

Feb. 18, 1941.

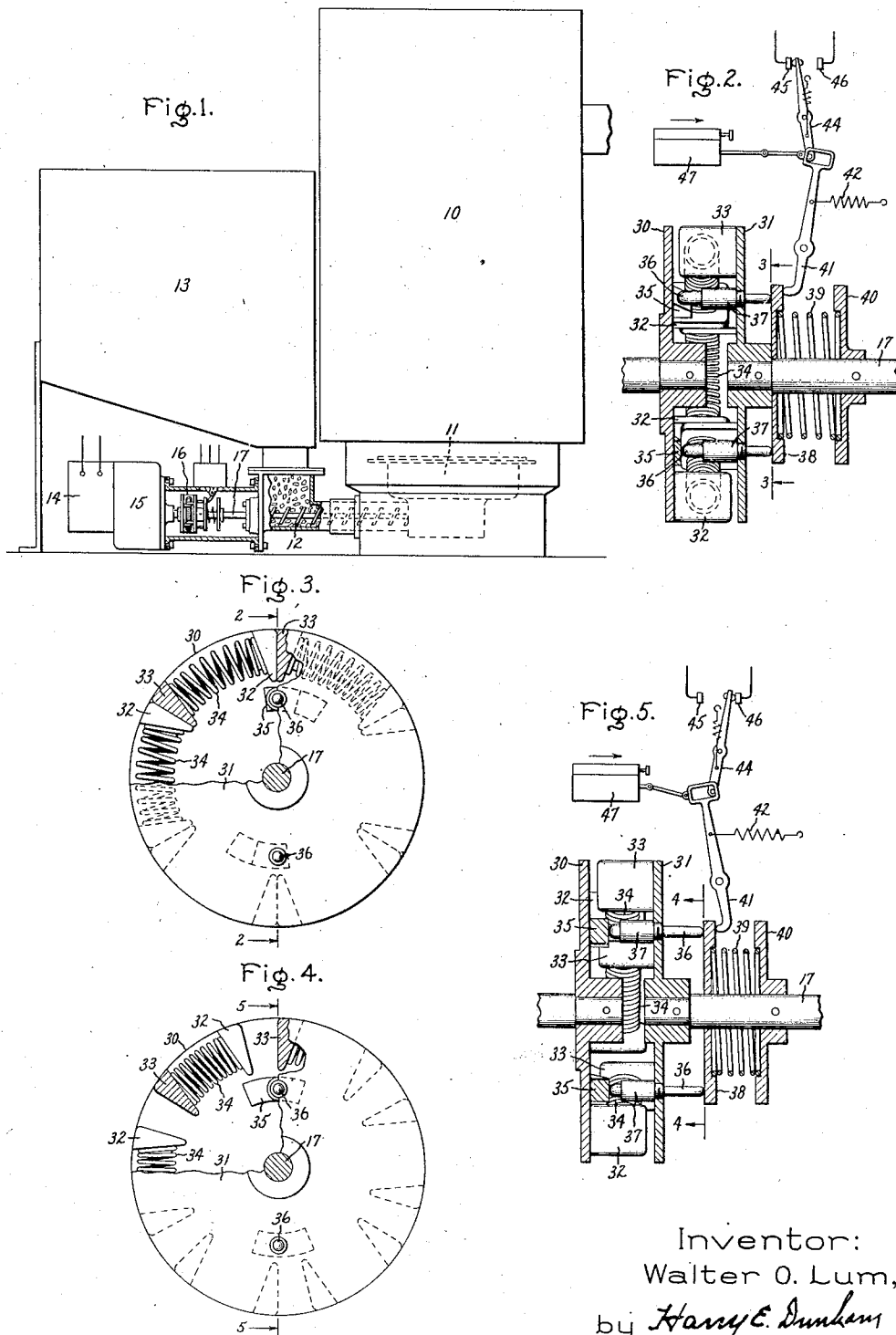
W. O. LUM

2,232,545

STOKER DRIVING ARRANGEMENT

Filed Nov. 16, 1939

3 Sheets-Sheet 1



Inventor:
Walter O. Lum,
by *Harry E. Dunham*
His Attorney.

Feb. 18, 1941.

