June 3, 1941. N. M. LOWER 2,243,970

FURNACE APPLIANCE

Original Filed Sept. 23, 1936 6 Sheets-Sheet 1

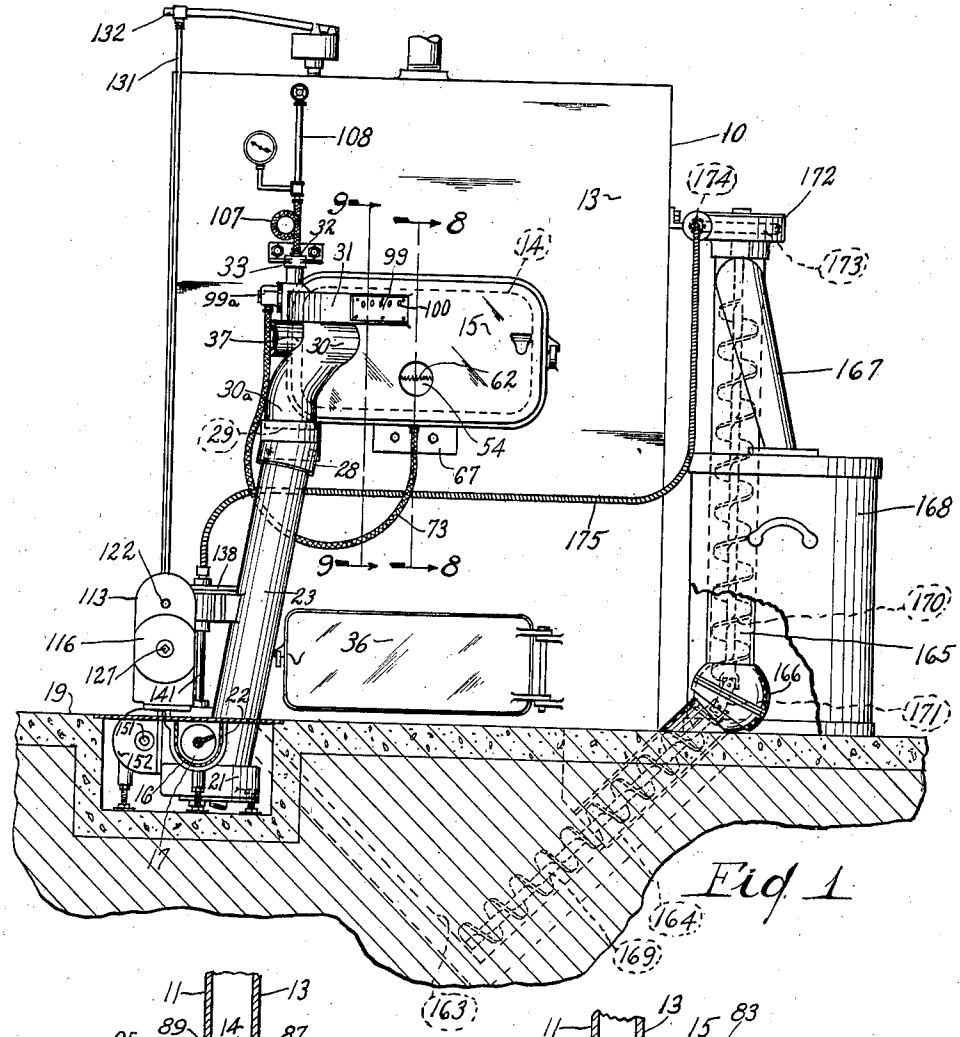


Fig. 1

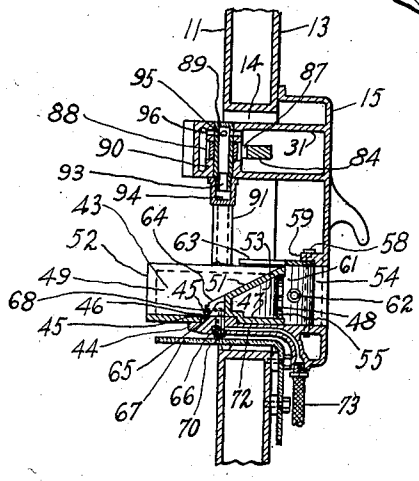


Fig. 8

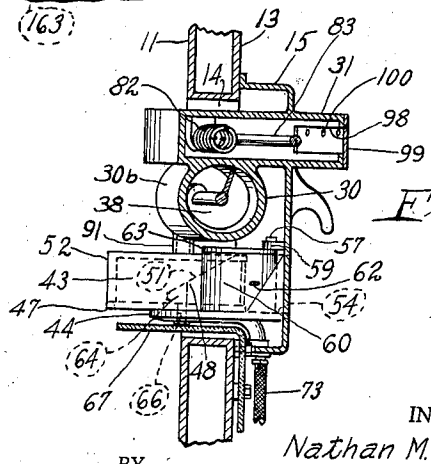


Fig. 9

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June 3, 1941. N. M. LOWER 2,243,970

