time following closing of said contacts.

5. In a furnace, a combustion chamber, heat responsive means positioned to be contacted by an ash bed in said chamber when said ash bed exceeds a predetermined depth and to be contacted by a burning fuel bed in said chamber when said ash bed is less than a predetermined depth, means for supporting ash and fuel beds in said chamber, means including said ash and fuel bed supporting means for removing ash from said chamber, power driven means for causing operation of said ash removal means, a power circuit for supplying energy to said power driven means, and contacts for controlling the supplying of energy by said power circuit to said power driven means,

said heat responsive means being adapted to cause closing of said contacts when said ash bed exceeds a predetermined depth, and to cause opening of said contacts when said ash bed is less than a predetermined depth.

6. In a furnace, a combustion chamber, heat responsive means positioned to be contacted by an ash bed in said chamber when said ash bed exceeds a predetermined depth and to be contacted by a burning fuel bed in said chamber when said ash bed is less than a predetermined depth, means for supporting ash and fuel beds in said chamber, means including said ash and fuel bed supporting means for removing ash from said chamber, power driven means for causing operation of said ash removal means, a power circuit for supplying energy to said power driven means, and contacts for controlling the supplying of energy by said power circuit to said power driven means, said heat responsive means being adapted to cause closing of said contacts when said ash bed exceeds a predetermined depth, and to cause opening of said contacts when said ash bed is less than a predetermined depth, and time limit switch means for breaking said power circuit and de-energizing said power driven means after a predetermined time following closing of said circuit under the control of said contacts.

7. In a furnace, a combustion chamber, heat responsive means positioned to be contacted by an ash bed in said chamber when said ash bed exceeds a predetermined depth and to be contacted by a burning fuel bed in said chamber when said ash bed is less than a predetermined depth, means for supporting ash and fuel beds in said chamber, means including said ash and fuel bed supporting means for removing ash from said chamber, power driven means for causing operation of said ash removal means, a power circuit for supplying energy to said power driven means, and contacts for controlling the supplying of energy by said power circuit to said power driven means, said heat responsive means being adapted to cause closing of said contacts when said ash bed exceeds a predetermined depth, and to cause opening of said contacts when said ash bed is less than a predetermined depth, a relay controlled by said contacts, said relay being energized when said contacts are closed and de-energized when said contacts are open, and means controlled by said relay for breaking said power circuit at the end of a predetermined time even though said relay remains energized.

HARRY A. GRINE.
JOHN G. REID.
HARRY A. WAGNER.