May 3, 1938. A. C. MUIR ET AL 2,116,322

FURNACE

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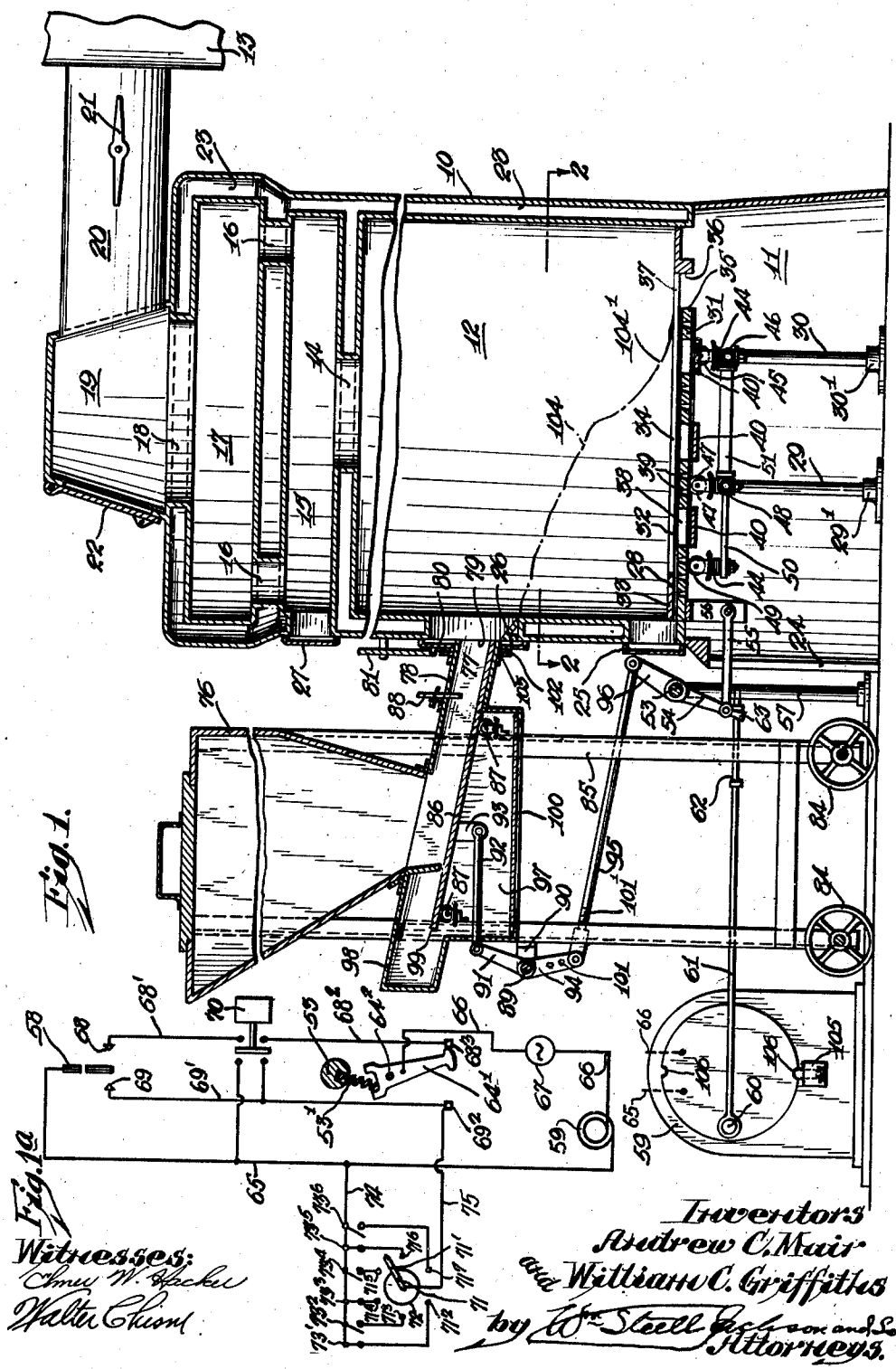


Fig. 1.

Fig. 1a

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Fig. 3.

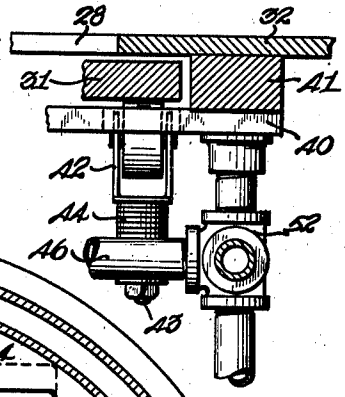
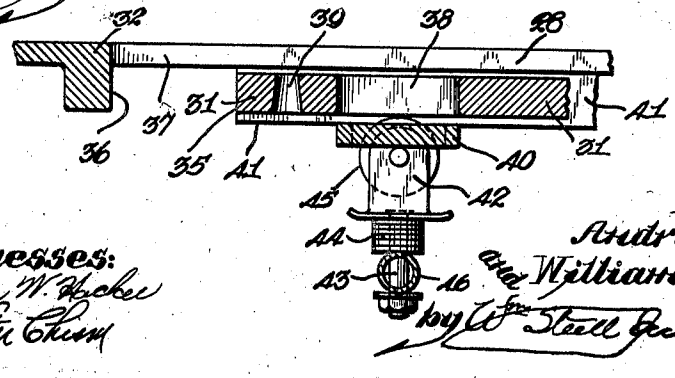


Fig. 2.

Fig. 4.