FURNACE APPLIANCE

Original Filed Sept. 23, 1936 6 Sheets-Sheet 2

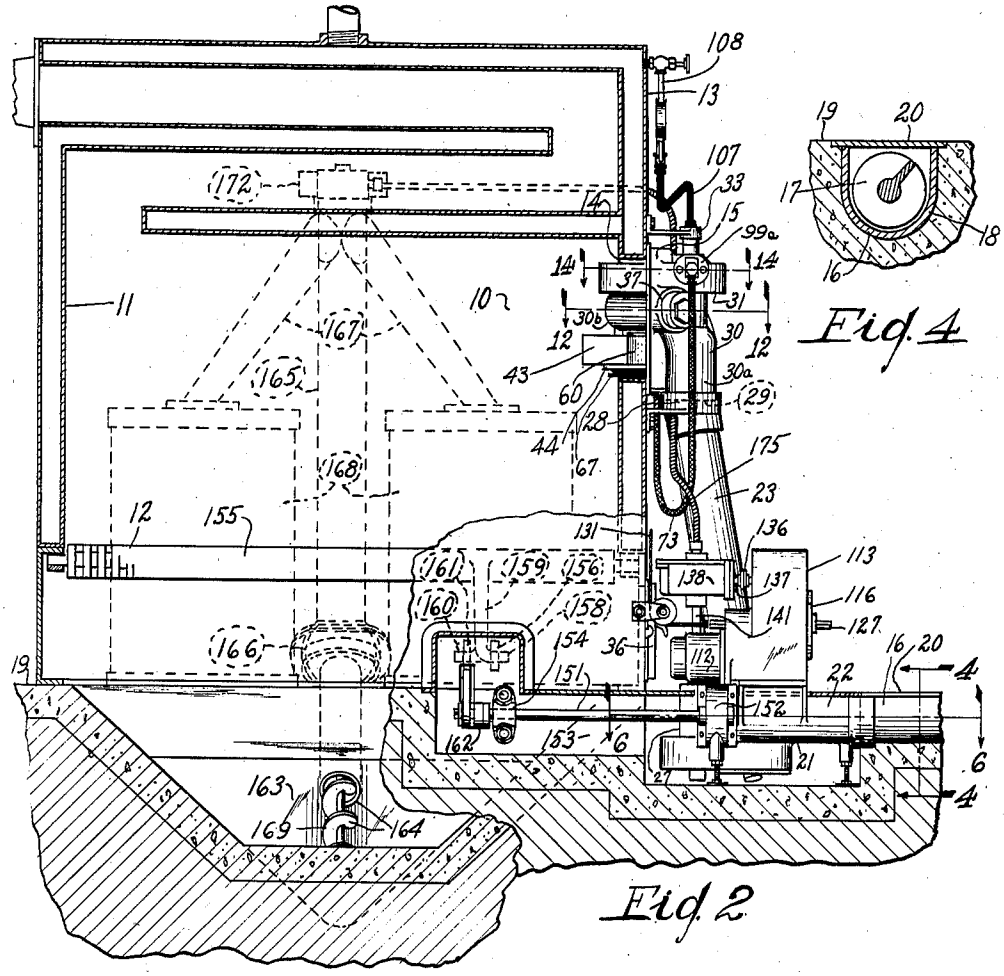


Fig. 2

Fig. 4

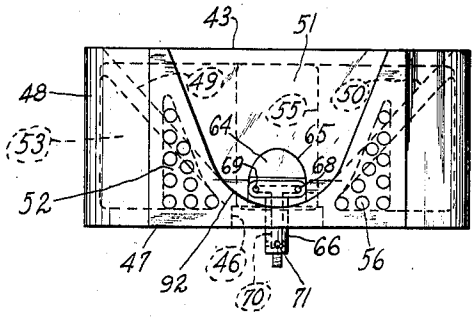


Fig. 11

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June 3, 1941. N. M. LOWER 2,243,970

FURNACE APPLIANCE

Original Filed Sept. 23, 1936 6 Sheets-Sheet 3

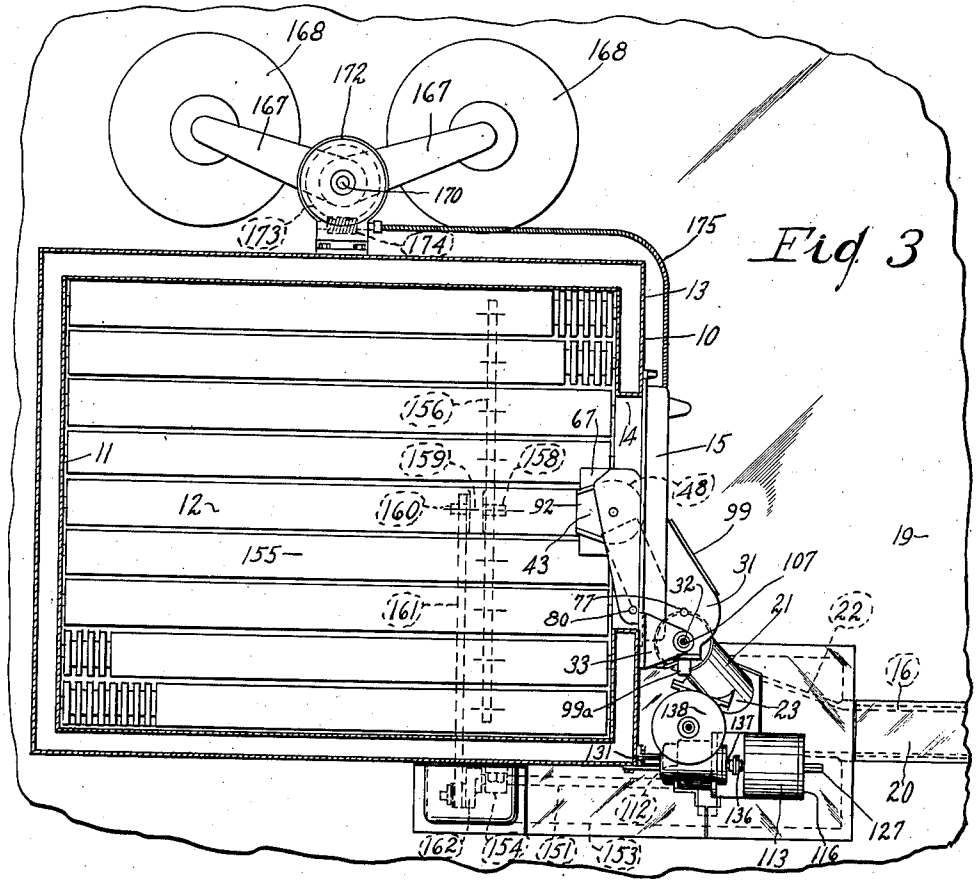


Fig. 3

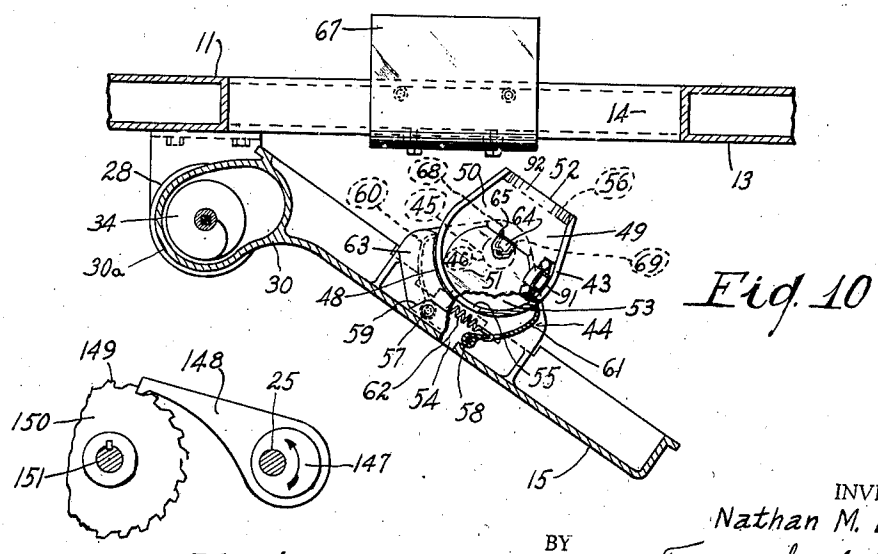


Fig. 10

Fig. 16

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June 3, 1941. N. M. LOWER 2,243,970

FURNACE APPLIANCE

Original Filed Sept. 23, 1936 6 Sheets-Sheet 4

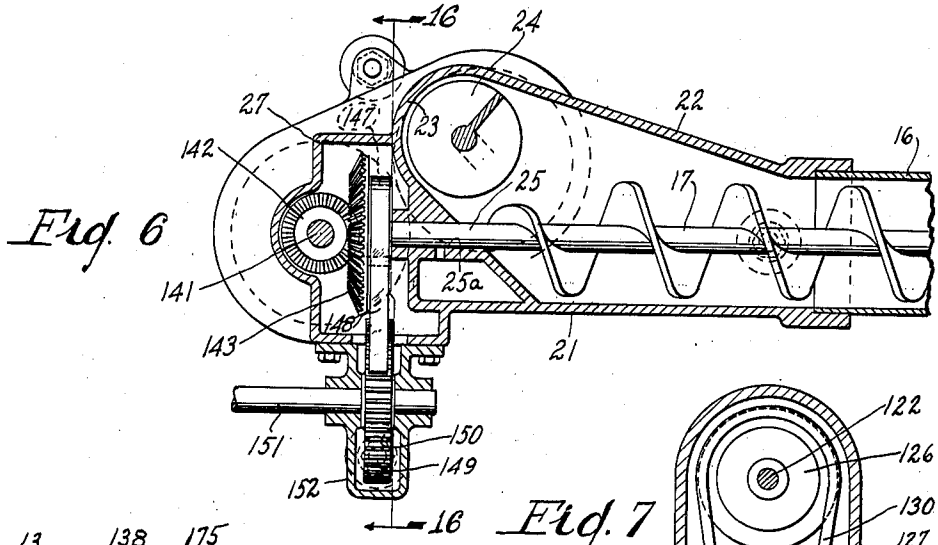


Fig. 6

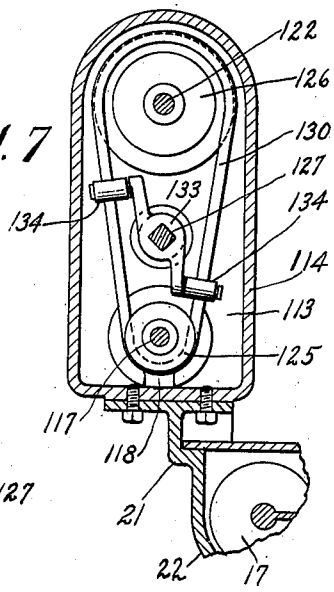


Fig. 7

Fig. 5

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June 3, 1941. N. M. LOWER 2,243,970