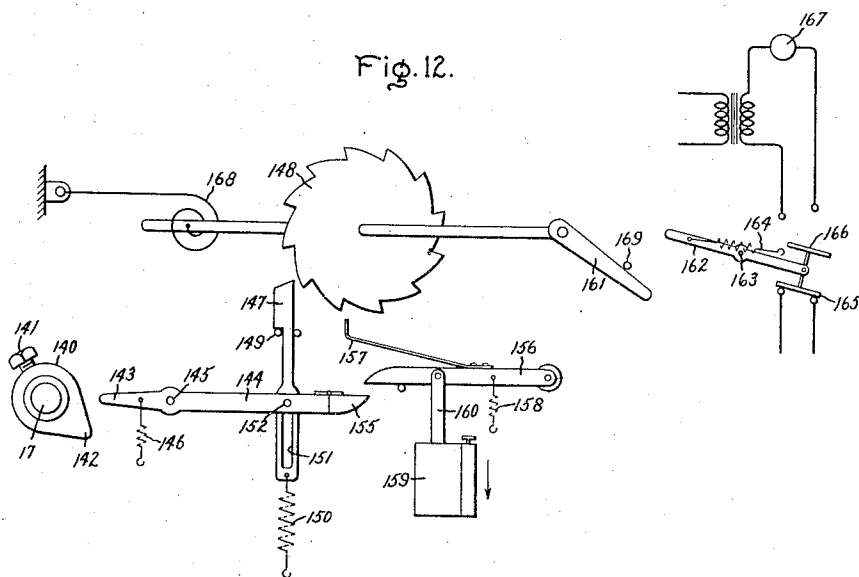
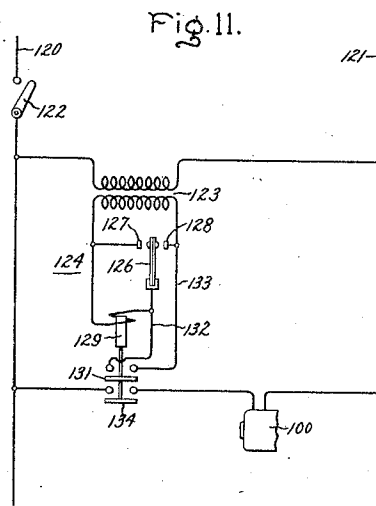
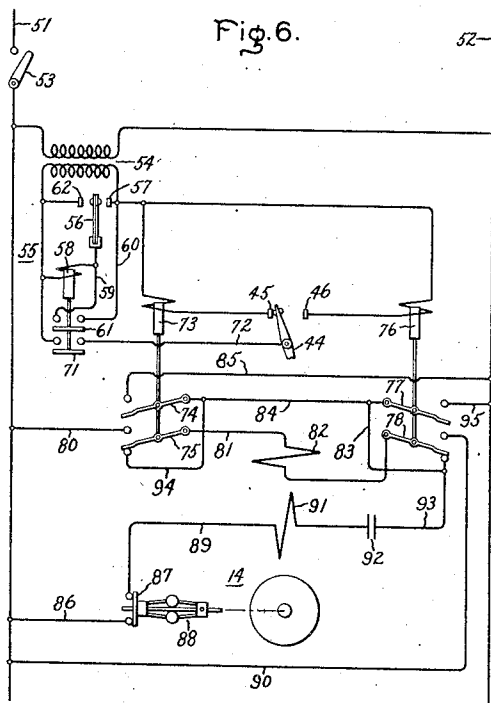
W. O. LUM

2,232,545

STOKER DRIVING ARRANGEMENT

Filed Nov. 16, 1939

3 Sheets-Sheet 2



Inventor:
Walter O. Lum,
by *Harry E. Dunham*
His Attorney.

Feb. 18, 1941.

W. O. LUM

2,232,545

STOKER DRIVING ARRANGEMENT

Filed Nov. 16, 1939

3 Sheets-Sheet 3

Fig. 7.

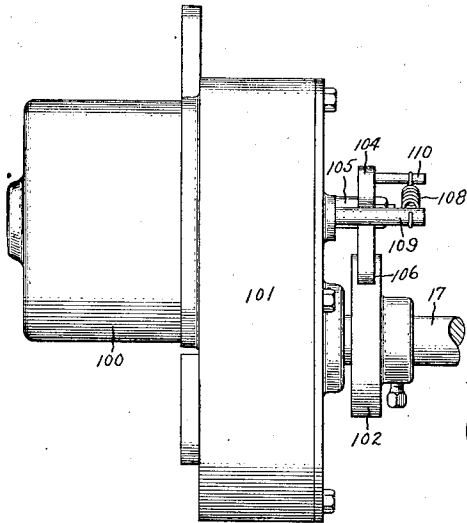


Fig. 8.

