June 24, 1952 C. E. SHAFFER 2,601,332

ASH REMOVER FOR STOKERS

Original Filed Sept. 4, 1947 3 Sheets-Sheet 1

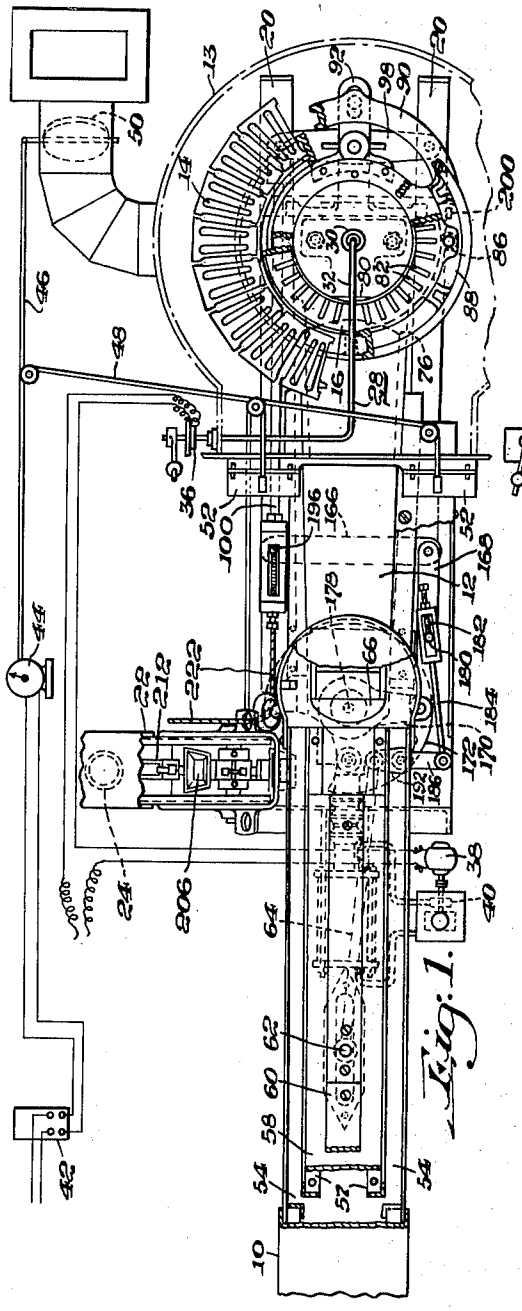


Fig. 1.

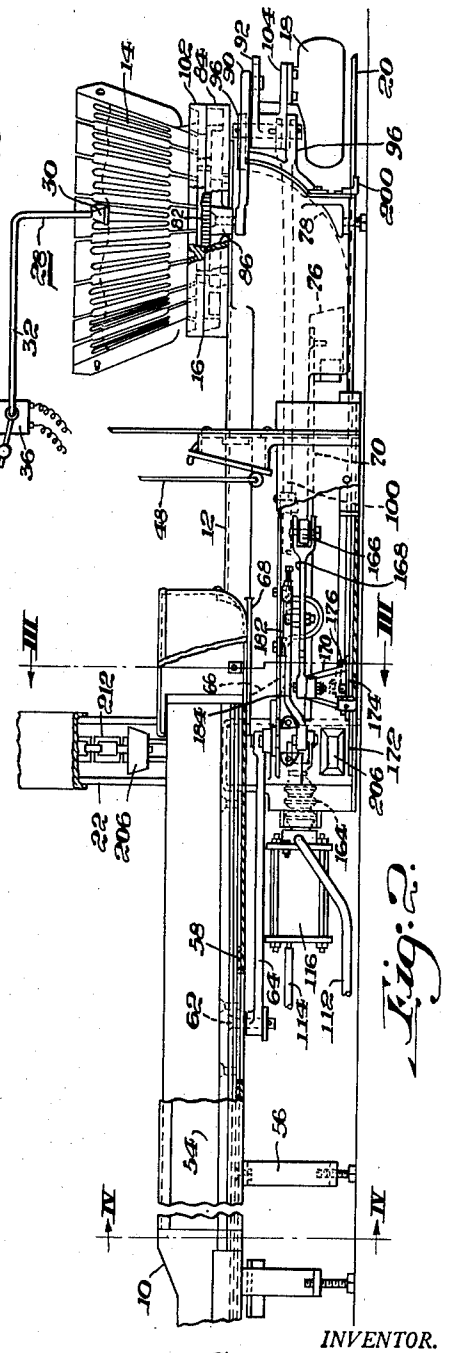


Fig. 2.