FURNACE APPLIANCE

Original Filed Sept. 23, 1936 6 Sheets-Sheet 5

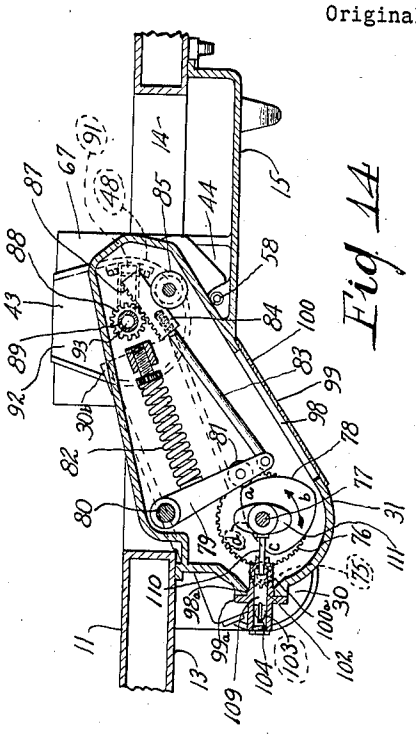


Fig. 14

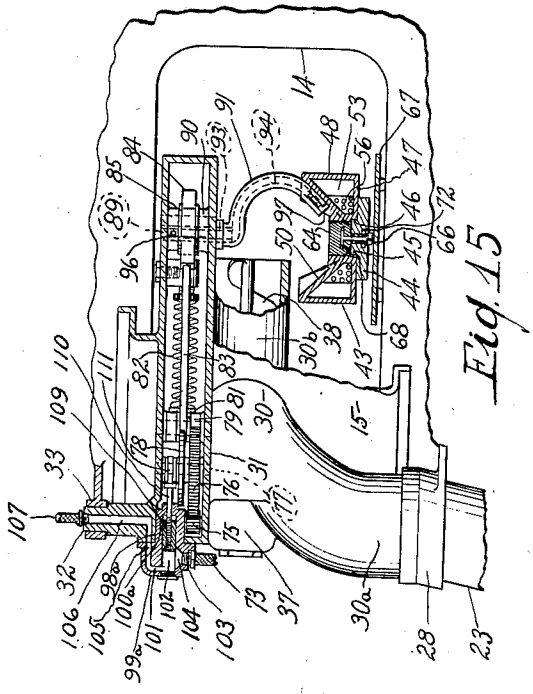


Fig. 15

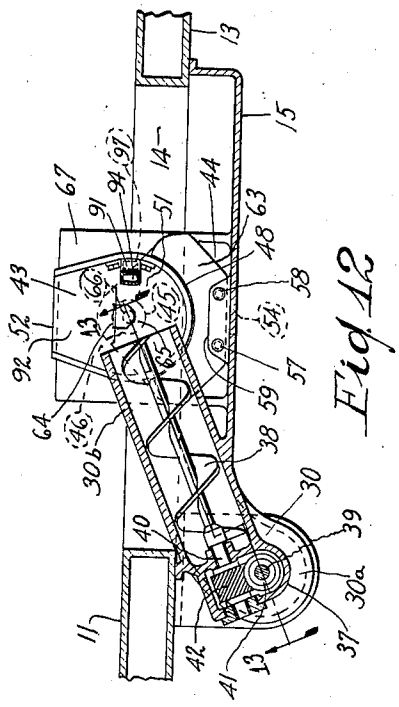


Fig. 12

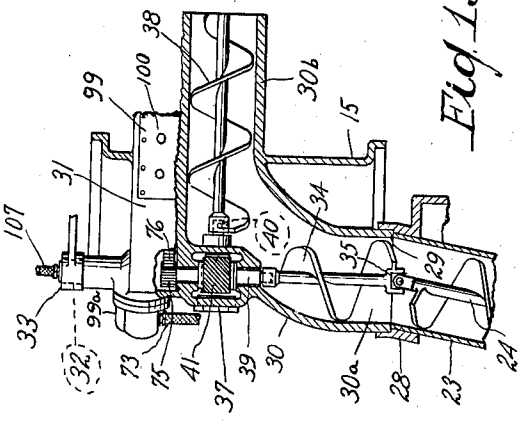


Fig. 13

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June 3, 1941. N. M. LOWER 2,243,970