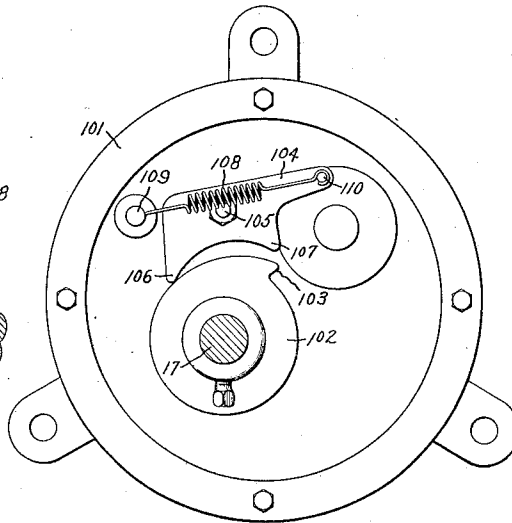


Fig. 9.

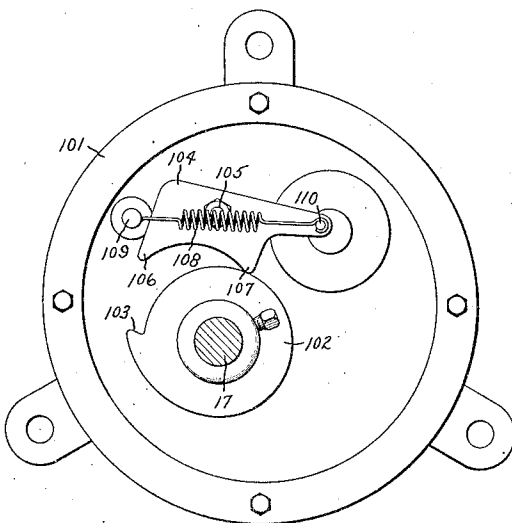
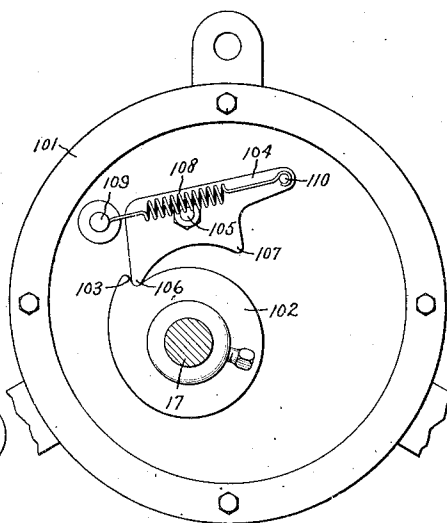


Fig. 10.



Inventor:
Walter O. Lum,
by *Harry E. Dunham*
His Attorney.

UNITED STATES PATENT OFFICE

2,232,545

STOKER DRIVING ARRANGEMENT

Walter O. Lum, West Orange, N. J., assignor to
General Electric Company, a corporation of New
York

Application November 16, 1939, Serial No. 304,754

15 Claims. (Cl. 198—213)

This invention relates generally to operating mechanisms for material conveying systems and more particularly for screw type coal conveyors of a furnace stoker arrangement.

5 Material conveying systems such as mechanical fuel stokers are liable to become clogged for various reasons such as by congestion of the material, or by large pieces of coal, pieces of metal or other foreign material becoming caught
10 between the screw and the edges of the hopper opening, resulting in the stalling of the driving motor. Means are usually provided in the driving connection between the motor and the conveyor screw to automatically sever the connection or to deenergize the motor upon the occurrence of a predetermined overload condition. Each time the motor becomes stalled and disconnected by reason of the conveyor becoming jammed, it is necessary for a person to investigate
20 the cause of the difficulty and to clear away the obstruction before the motor may be reset for the continuation of operation. This procedure involves more or less manual labor, is expensive and generally unsatisfactory. In the majority
25 of instances, the jammed condition of the conveyor may be rectified by temporarily reversing the direction of operation of the motor and subsequently operating it forward again. If necessary, the reversal of the motor may be repeated
30 several times until the passage becomes clear and free of the obstruction. It is therefore the principal object of this invention to provide a driving mechanism for a material conveying system which is automatically controlled upon the occurrence of a clogged condition of the conveyor
35 system for temporarily reversing the direction of operation of the driving motor, which operation is repeated until the conveyor is free of the obstruction causing its clogging.

40 Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with greater particularity in the claims annexed hereto and forming a part of this specification.