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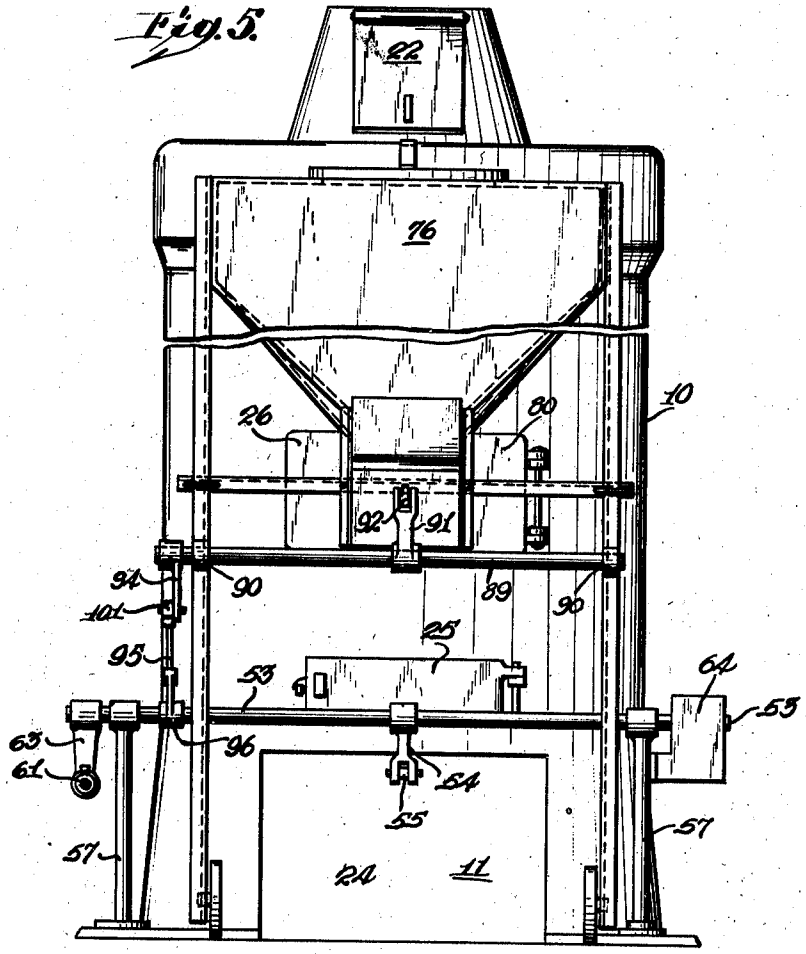
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FURNACE

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Fig. 5.



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May 3, 1938. A. C. MUIR ET AL 2,116,322

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Fig. 6.

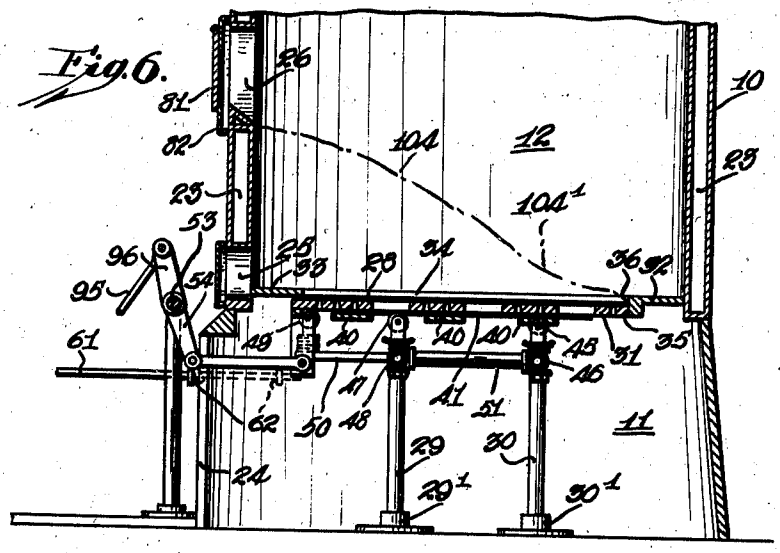
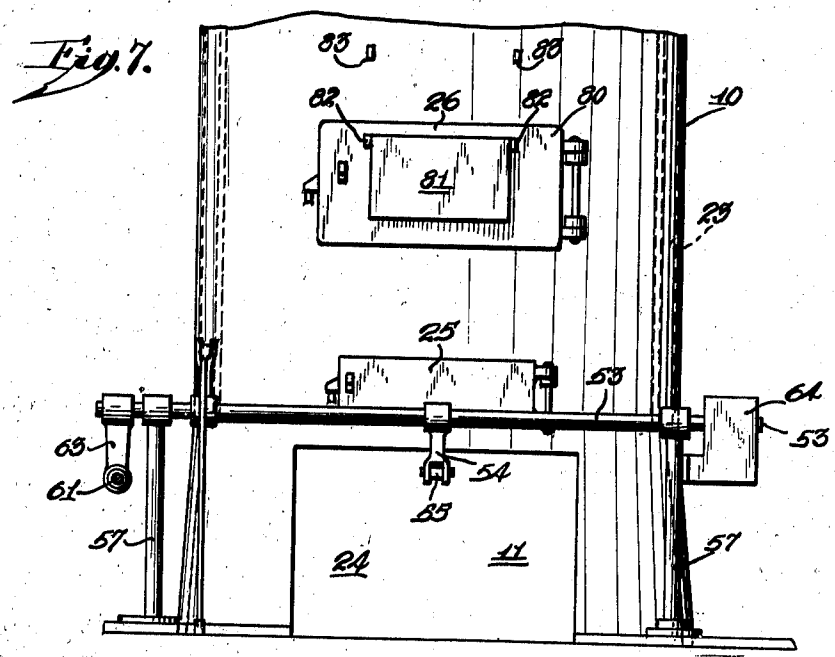


Fig. 7.



