May 14, 1946. C. E. SHAFFER 2,400,141

FUEL-SUPPLY CONTROL FOR AUTOMATIC STOKERS

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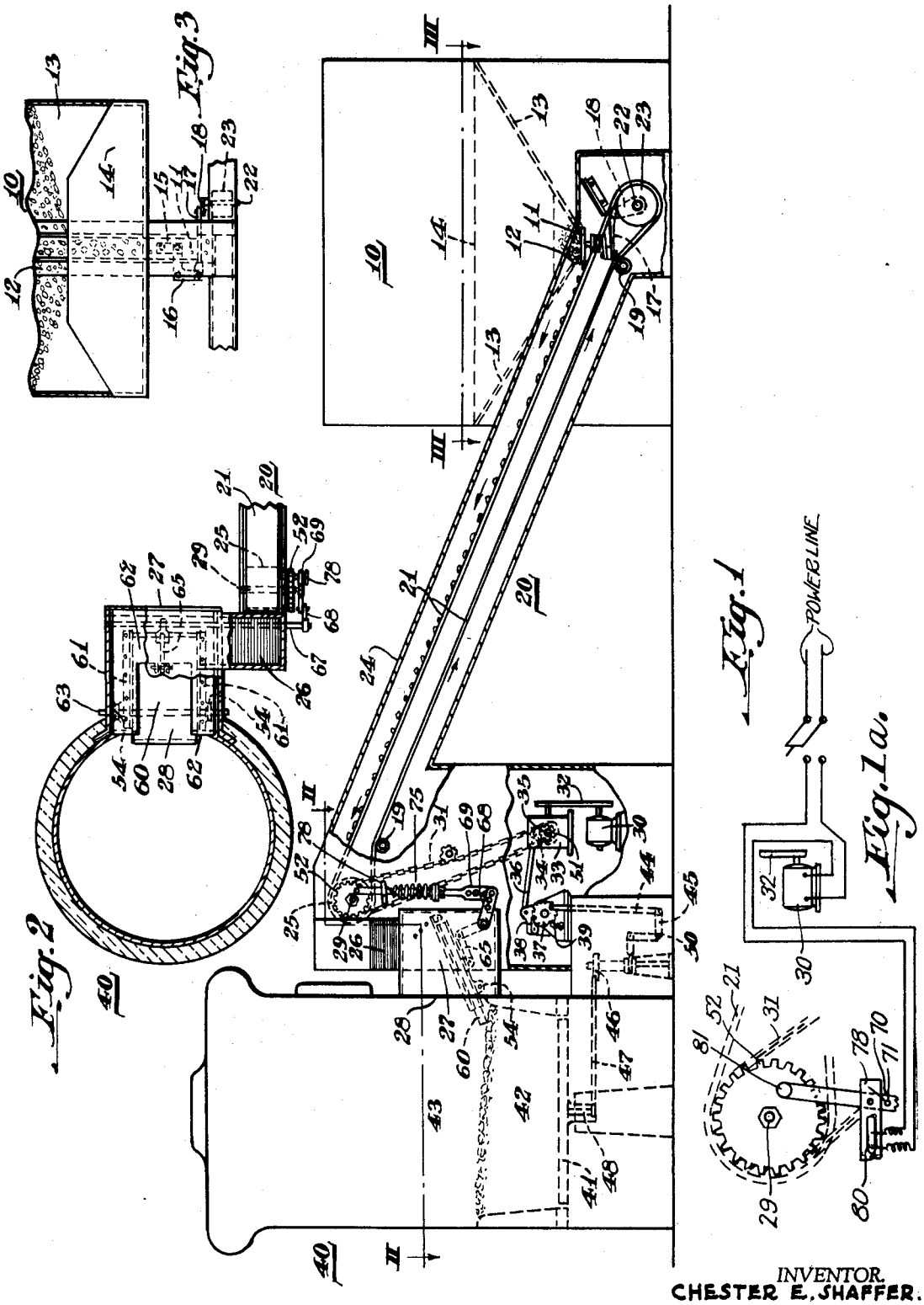


Fig. 3

Fig. 2

Fig. 1

Fig. 1a.