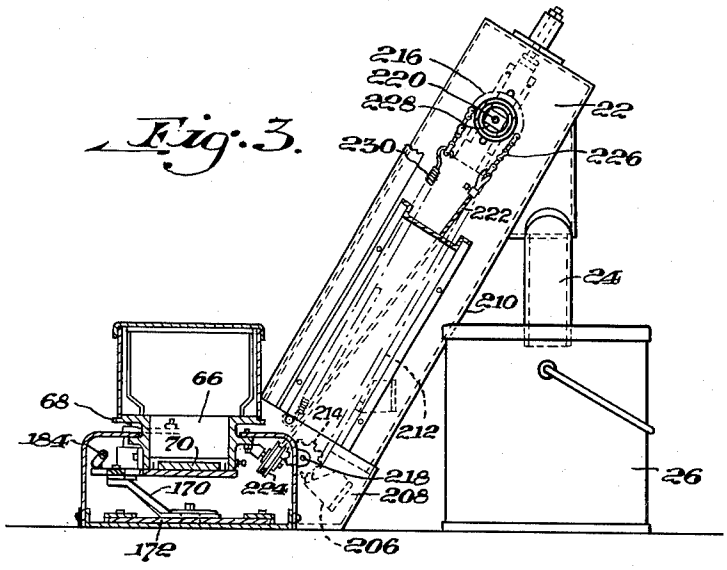
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ASH REMOVER FOR STOKERS

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Fig. 3.



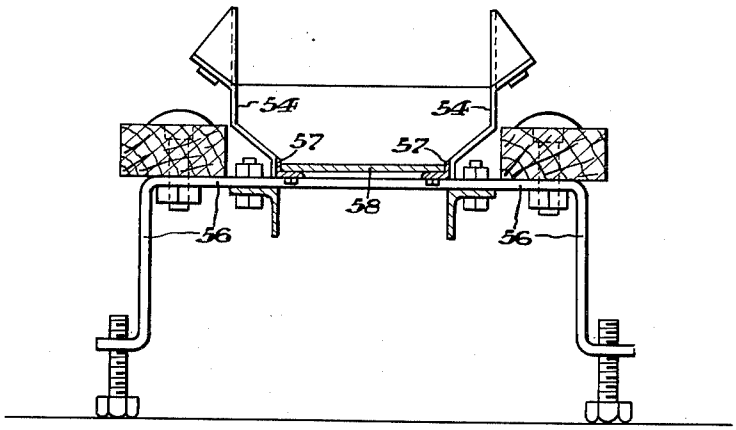


Fig. 4.