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Patented May 3, 1938 2,116,322

UNITED STATES PATENT OFFICE

2,116,322

FURNACE

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Application August 29, 1936, Serial No. 98,570

20 Claims. (Cl. 110—33)

Our present invention relates to furnaces fired by solid fuel such as coal or coke, and while intended for any use to which it may be adapted, is thought to have its best application to domestic heating, preferably with thermostatic control and suitably for application to furnaces already installed.

A purpose of the invention is to provide furnace equipment for natural draft domestic heating using either new or old furnace installations, which is at once easy and inexpensive to manufacture and well suited to the needs of service.

A further purpose is to provide a reciprocating grate with major and minor air passages, to bypass the grate and to close the major air passages when the grate is bypassed.

A further purpose is to control the pressure drop through a fuel bed, and thereby the rate of fuel combustion, by suitable back and forth shiftings of a grate supporting the fuel.

A further purpose is to determine the high and low combustion rates of a thermostatically controlled furnace by thermostatically shifting the fuel bed, to close and open respectively a space beyond the grate which connects the fire chamber to the ash chamber.

A further purpose is to aid the delivery of ashes out of a fuel bed into an ash compartment by back and forth shiftings of a grate supporting the fuel bed to positions that respectively determine high and low rates of combustion.

A further purpose is to operate a stoker and the back and forth shifting of a grate by thermostatically controlled common mechanism using successive shiftings of the grate to successively increase and check the rate of heat development and the corresponding retracting and feeding strokes of the stoker to add fuel to the furnace with each checking of the furnace.

A further purpose is to operate the stoker at time intervals while the thermostat is in the "more heat" position.

A further purpose is to provide novel, effective and inexpensive mechanism respectively for supporting a bed of burning fuel and for adding fresh fuel, preferably each time the furnace is put on high heating, and during high heating.

Further purposes will appear in the specification and in the claims.

We have elected to show one only of the different forms of our invention, selecting a form however that is practical and efficient in operation and which well illustrates the principles involved.

Figure 1 is a vertical section to illustrate a desirable embodiment of the invention as applied to a domestic heater. In its more broad features the heater illustration is intended for a conventional illustration of any heater to which the invention may be applied. The grate is in the draft bypass position in Figure 1.

Figure 1a is a diagrammatic view of the electric circuit.

Figure 2 is a horizontal section of Figure 1, taken upon the line 2—2 thereof and to enlarged scale.

Figures 3 and 4 are detail sections of Figure 2, upon the lines 3—3 and 4—4 thereof respectively, to show supporting mechanism of the furnace floor, as well as draft bypass.

Figure 5 is a left side elevation of Figure 1, omitting motor and thermostatic control equipment shown in Figure 1.

Figure 6 is a broken vertical section corresponding to a portion of Figure 1 but with the hopper structure of Figure 1 not shown in Figure 6, the hopper having been wheeled aside for hand firing. The grate is in the high combustion position in Figure 6.

Figure 7 is a left side elevation of Figure 6.

Like numerals refer to like parts in all figures.

Describing in illustration and not in limitation and referring to the drawings:—

Our invention relates to heaters of the type used for domestic heating and for industrial installations, burning solid fuel such as anthracite coal, bituminous coal, coke, petroleum coke, etc. The problem of controlling the combustion in such heaters has received extensive attention and has been solved in the main by the use of various doors, dampers, etc., the correct use of which is an art only imperfectly understood by the ordinary householder.

By our invention it is possible to greatly simplify the control of domestic heaters operating on natural draft or on mechanical draft. The entire control of the heater is accomplished by changing the position of the grate, and only grate positions corresponding with high heating or checking of the fire are necessary. The difficulty of prior art shiftable grate constructions, that the grate air passages necessary when the fire is on high heating proves to be excessive when the fire is checked, has been corrected by employing major and minor grate air passages, bypassing the grate air passages by a passage of relatively zero air friction compared to the grate air passages when the fire is checked, and concurrently closing the major but not the minor grate air passages, and leaving the major and

preferably some of the minor grate air passages open when the fire is on high heating.

A furnace 10 is shown as a water heater type, with ash and fire compartments 11 and 12 and the hot gases escaping to a chimney 13 by flue passages 14 to 20. The butterfly damper 21 is indicated as being open, and the damper door 22 as being closed, since neither the butterfly damper nor the damper door is used in control of the furnace in accordance with our invention and they are illustrated merely for completeness. A water space 23 surrounds the flue passages except at doorways 25, 26 and 27 for poking, charging and clean out, respectively. Doorway 24 in the base is provided for ash removal.

A composite floor 28, separating the ash and fire compartments, and replacing any hitherto usual grate mechanism, is supported preferably on several posts 29 and 30 in the ash pit, near opposite sides of the front and rear thereof, respectively. The posts 29 and 30 are preferably flanged at 29' and 30'. The composite floor, usually preferably horizontal, comprises a movable grate 31 and a stationary centrally open frame-like member 32 which peripherally fits the interior of the furnace and at the front 33 and opposite sides 34 of its central opening overlaps the front and sides respectively of the grate 31.