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Fig. 5

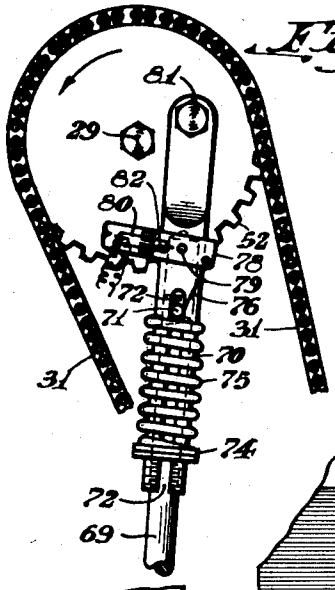


Fig. 4

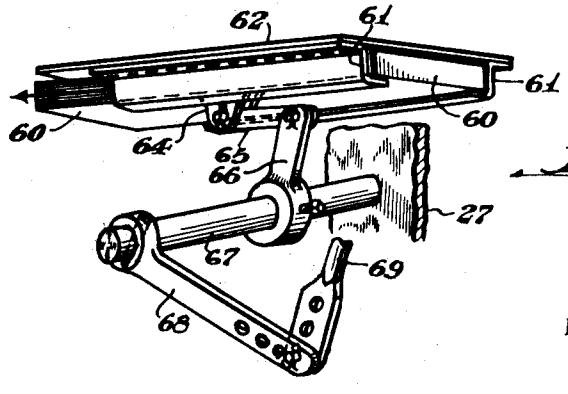


Fig. 6

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FUEL-SUPPLY CONTROL FOR AUTOMATIC STOKERS

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Application November 28, 1940, Serial No. 367,598

14 Claims. (Cl. 110—101)

The present invention relates to improved means for regulating the level of solid fuels in furnaces, heaters, boilers, or other apparatus in which said fuels are accumulated to some depth on a fuel-bed, by control of automatic stoking means arranged to deliver solid fuels to said apparatus. The invention is adapted more especially for use in combination with overfeed stokers but it is in nowise limited thereto.

Means for automatically regulating the delivery of solid fuels to a combustion-chamber in response to changes in level of the fuel-bed within the chamber are known to the art and have been developed for use in combination with both underfeed and overfeed stokers. It is the purpose of this invention to provide for such an improved regulating device hereinafter-described features that are of special advantage for overfeed stokers but are also of utility in combination with underfeed stokers.

An object of the present invention is to provide a fuel-bed-level control that is adapted for operation adjacent to a cooler portion of the combustion-chamber, so that said control operates in less direct contact with the destructive effects of heat radiation and hot combustion gases from the fuel-bed and gives, therefore, improved length of service.

A further object of the invention is the provision of adjustably controllable means of the stated class whereby the level of a fuel-bed can be optionally varied, thereby making possible the maintenance of that fuel-bed depth which is most suitable for efficient combustion of any one of divers sizes of solid fuels and burning characteristics.

A further object of the invention is to provide a fuel-bed-level control that is itself disposed, more especially in combination with overfeed stokers, to assist in the distribution of inflowing fuel over the fuel-bed and cannot be rendered inoperative by the accumulation of inflowing fuel thereon, and is in operative control throughout substantially an entire stoking period.

The invention has for further objects such other improvements and such other operative advantages or results as may be found to obtain in the apparatus hereinafter described or claimed.

Briefly stated, the invention comprises a reciprocatory, inclined plate that is disposed adjacent to a fuel-bed in a furnace and is adapted to move into and out of contact with the grate-supported fuel adjacent its peripheral margin. For directing its movement, the plate-like member is adapted reciprocally to slide in guide flanges that are adjustable in their inclination downward toward the firebox in said furnace. A driving motor imparts reciprocal motion to said plate by means of a linkage, and, interposed between said motor and said linkage, there is a chain-driven wheel to which one end of the linkage is rotatably attached by a fixed pin.

According to the invention a link of the above-said linkage is a composite of a pair of coaxially-slidable members that jointly actuate a spring, or any preferred resilient means, which permits a regulably independent movement of the one member in respect of the other upon application of a predetermined tension thereto and which also permits a resumption of said link's original length upon release of said tension.

When, during its operation, the reciprocatory plate is arrested in its movement toward the fuel-bed by an accumulation of fuel on said bed, the composite link is increased in its effective length by the above-described independent movement of one of its members that is induced by rotation of said motor-driven wheel to which it is attached, and thereby turns an electric switch and breaks the circuit to said motor which also drives the fuel-feeding apparatus for said furnace. At the same time, the spring-member is compressed. The plate-member remains in pressure-contact with the accumulated fuel until combustion in the fuel-bed lowers the fuel-bed level and, consequently, lowers the contact-pressure below a predetermined amount, whereupon the plate completes a previously-initiated forward movement under the influence of said spring's expansion, thereby turning the said electric switch which again starts the driving motor for said reciprocatory plate.

By adjustment of the slope of the reciprocating plate in respect of the fuel-bed, and by adjustment of the tension on the spring in the plate's driving mechanism, the volume of fuel in the combustion-chamber can be regulated.

The fuel-bed-level control of the invention employed in combination with means for automatic delivery of fuel to a combustion apparatus insures the maintenance of a preferred fuel-bed level, said control itself assisting in the even distribution of the inflowing fuel over the fuel-bed where, in turn, the combustion reaction or the rise of combustion gases from same is in no way hampered by the presence of any part of the control. The improved control is adapted for long periods of operation without replacement because it is substantially removed from the corrosive effects of the heat of the combustion-chamber and of the combustion gases rising therein.