FURNACE APPLIANCE

Original Filed Sept. 23, 1936 6 Sheets-Sheet 6

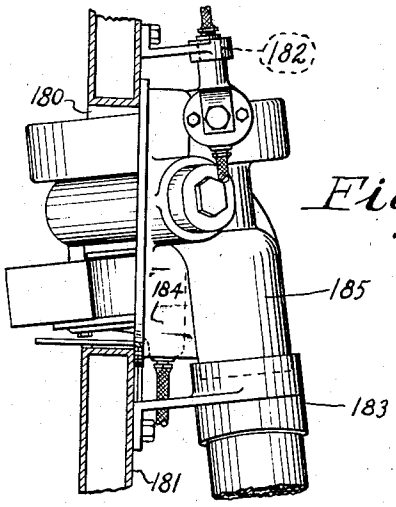


Fig. 17

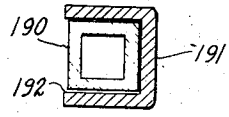


Fig. 21

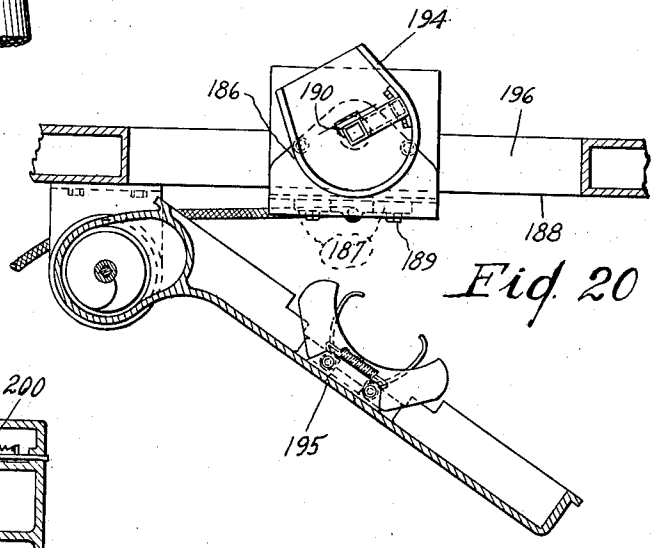


Fig. 20

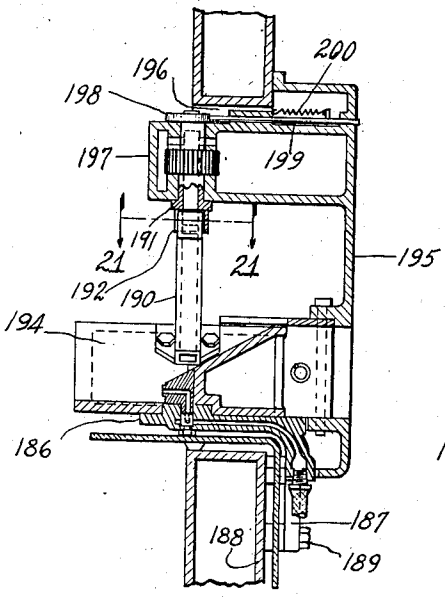


Fig. 18

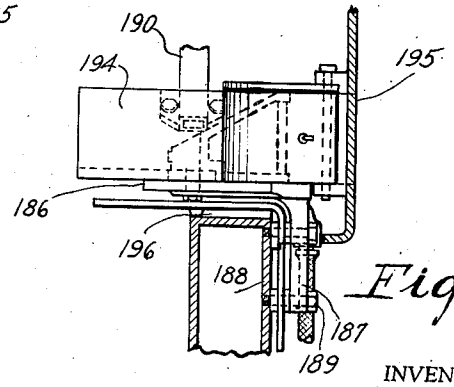


Fig. 19

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Patented June 3, 1941

2,243,970

UNITED STATES PATENT OFFICE

2,243,970

FURNACE APPLIANCE

Nathan M. Lower, Erie, Pa.

Application September 23, 1936, Serial No. 102,057
Renewed January 31, 1940

18 Claims. (Cl. 110—105.5)

My invention relates to improvements in furnaces and has for its main object the provision of an improved automatic furnace which does not require the services of an attendant.

A more specific object of the invention resides in the provision of a stoker for a furnace arranged to deliver fuel through the normal firedoor opening of the furnace, the fuel feed conduit of the stoker forming a hinging element about which the door may be swung to opened or closed position.

Another object of the invention resides in the provision of improved means for distributing fuel evenly over all parts of the furnace grate.

The invention further contemplates the provision of simple, efficient and compact means for oscillating the fuel trough of the fuel distributing mechanism and means for regulating the intensity of the fuel projecting blast.

Still another object of the invention resides in the provision of a novel door for a furnace firing opening arranged when opened to carry with it the fuel discharge trough and the mechanism for oscillating the trough, leaving an unobstructed firing opening.

Another novel feature of the invention resides in the construction and relation of those parts of the stoker located in the firing opening whereby efficient cooling thereof is provided.

The invention also contemplates the provision of improved ash conveying means operated in timed relation with the stoker and by the same power that drives the stoker.

Another object of the invention resides in the novel ash pit construction beneath the furnace.

The invention has for another object the provision of novel variable speed reducing means between the ash and fuel conveyors and the motor for driving them and means responsive to the boiler pressure automatically regulating the speed reducer for controlling the speed of the ash and fuel conveyors.

With the above and other objects in view, the invention consists of the novel details of construction and operation, and the novel combination and relation of parts, hereinafter more fully described and illustrated in the accompanying drawings, wherein

Fig. 1 is a front elevation of the preferred arrangement of furnace and stoking and ash conveying apparatus, the furnace room floor being shown in vertical section;

Fig. 2 is a side view of the arrangement shown in Fig. 1, with the furnace and furnace room floor shown in vertical section and the stoking apparatus and grate shaking means shown in elevation;

Fig. 3 is a sectional plan view through the upper portion of the furnace with the stoking apparatus and other parts shown in top plan view;

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

Fig. 5 is a view of the drive mechanism of the stoking, ash conveying and grate shaking mechanism, shown in vertical section with parts in side elevation;

Fig. 6 is a sectional view taken on the line 6—6 of Fig. 2;

Fig. 7 is a sectional view taken on the line 7—7 of Fig. 5;

Fig. 8 is a sectional view taken on the line 8—8 of Fig. 1;

Fig. 9 is a sectional view taken on the line 9—9 of Fig. 1 with the protecting plate shown in section;

Fig. 10 is a view showing the door in open position, the door and a portion of the boiler being shown in horizontal section with parts broken away;

Fig. 11 is a view in elevation of the discharge end of the stoker distributor trough and distributor jet;

Fig. 12 is a view in section taken on the line 12—12 of Fig. 2;

Fig. 13 is a view in section taken on the line 13—13 of Fig. 12;

Fig. 14 is a view in section taken on the line 14—14 of Fig. 2;

Fig. 15 is a fragmentary diagrammatic view of the furnace and that portion of the stoker mechanism located at the furnace firing opening, with parts broken away and shown in section;

Fig. 16 is a view in section taken on the line 16—16 of Fig. 6;

Fig. 17 is a view in section through the firing opening of a furnace with a modified form of the invention shown applied thereto;

Fig. 18 is a vertical section of a portion of the furnace taken on the longitudinal center line of the firing opening with a further modification of the invention shown applied thereto in similar section;

Fig. 19 is a view in elevation of a portion of the structure shown in Fig. 18, with the furnace and firedoor in section;

Fig. 20 is a sectional plan view through the firing opening of the furnace with the modified

structure shown in Fig. 18 applied thereto, the firedoor being shown in an open position; and

Fig. 21 is a view in section on the line 21—21 of Fig. 18.

In the drawings, a furnace is designated generally by the numeral 10, the firebox thereof is shown at 11 and the grates upon which the firebed is supported are indicated at 12. The furnace front 13 is provided with a firing opening 14 above the level of the grates 12 and through which fuel may be manually or mechanically introduced into the firebox. For the purpose of mechanically delivering fuel from a suitable source of supply, as from a fuel bin (not shown), and introducing it into the furnace, a stoker of novel and practical construction is provided. The novel construction of the stoker as well as the novel construction of the door 15 for the firing opening, which is particularly designed to accommodate the stoker, will be described hereinafter in detail.

The stoker includes a transfer conduit 16 leading from the source of fule supply toward the furnace front 13 and mounted therein is a screw conveyor 17 for advancing fuel therethrough. The conduit 16 is preferably disposed in a depression 18 formed in the furnace room floor 19, so that the space above the floor is kept as free of obstructions as possible. For convenience in gaining access to the screw conveyor, the conduit 16 is preferably made U-shaped and is provided with a separable cover 20, which when in place is flush with a furnace room floor 19. The depression 18 in the floor 19 is somewhat enlarged subjacent the furnace front 13 and mounted therein is the casting 21. This casting 21 comprises a horizontal conduit section 22, forming a continuation of the transfer conduit 16, and a riser conduit section 23, offset at its lower end to one side of the horizontal conduit section 22 and being in communication therewith. Mounted in the riser conduit section 23 is a conveyor screw 24 arranged at its lower end to receive the fuel delivered by the transfer conduit screw 17 and to elevate it through the riser conduit section 23.

As is best illustrated in Fig. 6, the conveyor screw 17 extends into the horizontal conduit section 22 and the flights and direction of rotation are so arranged that the fuel will be urged toward the riser conduit screw 24. The screw conveyor 17 is provided with an extended shaft 25 which is journaled in a bearing 25*a* formed with the casting 21 and projects into a gear housing 27, also formed with the casting 21.