In its rearward position the grate, except for its own air passages, closes the entire opening of the stationary member 32, the rearward edge 35 of the grate then registering against the forwardly presented rear wall 36 of the opening as shown in Figure 6.

In its forward position, as in Figure 1, the grate leaves an opening 37 back of the grate and in front of the wall 36, which opening 37 will then effectively check the fire, since it reduces substantially to zero the difference in pressure between the ash and fire compartments and therefore the fall in pressure through the fuel bed.

We provide the grate with major and minor air passages 38 and 39, respectively, in alternate laterally spaced transverse rows, with the major passages 38 for use when the grate is rearward and therefore in its high heating position, with the opening 37 closed, and the minor passages 39 for use when the grate is forward and therefore in its low heating or fire checking position. This is accomplished by means of stationary closure strips 40 under and transversely across the grate and fastening at their ends to grate side-guide portions 41 of the stationary member 32. The minor air passages are preferably tapered with the smaller opening at the top as shown so that ash entering them will readily drop through.

The strips 40 are located to close the rows of major air passages 38 when the grate is in its forward position as shown in Figure 1. The air passages are uncovered when the grate is moved back to its rearward position.

Obviously the best form and spacing and number for the air passages 38 will be quite widely variant with quite widely different fuels and furnaces so that smaller sizes of free-burning or non-coking coals, for example, will require smaller passages and more of them than will be most suitable for larger fuel.

We prefer to provide the movable grate with roller support, suitably on casters supported in bearings 42 secured to the under-structure by bolts 43 carrying spacing washers 44.

Rear side rollers 45 are supported upon a cross connection, suitably a pipe 46 between the posts 30; forward side rollers 47 are supported upon a cross connection 48 between the posts 29; and front rollers 49 are supported upon branch members 50 from the cross members 48. The cross connections 46 and 48, and side connections 51, are integrated into a strong structure by fittings 52 which form parts of the posts 29 and 30.

The grate is shiftable back and forth, respectively, back into its high heating position and forward into its low heating or checking position, by any suitable means, such as hand manipulation or back and forth movements of a rocker shaft 53, crank 54 thereon and link 55 connecting the crank to a yoke 56 extending downward from and rigidly fastened to the grate 31. The rocker shaft 53 is pivotally supported on posts 57.

The operation of the grate may be purely manual and non-automatic. For automatic operation, if such be desired, we provide thermostatically controlled means for operating the rocker shaft 53 and therefore for positioning the grate for high or low heating according to the need or lack of need for high heating.

As illustrated in Figures 1*a* and 1, a thermostat 58 controls the operation of a reduction gear motor unit 59, which, through a crank 60 and connecting rod 61, has at 62 a lost motion operative connection with an arm 63 fastened to the rocker shaft 53. A stop switch 64, suitably operatively connectd to the shaft 53, as by a spring full-stroke connection 53', stops the motor at the completion of each shift movement.

In the diagrammatic electric connections of Figure 1*a*, the thermostat 58 and the stop switch arm 64', pivoted at 64^2, connect to the motor terminals by conductors 65 and 66, suitably in series with a current source 67. A thermostat contact 68, with which connection is made when more heat is demanded, is connected by leads 68' and 68^2 with the contact 68^3 of switch 64, and a thermostat contact 69 with which connection is made when less heat is demanded, is connected by lead 69' with contact 69^2 of switch 64. An aquastat switch 70 operatively connected to the water temperature of the heater breaks connection between the "more heat" wires 68', 68^2 if or when the water temperature of the heater reaches any selected high limit, at the same time connecting the conductors 65 and 69' to effect a "less heat" shift of the grate if ever or whenever the water temperature reaches this selected high limit.

We add fuel to the furnace at least once for each back and forth shifting cycle of the grate, preferably adding this charge of fresh fuel each time the grate moves rearward into its position for high combustion, since in this position the grate has progressed the fuel bed toward the rearward end of the grate, leaving space at the forward end for fresh fuel.

In order to provide for the supply of successive increments of fuel in case the thermostat remains in the "more heat" position for a substantial period of time, it has been found desirable to operate the stoker at predetermined time intervals while the thermostat continues to demand more heat. In Figure 1*a*, a time switch 71 is shown having a rotatable switch arm 71' driven in one direction by a time clock 72. The switch arm 71' passes over any suitable number of contacts 71^2, 71^3, 71^4, 71^5, 71^6, 71^7 which are suitably connected through switches 73', 73^2, 73^3, 73^4, 73^5, 73^6 to a lead 74 extending to the lead 65. A lead 75 likewise extends from the switch arm 71' to the lead 69'. Any of the contacts 71^2 to 71^7 may be rendered ineffective by opening the corresponding switch 73' to 73^6.

As illustrated a hopper 76 is removably mounted to present the open end 77 of its delivery spout 78 into an opening 79 cut in the furnace charging door 80, an auxiliary door 81 normally closing the opening 79 when the hopper is out of its operating position in front of the furnace. As illustrated, the auxiliary door 81 has alternative lug supports at 82 and 83, respectively, on the charging door 80 and on the furnace wall above the charging door.

The hopper 76 is mounted on wheels 84 by means of suitable frame structure 85. The delivery mechanism includes a movable stoking plate 86 that in effect forms a bottom of the hopper shaping toward the furnace. The stoking plate is preferably roller supported, as at 87, and is shifted from the rocker shaft 53 that shifts the grate, preferably toward the furnace each time the grate is shifted rearward into its "more heat" position and away from the furnace each time the grate is shifted to its "less heat" position.