For a better understanding of my invention, reference may be had to the accompanying drawings in which Fig. 1 represents a furnace equipped
50 with a stoker mechanism and driving means therefor; Figs. 2 and 3 are enlarged views partly in section of a torque responsive coupling arranged between the motor and stoker shown in Fig. 1; Figs. 4 and 5 are views similar to Figs. 2
55 and 3, respectively, showing the coupling in a sec-

ond operative position; Fig. 6 is a schematic circuit diagram illustrating a control scheme for the motor of Fig. 1; Fig. 7 illustrates a second embodiment of the invention in which a different and particular type of motor is substituted for that shown in Fig. 1; Figs. 8, 9 and 10 illustrate various positions of the mechanical control means for the motor illustrated in Fig. 7; Fig. 11 is a schematic circuit diagram for the control of the motor shown in Fig. 7; and Fig. 12 is a schematic diagram illustrating an automatic timing mechanism for use in connection with either modification.

Referring now to Fig. 1 of the drawings, 10 is a furnace having a firepot 11 arranged in the lower portion thereof to which fuel is fed by means of a suitable stoker or conveyor screw 12 from a storage bin or hopper 13. A suitable motor 14 having a speed reduction gearing 15 is coupled through a torque responsive device 16 to the shaft 17 of the conveyor screw. The motor 14 is of a reversible type, as will be more fully described hereinafter, and is adapted for driving the conveyor screw in the forward direction to advance fuel from the bin 13 to the firepot 11. Upon the conveyor screw 12 becoming clogged or stalled for any reason, such as by a large lump of coal getting caught at the inlet thereto, the torque responsive device 16 will effect the reversal of the connection to the motor 14 to reverse the rotation of the screw for a predetermined period of time. The period of reverse operation of the motor is limited to merely one or two revolutions of the conveyor screw 12 so as not to feed live coals from the firepot 11 into the storage bin 13. Subsequent to the period of reverse operation, the motor 14 will be automatically reconnected for operation in the forward direction again and after a number of such reversals the congestion causing the stalling will be cleared away, or the large lump of coal will be broken up and the advancement of fuel will continue in the regular manner.

Referring now to Figs. 2 and 3, the details of the torque responsive device 16 will be described. This device comprises a pair of similar disks 30 and 31, disk 30 being keyed to the motor driving shaft while disk 31 is keyed to the driven or conveyor shaft 17. A portion of disk 31 is broken away for the purpose of more clearly illustrating the structure of the facing surfaces of the cooperating disks. A number of suitably spaced apart lugs 32 are integral with the peripheral portion of the disk 30. A similar number of similarly spaced apart lugs 33 are provided in-

tegral with the adjacent face of the disk 31. Springs 34 are arranged between the lugs 32 and 33 to maintain the backs of the pairs of adjacent lugs of the two disks in an abutting relationship as shown. Assuming now that the coupling is being driven in the fuel advancing direction, or counterclockwise, and that the conveyor screw 12 operating in the forward direction becomes clogged creating a predetermined abnormal increased resistance to rotation of the driven disk 31, due to an increase in torque applied to the driving disk 30 by the motor, the springs 34 will be compressed and the normally abutting lugs 32 and 33 will be separated, as indicated more clearly in Fig. 4. This relative angular displacement of the disks 30 and 31 from their normal relationship will cause the cams 35, which are integral with disk 30, to engage with the plungers 36, which are slidably mounted in bushings 37 secured to disk 31, to force the plungers to the right against the collar 38. The collar 38 is normally biased to the left by means of a spring 39 arranged between the collar 38 and a stop 40 fixed to the shaft 17. The collar 38 being axially movable upon the shaft 17, when engaged by the end of the plunger 36, will be forced to the right to pivot the engaging circuit controller lever 41 in the counterclockwise direction against the force of the biasing spring 42 as shown in Fig. 5. The upper end of the controller lever 41 is loosely connected to the overcenter snap acting switch arm 44 and upon actuation of the lever 41, the switch 44 is thrown over to its second operative position, disengaging the fixed contact 45 and engaging fixed contact 46. Connected to the lever 41 is a suitable time delay device 47 which retains the lever 41 in the operated position, illustrated in Fig. 5, for a predetermined length of time after which the lever 41 is returned to its normal position, as indicated in Fig. 2, by the biasing spring 42. It is understood that immediately following the initial operation of the lever 41, the motor connections are reversed whereupon the conveyor screw 12 is driven in the reversed or clockwise direction. During reverse operation of the motor the lugs 32 of the driving disk 30 engage directly with the abutting faces of the lugs 33 of the driven disk 31 and positively rotate the conveyor screw 12 in the reversing direction. It is obvious, therefore, that the collar 38 will be restored to its normal position immediately following the reversal of the motor connections, while the time delay device maintains the reversing connection for the stoker motor 14 for a predetermined length of time, sufficient for the screw 12 to make one or two complete revolutions in the backward direction.