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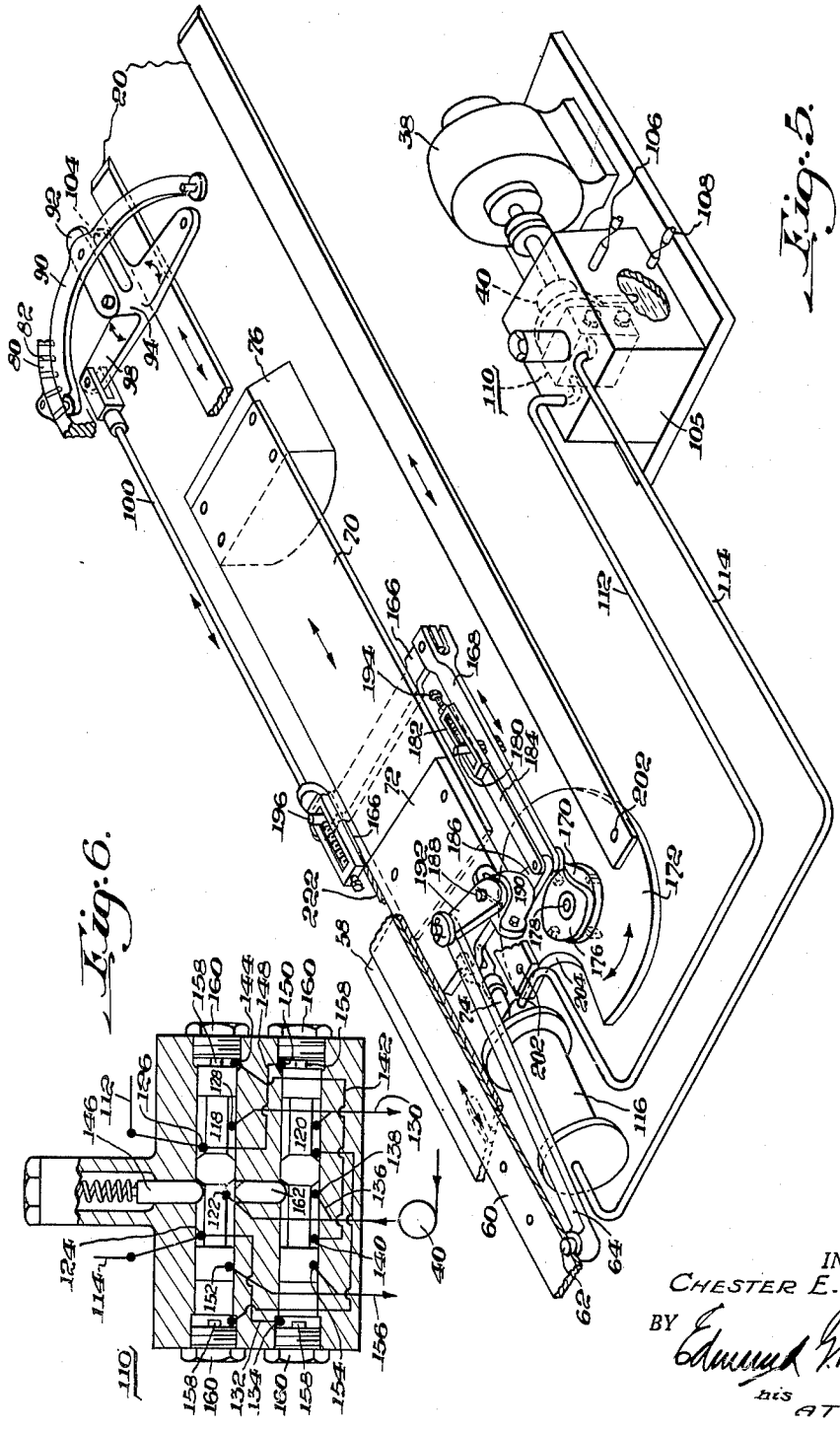


Fig. 5.

Fig. 6.

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2,601,332

ASH REMOVER FOR STOKERS

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Original application September 4, 1947, Serial No. 772,049. Divided and this application May 2, 1950, Serial No. 159,585

6 Claims. (Cl. 110—165)

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This invention relates to coke stokers. More particularly the invention relates to an apparatus for removing ash from a stoker-fired furnace.

The present invention embodies several features of the coke stokers embodied and claimed in my Patent 2,388,294 granted November 6, 1945 and in my patent application Serial No. 551,084 filed August 25, 1944, now Patent No. 2,453,162, of November 9, 1948. The features of these patents, however, are embodied in the present invention in such a way that the coke feed and ash removal are more positive and adaptable for different sizes of fuel. Further the furnace grate is kept freer of ash and the operation of the stoker is more quiet and clean.

The primary object of the present invention is to provide an ash removal apparatus for a stoker-fired furnace which will automatically remove any ash and clinker discharged from the grate of the furnace without interrupting any operation of the furnace.

Another object is to provide an ash removal apparatus for a stoker-fired furnace which is effective in removing ash and clinker discharged from the furnace grate irrespective of its character or hardness.

Another object of the invention is to provide a simple and effective ash removal means for passing ash from the ash bars of my aforesaid patents to an ash elevator for automatic removal.

A further object of the invention is to provide a stoker which may be installed on the floor level of a furnace without removing parts of the floor to accommodate the fuel feeding or the ash removal apparatus.

With these and other objects and features in view, the invention consists in the improved stoker hereinafter described and particularly defined in the claims.