A vertically adjustable gate 88 in the delivery spout extending downwardly from the roof thereof enables the operator to properly relate the fuel feed to the rate of combustion within the furnace.

The operating mechanism between the rocker shaft 53 and the stoking plate 86, as shown, includes a rocker shaft 89 pivotally supported at 90 on the frame structure 85, having crank and link connection at 91 and 92 with a downward lug 93 from the stoking plate 86, and having crank and link connection at 94 and 95 with a crank 96 upon the rocker shaft 53. The rocker shaft 53 is thus a common shifter for the grate 31 and for the stoking plate 86.

We preferably provide a catch compartment 97 below the stoking plate, to catch fuel dust and fuel particles that may escape from the hopper at the sides and forward end of the shifting stoking plate. We extend the catch compartment 97 far enough at 98 to inclose the end 99 of the stoking plate when the plate is retracted to its furthermost position.

A bottom slide 100 of the catch compartment permits an easy periodic cleaning out of the compartment. For easy assembly and disassembly, each of the links 55, 95 and 92 may have hook connection with either or both of the cranks driving it and the member that it in turn drives.

The distance of the shifting movements of the grate 31 and of the stoking plate 86 may be adjusted together by adjusting the lost motion at one or both of the stops 62, to adjust the reciprocating action of the rocker shaft 53, and, if desired, either the grate or the stoking plate may be adjusted separately by an adjustment of the effective length of one or more of the appropriate cranks 54, 91, 94 or 96, as indicated at 101 for the crank 94. The effective length of the link 95 may be adjusted at 101' for any effective length of the crank 94.

When it is desired to move the hopper assembly away from before the furnace, as for continuous hand firing or for an initial building of a fire, or to fill the hopper at the coal bin, the link 95 is disconnected from the crank 94, as by unhooking, and any blocking of the wheels 84 is removed, after which the hopper assembly will readily wheel away. If desired the hopper may be entirely omitted.

It will be seen that when the hopper assembly is in place before the furnace, it seals therewith at a gasket 102, suitably of asbestos, compressed between the furnace door and a peripheral shoulder 103 of the hopper spout 78.

While the contour of the burning fuel bed will vary quite widely with different fuel characteristics as well as with different operating conditions that will make essential different adjustments at the gate 88, a typical contour may be about as indicated by the line 104, Figure 1.

The manual operation of the device is very simple when the hopper 76 is not used. Any suitable solid fuel such as hard or soft coal, coke or petroleum coke of any one of the commercial sizes burned in domestic heaters is charged from time to time at the upper end of the fuel bed 104. As long as it is desired to check the fire, the grate 31 remains in its forward position as shown in Figure 1. The air then passes almost entirely through the bypass opening 37 between the end of the grate and the edge 36 of the rear plate. The closure strips 40 prevent substantial flow of air through the major grate air passages 38, thus avoiding the difficulty that substantial flow of air will take place through the grate and cause burning up of the relatively thin end 104' of the fuel bed when the fire is intended to be checked. Substantially the only air passing through the fuel bed when the fire is checked is that passing through the minor grate air passages 39 and causing very gradual combustion at the relatively thin end 104' of the fuel bed.

If now it be desired to obtain high heating from the fire, grate 31 may be slid manually to its rearward position as shown in Figure 6, thereby uncovering the major grate air passages 38 (and incidentally obstructing some of the minor grate air passages 39 which are relatively unimportant at this time). Air passing from the ash chamber to the combustion chamber must now pass through the major grate air passages 38 and such of the minor grate air passages 39 as remain open, thus causing vigorous combustion, as the opening 37 which formerly bypassed the air around the fuel bed is now closed.

The period required for burning up the fire will normally be relatively short. For example, in moderately cold weather it has been found sufficient to burn up the fire about a half hour in the morning and a half hour in the evening, maintaining the fire checked during the remainder of the 24-hour period.

Each time that the grate is moved from the high heating to the checking position, a quantity of ash at the rearmost end of the grate drops into the ash pit, where it can be removed manually or mechanically as desired, in any well known manner.

It will be noted that the butterfly damper 21, damper door 22 and the various furnace doors have no function whatever in the control of the fire, which is controlled wholly by movement of the grate to one or the other of its limiting positions. The doorway 24 is continuously open, and the doorways 25 and 26 are continuously closed except for the charging opening in the doorway 26 which will normally be connected with the hopper. It is intended to maintain the hopper sufficiently full of fuel so that air will not enter to any substantial extent through the doorway 26.

With automatic operation the principles underlying the control of the furnace are the same as those indicated above, although the structure accomplishing the purpose is somewhat different. Assuming that the thermostat 58 has just been demanding less heat and has shifted the grate to

its forward position as seen in Figure 1, let us assume that the thermostat 58 demands more heat, thus moving to a position touching contact 68. This completes a circuit from the source 67 through the lead 66, the motor, the lead 65, the thermostat 58, the lead 68', the aquastat contacts, the lead 68^2, the switch contact 68^3, the switch arm 64' in the position shown in Figure 1, and the lead 66.

The motor starts up, moving the crank 60 clockwise for example for a half revolution, and thus carrying the connecting rod 61, the crank 63, the rocker 53, the crank 54, the link 55, the lug 56 and the grate 31 to the position of Figure 6. Actually the connecting rod 61 moves much farther than the link 55, but the overtravel is taken care of by the lost motion connection 62 which is adjusted so that the latter part of the stroke of the connecting rod 61 will be operative to move the grate.