In the accompanying drawings forming a part of this specification and showing for the purpose of exemplification a preferred apparatus and method in which the invention may be embodied and practiced but without limiting the claimed invention specifically to such illustrative instance or instances;

Fig. 1 is a side elevation with parts broken away of an assembly for supplying automatic

heat, the assembly comprising a fuel-bin, a stoker and a driving mechanism for the latter, and a domestic-type boiler in combination with the fuel-bed-level control of the present invention;

Fig. 1a is diagrammatic view illustrating the electrical circuit which includes a motor for driving the plate-like member and fuel feed means therefor.

Fig. 2 is a section taken on line II—II of Fig. 1, but with certain parts omitted and others broken away, said figure being on a slightly larger scale;

Fig. 3 is a section taken on line III—III of Fig. 1, but with certain parts omitted and others broken away, said figure being on a slightly larger scale;

Fig. 4 is an enlarged portion, with parts broken away, of Fig. 1 showing in greater detail the apparatus of the present invention;

Fig. 5 is a portion of the apparatus of the invention illustrated in Fig. 4, and showing the relative position of certain parts of the improved control means when the stoker is not in operation; and

Fig. 6 is a perspective view of the reciprocatory plate, its guideways, and a portion of the actuating mechanism for the present improved fuel-bed-level control.

The same characters of reference designate the same parts in each of the views of the drawings.

In Fig. 1 there is shown the present invention embodied in a system for automatically conveying fuel from a storage to a furnace grate. Fuel-bin 10 which is of adequate capacity for storage of a preferred amount of solid fuel is provided with a reciprocatory feeder plate 11 for discharging fuel therefrom, said plate being mounted in feeder trough 12 located at the bottom of said bin, the latter having sloping sides 13 and a front and a back dam. When the employed fuel is of a size commonly employed in domestic coke stokers, the front dam 14 should extend downwardly to approximately 9 inches above the reciprocatory feeder plate 11 and should extend inwardly approximately 5 inches beyond the end of the bin section of the feeder plate. The back dam, not shown, extends downwardly to the feeder plate. The bin 10 and the reciprocatory feeder plate 11 are clearly described in the co-pending application of Shaffer and Fisher, S/N 324,048, filed March 15, 1940, and their operation requires no further description here. In the present instance, the reciprocatory plate 11 is actuated through a lever system comprising link 15, bell-crank lever 16, connecting-rod 17, and crank 18, which is affixed to shaft 22 of tail pulley 23.

Fuel discharged from fuel-bin 10 at the outer end of reciprocatory plate 11 is received on endless belt 21 at the lower end of the overfeed stoker 20 whereby it is conveyed upwardly to the furnace mouth. Endless belt 21, which is enclosed in casing 24 to prevent rise of dust from traveling fuel, is held tightly against both head pulley 25 and tail pulley 23 by adjustable idlers 19. The preferred inclination of said endless belt should be such that it permits conveying of fuel delivered thereto without substantial slippage; however, cleats may be applied to the surface of the belt, in which case the angle of elevation can naturally be increased. Head pulley 25, which drives said belt 21, rotates in a counter-clockwise direction (as shown by the arrows in the drawings) with shaft 29 to which it is affixed, the latter being driven by electrical motor 30 operating in sequence through endless V belt 32, gear reducer 33, lower sprocket wheel 51 on shaft 35 of said gear reducer, and endless gear chain 31 that meshes with large sprocket wheel 52 which is also rigidly mounted on shaft 29 along with said head pulley 25.

Beneath the face of head pulley 25 there is the inclined directing-plate 26 that is arranged to slope downwardly through an opening in fire-door box 27 enclosing fire doorway 28 in domestic furnace 40, the form of which is well known in the art. This inclined plate serves to direct fuel, as it changes direction on being discharged from conveyor belt 21, over the reciprocatory plate 60 of the present fuel-bed-level control and into the fuel-bed of the furnace. The inflowing fuel is assisted in its distribution across the fuel-bed by the reciprocatory plate 60 which, in consequence of the inclination at which it is operated, functions as a sort of baffle means to direct fuel flowing over it into more remote portions of the combustion-chamber.