Referring now to Fig. 6, the electrical control system for the stoker driving motor 14 will be described. Current may be supplied to the system from a suitable alternating-current source indicated by the supply lines 51 and 52. To initially energize the system the control switch 53 may be closed, which connects the primary winding of the transformer 54 directly across the supply lines. The operation of the stoker is normally primarily controlled by means of a thermostat 55 which may be suitably arranged within the enclosure to be heated by the furnace 10. The thermostat 55 comprises a temperature responsive bimetallic element 56 which upon a predetermined low temperature condition engages with the fixed contact 57 to connect the winding of relay 58 across the secondary winding of the transformer 54. Upon the pick-up of the relay

58 a holding circuit is completed therefor through the conductors 59 and 60 and contact arm 61 paralleling the thermostat element 56 and fixed contact 57. Upon a predetermined high temperature condition occurring within the enclosure the thermostat element 56 will bend to the left engaging with the fixed contact 62, thereby short circuiting the relay winding 58 causing it to drop to the deenergized position.

Assume first that the furnace is in normal operation and that the enclosure thermostat calls for heat. The contact arm 71 of the relay 58 establishes a control circuit for connecting the stoker motor 14 for operation in the forward direction. This circuit extends from the left-hand terminal of the secondary winding of transformer 54 through the contact arm 71, line 72, torque switch arm 44, fixed contact 45, winding of relay 73, to the right-hand terminal of the secondary winding of transformer 54. As the relay 73 picks up, its contact arms 74 and 75 establish circuits for energizing the motor 14 for operation in the forward running direction. The motor will be maintained in operation until the demand for heat by the enclosure is satisfied, when the thermostat element 56 will engage with the fixed contact 62 to cause the relay 58 to drop out, thereby deenergizing the control relay 73. If, however, the conveyor screw 12 becomes stalled, the torque switch 44 will be operated to engage the fixed contact 46, thereby energizing the relay 76 which picks up contact arms 77 and 78 to establish circuits for operating the motor 14 in the reverse direction. As previously explained, after a predetermined time the torque switch 44 will be restored to the normal position engaging with fixed contact 45, thereby deenergizing relay 76 and energizing relay 73 to again connect the motor 14 for operation in the forward direction.

The forward running circuit for the motor established by the pick-up of relay 73 extends from the supply line 51 through line 80, contact arm 75 of the relay 73 in the energized position, line 81, the running winding 82 of the motor 14, contact arm 78 of the relay 76 in the deenergized position, lines 83, 84, contact arm 74 of relay 73, line 85, to the other supply line 52. Another circuit is established for energizing the starting winding of the motor 14 extending from the supply line 51 through line 86, contactor 87 of the motor speed responsive device 88, line 89, motor starting winding 91, capacitor 92, lines 93, 94, contact arm 74 of the relay 73, line 85, to the other supply line 52. As soon as the motor reaches approximately normal speed, the centrifugal device 88 will open the contacts 87 to effect the deenergization of the starting winding 91. The reversing circuit for the motor established by the pick-up of relay 76 extends from the supply line 51 through line 90, contact arm 78 of the relay 76 in its upper position, running winding 82 of the motor 14, the contactor arm 75 of the relay 73 in its lower position, connection 94, line 84, contact arm 77 of the relay 76 in its upper position, line 95, to the other supply line 52. The starting winding connection is of course not reversed but is completed through contact arm 77 of relay 76.

In a second and preferred embodiment of my invention, I utilize a self-reversing motor in lieu of the motor 14 described above. Such a motor is described in the Patent No. 2,105,514, Alfred S. Welch, issued January 18, 1938, and assigned to the General Electric Company, the assignee of the present invention. This motor has such