The motion of rocker shaft 53 as it travels beyond its intermediate position will move full stroke device 53' and throw switch arm 64' to a position against switch contact 69^2, thus breaking the motor circuit and causing the motor to stop. By selection of a motor and gear reduction having sufficient friction, it is possible to make the motor stop reliably at the half circumference, although if desired a spring detent 105 may be made to engage in one of the slots 106 of the crank disc to limit the stroke to a half revolution. The contact between the switch arm 64' and the contact 69^2 is at this point ineffective to re-start the motor because the thermostat is presumably still demanding more heat.

At the same time that the rocker shaft 53 turns to shift the grate 31 to its rearward position, it likewise moves the stoker plate 86 to its feeding position by imparting motion to the crank 96, link 95, crank 94, rocker shaft 89, crank 91, link 92 and lug 93.

Unless the time switch 71 closes the circuit between the leads 65 and 69', the stoker plate and grate remain in the position indicated until the thermostat 58 demands less heat and thus completes the motor circuit from the source 67 through lead 66, the motor, lead 65, contact 69, lead 69', contact 69^2, switch arm 64' and lead 66, thus causing the motor to travel another half revolution in the same direction and move the grate and stoker plate from the position of Figure 6 back to the position of Figure 1, concurrently dropping off ash from the end of the grate and retracting the stoker plate.

Assuming that the thermostat is in the "more heat" position and has shifted the grate to the corresponding position as shown in Figure 6, and assuming that the climatic condition is such that "more heat" is demanded for a substantial period of time, the time switch arm 71' will after a predetermined time interval touch one of the contacts 71^2 to 71^7 whose corresponding switch 73' to 73^6 is closed, thus completing the circuit between the leads 65 and 69', and operating the motor to move the grate into the "less heat" position as shown in Figure 1, to charge the stoker plate and to move the switch arm 64' to the position of Figure 1a.

If during the interval of shifting of the grate from the "more heat" to the "less heat" position, the thermostat has ceased to demand "more heat", nothing further will happen at this time. If however the thermostat continues to demand "more heat", the motor will immediately shift the grate back to the "more heat" position and concurrently operate the stoker plate to feed a charge of fuel to the fire. This series of operations will be repeated while the thermostat demands "more heat", as long and as often as the time switch arm 71' touches a contact 71^2 to 71^7 whose corresponding switch 73' to 73^6 is closed.

In this way it is possible to provide repeated charges of fuel during the period that the thermostat is demanding more heat without any shift in the thermostat position. The number of charges of fuel supplied in a given time may be varied by changing the size of the contacts 71^2 to 71^7 and by opening and closing the switches 73' to 73^6.

The fresh charges of fuel are successively carried rearward along the grate by the successive rearward movements of the grate to its high heating position.

An important feature of the invention is the use of major grate air passages when the fire is on high heating and the closure of the major grate air passages when the grate air passages are bypassed and the fire is checked.

Since the invention is intended particularly to apply to domestic heaters, it will be evident that it affords a very convenient means of controlling such heaters, dispensing with the numerous dampers and checks which have previously been used.

In view of our invention and disclosure, variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art to obtain part or all of the benefits of our invention without copying the structure shown, and we, therefore, claim all such in so far as they fall within the reasonable spirit and scope of our invention.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:—

1. A furnace having fire and ash compartments and a composite grate between the compartments comprising relatively movable members, said grate having openings at intervals which are open in one position of the members for passing air through the fuel bed and having a by-pass opening which is open in another position of the members for by-passing air around the fuel bed, and thermostatically controlled means having a position demanding less heat and a position demanding more heat for relatively shifting the said members back and forth, progressing the fuel bed toward the by-pass opening, passing the air through the by-pass opening and not through the fuel bed when said means demands less heat and passing the air through the fuel bed when said means demands more heat.

2. A furnace having fire and ash compartments and a composite floor between the compartments comprising a grate shiftable back and forth and normally supporting the main body of the fuel, and structure sealing against the back edge of the grate in the back position thereof and leaving a by-pass opening between the structure and the grate in the forward position thereof and sealing the side and forward portions of the grate in both positions thereof and thermostatically controlled means for shifting the grate back and forth to determine respectively high and low rates of combustion, said thermostatic means holding the grate in its forward position as long as combustion is to proceed at a low rate, and holding the grate in its back position as long as combustion is to proceed at a ligh rate.

3. A heater burning solid fuel including a grate

having major and minor air passages, the grate being supported to reciprocate between limiting positions, there being a bypass air opening around an edge of the grate when the grate is in a limiting position corresponding with checking of the fire and closure strips cooperating with the major air passages to restrict them when the grate is in the checking position, the minor air openings being open when the grate is in the checking position and the closure strips permitting the major grate openings to open when the grate is in the position for high heating and the bypass opening is closed.

4. A furnace burning solid fuel including a grate having sets of major and minor air passages, rollers beneath and supporting the grate, walls limiting the movement of the grate between a high heating and a checking position, closure strips cooperating with the major air passages in the checking position and uncovering the minor air openings in this position, there being a bypass air opening behind the grate in the checking position, and the closure strips uncovering the major air openings in the high heating position.

5. A furnace having fire and ash compartments and a composite floor between the compartments comprising a grate shiftable back and forth and for normally supporting the main body of the fuel, and structure sealing against the back edge of the grate in the back position thereof and sealing the side and forward portions of the grate in both positions thereof, the grate having major air passages and minor air passages, closures under the grate registering with the major air passages in one limiting position of the grate and uncovering the said major air passages in another limiting position and thermostatically controlled means for shifting the grate back and forth between its limiting positions which correspond with high and low rates of combustion.