Within domestic furnace 40, grate 41 is disposed for oscillatory motion in a horizontal plane and for support of fuel-bed 42 in combustion-chamber 43. Electrical motor 30 is also employed to oscillate said grate 41 that is connected therewith by means of said endless V belt 32 and of gear reducer 33, of which the shaft 35 has attached thereto at the opposite end from the sprocket wheel 51 a crank 34 that is arranged to reciprocate connecting-arm 36; the said connecting-arm 36 can be provided with a slot of regulatable length at its union with said crank 34, that allows a certain amount of independent movement of the one in respect of the other for regulating the extent of oscillation of grate 41. The connecting-arm 36 in turn operates ratchet wheel 37, pawl 38, and click 39 which have the purpose of reducing the speed of the motion imparted by the gear reducer. Vertically disposed connecting-arm 44 is revolvably mounted on ratchet wheel 37 and moves bell-crank lever 45 about pin 50. The to-and-fro movement of bell crank 45 is employed to oscillate centrally pivoted lever arm 46 and therewith-connected connecting-rods 47 that are pivotally mounted at their one ends on shoulders 48 which are cast integrally with the grate and are similarly mounted at their other ends on said lever arm 46. The motion imparted to the grate by the aforesaid mechanism may be described as a sequence of step-wise movements in one angular direction followed by a similar sequence in the opposite angular direction. The grate-shaking mechanism and its manner of operation are clearly described in the aforementioned co-pending application and thus require no further description here.

As shown in the figures the fuel-bed-level control of the present invention has a fuel-contacting member that comprises a slidably-movable, reciprocatory plate 60 which is disposed within fire-door box 27 and at an inclination downwardly through firebox doorway 28. In its preferred and relatively protected disposition, as shown in the drawings, the said fuel-contacting member need not be water-cooled, nor be formed of a refractory, nor ordinarily be made of expensive heat-resistant alloys so as to prevent its heat-deterioration. Other important advantages arising from its relatively protected location at one side of the fuel-bed are that it offers neither important hindrance to the combustion-reaction nor obstruction to the rise of combustion-products from the fuel-bed nor creation of a "cold spot" in the zone of vigorous combustion. During the

forward movement of the reciprocatory plate, toward the firebox doorway, the plate is driven by a yieldable, resilient member in its actuating apparatus; during the rearward movement of the plate it is positively driven; that is, in the latter movement the resilient member is not effectively operative. The said plate **60** rides in guideways formed of guide flanges **61** and partial cover-plate **62**, and moves reciprocally to and from therebeneath with only a part of its surface exposed to the inflowing fuel. The cover plate is flush with the top edges of the guide flanges and is so formed and disposed as to protect from the accumulation of fuel-dust therein those interspaces provided, between the vertical edges of reciprocatory plate and said flanges, to facilitate movement of the former. The guideways are angularly adjustable; that is, by their means it is possible to establish the inclination at which the reciprocatory plate moves. For this purpose, the guide flanges **61** are each supplied at their lower ends with perforated lugs **54** through which extends supporting-rod **63**, that is itself fixedly-supported in opposite walls of the firedoor box, and at their upper ends said flanges are provided with lugs **53** by which they are pinned to the sides of said firedoor box at pin-holes **55**.

On the underside of reciprocatory plate **60** are integrally mounted perforated lugs **64**, whereby the reciprocatory plate **60** is pivotally connected to link **65** that is itself pivoted to one end of rocker arm **66** of which the other end is fixed to rocker shaft **67** by means of the shown set screw. The rocker shaft **67** is disposed horizontally and substantially parallel to fire doorway **28** and is journaled through one side of firedoor box **27**, and is supported at the opposite side in a manner to permit rotation.

Shaft **67** is rocked through an adjustable arc by a crank arm **68** that is pinned to the end of shaft **67** beyond that point where it is journaled through the firedoor box. At a preferred one of the several perforations in the crank arm **68** there is pivoted to the same a composite link comprising the two independently movable coaxial members, connecting-rod **69** and slotted sleeve **70**, which are resiliently interconnected when they are under tension and are capable of rigid unitary movement when they are under pressure. As is clearly shown in the drawings, connecting-rod **69** extends upwardly within sleeve **70** and is slidably arranged, pistonlike, within said sleeve. Rigidly fixed transversely of and through connecting-rod **69** at its upper end is pin **71** which rides in longitudinally extending slots **72** at the opposite ends of a diameter of sleeve **70**. The lower end of sleeve **70** is threaded to receive removably-mounted adjusting nut **74**. A helical compression spring **75** is concentrically mounted on sleeve **70** and bears on adjusting nut **74** and against pin **71**. Pin **71** is linked by rigid wire **76**, to one end of arm **78** that is rotatable about a pin **79** which is rigidly attached to the outer surface of the sleeve **70**. Mounted on said arm **78** is a "Mercoid"-type electric switch **80** that controls an electrical circuit wherein is included electric motor **30** by which all the features of the automatic-heating apparatus of Fig. 1 are operated as a unit. The upper end of the hollow, cylinder-like sleeve **70** is flattened to form a solid end whereat it is revolvably mounted on a pin **81** that is attached to the outer face of large sprocket wheel **52**. As shown in Figs. 1 and 4, the large sprocket wheel **52** is driven in a counter-clockwise direction by endless gear chain **31**.