The riser conduit section 23 terminates at its upper end subjacent one side wall of the firing opening 14. An annular flange or coupling 28, which is rigidly secured to the furnace front 13, encircles the upper end of the riser conduit section 23 for laterally supporting the same. A portion of the annular flange or coupling 28 extends above the upper end of the riser conduit 23 and is provided with a counterbore forming a seat 29. One end of an elbow-shaped conduit 30 is received in the annular flange or coupling 28 and engages the seat 29 forming a continuation of the riser conduit 23. Upon its elbow portion, the conduit 30 is provided with a housing 31, the purpose of which is brought out further on in the description, and on the housing 31 is formed a stub shaft 32 journaled in a bearing 33 which is rigidly secured to the furnace front 13. The stub shaft 32 is arranged to be in axial vertical alinement with the coupling 28 so that the conduit 30 is free to swing about a vertical axis.

The delivery end 30*b* of the elbow-shaped conduit 30 is formed with and extends through the firedoor 15. Thus, that end of the elbow-shaped conduit mounted in the coupling 28, which will be termed the receiving end 30*a*, since it receives fuel from the riser conduit 23, forms a hinge for the firedoor 15, permitting the door to be opened for inspection of the fire or other purposes without removing or dismantling any portion of the stoker mechanism. When the stoker is in operation, it is evident that the fuel is in effect delivered through the hinge of the firedoor to the firebox of the furnace.

In order to facilitate advancement of fuel through the upright or receiving portion 30*a* of the elbow-shaped conduit 30, there is mounted therein a short screw section 34. The riser conduit 23, as it extends downwardly from the conduit 30, slopes laterally toward one side of the furnace, see Fig. 1, and rearwardly away from the furnace front 13, see Fig. 2, so that the riser conduit 23 is out of axial alinement with the receiving portion 30*a* of the conduit 30, thus necessitating a universal connection 35, see Fig. 13, between the riser screw section 24 and the short screw section 34 to provide an operative driving connection therebetween. Offsetting the lower end of the riser conduit 23 in this manner permits the stoker to be applied to the conventional type of furnace. It is apparent, however, that by making slight changes in the furnace construction, as by reducing the size of the ash door 36 and by recessing the furnace front to provide more space between it and the lower end of the riser conduit 23, the riser conduit 23 could be disposed in axial alinement with the receiving portion of the conduit 30, thus eliminating the universal joint 35.

As explained above, the elbow-shaped conduit 30 is formed with and opens through the firedoor 15. A portion of the delivery end 30*b* of the conduit 30 projects through the firedoor 15 terminating approximately at the center of the firing opening. Fuel is conveyed through the delivery portion 30*b* of the elbow-shaped conduit 30 by a conveyor screw 38 which is operatively connected to the conveyor screw 34 by gearing mounted in a casing 37 formed integral with the elbow conduit 30. The adjacent offset ends of the screws 34 and 38 are keyed to the crossed shafts 39 and 40, respectively, journaled in suitable bearings in the casing 37. The shaft 39 carries a spiral gear 41 which meshes with a spiral gear 42 carried by the shaft 40.

Below the end of the delivery portion 30*b* of the conduit 30 is a fuel receiving trough 43 which is carried by the firedoor 15 on a ledge 44 formed with and extending inwardly from the firedoor through the firing opening 14. The ledge 44 is provided with an annular upwardly projecting boss 45 fitting within an annular recess 46 in the bottom wall 47 of the trough 43 whereby the trough 43 may swing in an arc about a vertical axis. The annular boss is disposed substantially in the plane of the inside wall of the furnace front. Means for continuously oscillating the trough 43 through an arc is provided, which will be described in detail further on in the description.

The trough 43 is preferably in the form of a hollow casting, horseshoe-shaped in horizontal cross section and including in addition to the bottom wall 47, the upstanding curved outer wall

48, the downwardly and inwardly sloping inner side walls 49 and 50, the downwardly and inwardly sloping rear wall 51 and the front wall 52. These walls enclose the chamber 53 through which a cooling fluid, as for example air, may be circulated. Air is drawn from without the furnace through the opening 54 in the firedoor 15 into the chamber 53 of the trough 43 through the opening 55 in the curved outer wall 49 thereof and is drawn into the firebox through the apertures 56 in the front wall 52 of the trough 43. At the sides of the opening 54 and adjacent the inner surface of the firedoor 15 are vertical pins 57 and 58 mounted in the lip 59 and ledge 44. Shield plates 60 and 61 are pivotally mounted on the pins 57 and 58, respectively, and extend forwardly one to each side of the trough 43. The free ends of the shield plates 60 and 61 are maintained in contact with the outer wall 48 of the trough 43 by a spring 62. The shield plates 60 and 61 together with the top plate 63 and the ledge 44 enclose a passage between the openings 54 and 55 so that substantially all the air drawn in through the opening in the firedoor passes directly into the chamber 53 of the trough 43.

Fuel is projected from the trough 43 in aerial paths over the firebed on the grates 12 by fluid under pressure issuing from a distributor head 64 seated in a recess 65 formed in the sloping rear wall 51 of the trough 43. The distributor head 64 is provided with a hollow pivot pin 66 mounted axially in the boss 45 of the ledge 44; thus with the pin 66 as an axis, the distributor head 64 is free to swing with the trough 43. The front face of the distributor head 64 is provided with a pair of laterally spaced nozzles 68 and 69 communicating with the cored passage 70 in the head 64. The cored passage 70 extends into the pivot pin 66 and openings 71 in the pivot pin 66 provide communication between the passage 70 and the cored passage 72 in the ledge 44. A flexible hose 73 leading from a source of fluid under pressure communicates with the cored passage 72. An angular baffle plate 67 made preferably of a material having high heat conductivity, is mounted with one leg thereof against the furnace wall beneath the firing opening, the other leg extending into the firing opening beneath the ledge 44 and trough 43 to protect the fuel distributing mechanism from the heat in the firebox.

The housing 31, preferably formed as an integral part of the firedoor 15, encloses mechanism for horizontally oscillating the trough 43. This mechanism is operatively connected with the stroker conveyor screws, thus coordinating the rapidity of oscillation of the trough with the amount of fuel being conveyed by the stoker conveyor screws.

In the housing 31 and keyed to the shaft 39 is a pinion 75 meshing with a gear 76 keyed to the vertical shaft 77. A large cam 78 is mounted on the shaft 77 and is arranged to rotate with the gear 76. A lever 79 pivotally mounted at one end in the housing 31 on stub shaft 80 carries a rotatable roller 81 which is maintained in contact with the cam 78 by a compression spring 82. The other end of the lever 79 is pivotally connected with a shaft 83 carrying a rack member 84. One side of the rack member 84 is received in a grooved roller 85 rotatably mounted in the housing 31, while the teeth 87 on the other side thereof engage the spur gear 88. The spur gear 88 is keyed to a hollow shaft 89 rotatably mounted in and extending through a bearing 90 within and formed with the housing 31. A curved arm 91 is secured at one end to the end of the shaft 89 projecting through the bottom wall of the housing 31 and at its other end to the trough 43.

In operation, when the stoker conveyor screws are rotating in a direction to advance fuel to the trough 43, the cam 78 will rotate in the direction of the arrow shown on Fig. 14. Still referring to Fig. 14, it is clear that when the cam is in the position illustrated, the discharge mouth 92 of the trough 43 will be directed along the longitudinal center line of the firebox. Now, as the cam rotates, the rack member 84 will be moved toward the right because of the gradually increasing radius of the cam between the points *a* and *b* thereof, and the operative connections between the rack and the trough will swing the trough so that the discharge mouth thereof will be directed toward the left side of the firebox.