The various features of the invention are illustrated in the accompanying drawings in which

Figure 1 is a top plan view with parts broken away of a stoker embodying the preferred form of the invention;

Figure 2 is a view in side elevation of the stoker shown in Figure 1;

Figure 3 is a view in side elevation with parts shown in section taken on the line III—III of Figure 2 showing the ash removal conveyor;

Figure 4 is a view in elevation with parts in section taken on the line IV—IV of Figure 2 showing the supports for the coke bin conveyor;

Figure 5 is a perspective view of the hydraulic drive mechanism and the connections between

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the hydraulic cylinder and the other moving parts of the stoker which are operated therefrom;

Figure 6 is a sectional view of the valve for controlling the operation of the hydraulic cylinder with the ports of the valve diagrammatically illustrated.

The present invention is designed and adapted particularly for feeding fuel to and removing ash from and controlling the combustion in a domestic house-heating furnace. The various parts and operation of the stoker may be briefly outlined as follows:

Referring more particularly to Figures 1, 2 and 3, coke is stored in a bin having a hopper bottom (not shown) with a feed bin conveyor **10** which extends under and forms the bottom of the hopper. The feed conveyor **10** advances coke from the bin to the opening of a stoker feed tube **12** (Figures 1 and 2) from which the coke is advanced to and pushed as an underfeed upwardly into the central area of the bottom of an upstanding stationary annular grate **14** mounted in the firebox of a furnace or boiler **13**. The continued feed movement of the coke into the grate provides an up and down motion of the fuel in the grate which acts to discharge ash through the grate to fall into the ashpit of the furnace. Simultaneously with the movement of the fuel a clinker breaker and ash removal ring **16** between the central fuel feed and the periphery of the bottom of the grate is operated to assist in discharging ash and clinker from the fuel bed into the ashpit of the furnace. The ash discharged into the rear of the ashpit is moved by a pusher **18** to opposite sides of the ashpit into the path of an ash feed conveyor consisting of reciprocably mounted horizontal bars or plates **20** which are reciprocated to carry the ash out of the ash box and to discharge it into the path of an ash removal conveyor **22**. The ash removal conveyor discharges the ash through a flexible tube **24** into a receiving container **26** (Fig. 3).

If the fuel is pushed into the grate faster than it is burned, it will build up in the grate and come in contact with a fuel bed level controller **28** (Figures 1 and 2). The controller **28** consists of a high temperature metal contact member **30** secured to a rod **32** which is pivotally mounted in the wall of the furnace **13**. As the controlling member **28** moves up and down, it operates an electric switch **36** mounted at the side of the furnace to open and close an electric circuit for operating a motor **38** which drives a hydraulic pump **40**. When the hydraulic pump is operated

the driving mechanism for the coke feed and ash removal is continuously operated, so long as the pump is operated. When the control member is raised by contact with the fuel to a predetermined point the electric circuit is opened to stop the motor. At the time that the fuel in the grate falls below the predetermined level the electric circuit is closed and the motor continues to operate until the fuel in the grate is raised to a point to open the electric circuit. The fuel feeding operation therefore will be continuous so long as the fuel in the grate is below a predetermined level.

The burning of fuel in the furnace is controlled by a thermostat 42 which is usually located in the house or room being heated. This thermostat in turn operates an electric switch to open and close an electric circuit for operating a damper control motor 44. When the thermostat calls for heat, the motor is operated to move an eccentric lever to pull cables 46 and 48 to open a stack damper 50 and draft doors 52 respectively. When the thermostat is not demanding additional heat the eccentric lever is moved back to operate the cables to close the stack damper and the draft doors at the front of the furnace. It will be seen that the fuel bed level controller and the thermostat operate independently of one another for controlling combustion but the operation of the fuel bed level control is dependent upon the heat demand as determined by the thermostat.

Detail description of the stoker parts

The fuel conveyor 10 is made up of steel sides 54 (Figure 4) that are mounted on a stand 56. At the bottom of the sides 54 are angles 57 upon which a hardened steel plate 58 forming the conveyor is slidably mounted. This conveyor plate 58 extends into and forms the bottom of a hopper in the coke bin. The plate 58 (Figures 1 and 4) has a plate 60 attached to the top thereof from which projects a pin 62. The pin 62 fits into one end of a lever 64 (Figure 5) which is connected with a driving mechanism as hereinafter described. The conveyor plate 58 is given a slow reciprocating motion. Upon its backward stroke it slides under the fuel or coke and upon its forward stroke the coke moves forward with the plate. The forward end of the plate discharges the coke upon a deflector member 66 (Figures 1, 2 and 3) forming the rear end of the underfeed stoker tube 12. The forward end of the frame in which the bin conveyor is mounted rests upon a plate 68 (Figures 2 and 3) which is integral with the rear end of the stoker feed tube. The plate 68 and the front end of the conveyor housing are circular in form so that the conveyor housing may be mounted in an angular position with reference to the feed tube to provide for different locations of the coke bin with reference to the furnace.