By means of the removably-mounted adjusting nut **74** the tension on spring **75** can be altered, optionally to vary the average depth of the fuel-bed. This optional variation of fuel-bed depth that can be obtained by the above-said means and by the previously described adjustment of the angular guide flanges **61**, has the special advantage that a small volume of fuel can be maintained in the combustion-chamber and a low fire sustained therein, when such is desired, as in mild weather.

The counter-clockwise movement of sprocket wheel **52** moves the composite link that is mounted thereon in alternate upward and downward movements. During the upward movement of the composite link, at which time it is under a small amount of tension and is driving reciprocatory plate **60** in its forward movement, spring **75** bears firmly against the pin **71** of connecting-rod **69**. During downward movement of the said link, at which time it is under pressure and is driving reciprocatory plate **60** in its rearward movement, pin **71** is held by the ends of slots **72**, and spring **75** rests on adjusting nut **74** and is not held by pin **71** or at most is only lightly in contact with same.

The reciprocatory movement of the plate proceeds without substantial alteration in the effective length of the composite link as long as the associated spring is able to resist compression during the plate's forward stroke, and the link's effective length will remain unaltered until the plate in its forward movement is obstructed and held by accumulated fuel in the fuel-bed. When this latter condition arises, connecting-rod **69** will be held stationary by reason of its associated linkage with said plate, whereas continued counter-clockwise rotation of the sprocket wheel **52** moves slotted sleeve **70** upwardly along said rod and lengthens the composite link comprising said sleeve and rod. As sleeve **70** moves upward, spring **75** is compressed against bearing pin **71** by the upward movement of adjusting nut **74** that is mounted on the moving sleeve **70**. Simultaneously, rotatable arm **78** is also moved upwardly with said sleeve **70**, and during such movement, the arm and the "Mercoid"-type switch mounted thereon are rotated in a clockwise direction about pin **79** by the pull of that rigid wire **76** which is attached to the stationary bearing pin **71** by virtue of the rod **69** being rendered momentarily immovable due to obstructions encountered by plate **60**. The rotation of the switch causes a globule of mercury **82**, that is contained within the glass tube thereof, to flow away from the two ends of the circuit-wires that extend to the motor **30** and are sealed into one of the ends of the switch, thereby to break the electrical circuit to said motor. The fuel-bed control mechanism is thereby halted in a position as shown in Fig. 5. As is clearly demonstrated by the above description, the stoker and the fuel-bed-level control in the present embodiment of the invention are operated by the same motor, and, obviously therefore, the stoker is in operation only during the movement of the movable parts of the level control and any obstruction sufficient to halt movement thereof and to turn the mercury switch **30** will immediately stop stoker operation. Thus, jamming of any movable member or similar operation failure of the control will simultaneously stop stoker operation and will automatically prevent overloading of the furnace firebox.

Spring **75** should be strong enough not only to

resist compression during the forward movement of the reciprocatory plate and until a preferred, predetermined contact-pressure with the fuel-bed is reached, but must also be sufficiently strong to drive the plate forward by its own expansion after fuel obstructing the plate's movement has been removed by combustion in the furnace. This expansion of spring 75 reestablishes the original length of the composite link, and drives plate 60 to the completion of its forward stroke. The independent movement of rod 69 moving upwardly in sleeve 70, turns rotatable arm 78 in a counter-clockwise direction by means of the connection of pin 71 and rigid wire 76. The inclination of the "Mercoid"-type switch then causes the mercury globule 82 to flow back to the contact points of the electrical circuit which is thereby opened for flow of current to the motor 30.

The motor 30 again drives sprocket wheel 52 in counter-clockwise movement moving slotted sleeve 70 alternately upwardly and downwardly. During the downward thrust of the sleeve the heads of its slots 72 come in contact with the rigidly attached pin of connecting-rod 69, thereby driving said connecting-rod positively in a downward direction. By their downward movement the reciprocably movable plate 60 is moved away from the edge of the fuel-bed and toward the outer edge of firedoor box 27 to an extent as indicated by the dotted lines X, X, in Fig. 4.

The operation of the apparatus comprising the invention and of the particular embodiment previously set forth is hereinafter described. As shown in Fig. 4, reciprocatory plate 60 has just completed its forward stroke and the front edge of said plate is in pressure-contact with the fuel-bed. Let it be assumed that fuel delivered during another revolution of sprocket wheel 52 will be sufficient to produce the preferred fuel-bed level and the predetermined contact-pressure with said plate. The spring 75 will then be compressed, the plate 60 will be held by the spring against the edge of fuel-bed 42, and the motor will be shut off as above described. Continued combustion of the fuel will lower fuel-bed 42, remove the obstruction of solid fuel from the path of reciprocatory plate 60, and in turn lower the contact-pressure therebetween. When a value below a predetermined contact-pressure is reached, the resulting freedom of movement for said plate will allow spring 75 to expand and to drive said plate 60 forward completing its stroke, and, in the above-described manner will open the circuit to the motor 21 that also actuates as a unit therewith the bin-discharging plate, the inclined belt of the overfeed stoker, the fuel-bed-level control and the grate-shaking apparatus.