Continued rotation of the cam 78 will cause the trough to swing back to the position shown in Fig. 14, since the gradually decreasing radius of the cam between the points *b* and *c* permits the spring 82 to force the rack member to the left. Between the points *c* and *d* of the cam, the radius is still further decreased causing the rack member 84 to move still further toward the left and in turn causing the trough to swing so that the discharge mouth thereof will be directed toward the right side of the firebox. Between the points *d* and *a* of the cam, the radius thereof increases, causing the rack member to reverse its movement and in consequence reverse the movement of the trough 43 so that it will return to the position shown in Fig. 14.

The oscillating mechanism is of such design that the trough 43 is oscillated a sufficient degree to each side of the longitudinal center line of the furnace to discharge the fuel substantially parallel to the plane of the inside wall of the furnace front. It will be seen, therefore, that the trough 43 oscillates continuously from side to side, thus permitting fuel to be discharged directly to all parts of the firebox and in proper amounts to each individual area of the firebed to provide a level firebed.

The shaft 89 and curved 91 are preferably provided with the communicating passages 93 and 94, respectively. The passage 93 communicates with the interior of the housing 31 through the registering openings 95 and 96 in the shaft 89 and bearing 90, respectively, and the passage 94 opens through the end of the arm 91 at 97. The housing 31 is provided with an opening 98 in a wall thereof exteriorly of the firebox and is provided with a cover 99 forming a closure therefor. Apertures 100 in the cover 99 permit air to be drawn from without the firebox into the housing 31 and then through the passages 93 and 94 into the firebox. The draft in the firebox causes a constant inflow of cool air from outside the furnace, providing cooling means for those parts within the firebox.

Since the distance from the firing opening, in which is located the fuel distributing means, to the opposite wall of the furnace is generally greater than the distance from the firing opening to either side wall, provision has been made for varying the pressure of the fluid blast as the distributor turns from one side to the other. One end of the housing 31 is provided with an opening 98*a* and a detachable head 99*a* forming a closure therefor. The head 99*a* has a hub 100*a* fitting in the opening 98*a* and extending

therethrough into the housing 31. The head 99a has a cored passage 101 therein communicating with the horizontal cylinder 102 formed in the hub 105a. The passage 101 communicates with the outlet 103 in the head 99a through a slot 104 and one end of the flexible hose 73 is arranged to be received in the outlet 103. The inlet 105 of the cored passage 101 is in registering communication with a cored passage 106 in the stub shaft 32 and a flexible hose 107 connects the cored passage 106 with a steam pipe 108 leading from the steam dome of the furnace 10 or from other suitable sources. Thus steam passes from the steam dome through the pipe 108, flexible hose 107, cored passage 106, cored passage 101, slot 104, outlet 103, flexible hose 73 and then into the distributor mechanism as previously explained.

Mounted in the horizontal cylinder 102 is a piston 109 arranged for movement across the slot 104. The piston rod 110 of the piston 109 extends through the hub 105 into the housing 31. Keyed to the shaft 77 is an elliptical cam 111, which, as can best be seen from Fig. 14, will when rotated move the piston 109 to the left across the slot 104. The pressure of the steam against the other side of the piston 109 will move the same to the right when the cam 111 is in a position to permit such movement. Thus it will be seen that as the cam 111 rotates, the the piston 109 reciprocates in the cylinder 102, gradually diminishing the size of the slot 104 as it moves toward the left and gradually enlarging the slot 104 as it moves toward the right. It follows that the volume of steam passing into the flexible hose 73 and thence to the distributor alternately decreases and increases.

Now, since the elliptical cam 111 which, as seen above, controls the blast of steam issuing from the distributor, and the cam 78, which controls the oscillating movement of the trough 43, are both keyed to the same shaft 77 it is apparent that the pressure fluid blast and oscillation of the trough 43 are coordinated. With the trough 43 in the position shown in Figure 3 and 14 it is clear that the fuel must be thrown a greater distance; so that, as shown in Fig. 14, the piston 109 is at one extreme position to entirely uncover the slot 104, thereby allowing a full volume of steam to reach the distributor. As the trough 43 turns, it is evident from Fig. 3 that the fuel should be projected a continuously lesser distance, at the same time the cam 111 is pushing the piston 109 to continuously cover more of the slot 104 so that a continuously smaller volume of steam is being delivered to the distributor, thus projecting the fuel a continuously shorter distance. Fuel is therefore projected with a greater velocity toward the more remote wall of the firebox than toward the side walls whereby fuel is distributed evenly over all parts of the firebed in the furnace.

The stoker is operated by a suitable source of power, such as the motor 112, through a speed reducer 113 and gearing hereinafter described in detail. The motor 112 is preferably rigidly but detachably secured to the speed reducer casing 114, which in turn is rigidly but detachably secured in place, being best shown in Figures 2 and 5 for purpose of illustration as secured to the stoker conduit casting 24. The casing 114 is provided with an opening 115 providing access to the interior thereof, and a cover 116 forms a closure for the opening 115. A shaft 117 rotatably mounted in bearings 118 and 119 in the lower portion of the casing 114 is connected with the motor drive shaft 120 by a flexible connection 121. In the upper portion of the casing is a shaft 122 rotatably mounted in bearings 123 and 124.

Mounted on the lower shaft 117 is a relatively small cone pulley 125 and on the upper shaft 122 a relatively large cone pulley 126 tapered in the opposite direction. A square shaft 127 lies between the lower shaft 117 and the upper shaft 122 and is mounted in the casing bearing 128 and the casing cover bearing 129. A narrow endless vulcanized rubber belt 130 passes around the pulleys 125 and 126 whereby motion is transmitted from the shaft 117 to the shaft 122, the speed of the shaft 122 being less than that of the shaft 117 because of the difference in the circumference of the parts of the pulleys 125 and 126 over which the belt 130 travels. Because of the taper of the pulleys 125 and 126 the speed of the shaft 117 may be varied with respect to the speed of the shaft 122 by shifting the belt 130 back or forth along the pulleys. Referring to Fig. 5, it is clear that by shifting the belt 130 to the left, the speed of the shaft 122 is decreased since the circumference of the pulley 122 becomes greater while the circumference of the pulley 117 becomes less; by shifting the belt 130 to the right, the speed of the shaft 122 is increased since the circumference of the pulley 122 becomes less while the circumference of the pulley 117 becomes greater.

A cable 131 is attached at one end to the free end of a lever 132 arranged to swing upwardly and downwardly in response to the steam pressure in the boiler of the furnace 10, and is attached at its other end to the square shaft 127. A belt shifter 133, keyed to the shaft 127 within the casing 114, is provided with rollers 134 arranged to guide and shift the belt 130. Now, referring to Figures 1 and 5, it is clear that as the pressure in the boiler increases, the free end of the lever 132 is raised, thus pulling the square shaft 127 to the left by the cable 131. In consequence, the belt shifter 133 is moved to the left and with it the belt 130 whereby the shaft 122 is caused to rotate at a slower rate. Since power for operating the stoker is transmitted through the shaft 122, it is evident that as the steam pressure in the furnace boiler increases the speed of the stoker decreases, thus delivering less fuel to the firebox.

Conversely, if the steam pressure in the boiler drops, the free end of the lever 132 is lowered, causing slack in the cable 131 and permitting the compression spring 135 to shift the square shaft 127 and belt shifter 133 to the right. Shifting of the belt shifter 133 to the right moves the belt 130 to the right whereby the shaft 122 is caused to rotate faster and it follows that the stoker is operated at a more rapid rate, delivering more fuel to the firebox. The delivery of fuel to the firebox by the stoker is thus automatically regulated by the boiler steam pressure.