The feed tube 12 (Figure 2) has a conveyor 70 slidably mounted therein. The conveyor plate is shown more particularly in Figure 5. The rear end of the plate 70 is connected with a pusher plate 72 (Figure 5), which in turn, is pivotally connected with a clevis on the front end of a piston rod 74. The coke which is discharged from the end of the conveyor plate 58 upon the deflector plate 66 falls upon the pusher plate 72 (Figures 1, 3 and 5). The plate 70 is given a slow reciprocating movement. On the rear stroke of the plate the coke resting on the plates 72 and 70 is held from movement with the plates by the deflector 66, but upon the forward movement of the plates 70 and 72 the coke is pushed forward. As the coke reaches the front end of the conveyor 70 it falls over a ram 76 at one end of the conveyor 70 (Figures 2 and 5) which ram is slidably mounted in the bottom of the feed tube. On the forward movement of the conveyor plate 70 the ram 76 forces the coke across a curved face 78 of the feed tube 12 to force the coke up through the throat of the feed tube centrally up into the annular upstanding grate of the furnace from below. As the coke is forced up into the central area of the grate it moves up and falls back with the movement of the ram 76. A chord edge 80 (Figure 1) at the top of the feed tube throat projects outwardly and tends to hold the coke in an arched position in the fuel bed so that only a part of the coke moves downwardly when the ram is retracted. The ram 76 moves the coke upwardly through the central portion of the feed tube and the fuel in the central portion of the feed tube moves upwardly and downwardly with the movement of the ram. During combustion there is a shrinkage of the coke at the grate walls and the ash and impurities gradually travel down the upstanding face of the annular grate to the annular clinker breaker 16. The fuel movement is thus an upward movement through the central portion of the grate and an outward and downward movement along the walls of the grate. In this movement the fine ash passes out through the spaces between the vertical bars of the grate and coarser impurities of ash or clinker are broken up or crushed by the clinker breaker ring 16. The clinker breaker ring 16 may remove fine ash as well as the coarser ash or clinker. It has been found that the upward and downward movement of the coke bed in the grate is necessary to get the fine ash and clinker from the center of the fuel bed out to the annular grate and down to breaker. This up and down movement of the coke in the fuel bed with each stroke of the ram tends to move the ash from the fuel bed toward the grate bars so that the ash moves through the grate bars to be discharged into the ashpit of the furnace.

To assist in removing ash and clinker from the fuel bed an oscillatably mounted clinker breaker and ash remover ring is positioned below the grate 14 between the lower periphery of the upstanding annular grate 14 and the central fuel feed. The clinker breaker consists of a ring 16 having a series of teeth 82 on the upper surface thereof (Figures 1 and 5). The ring forms a portion of the grate and thus supports part of the fuel bed. The ring 16 is supported on top of a grate ring 84 which rests directly on top of the tube 12. The ring 84 is secured to the tube 12 while the ring 16 is slidably mounted on the ring 84. A pair of downwardly projecting lugs 86 are formed on opposite sides of the ring 16 which extend through openings 88 in the ring 84. The lugs have pins fixed therein which project into holes in each arm of a yoke 90 (Figure 5), which is positioned under the ring. The yoke 90 is pivotally mounted at its mid-portion in an arm 92 of a compound lever 94 which is pivotally mounted between flanges 96 projecting outwardly from the front end of the feed tube (Figure 2). A transversely extending arm 98 (Figure 5) on the compound lever 94 is connected with a driving link 100 which is connected with the driving mechanism, as hereinafter described. The ring 16 loosely fits in the ring 84 to leave a space by which ash and

clinker may move around the outside of the ring to be discharged into the ashpit. On top of the ring 84 is mounted a grate ring 102 which has a groove in its upper surface shaped to receive the lower end of the grate bars 14. The grate bars incline from the ring 102 upwardly and outwardly so that the upper ends of the grate bars rest against the firebox wall of the furnace.