a characteristic that it will drive any load less than that corresponding to its pullout torque but when it encounters a load which it cannot carry at synchronous speed, it immediately stops because its synchronous torque is greater than any torque below synchronous speed and if the motor remains energized when thus stopped by an overload in one direction, it will immediately start up in the opposite direction. It will continue to run in this direction until it is again stalled, when it will commence to rotate in the forward direction again. Referring to Fig. 7, such a motor 100 is shown provided with suitable speed reducing gearing in casing 101 and is adapted to be fast coupled to the fuel advancing screw shaft 17. When initially energized, the motor may start in either direction and will drive the fuel conveyor screw in either direction until it is stalled for any reason, when the motor will automatically reverse its direction of rotation. A ratchet means is provided for limiting the rotation of the motor in the reverse direction which is more clearly shown in the end views 8, 9 and 10. A ratchet disk 102 is secured to the shaft 17 and is provided with a shoulder or stop 103 facing away from the direction of normal or forward rotation of the motor. A cooperating pawl 104 is pivoted as at 105 to the gear housing 101 and is provided with a toe 106 and a heel 107. The pawl 104 is biased to either of two positions by means of an overcenter spring 108 arranged between a stud 109 and one end 110 of the pawl 104. During forward rotation of the motor, when the disk 102 is rotated in the counterclockwise direction, the pawl 104 will be merely rocked about its pivot as the tip of the stop 103 alternately strikes the heel 107 and the toe 106. Now assume that the torque of the motor in the forward direction has been overpowered by the resistance of the fuel advancing screw by reason of its having become clogged. The motor will immediately start up in the opposite or clockwise direction of rotation. Assume that at the moment of reversal the ratchet disk and pawl are in the relative positions in Fig. 9. The disk 102 rotating clockwise will first strike the heel 107, which is riding on the edge of the disk, rocking the pawl about its pivot so that the toe 106 is moved into engagement with the disk edge by means of the overcenter spring 108. As the stop 103 comes around a second time, it will engage with the toe 106 of the pawl 104. The motor thereupon will be stalled and it will immediately start up in the opposite or forward direction of rotation. The motor will continue to operate in the forward direction until the fuel advancing screw jams again or until the motor is deenergized by the operation of the control to the open circuit position. By the ratchet arrangement shown, the rotation of the motor in the reversing direction will continue for more than one revolution and is positively limited to a maximum of two complete revolutions of the fuel conveyor screw.

The electrical control system for the motor just described is relatively simple in that no apparatus is required for reversing the motor connections. As illustrated in Fig. 11, power is adapted to be supplied to the stoker motor from a suitable alternating-current source of supply through the leads 120, 121, a suitable switch 122 being provided in the line 120 for controlling the energization of the system. Upon the closure of switch 122, the primary winding of the transformer 123 is connected across the supply lines,

thereby energizing the enclosure thermostat 124. The enclosure thermostat 124 is similar to the thermostat 55 and comprises a bimetallic temperature responsive element 126 adapted to engage with either of two oppositely arranged fixed contacts 127 and 128. Upon the temperature within the enclosure dropping below a predetermined value, the element 126 will bend to the right engaging with fixed contact 128, thereby connecting the winding of relay 129 across the secondary winding of the transformer 123. Upon the pick-up of relay 129, a holding circuit will be established therefor by its contactor 131 and the lines 132 and 133 paralleling the thermal responsive element 126 and fixed contact 128. Upon the pick-up of relay 129, its contactor 134 will complete an energizing circuit for the motor 100. The operation of the motor 100 will be continued until the demand for heat by the enclosure is satisfied, as indicated by the bending of the thermal responsive element 126 to the left engaging with the fixed contact 127 which short-circuits the winding of relay 129, causing it to drop out and open-circuiting the motor 100.

Although it is not essential to the practice of this invention, I prefer to embody means operable in conjunction with either modification for deenergizing the motor circuits and completing an alarm circuit in the event that the motor does not break through the obstruction after a predetermined number of reversals. Any suitable arrangement may be provided for accomplishing this result such as that shown schematically in Fig. 12. A collar 140 may be secured to the conveyor shaft 17 by means of a set screw 141, the collar being provided with a cam projection 142. The cam is adapted to engage with an end 143 of a lever 144 which is pivoted as at 145 and biased in a counterclockwise direction by means of a relatively light spring 146. The lever 144 is arranged for operating a pawl 147 into engagement with a ratchet wheel 148 to rotate it by steps in a clockwise direction. The pawl 147 is biased against a stop 149 by means of a spring 150 and is provided with a slot 151 for receiving a pin 152 secured to the arm 144. The end of the arm 144 is provided with a hinged tip 155 which is adapted to engage with the end of the pivoted lever 156 to carry it upwardly but not downwardly. Secured to the lever 156 is a spring pawl 157, the end of which is adapted to engage with the teeth of the ratchet disk 148 to retain it in the actuated position as it is moved by the pawl 147. The lever 156 and spring 157 are normally biased to the inoperative position by means of a spring 158. The return of the lever 156 to the inoperative position after actuation by the lever 144 is delayed by a suitable time delay device 159 which is connected to the end of the lever 156 by link 160. Operatively secured for rotation with the ratchet wheel 148 is a switch operating arm 161 which, when rotated through the requisite angle, will engage with the switch lever 162. The switch lever 162 is stationarily pivoted as at 163 and is biased to either one of two operative positions by an overcenter spring 164. The other end of the lever 162 is provided with one contact arm 165 which is adapted to bridge a pair of stationary contacts arranged in the conveyor driving motor circuit. The lever 162 is also provided with a second contact arm 166 which in the tripped position of the lever 162 is adapted to bridge a pair of fixed contacts for completing an energizing circuit for a suitable

alarm device indicated at 167. The ratchet wheel 148 is biased to the reset position by means of a suitable spring 168, this position being determined as by the engagement of lever 161 with the stop 169.

