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ROTARY DRYER OPERATION UNDER EMERGENCY CONDITIONS

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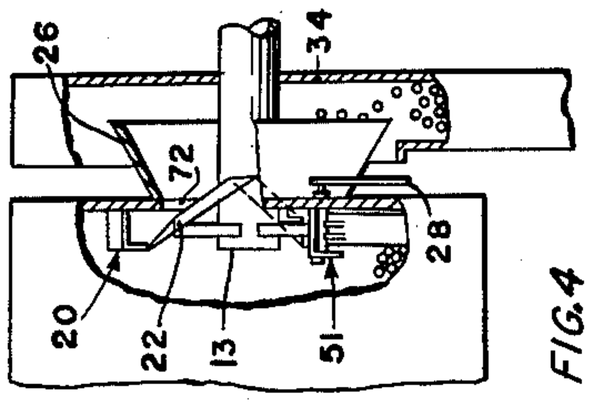

FIG. 4

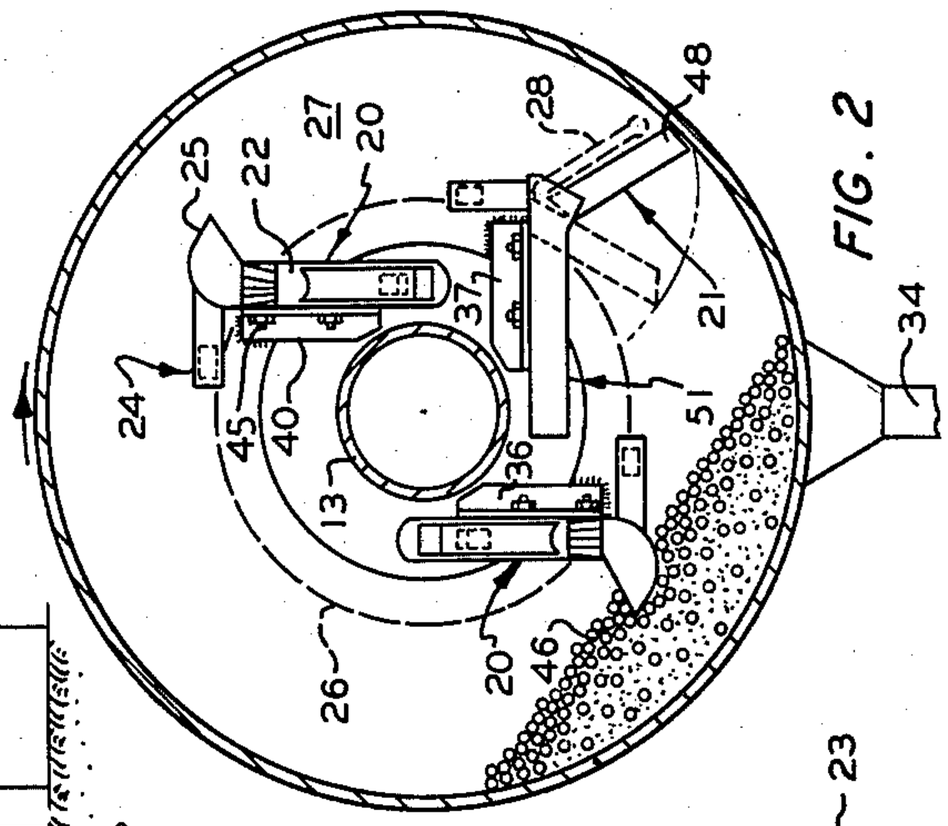

FIG. 2

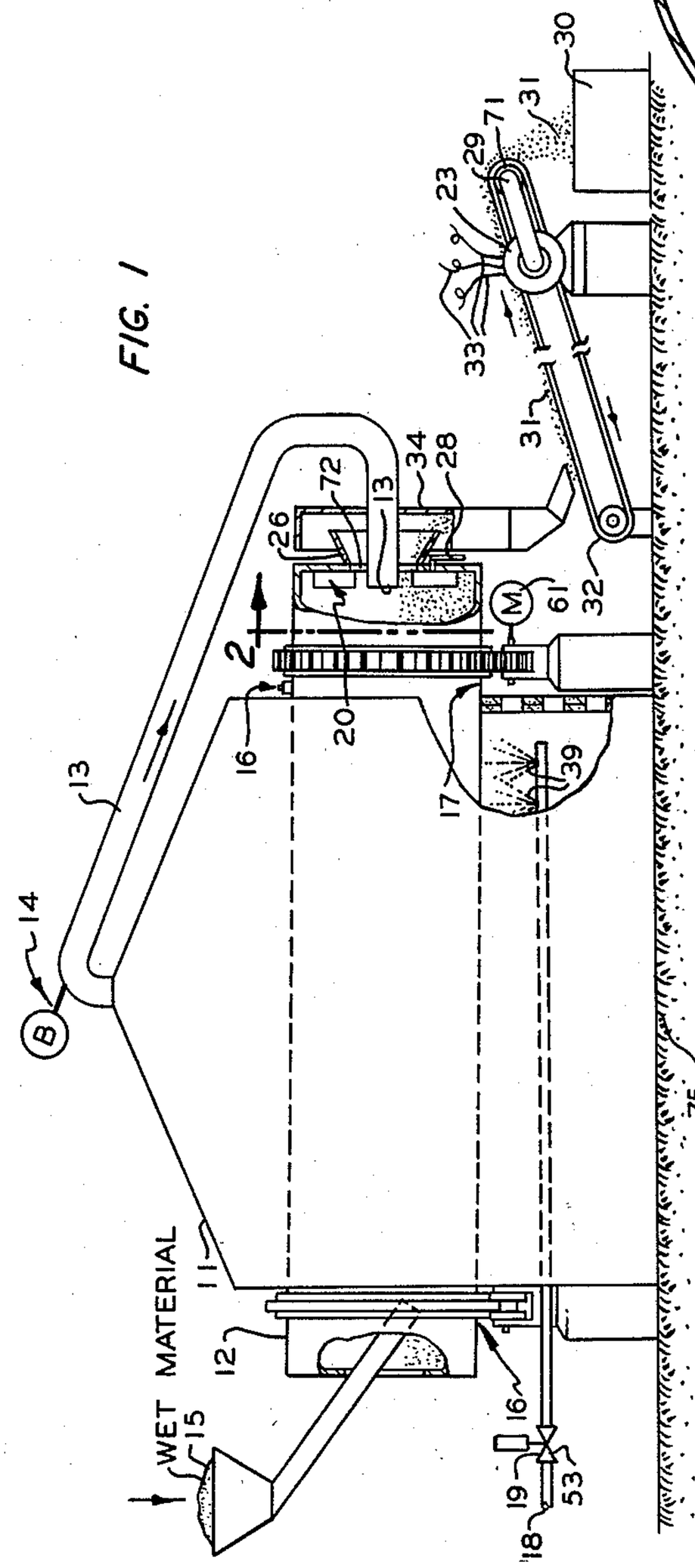

FIG. 1

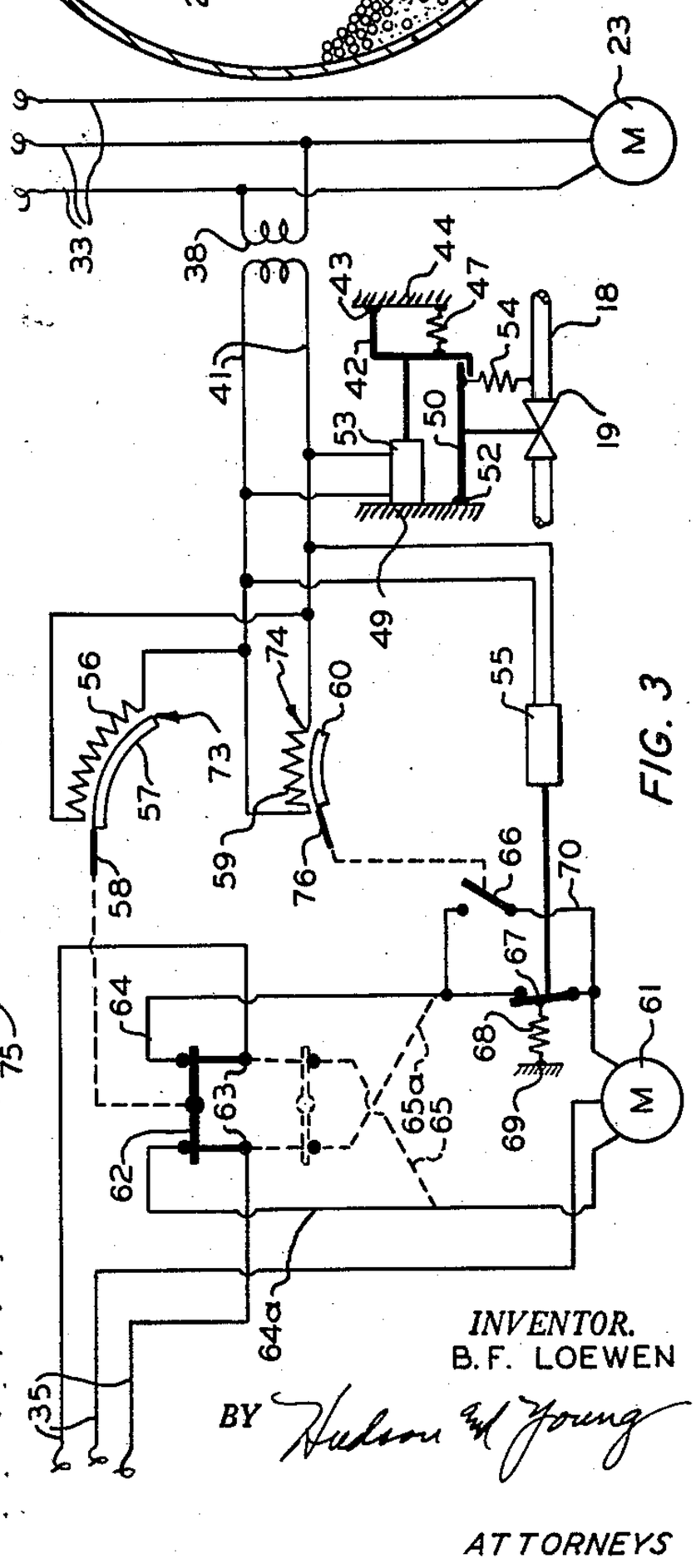

FIG. 3

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ROTARY DRYER OPERATION UNDER EMERGENCY CONDITIONS

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This invention relates to the operation of tubular drying mills. In one aspect, it relates to the operation of tubular drying mills under certain conditions of equipment malfunction. In another aspect, it relates to apparatus and the operation of such a dryer mill under the condition of malfunction of a conveyor provided for removing dried material from the dryer mill.

Horizontally positioned, rotatable, tubular mills are frequently used for drying wet or moist granular materials. In one instance, such a tubular mill is used for drying carbon black pellets produced by a wet pelleting process. Such a pellet dryer mill is frequently provided with scoops which upon rotation of the mill lift the dry carbon black pellets from the bed of pellets at the outlet