Solid fuel in bin 10 naturally gravitates to feeder trough 12 and forms beneath the protecting overhang of front dam 14 a small, substantially uniform pile. From feeder-trough 12 the fuel is uniformly fed to endless belt 21 by the reciprocatory feeder plate 11, operated in its reciprocatory motion by tail pulley 23 through the linkage hereinbefore described. Fuel is carried by belt 21 in an upward movement, as indicated by the arrows, in Fig. 1, over the head of pulley 25, whence it falls, guided by chute 26 onto plate 60, from which it caroms into combustion-chamber 43. The reciprocatory movement of plate 60 augments the distributive effect obtained by the deflecting angle of said plate, and in this and other instances when fuel is fed to the furnace from a stoker or from even a hopper discharge disposed over the reciprocatory plate, it does not impede, but rather assists in the distribution of the inflowing fuel. The angle of said plate 60 may be adjusted to serve to deflect to a preferred degree the impinging pieces of solid fuel, and by the resulting change in the angle of contact of said plate with the fuel-bed, to maintain a preferred volume of solids in said fuel-bed.

When motor 30 for the fuel-feeding system is in operation, it also slowly moves the grate 41 to an extent that can be made adjustable as hereinbefore indicated to keep the fuel-bed substantially free from ash without removing live fuel, and thus to reduce the possibilities of clinker formation. Although the grate is driven by the same source as that which drives the fuel-feeding means, it is caused to operate more slowly and within adjustable limits by the hereinbefore described mechanical arrangement. The grate is slowly moved automatically during the entire time that the stoker is in operation, and the resultant removal of ashes provides space for inflowing fuel in the fuel-bed and assures the presence of sufficient live fuel therein.

During the feeding of fuel to the combustion-chamber, the fuel-bed-level control is continuously in operation, and accordingly the reciprocatory plate 60 thereof is in continuous reciprocatory motion, until in its resiliently-driven forward movement, it is obstructed and held by the accumulated fuel in the fuel-bed. At this time continued counter-clockwise movement of the sprocket wheel 52 and continued upward movement of slotted sleeve 70 again compresses spring 75, again tilts "Mercoid"-type electric switch 80, and breaks the circuit to motor 30.

When the edge of fuel-bed 42 adjacent the level control has been raised to the proper level, plate 60 comes in contact therewith and pushes loose and freshly charged fuel further over the surface of said fuel-bed. The angle of the fuel-bed surface and the depth of said bed can be established as predeterminedly preferred by several adjustments, such as: altering the tension of spring 75 by turning adjusting nut 74; changing the point of linkage of connecting-rod 69 with link 68 which governs the relative reaches of the backward and forward strokes of reciprocatory plate 60; altering the inclination of reciprocatory plate 60; or by any of these adjustments in combination.

After a completion of a period of feeding of fuel to the combustion-chamber to restore a preferred and predetermined fuel-bed volume, operation of all individual units of the above-described assembly are at rest but are ready immediately to respond to the demand of the level control for fuel additions to the firebox.

The invention as hereinbefore set forth is embodied in a particular form and manner but may be variously embodied within the scope of the claims hereinafter made.

I claim:

1. Apparatus adapted to control the fuel-bed level in a furnace by regulable delivery of solid fuel thereto, and comprising: a plate-like member adapted for reciprocatory, inclined motion adjacent a fuel-bed within the furnace firebox; a motor; a reciprocatory lever system adapted for driving said member by said motor and comprising, resiliently-co-operative members arranged to change the effective length of a link of said system during one direction of their movement and in response to a predetermined pressure between said plate-member and said fuel-bed; and an

electrical switch that is operative by said cooperative members and is arranged to employ changes in the effective length of said link to control flow of electrical current through a circuit wherein a motor for operating fuel-feeding means for said furnace is included.

2. Apparatus adapted to control the fuel-bed level in a furnace by regulable delivery of solid fuel thereto, and comprising: a plate-like member adapted for reciprocatory, inclined motion adjacent a fuel-bed within a furnace firebox; a motor for operating said member and for driving a fuel-feeding means for said furnace; a reciprocatory lever system that is adapted for driving said member by said motor and comprises a link that itself comprises, coaxial and slidably disposed members joined by resilient means arranged to permit increase and recovery of said link's original length respectively at a predetermined pressure between said fuel-bed solids and said plate-like member and at a reduction of said pressure thereof; and an electrical switch that is operative by said coaxial members and is arranged to employ changes in the effective length of said link to control flow of an electrical current through a circuit wherein said motor is included.