When the conveyor shaft is rotated in the fuel advancing or counterclockwise direction the cam 142 will strike the end of the operating lever 143 to rotate the lever 144 in the clockwise direction. The pin 152 will merely slide downwardly in the slot 151 causing no operation of the pawl 147. The lever 144 will be returned to the normal position each time by the biasing spring 146. Upon the reversal of the stoker motor, as when the conveyor is stalled, the cam 142 will be rotated in the clockwise direction striking the end 143 of the arm 144 to rotate the latter lever in the counterclockwise direction and actuate the pawl 147 upwardly into engagement with the teeth of the ratchet wheel 148. The hinged end 155 of the lever 144 will simultaneously engage with the end of the lever 156 to carry the spring 157 into engagement with the teeth of the ratchet wheel 148. Under the impulse of the pawl 147 the ratchet wheel will be turned through a predetermined angle as measured by the spacing of the teeth. The wheel will be retained in the actuated position for a predetermined time by the spring 157 against the biasing force of the restoring spring 168. The spring 158 will tend to move the lever 156 and spring 157 to the inoperative position but due to the action of the time delay device 159, the return movement will be somewhat delayed.

The time delay device 159 is so adjusted that it will retain the lever 156 in the actuated position for a period, for example, twice as great as the period of each reverse operation of the stoker driving motor. As long as the stoker driving motor continues to alternate in the direction of rotation, the reversals following each other in relatively rapid succession, the ratchet wheel 148 will be progressively advanced until after a predetermined number of reverse operations the switch operating arm 161 engages with the lever 162 to deenergize the motor circuit and close the alarm circuit. After the motor is stopped, the time delay device 159 will drop out, permitting spring 158 to withdraw pawl 157 from the ratchet wheel. Under force of spring 168 the ratchet wheel will be reset, arm 161 moving free of the tripped switch operating lever 162 and into engagement with stop 169. However, if the stoker driving motor should succeed in breaking through the obstruction after a fewer number of reversals, and the conveyor shaft be operated in the forward direction for a period of time greater than the time for which the time delay device 159 is set, the spring 157 will be withdrawn from the ratchet wheel 148 and permit the spring 168 to return the ratchet wheel and the lever 161 to the normal or reset position.

When the alarm circuit is closed indicating that the stoker motor has been shut down by virtue of its inability to break through the obstruction, an attendant may correct the difficulty and reset the switch arm 162 to the operative position indicated.

Having described the principle of operation of my invention together with the apparatus which I consider to represent the best embodiments thereof, I desire to have it understood that the apparatus shown is merely illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In a furnace stoker apparatus, the combination comprising a fuel conveyor, motor means connected to said conveyor for normally driving said conveyor in the forward direction, said motor being automatically reversible in response to a predetermined torque exerted thereby to said conveyor, means for limiting the reverse operation of said conveyor, means for counting the consecutive number of reverse operations of said conveyor, means for deenergizing said motor upon a predetermined consecutive number of reverse operations of said conveyor being counted by said counting means, and means for automatically resetting said counting means upon the consecutive number of reverse operations of said conveyor being less than said predetermined number.

2. In a furnace stoker apparatus, the combination comprising fuel advancing means, motor means connected for normally driving said fuel advancing means in the forward direction, means including said motor for causing the direction of operation of said fuel advancing means to be automatically reversed in response to a predetermined torque exerted thereto by said motor means, means for limiting the reverse operation of said fuel advancing means, means responsive to a predetermined consecutive number of reverse operations of said fuel advancing means for causing the deenergization of said motor, and signal means adapted to be energized upon the deenergization of said motor.

3. In a bulk material handling apparatus, the combination comprising a material conveyor, a motor connected for driving said conveyor normally in the forward direction, means including said motor for automatically reversing the direction of operation of said conveyor in response to said conveyor encountering a predetermined resistance to operation in the forward direction, means for limiting the reverse operation of said conveyor and for causing said conveyor to be operated again in the forward direction, means responsive to a predetermined consecutive number of reverse operations of said conveyor for deenergizing said motor.