6. A heater burning solid fuel, including combustion and ash chambers, and including a grate having air passages and supported for movement between two limiting positions, provided at its rearward end with a by-pass opening between the combustion and the ash chamber to discharge ash and by-pass air when the grate is in its forward position, there being an opening for introduction of fuel at a substantial height above the grate at the forward end, thereby producing an inclined fuel bed from the opening to the rear end of the grate, a thermostat having a position demanding more heat and a position demanding less heat, means operating when the thermostat is in the position demanding more heat for moving the grate to the rearward position to direct the draft through the air passages into the fuel bed and means operating when the thermostat is in the position demanding less heat for reciprocating the grate to its forward position to divert the draft through the by-pass opening.

7. A furnace having fire and ash compartments and a composite grate between the compartments comprising relatively movable members, said grate having openings at intervals which are open in one position of the members for passing air through the fuel bed and having a by-pass opening which is open in another position of the members for by-passing air around the fuel bed, and thermostatically controlled means having a position demanding less heat and a position demanding more heat for relatively shifting the said members back and forth, progressing the fuel bed toward the by-pass opening, passing the air through the by-pass opening and not through the fuel bed when said means demands less heat and passing the air through the fuel bed when said means demands more heat, and for delivering additional fuel into the furnace.

8. A furnace having fire and ash compartments and a composite floor between the compartments comprising a grate shiftable back and forth and normally supporting the main body of the fuel, and structure sealing against the back edge of the grate in the back position thereof and sealing the side and forward portions of the grate in both positions thereof but leaving a by-pass opening at the back edge of the grate when it is in its forward position, and thermostatically controlled means for shifting the grate back and forth, progressing the fuel bed toward the by-pass opening, passing the air through the by-pass opening and not through the fuel bed when the thermostatic means demands less heat and passing the air through the fuel bed when the thermostatic means demands more heat, and means for delivering additional fuel into the furnace.

9. A heater burning solid fuel on natural draft, including a substantially horizontal grate having air passages through the grate, means for supporting, guiding and reciprocating the grate, there being a by-pass opening open behind the grate at one limiting position and closed by the grate in the other limiting position, there being considerable air flow through the passages in the grate and through the fuel bed in the high heating position and there being bypassing of air through the by-pass opening in the checking position, a stoker device charging fuel above the forward end of the grate, a thermostat having a position demanding less heat and a position demanding more heat, means operatively connecting the thermostat, the grate and the stoker for moving the grate into the forward position, discharging ash through the by-pass opening and bypassing the draft around the fuel bed and retracting the stoker when the thermostat demands less heat and means operatively connecting the thermostat, the grate and the stoker for moving the grate into the high heating position and operating the stoker to introduce a charge of fuel when the thermostat demands more heat.

10. A heater burning solid fuel, including combustion and ash chambers, a grate having major and minor air passages, supports for the grate permitting the grate to reciprocate between limiting positions, structure surrounding and sealing against air flow between the ash and combustion chambers around the grate except for a by-pass air space left between the combustion chamber and the ash chamber in one limiting position, closures obstructing the major air passages when the by-pass air space is open, in the other limiting position the by-pass air space being closed and the major grate air passages being open, electric circuits respectively demanding more heat and less heat, a thermostat which selectively completes the electric circuit demanding more heat or the electric circuit demanding less heat, an electric motor connected selectively in one or the other of said electric circuits by the thermostat, a switch having a switch arm which is connected alternately in one or the other of said electric circuits, mechanical connections from the motor to the grate for reciprocating the grate and mechanical connections from the motor to the switch arm for throwing the switch arm to the other circuit when the motor is operating in one circuit.

11. A heater burning solid fuel, including combustion and ash chambers, a grate having major and minor air passages and supporting a fuel bed, supports for the grate permitting the grate to reciprocate between limiting positions, structure surrounding and sealing against air flow between the ash and combustion chambers around the grate except for a by-pass air space left between the combustion chamber and the ash chamber in one limiting position, closures obstructing the major air passages when the by-pass air space is open, in the other limiting position the by-pass air space being closed and the major grate air passages being open, electric circuits respectively demanding more heat and less heat, a thermostat which selectively completes the electric circuit demanding more heat or the electric circuit demanding less heat, an electric motor connected selectively in one or the other of said electric circuits by the thermostat, a switch having a switch arm which is connected alternately in one or the other of said electric circuits, mechanical connections from the motor to the grate for reciprocating the grate and mechanical connections from the motor to the switch arm throwing the switch arm to the other circuit when the motor is caused to operate in one circuit, a stoker having a stoker plate and mechanical connections between the motor and the stoker plate moving the stoker plate toward the fuel bed when the thermostat demands more heat and away from the fuel bed when the thermostat demands less heat.

12. A furnace having fire and ash compartments and a composite floor between the compartments comprising a grate having air openings and which is shiftable back and forth and normally supports the main body of the fuel, and sealing structure overlapping the sides and front of the grate, open intermediate the overlapping portions and at the back edge of its opening adapted to seal against the back of the grate when the grate is in its rearward position and to leave a by-pass opening when the grate is in its forward position, and means for shifting the grate between its back and forth positions to render the by-pass opening effective or ineffective to divert air from passing through the openings into the fuel bed.