A second outwardly extending arm 104 (Figures 2 and 5) on the compound lever 94 has the rear ash-pit pusher 18 attached thereto which pusher extends downwardly from the lever 94 in close proximity to the bottom of the ashpit but above and between the spaced apart ash bars 20 for the purpose of moving the ash which falls from the grate at the rear of the ashpit into the path of the ash feed conveyors or bars 20.

The hydraulically operated driving mechanism is illustrated more particularly in Figures 1, 2 and 5. The pump for placing the driving fluid under pressure is submerged in a driving fluid in chamber 105 which has a hydraulic liquid filling tube 106 and a cleaning tube 108. The pump draws fluid from the closed chamber and forces it through a valve mechanism 110 which is mounted within the chamber 105. The motive fluid flows from the valve 110 through a tube 112 or tube 114 to a hydraulic cylinder 116 in accordance with the position of the driving pistons 118, 120 within the cylinder. When one of the tubes 112 or 114 is used for driving the cylinder piston, the other tube is used for exhausting the fluid from the opposite side of the piston. The fluid returning from the cylinder to the valve is exhausted through the valve into the chamber.

The construction and arrangement of the valve 110 is illustrated in Figure 6. The valve consists of a block having cylindrical plungers 118 and 120 slidably mounted within the block. Each plunger is provided with three faces which are arranged to open and close ports in the block 110 to provide different paths of flow of the hydraulic fluid through the valve. The pump 40 is diagrammatically illustrated in Figure 6 as opening into a port 122 under the plunger 118. The fluid entering the port 122 flows through a port 124 to the tube 114 and thence through the tube into the cylinder 116. While the fluid is forcing the plunger to move through the cylinder, fluid from the other side of the cylinder flows through the line 112 into a port 126 and thence through a port 128 and passage 130 in the block down into the storage chamber 105. At the same time oil flows from the port 124 through a passage 132 to a port 134 behind the end of the plunger 120, thus holding the plunger 120 to the right in the position shown in Figure 6. Also the oil from the pump flows through a passage 136 into a port 138 behind the plunger 120 and this oil also passes through a port 140, through passage 142 into a port 144 against the end of the plunger 118. The plunger 118 is held in its position by spring pressed detent 146 which rests against a central shoulder on the plunger. The pressure of the spring will hold the plunger 118 stationary under the ordinary operating pressure of the pump. However, when the piston reaches the end of its stroke the continuous operation of the pump 40 tends to build up the oil pressure and when this pressure rises above the usual or operating pressure, then the fluid flows from the port 140 through the passage 142 to the port 144 and moves the plunger 118 to the left (viewing Figure 6). When the plunger 118 moves to the left the port 122 is positioned on the right side of the central face of the plunger so that the fluid may flow through the port 126 and a passage 148 to a port 150 behind the plunger 120. The operation of the plungers 118 and 120 is such that the plunger 118 moves from one position to the other before the plunger 120 follows in this movement. With this operation the ports are all completely closed or completely open. When the plungers move to the left, ports 152 and 154 are open to passage 156 which permits the oil to flow into the sump. It will be understood that when the plungers are shifted to the left the pressure oil flows through the valve to the line 112 and oil exhausted from the cylinder flows from the line 114 into the port 144 and thence through the passage 156 to the sump in the pressure chamber 105. Rubber bumpers 158 are mounted on the inner ends of the nuts 160 which close the passages in which the plungers 118 and 120 are mounted so that the plungers strike against the bumpers and thus deaden the sound of the valve shifting. The valve arrangement which is described above is important in that the valves are reversed when excessive oil pressure develops in the feed lines. This arrangement acts as a safety measure so that if the driving mechanism is prevented from making a full stroke by some obstruction to the fuel feed or ash removal the driving mechanism will be reversed to relieve the pressure and therefore an excess pressure will not be exerted upon the driving mechanism. A locking pin 162 is mounted in the central portion of the valve block 110 and moves between the plungers 118 and 120. This detent prevents the plunger 120 from moving to the left (Figure 6), when oil is being forced into the cylinder through the tube 114. When the plunger 118 has been moved to the left the oil entering through the port 122 flows through the port 126 and passage 148 to the port 150. This oil moves the plunger 120 to the left. As the plunger 120 moves to the left the detent 162 is raised. The detent 162 thus insures that the plunger 118 will move in each direction in advance of the following movement of the plunger 120. The same fluid pressure tends to raise the detent 162 and also acts to raise the detent 146.