3. In a system for transporting solid fuel from a storage to a combustion-chamber of a furnace in said system, the combination of: a reciprocatory linkage disposed to drive a plate-like member into and out of contact with solids in the fuel-bed of said chamber; and in said linkage a link that comprises, a plurality of coaxial members that are slidably disposed in respect of each other under the influence of resilient means arranged to permit increase and recovery of said link's original length respectively at a predetermined pressure between said fuel-bed solids and said plate-like member and at reduction of said pressure, said link being arranged by change in its effective length to operate an electrical switch disposed to control flow of electrical current through a circuit wherein is included a motor that is adapted for operating fuel-feeding means for said furnace and also for driving said reciprocatory linkage.

4. In a system comprising a furnace having a grate and fuel-feeding means therefor, control means for regulating the level of solids in a fuel-bed on said grate, and comprising: a reciprocatory plate-like member that is covered at least in part by a stationary plate across which flows solid fuel delivered to said fuel-bed by said fuel-feeding means, said reciprocatory plate-like member being adapted to reciprocate below said stationary plate into and out of contact with surficial solids of said fuel-bed; a motor for actuating said plate-like member and said fuel-feeding means; an electrical circuit arranged to deliver current to said motor; and means including a switch responsive to the fluctuations in pressure-contact between said plate-like member and said fuel-bed, said switch being further disposed alternately to close and to open said electrical circuit respectively above and below a predetermined pressure-contact between said member and said fuel-bed.

5. In a system having apparatus adapted to transport solid fuel from a storage therein to a combustion-chamber having a grate, means for regulating the level of solids delivered by said apparatus to the fuel-bed of said combustion-chamber, said controlling means comprising: a reciprocatory member adapted for movement into intermittent contact with a marginal surface of the fuel-bed; a driving device adapted for operating the fuel-transporting apparatus and the reciprocatory member; means for operatively connecting said driving device and said reciprocatory member, said connecting means being itself arranged for reciprocatory motion and comprising a resilient member that is arranged for recoverably yielding to a predetermined pressure between said reciprocatory member and said fuel-bed; and a control member that is adapted for optional operation of said driving device and for actuation by the yielding of said resilient member of said connecting means.

6. In a system adapted to transport solid fuel from a storage therein to a combustion-chamber having a grate, means for controlling the level of solids in the fuel-bed of said combustion-chamber, said controlling means comprising: a reciprocatory member adapted for movement into intermittent contact with a marginal surface of the fuel-bed; means for operatively connecting the same with a driving device therefor, said connecting means being itself arranged for reciprocatory motion and comprising a resilient member arranged for recoverably yielding at a predetermined pressure between said reciprocatory member and said fuel-bed; and a control member that is adapted for optionally operating said driving device and for actuation by the yielding of said resilient member of said connecting means.

7. Apparatus adapted to control the fuel bed level in a furnace by regulable delivery of solid fuel thereto comprising: a member adapted for reciprocatory motion by substantially equal unidirectional displacement of all portions of said member, and adjustable, in respect of and adjacent a fuel bed within the furnace firebox and having means disposed for contact with solids of the fuel bed during at least one of its directions of movement upon reciprocation thereof; a motor; mechanism operable by said motor for driving said member, said mechanism being arranged for reciprocatory motion and comprising recoverably yieldable means adapted to yield, on movement of the mechanism in its direction for movement of the member towards the fuel bed, so as to accommodate the arrestment of the movement of said member by resistance of the fuel bed when the level of the fuel bed rises in the firebox into arresting relationship with said member, and adapted to recover, on release of the resistance of the fuel bed when its level recedes, so as to complete the arrested movement of the member towards the fuel bed; fuel feeding means for said furnace; an electrical circuit for operating the same, including controlling means for the circuit; and a device operable to actuate said controlling means, said device being connected with said mechanism so as to be operated by the yielding and recovery movements of the recoverably yielding means, to actuate the controlling means to stop the operation of the fuel feeding means on the yielding movement, and to resume the operation of the fuel feeding means on the recovery movement.

8. In a system adapted to transport solid fuel from a storage therein to a combustion-chamber having a grate, means for maintaining the level of solids in a fuel bed in said chamber and comprising: a member disposed for contact with solids at the upper surface of said fuel-bed and adapted for movement into and out of contact therewith by substantially equal unidirectional displacement of all portions of said member, thereby to avoid continuous contact of said member with

hot solids of the fuel-bed surface; connected with said member, resilient means that are sensitive to a variation of a predetermined degree for pressure of contact between said member and fuel bed solids at a predetermined level for the upper surface of the bed; a motor operative by an electrical current to actuate fuel-transporting means for the fuel-feed member; and a motor control switch operable by said resilient means alternately to stop and to start said motor with alternate changes of pressure above or below the predetermined degree for contact-pressure between said fuel bed solids and said feed member.