13. A furnace having fire and ash compartments and a composite floor between the compartments comprising a grate shiftable back and forth and normally supporting the main body of the fuel and sealing structure overlapping the sides and front of the grate, open intermediate the overlapping portions and at the back edge of its opening adapted to seal against the back of the grate when the grate is in its rearward position and to leave a by-pass opening when the grate is in its forward position, the grate having under the opening of said structure laterally spaced rows of major air passages, laterally spaced strips under the grate and located to register with the rows of, and close the major air passages when the grate is in its forward position and the by-pass is open and means for shifting the grate between its back and forth positions to render the by-pass opening effective or ineffective to divert air from passing through the openings into the fuel bed.

14. A furnace having fire and ash compartments and a composite floor between the compartments comprising a grate shiftable back and forth for normally supporting the main body of the fuel and sealing structure overlapping the sides and front of the grate, open intermediate the overlapping portions and at the back edge of its opening adapted to seal against the back of the grate when the grate is in its rearward position and to leave a by-pass opening when the grate is in its forward position, the grate having under the opening of said structure laterally spaced rows of major air passages and having minor air passages intermediate the said rows, laterally spaced strips under the grate located to register across the major air passages when the grate is in its forward position and the by-pass is open and across certain of the minor air passages when the grate is in its rearward position and means for shifting the grate between its back and forth positions to render the by-pass opening effective or ineffective to divert air from passing through the openings into the fuel bed.

15. A furnace having fire and ash compartments and a composite floor between the compartments comprising a grate having air openings shiftable back and forth and normally supporting the main body of the fuel and structure overlapping the sides and front of the grate, open intermediate the overlapping portions and at the back edge of its opening adapted to seal against the back of the grate when the grate is in its rearward position and to leave a by-pass opening when the grate is in its forward position, a floor-support within the ash compartment and including posts under the stucture at portions thereof laterally beyond the grate, rollers beneath the grate and cross connections between the posts supporting the rollers, and means for shifting the grate between its back and forth positions to determine whether or not the by-pass opening is effective to divert air from passing through the fuel bed.

16. A furnace having fire and ash compartments and a composite grate between the compartments comprising relatively movable members, said grate having openings at intervals which are open in one position of the members for passing air through the fuel bed and having a by-pass opening which is open in another position of the members for by-passing air around the fuel bed, and means having a position demanding less heat and a position demanding more heat for relatively shifting the said members, progressing the fuel bed toward the by-pass opening, passing the air through the by-pass opening and not through the fuel bed when said means demands less heat and passing the air through the fuel bed when said means demands more heat and said means including a motor, a source of current, a stop switch, a thermostatic three-way switch, a circuit including the source, the switches and the motor and mechanism operatively connecting one of the members and the motor and an operative connection between the motor and stop switch.

17. A heater, a furnace for the heater and having fire and ash compartments and a composite grate between the compartments comprising relatively movable members, said grate having openings at intervals which are open in one position of the members for passing air through the fuel bed and having a by-pass opening which is open in another position of the members for by-passing air around the fuel bed, and means having a position demanding less heat and a position demanding more heat for relatively shifting the said members, progressing the fuel bed toward the by-pass opening, passing the air through

the by-pass opening and not through the fuel bed when said means demands less heat and passing the air through the fuel bed when said means demands more heat and said means including a motor, a source of current, a stop switch, a thermostatic three-way switch, two way "more heat" and "less heat" conductors between the switches, an aquastat switch connected normally to close the "more heat" conductor and at abnormally high temperature of the water to open the said "more heat" conductor while connecting the "less heat" conductor to the thermostatic switch, a circuit including the source, the switches and the motor, mechanism operatively connecting one of the members and the motor and an operative connection between the motor and the stop switch.

18. A furnace having fire and ash compartments, a movable grate therebetween supporting the main bed of burning fuel, mechanism for shifting the grate to and from its backward and forward positions, structure relatively sealing the compartments along the sides and front of the grate when the grate is either forward or back and along the back of the grate when the grate is in its rearward position and leaving a by-pass opening back of the grate between the compartments when the grate is in its forward position, a fuel hopper and spout having delivery into the furnace above the forward portion of the grate, having a floor of the hopper overlapping the floor of the spout, a downwardly adjustable gate in the spout, mechanism for shifting the hopper floor toward and away from the furnace and thermostatically controlled common means operating the said mechanisms with demand for more heat at the thermostat to shift the furnace grate back and the hopper floor toward the furnace and with demand for less heat at the thermostat to shift the furnace grate forward and the hopper floor away from the furnace.

19. A furnace including a movable grate which has openings for air passing through the fuel bed in its high heating position and opens a by-pass for the air in its fire checking position, in combination with a stoker operatively connected with the furnace, a thermostat having a "more heat" and a "less heat" position, means for shifting the grate to the high heating position when the thermostat demands more heat, means effective while the thermostat demands more heat for operating the stoker at timed intervals to supply fuel to the fire and means for moving the grate to its fire checking position to divert the draft through the by-pass opening when the thermostat demands less heat.

20. A furnace including a movable grate which has openings for air passing through the fuel bed in its high heating position and opens a by-pass for the air in its fire checking position, a stoker operatively connected to the furnace, a thermostat having a "more heat" and a "less heat" position, means operated by the stoker for concurrently moving the grate to its high heating position and moving the stoker to its position for charging fuel on the fire when the thermostat demands more heat, means operative at timed intervals while the thermostat is demanding more heat to concurrently move the grate to its fire checking position to divert the draft through the by-pass and the stoker to its retracted position and then to concurrently move the grate to its high heating position to direct the draft through the fuel bed and the stoker to its feeding position and means operated when the thermostat demands less heat to move the grate to its fire checking position to divert the draft through the by-pass and the stoker to its retracted position.

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