end of the mill and discharge them from the mill. The pellets discharged from the mill are ordinarily funneled to a conveyor, such as a belt conveyor, for passage from the dryer mill to storage or other disposal, as desired. In case of failure of electrical power for operation of the conveyor belt or because of mechanical failure of the belt, pellets continue to be discharged from the dryer mill thereby overflowing the funnel-shaped hopper at the inlet end of the conveyor adjacent the dryer mill and the conveyor itself. Upon further discharge of dried pellets from the dryer mill, the pellets spill over the ground thereby necessitating a clean-up job and unloading of the conveyor.

Such mills are ordinarily housed within a furnace and burners provide heat for drying of the wet granular material. In case the dryer mill stops, the intense heat on the burner side of the mill is greater than on other surface areas and the mill may become warped so badly that mill repairs or even mill replacement may be necessary. Even upon turning out the fires or closing off the burners does not solve the problem of overheating the dryer mill in case the mill ceases to rotate because of the heat retained within the fire box.

An object of this invention is to provide apparatus and a method for the operation of a tubular drying mill under conditions of failure of certain related equipment. Another object of this invention is to provide apparatus and a method of operation of a tubular drying mill under the conditions that a conveyor which normally receives dry product from the mill and transports same to a point of disposal such as storage, so that the dry product will not accumulate at the inlet to the conveyor, spill over the feed means to the conveyor and over the ground. Yet another object of this invention is to provide apparatus and a method to protect a dryer mill from overheating in case of emergency shutdown of a dryer mill product removal conveyor. Other objects and advantages of this invention will be realized upon reading the following description which, taken with the attached drawing, forms a part of this disclosure.

In the drawing, FIGURE 1 illustrates, in diagrammatic form, an arrangement of the apparatus of this invention. FIGURE 2 is a sectional view taken on the line 2—2 of FIGURE 1. FIGURE 3 illustrates an embodiment of apparatus suitable for use with the dryer of FIGURE 1 for achieving the objects of this invention. FIGURE 4 illustrates, on an enlarged scale, detail of the outlet end of the apparatus of FIGURE 1.