9. In fuel feeding mechanism, the combination of a receptacle adapted to contain a fuel bed therein, means for feeding material to said receptacle, a member extending laterally into said receptacle and having means in position to bear upon the material in the receptacle, means for guiding said member in rectilinear movement relative to the receptacle, means for actuating said member relative to the guide means to reciprocate said bearing means across the fuel in contact therewith, and means operatively connected with said member and constructed for controlling the feeding of fuel by said fuel feeding means in response to the obstruction by the height of the fuel bed to the movement of said bearing means across the fuel bed, whereby the quantity of fuel fed to the heater is automatically controlled.

10. In a system adapted to transport solid fuel from a storage therein to a combustion-chamber having a grate adapted to support a fuel bed thereon, means for maintaining the level of solids in the fuel bed of said chamber, said means comprising a reciprocable level-determining member that is disposed to move rectilinearly during its reciprocatory movement across and in pressure contact with the solids at the upper surface portion of said fuel bed, a device adapted for operation alternately to stop and to start a mechanism for transporting solid fuel from said storage to said combustion chamber, said device including means operable in response to the obstruction by the height of the fuel bed to the movement of said reciprocable member across the fuel bed to stop said mechanism and to start said mechanism when the obstruction to said movement is removed.

11. In a system having apparatus adapted to transport solid fuel from a storage therein to a combustion-chamber having a grate, means for regulating the level of solids delivered by said apparatus to the fuel-bed of said combustion-chamber, said regulating means comprising: a member adapted for alternating movement and arranged for contact with a surface of the fuel-bed on a movement of said member during movement thereof in at least one of its directions of movement upon alternating movement thereof; a driving device adapted for operating the fuel-transporting apparatus and said member; means for operatively connecting said driving device and said member, said connecting means comprising a link arranged for reciprocatory motion and itself comprising a resilient member that is arranged for recoverably yielding to a predetermined pressure between said member and said fuel-bed; and a control member that is adapted for optional operation of said driving device and for actuation by the yielding of the resilient member of said link of the connecting means.

12. In a system adapted to transport solid fuel from a storage therein to a combustion-chamber having a grate, means for controlling the level of solids in the fuel-bed of said combustion-chamber, said controlling means comprising: a reciprocatory member adapted for reciprocatory movement and arranged for contact with a marginal surface of the fuel-bed on a movement of said member during movement thereof in at least one of its directions of movement upon reciprocatory movement of said reciprocatory member; means for operatively connecting the same with a driving device therefor, said connecting means comprising a link arranged for reciprocatory motion and itself comprising a resilient member arranged for recoverably yielding at a predetermined pressure between said reciprocatory member and said fuel-bed; and a control member that is adapted for optionally operating said driving device and for actuation by the yielding of the resilient member of said link of the connecting means.

13. Apparatus adapted to control the fuel-bed level in a furnace by regulable delivery of solid fuel thereto, and comprising: a member adapted for motion adjacent a fuel-bed within the furnace fire-box; a motor; a reciprocatory lever system adapted for driving said member by said motor and comprising, resiliently co-operative members arranged to change the effective length of a link of said system during one direction of their movement and in response to a predetermined pressure between said first mentioned member and said fuel-bed; and an electrical switch that is operative by said co-operative members and is arranged to employ changes in the effective length of said link to control flow of electrical current through a circuit wherein a motor for operating fuel-feeding means for said furnace is included.

14. Apparatus adapted to control the fuel bed level in a furnace by regulable delivery of solid fuel thereto comprising: a member disposed for contact with solids of a fuel bed within a furnace firebox and mounted for alternating movement into and out of contact therewith, thereby to avoid continuous contact of said member with hot solids of the fuel-bed, a motor; mechanism operable by said motor for driving said member, said mechanism comprising recoverably yieldable means adapted to yield, on movement of the mechanism in its direction for movement of the member towards the fuel bed, so as to accommodate the arrestment of the movement of said member by resistance of the fuel bed when the level of the fuel bed rises in the firebox into arresting relationship with said member, and adapted to recover, on release of the resistance of the fuel bed when its level recedes; so as to complete the arrested movement of the member towards the fuel bed; fuel feeding means for said furnace; an electrical circuit for operating the same by means of the aforesaid motor, including controlling means for the circuit; and a device operable to actuate said controlling means, said device being connected with said mechanism so as to be operated by the yielding and recovery movements of the recoverably yielding means, to actuate the controlling means to stop the operation of the motor and of the fuel feeding means on the yielding movement, and to resume the operation of the motor and of the fuel-feeding means on the recovery movement.

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