The shaft 122 is connected by a flexible coupling 136 to a shaft 137 mounted in a casing 138 carried by the stoker conduit casting 23. Mounted on the shaft 137 within the casing 138 is a worm 139 meshing with a gear 140 mounted on a vertical shaft 141. The vertical shaft 141 extends downwardly through the casing 138 into the gear housing 27 and carries at its lower end within the housing 27 a bevel gear 142 engaging the teeth of a bevel gear 143 mounted on

the shaft extension 25 of the transfer conduit screw 17 for operating the same. Mounted on the same vertical shaft 141 below the bevel gear 142 is a gear 144 meshing with a helical gear 145 mounted on the extended shaft 146 of the inclined riser screw 24 for operating the same.

The grates 12 are arranged to be shaken in timed relation with the operation of the stoker by mechanism hereinafter described in detail with particular reference to Figures 2, 5, 6 and 16. Pressed on or otherwise suitably secured to the shaft extension 25 of the screw conveyor 17 and within the gear housing 27 is an eccentric 147. A dog 148 is mounted on the eccentric 147 so that rotation of the eccentric 147 will cause reciprocation of the dog 148. The free end of the dog 148 rests against the teeth 149 of a ratchet wheel 150 by reason of gravity and direction of rotation of the shaft extension 25. The ratchet wheel 150 is secured on one end of the shaft 151, and a casing 152, preferably secured to the gear housing 27, houses the ratchet wheel and the end of the shaft 151 on which the ratchet wheel is secured. The teeth 149 of the ratchet wheel 150 are cut at an angle so that movement of the dog 148 in one direction will cause engagement of the free end of the dog with one of the teeth of the ratchet wheel, rotating the ratchet wheel and consequently the shaft 151 a fraction of a turn; retrograde movement of the ratchet wheel, when the dog 148 moves in the opposite direction, is prevented by the formation of the teeth 149 which permits the free end of the dog 148 to slide over the teeth 149.

The shaft 151 extends forwardly in a depression 153 in the floor of the furnace room along one side of the furnace, and is supported at its forward end in a bearing 154. The grate 12 comprises a number of longitudinal grate bars 155 which are mounted to rock back and forth in the usual manner. These bars 155 are inter-connected by a rod 156 which is movably mounted on the horizontal projections 158 of the grate shaker arms 159 depending from the bars 155. One of the grate shaker arms 159 has an oppositely extending horizontal projection 160 and a link 161 is pivotally mounted at one end thereon and at its other end pivotally mounted to a crank arm 162 mounted on the shaft 151. Thus rotation of the shaft 151 is communicated to the crank arm 162 causing the link 161 to move back and forth, which in turn causes oscillation of the grate bars 155 through the inter-connected depending grate shaker arms 159.

The ashes drop through the grate 12 into a pit 163 in the furnace floor beneath the furnace. The sides defining the pit 163 slope downwardly and inwardly toward each other, so that the pit resembles an inverted pyramid. Communicating with the pit 163 from a point at one side and exteriorly of the furnace is a short inclined conduit section 164. A conduit 165 extends upwardly at one side of the furnace from the conduit section 164, to which it is connected, preferably though not necessarily by a universal connection 166. One or more chutes 167, two being shown in the drawings for purposes of illustration, communicate with and extend downwardly at an angle from the upper end of the upright conduit 165 and empty into ash receptacles 168. Ash is conveyed from the pit 163 through the conduits 164 and 165 by conveying means including a screw conveyor 169 extending upwardly from the bottom of the pit along a wall thereof and through the conduit section 164, and a screw conveyor 170 in the upright conduit 165. A universal joint 171 connects the screw conveyors 169 and 170 so that one may be driven by the other.

At the upper end of the upright conduit 165 is a gear casing 172, housing a worm gear 173 which is mounted on the shaft of the screw 170. Meshing with worm gear 173 is a worm 174 which is operatively connected with the shaft 141 by a flexible cable 175.

In Fig. 17 there is shown a modification of the stoker mechanism adjacent the firing opening 180 in the furnace front 181. In the preferred form of the invention, as described before, the stub shaft 32 is arranged in axial vertical alinement with the coupling 28 so that the conduit 30 and firedoor 15 are free to swing about a vertical axis. In this modified form of the invention, the stub shaft 182 and the coupling 183 are in axial alinement, but the axis is inclined from the vertical so that the door 184 upon being opened swings outwardly and upwardly about the conduit 185 as an axis. Since the door is swung slightly upwardly upon being opened, the weight thereof makes it self-closing upon being released.

As previously described, in the preferred form of the invention the fuel receiving trough 43 is carried by the firedoor 15 on a ledge 44 formed with and extending inwardly from the firedoor 15, so that upon opening the door 15 the trough 43 is withdrawn from the firebox. In the modified form of the invention, as shown in Figures 18, 19, 20 and 21, the ledge 186 is generally the same as the ledge 44, but instead of being formed with the firedoor, it is provided at its end outside the firebox with a pair of depending legs 187 through which the ledge 186 is secured to the furnace wall 188 by suitable means, such as bolts 189. As has also been described, in the preferred form of the invention the trough 43 is oscillated by mechanism mounted in the housing 31 through the curved arm 91. In the modified form of the invention, as best shown in Figures 18 and 21, the curved arm 190 is disengaged from the shaft 191 through a cutaway, as at 192, in the shaft 191. Thus in this form of the invention, when the door 195 is swung open, the trough 194 remains in its position in the firing opening 196 by reason of its being supported by the furnace wall 188 through the ledge 186 and by reason of the disengageable nature of the arm 190 and shaft 191.

As in the preferred form of the invention, mechanism is provided for oscillating the trough 194. This mechanism is disposed in the housing 197 and is operatively connected with the trough 194 through the arm 190 and shaft 191. It is clear that the door 195 can be opened only when the arm 190 and shaft 191 are in a particular phase of their oscillating movement, as shown in Fig. 20, since the arm 190 is disengageable from the shaft 191 only through the cutaway 192. In order to determine when the arm 190 and shaft 191 are in position to permit opening of the door 195, a cam 198 is mounted on the upper end of the shaft 191. A rod 199 is slidably mounted in the door 195, one end thereof being held in contact with the cam 198 by a spring 200 and the other end thereof extending through the door. The cam 198 and rod 199 are arranged so that when the end of the rod 199 are flush with the outside surface of the door 195, the arm 190 and shaft 191 are in position to be disengaged, permitting the door to be opened.

I claim:

1. In a stoker for feeding fuel to a furnace, a trough opening into said furnace, means for delivering fuel to said trough, means for issuing a

continuous blast of fluid under pressure for continuously projecting the fuel from said trough into the furnace, means for continuously horizontally oscillating said trough, means for continuously varying the intensity of said pressure fluid blast and means common to said trough oscillating means and said blast intensity varying means for actuating the same in synchronism.

2. In a stoker for feeding fuel to a furnace, a trough opening into said furnace, means for delivering fuel to said trough, means for issuing a continuous blast of fluid under pressure for continuously projecting the fuel from said trough into the furnace, a supply line for continuously delivering fluid under pressure to said last named means, means for continuously horizontally oscillating said trough, means operable in said supply line for continuously varying the supply of fluid under pressure to said blast issuing means, and means common to said trough oscillating means and said blast intensity varying means for actuating the same in synchronism.

3. In a stoker for feeding fuel to a furnace, a trough opening into said furnace, means for delivering fuel to said trough, a jet nozzle for issuing a continuous blast of fluid under pressure for continuously projecting the fuel from said trough into the furnace, a supply line for continuously delivering fluid under pressure to said jet nozzle, means for continuously horizontally oscillating said trough, said jet nozzle being carried by said trough and being oscillatable therewith, means operable in said supply line for continuously varying the supply of fluid under pressure to said jet nozzle, and means common to said trough oscillating means and said blast intensity varying means for actuating the same in synchronism.