A piston mounted in the cylinder 116 is connected with a pusher plate 72 by the piston rod 74 (see Figures 1 and 5). The movement of the cylinder piston which drives the feed tube conveyor furnishes the power for operating all of the stoker mechanism.

To drive the coke bin conveyor a cross bar 166 (Figures 1 and 5) is attached to the bottom of the conveyor plate 70 so as to move with the conveyor plate. A connecting rod 168 is pivotally connected to the right hand end of the bar 166 (viewing Figure 5) and the other end of the link is connected with a lever 170 which is secured to a rotatable ash conveyor plate 172 having ash moving means in the form of a quadrant cut out area 204. The ash conveying quadrant cut-out plate and lever 170 are pivotally mounted on the bottom of the feed tube frame 174 (Figure 2) for oscillation near an ash receiver 208 by means of a plate 176 and pin 178 (Figures 1, 2 and 5). An upwardly extending pin 180 is mounted in the rod 168 to receive a slotted end 182 of a link 184. The link 184 is connected with a lever 186 which is fixed on a pin 188 (Figure 5) pivoted in a bearing 190 which is attached to the side of the feed tube. A lever 192 is secured to the upper end of the pin 188 so as to be movable therewith.

The lever 192 is pivotally connected with the link 64 so that the movement imparted to the link 184, levers 186 and 192 is imparted to the link 64 for giving the reciprocating movement to the coke bin conveyor plate 58. The slot 182 in the link 184 is provided with a threaded bolt 194 by which the amplitude of, or the extent of the movement of the coke bin conveyor may be varied. It has been found in practice that the stroke of the coke bin conveyor should be shorter than the stroke of the feed tube conveyor in order to properly allocate the desired amount of coke being fed to the fuel bed.

To operate the clinker breaker 16 and ash pusher 18 the link 100 which is connected with the compound lever 94 has a pin and slot connection with the left hand end of the bar 166 (viewing Figure 5). The link 100 has a slot and pin connection with a pin 196 mounted in the rod 166 by which the length of stroke of the crusher may be varied.

The coke feed tube has a circular cross section at the front side of the grate so that ash which falls in the vicinity of the feed tube flows down to the floor of the ashpit. The ash pusher 18 moves the ash which falls at the back of the grate to the sides of the ashpit into the path of movement of the ash feed conveyor bars 20. The ash feed conveyor bars consist of two reciprocable bars or plates 20 which are slidably mounted in guides 200 positioned under the feed tube (Figure 2). The front ends of the flat bars or plates 20 are connected with pins 202 that are mounted in the face of the rotatable ash conveyor quadrant cut-out plate 172. The movement of the link 168 and lever 170 oscillates the plate 172 to give a reciprocating motion to the flat conveyor bars or plates 20. The bars or plates 20 are spaced from each other on opposite sides of the feed tube and move in opposite directions. The slow reciprocating motion of the bars or plates 20 carries the ash from the ashpit of the furnace forwardly to the rotatable ash conveyor quadrant cut-out plate 172. The rotatable conveyor plate has a quadrant cutout section 204 which acts to move the ash into ash receiver 208 for the elevator cups 206 of the ash removal elevator 22. The position of the elevator cups with reference to the quadrant cut-out plate 172 is shown in Figures 1 and 2. Each oscillating stroke of the conveyor quadrant cut-out plate 172 acts to move ash from one of the bars or plates 20 to the ash receiver 208 at the bottom of the elevator, whence the ash is picked up by the cups 206.