4. In a bulk material handling apparatus, material conveying means, a motor connected for normally driving said conveying means in the forward direction, torque responsive means for causing said motor to operate in the reverse direction upon said conveying means encountering a predetermined resistance to operation in the forward direction, means for limiting the reverse operation of said motor, and means responsive to a predetermined consecutive number of reverse operations of said motor for causing the deenergization thereof.

5. In a stoker, the combination with fuel advancing means, a motor for normally driving said fuel advancing means in the forward direction, said motor having the characteristic that it automatically reverses its direction of rotation upon encountering a predetermined resistance to operation in either direction, and ratchet means for limiting the operation of said motor in the reverse direction as regards said fuel advancing means.

6. In a bulk material handling apparatus, the combination comprising a material conveyor, a self-reversing rotatable electric motor fast coupled to said conveyor, said motor being auto-

5 matically reversible upon a predetermined torque being exerted thereby to said conveyor, means for stalling said conveyor after a predetermined period of reverse operation thereof so that said motor may operate in the forward direction again.

10 7. In combination, a stoker apparatus comprising a spiral screw fuel conveyor, a motor fast coupled to said conveyor screw, said motor being automatically reversible upon said conveyor screw encountering a predetermined resistance to operation in the one direction, and means for automatically limiting the operation of said conveyor screw in the reverse direction to a predetermined maximum number of revolutions.

15 8. In a stoker apparatus, the combination including fuel advancing means, a motor for driving said fuel advancing means, said motor being arranged for normally driving said fuel advancing means in the forward direction, a torque responsive device between said motor and said fuel advancing means, a switch responsive to a predetermined actuation of said torque responsive device for altering the electrical connections for said motor for causing the reverse rotation thereof, and means for restoring said switch to the normal condition a predetermined time following the actuation thereof by said torque responsive device.

20 9. In a furnace stoker apparatus, the combination comprising a rotatable screw type fuel conveyor, an electric motor coupled to said conveyor for normally rotating same in the forward direction, means responsive to a predetermined abnormal resistance to rotation of said conveyor in the forward direction, switch means actuable by said means for changing the connections of said motor to cause a reverse operation thereof, and means for restoring said switch to the previous condition a predetermined time following actuation thereof by said first means.

25 10. In a furnace stoker apparatus, the combination comprising fuel advancing means, motor means for normally driving said fuel advancing means in the forward direction, means responsive to a predetermined abnormal effort applied by said motor to said advancing means for causing said fuel advancing means to be driven by said motor means in the reverse direction and means responsive to a predetermined reverse operation of said fuel advancing means for causing the forward operation thereof.

30 11. In a bulk material handling apparatus, the combination comprising a material conveyor, an electric motor for normally driving said conveyor in the forward direction, means responsive to a predetermined abnormal amount of energy

transmitted by said motor to said conveyor, means actuable by said last mentioned means for changing the connections of said motor to reverse the direction of operation thereof and said material conveyor means, and means for limiting the reverse operation of said motor and reconnecting said motor for operation in the forward direction.

35 12. In a bulk material handling apparatus, the combination comprising a material conveyor, 10 means for driving said conveyor normally in the forward direction, means for automatically causing said driving means to reverse the direction of operation of said conveyor means upon said conveyor means encountering a predetermined abnormal resistance to operation in the forward direction, and means for automatically causing said driving means to operate said conveyor means in the forward direction again following a predetermined reverse operation thereof.

40 13. In a furnace stoker, the combination comprising fuel advancing means, motor means connected for normally driving said fuel advancing means in the forward direction, means including said motor means for causing the direction of operation of said fuel advancing means to be automatically reversed upon said fuel advancing means encountering a predetermined abnormal resistance to operation in the forward direction, and means for limiting the reverse operation of said fuel advancing means and causing said motor means to again drive said fuel advancing means in the forward direction.

45 14. In a stoker, the combination with fuel advancing means, a motor for driving said fuel advancing means, said motor being arranged for normally driving said fuel advancing means in the forward direction, means including said motor responsive to a predetermined abnormal resistance to forward operation of said fuel advancing means for reversing the direction of operation of said motor, and means for reconditioning said motor for operation in the forward direction after a predetermined period of operation in the reverse direction.

50 15. In a bulk material handling apparatus, the combination comprising a material conveyor, motor means connected to said conveyor for normally driving said conveyor in the forward direction, means including said motor for causing the direction of operation of said motor to be automatically reversed upon said conveyor encountering a predetermined resistance to operation in the forward direction, and means for limiting the reverse operation of said motor and said conveyor.

55 WALTER O. LUM.