4. In combination with a furnace having a firing opening in a wall thereof, a firedoor for said opening, a ledge formed with said firedoor and extending inwardly of the furnace through the lower portion of the firing opening, said ledge having an annular upstanding boss disposed in approximately the plane of the inside surface of the furnace wall, a fuel trough positioned on the inner side of said firedoor and carried by said ledge, said fuel trough having an annular recess in the bottom wall thereof for receiving said boss and means for horizontally oscillating said trough about the said boss as an axis.

5. In combination with a furnace having a firing opening in a wall thereof, a firedoor for said opening, a hollow-walled fuel trough in said firing opening positioned on the inner side of and spaced from said firedoor, the exterior rear wall of said hollow-walled trough having an air admission opening and the exterior front wall of said hollow-walled trough having air emission apertures, an opening in said firedoor, and means forming a passage from the opening in said firedoor to the opening in the rear wall of said hollow trough.

6. In combination with a furnace having a firing opening in a wall thereof, a firedoor for said opening, a hollow-walled fuel trough in said firing opening spaced from said firedoor, the exterior rear wall of said hollow-walled trough having an air admission opening and the exterior front wall of said hollow-walled trough having air emission apertures, an opening in said firedoor, and means forming a passage from the opening in said firedoor to the opening in the rear wall of said hollow trough, said trough and passage forming means being supported by and arranged to move with the firedoor when said door is opened and closed.

7. As an article of manufacture a fuel discharge trough for a stoker, said trough having a bottom wall, an upstanding curved exterior wall U-shaped in section parallel to said bottom wall, interior walls converging from the upper rim of said upstanding exterior wall to said bottom wall, a front wall connecting the contiguous front edges of said bottom, interior and exterior walls, said front, interior, exterior and bottom walls forming in said trough a chamber.

8. As an article of manufacture a fuel discharge trough for a stoker, said trough having a bottom wall, an upstanding curved exterior wall U-shaped in section parallel to said bottom wall, interior walls converging from the upper rim of said upstanding exterior wall to said bottom wall, a front wall connecting the contiguous front edges of said bottom, interior and exterior walls, said front, interior, exterior and bottom walls forming in said trough a chamber, a plurality of apertures in said front wall communicating with the chamber in said trough and an opening in said exterior wall opposite said front wall communicating with said chamber.

9. In a stoker for feeding fuel to a furnace, a trough opening into said furnace, means for delivering fuel to said trough, means for projecting the fuel from said trough into the furnace, a rotatably mounted shaft operatively connected with said fuel delivering means, a cam mounted on said shaft, means responsive to said cam for horizontally oscillating said trough, a second cam mounted on said shaft, and means responsive to said second cam for varying the force of said fuel projecting means.

10. In a stoker for feeding fuel to a furnace, a trough opening into said furnace, means for delivering fuel to said trough, means for projecting the fuel from said trough into the furnace, a rotatably mounted shaft operatively connected with said fuel delivering means, a cam mounted on said shaft, means responsive to said cam for horizontally oscillating said trough, a second cam mounted on said shaft, and means responsive to said second cam for varying the force of said fuel projecting means, said cams being arranged to actuate said projecting means with maximum force when the discharge end of the trough is directed toward the remote portions of the firebox, and with minimum force when the discharge end of the trough is directed toward the near portions of the firebox.

11. In a stoker for feeding fuel to a furnace, a trough opening into said furnace, means for delivering fuel to said trough, means for issuing a blast of fluid under pressure for projecting the fuel from said trough into the furnace, a supply line for delivering fluid under pressure to said means, a rotatably mounted shaft operatively connected with said fuel delivering means, a cam mounted on said shaft, means responsive to said cam for horizontally oscillating said trough, a second cam mounted on said shaft, and means in said supply line responsive to said second cam for varying the supply of fluid under pressure to said blast issuing means.

12. In a stoker for feeding fuel to a furnace, a trough opening into said furnace, means for delivering fuel to said trough, means for issuing a blast of fluid under pressure for projecting the fuel from said trough into the furnace, a supply line for delivering fluid under pressure to said means, a rotatably mounted shaft operatively

connected with said fuel delivering means, a cam mounted on said shaft, means responsive to said cam for horizontally oscillating said trough, a second cam mounted on said shaft, and means in said supply line responsive to said second cam for varying the supply of fluid under pressure to said blast issuing means, said cams being arranged to provide a blast of maximum intensity when the discharge end of the trough is directed toward the remote portions of the firebox, and a blast of minimum intensity when the discharge end of the trough is directed toward the near portions of the firebox.

13. In combination with a furnace having a firing opening in an upright wall thereof, a movably mounted firedoor for closing and exposing said firing opening, a fuel conduit comprising an upstanding portion mounted for axial rotation and a portion extending laterally from the delivery end of said upstanding portion, said last named portion being formed with said firedoor and opening therethrough to the furnace, said upstanding portion forming a hinging element for moving said firedoor to close or expose said firing opening, a screw conveyor in said upstanding conduit portion, a screw conveyor in said laterally extending conduit portion, and means outside the conduit passage operatively connecting the adjacent ends of said screw conveyors.

14. In a stoker for feeding fuel to a furnace, a trough opening into said furnace, means for delivering fuel to said trough, means for projecting the fuel from said trough into the furnace, means for varying the force of said projecting means, means for horizontally oscillating said trough, means for operating said fuel delivery means, a shaft actuated by said fuel delivery means, and means on said shaft for actuating said force varying means and said oscillating means in synchronism.

15. In a stoker for feeding fuel to a furnace, a trough opening into said furnace, means for delivering fuel to said trough, means for projecting the fuel from said trough into the furnace, a rotatably mounted shaft, means for rotating said shaft, cam means mounted for rotation with said shaft, means responsive to said cam means for horizontally oscillating said trough and means responsive to said cam means for varying the force of said fuel projecting means.

16. In a stoker for feeding fuel to a furnace, a trough opening into said furnace, means for delivering fuel to said trough, means for issuing a blast of fluid under pressure for projecting the fuel from said trough into the furnace, a supply line for delivering fluid under pressure to said means, a rotatably mounted shaft, cam means mounted for rotation with said shaft, means responsive to said cam means for horizontally oscillating said trough, and means in said supply line responsive to said cam means for varying the supply of fluid under pressure to said blast issuing means.

17. In combination with a furnace having a firing opening in a wall thereof, a firedoor for said opening, a ledge formed with said firedoor and extending inwardly of the furnace through the lower portion of the firing opening, a fuel trough carried by said ledge, said fuel trough and said ledge being provided, one with a vertical annular boss and the other with an annular recess receiving said boss, said boss and recess being disposed in approximately the plane of the inside surface of the furnace wall, and means for horizontally oscillating said trough about the axis of said boss.

18. In combination with a furnace having a firing opening in a wall thereof, a firedoor for said opening, a hollow-walled fuel trough in said firing opening positioned on the inner side of and spaced from said firedoor, the exterior rear wall of said hollow-walled trough having an air admission opening, an opening in said firedoor, means forming a passage from the opening in said firedoor to the opening in the rear wall of said hollow trough, said passage forming means including side walls pivotally mounted at one end on vertical axes adjacent opposite sides of the opening in said firedoor, and means for maintaining the free ends of said side walls in contact with said trough.

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