The construction of the ash removal elevator is illustrated more particularly in Figures 1, 2 and 3. A boot 208 constructed to receive the lower end of a frame 210 for housing the ash removal elevator is attached to the frame of the feed tube immediately under the front end of the coke bin conveyor. The boot is constructed and arranged so that it may be attached to either side of the feed tube frame in order to permit the elevator to be located in any desired arrangement of the housing for the heating furnace. The boot constitutes the ash receiver 208 for the elevator 22. The elevator consists of a chain 212 which runs between sprockets 214 and 216 that are rotatably mounted on axles 218 and 220, respectively. The axle 218 is mounted in bearings in the boot 208 and the axle 220 is mounted in bearings in the frame 210. The axle 220 is the driving axle for the elevator. To drive the elevator a cable 222 (Figure 5) is connected with the left hand end of the bar 166 (Figure 5) and extends to a pulley 224 pivotally mounted in the boot 208. The cable passes over the pulley 224 and is connected with a chain 226 which passes around a clutch pulley 228 on the axle 220. Upon the forward stroke of the feed tube conveyor 70 the cable 222 operates the clutch 228 to impart an active stroke to drive the elevator for a predetermined distance. Upon the return stroke of the feed conveyor 20 cable and clutch are moved with an idle stroke in a reverse direction by a coiled spring 230 which is connected to the chain 226 and the elevator frame 210. Accordingly the elevator is given an intermittent stepwise motion which corresponds to the feed stroke of the feed tube conveyor. A series of cups 206 mounted on the chain 212 move into the path of the ash in the boot 208, advanced by the ash conveyor bars and carry the ash to the outlet discharge tube 24 and receiver 26.

With the construction outlined above, it will be seen that all of the stoker parts are mounted on frames which rest on the floor level of the furnace. The coke bin conveyor may be adjusted to angular positions to permit different locations of the coke bin with reference to the furnace. The ash elevator may be mounted on either side of the coke feed tube. Two ash receivers 26 are positioned on the floor at the side of the ash elevator. An empty receiver thus may be readily placed under the tube 24 when one container has been filled.

The movement of the coke to the furnace grate and the removal of ash and clinker from the ashpit are carried out by flat reciprocating bars or plates 20, and the oscillatable quadrant cut-out plate. Such an ash conveyor has a distinct advantage over screw conveyors or continuously operating belts, because such conveyors do not become clogged with the different kinds of material being conveyed.

The hydraulic drive is positive and quiet and still will automatically change the stroke or reverse itself if the driving parts become clogged.

This application is a division of my pending application relating to Coke Stokers, Serial No. 772,049 filed September 4, 1947.

The preferred form of the invention having been thus described, what is claimed as new is:

1. An ash removal apparatus for a stoker-fired furnace, comprising: a furnace, a grate mounted in the furnace, an ashpit in the furnace below the grate, an ash elevator positioned a substantial distance from the furnace, an ash receiver at the bottom of the elevator, an ash conveyor extending between the ashpit and the ash receiver at the bottom of the elevator, said ash conveyor comprising reciprocable flat bars mounted adjacent the ash pit in position to receive ash discharged from the grate and a rotatable plate having ash moving means thereon and mounted for oscillation near the ash receiver, said flat bars being connected with said rotatably mounted plate to push ash advanced by the bars over the rotatable plate to the ash moving means thereon for discharge thereby to the ash receiver of the ash elevator.

2. Apparatus as claimed in claim 1, and in which driving means are connected with the rotatable plate for oscillating the same and thereby also imparting a reciprocating motion to the reciprocable flat cars connected to the rotatable plate.

3. Apparatus as claimed in claim 1, and in which an oscillatable ash pusher is mounted for oscillation in position in the ashpit between

and above the reciprocable flat ash bars to push ash into the path of movement of the ash bars.

4. Apparatus as claimed in claim 1, and in which the ash moving means on the rotatable plate comprises a quadrant cut-out portion of the rotatable plate.

5. Apparatus as claimed in claim 1, and in which means are provided for driving the ash bars and the rotatable plate to impart a reciprocating motion to the ash bars and an oscillating motion to the rotatable plate, and in which said driving means is connected with the elevator by a reciprocating member and a member driven thereby which has an active and an idle stroke, to operate the elevator on the active stroke to carry ash out stepwise to an outlet on each reciprocation of the ash bars.

6. Apparatus as claimed in claim 5, and in

which the ash elevator is an endless chain and a cup elevator having a clutch drive with an active and idle stroke to give a step by step movement to the elevator when the ash conveyor is operated.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,785,456	Ousdahl	Dec. 16, 1930
1,933,656	Carter et al.	Nov. 7, 1933
1,971,716	Hitchcock	Aug. 28, 1934
1,992,149	O'Hara	Feb. 19, 1935
2,248,206	Suman	July 8, 1941
2,388,294	Shaffer et al.	Nov. 6, 1945