On reference to FIGURE 1, reference numeral 11 identifies a furnace in which is disposed a rotatable shell 12 in which the wet granular material, hereinabove referred to, is dried. This shell rotates on an axis preferably inclined slightly from the inlet end downward to the outlet end of the mill as shown in FIGURE 1. The furnace 11 is provided with a fuel inlet pipe 18 having a normally closed valve 19 operated by a solenoid 53. A wet pellet inlet means 15 is provided for inlet of wet material to be dried into the shell 12. A hopper 34 at the outlet end of the mill receives dried pellets discharged from the mill and directs them to the top surface of a belt conveyor 32. Reference numeral 31 identifies dried carbon black pellets on the surface of belt 32. These pellets are transferred by the belt to a container 30 such as a tank or bin. Conveyor 32 is operated by an electric motor 23 which drives a pulley wheel 71 through a gear train 29. Gear train 29 reduces the speed of the electric motor to the relatively slow speed required by the belt drive wheel. Wires 33 conduct electric current from a source, not shown, to motor 23.

The fuel inlet pipe extends through the wall of the furnace 11 or if desired the pipe may extend along the outer surface of the furnace with branch pipes extending through the wall of the furnace with burners 39 provided on their inner ends. At the top portion of the furnace 11 or at a portion near the top is provided a pipe 13 for passage of hot gases of combustion for introduction into the interior of the rotatable shell 12 for assisting in drying of the wet granular material. A motor operated blower 14 is provided for transfer of the hot gases from the furnace through the rotatable shell 12.

The tubular shell 12 is supported by a separate roller support assembly 16 disposed near each end of the mill and outside of the furnace 11. These roller support assemblies can, if desired, be metal wheels in contact with a metal, circular member or rim extending around the mill. Such roller support assemblies are described in a copending application Serial No. 833,787, filed August 14, 1959, now U.S. Patent No. 2,994,912.

Means 17 for rotating the mill comprises a large geared ring surrounding the shell and meshing with a small drive gear on the shaft of an electric motor 61. This electric motor as contemplated in this invention is a reversible electric motor.

The dried product removal scoops or dipper assemblies of this invention are identified by reference numeral 20 and a drain dipper assembly is identified by reference numeral 21. FIGURE 2 illustrates the construction of the dippers 20 and drain dipper 21 as viewed from the line 2—2 of FIGURE 1. These dippers 20 and drain dipper 21 are also fully described in the abovementioned copending application. Briefly, in a mill which is intended to rotate in a clockwise direction when looking in the direction of the arrowed line 2—2 the scoops 20 are attached by riveting, welding or by bolts 45 to angle irons 36 and 40 which in turn are fastened to a flange 26 on the end wall 27 of the mill.

As the mill rotates, dried granular material is scooped up by scoops 25 and remains in the scoop until such time as the scoop approaches the high point of its travel at which time the pellets roll gently downward through a chute 22. The pellets then are discharged from the dryer outward beyond flange 26 and flow downward in the hopper 34.

It will be noted that the dipper assemblies are so positioned and oriented that, as a scoopful of pellets flows through the chute 22, they flow downward beyond one side of the tube 13. In this manner the dried material does not fall against this tube to cause breakage. By positioning the scoop assemblies 20 as herein disclosed, the scoops discharge their load of dried material at a point approximately 270° from the point of pickup. The dried material also rolls gently down the chute 22 with the rotation of the dryer mill and to one side of the centrally

positioned tube 13. This positioning and operation of the apparatus reduced pellet breakage, thereby improving the product and reducing dusting. When drying carbon black pellets produced in the wet pelleting process, some little carbon black may be abraded from the outer surface of the pellets during the rotation of the mill. Such carbon black can, under certain conditions, adhere to the inner walls of the mill and to the dry material removal apparatus. To prevent adherence of such carbon black on the dippers, rappers 24 are provided as illustrated. These rappers are merely a piece of heavy metal provided slidably within a closed end tube in such a manner that one end of the tube is attached to a scoop 25. Then, on rotation of the mill, the slidable metal slides from one end to the other thereby jarring or rapping the scoops thereby preventing adherence of the carbon black to the scoops. Such rappers are fully disclosed in U.S. Patent 2,883,274.

When an occasion arises necessitating emptying the dryer mill of its charge of granular material, in this case carbon black pellets, the drain dipper assembly 21 is provided. This drain dipper assembly comprises a dipper 48 which is attached to a handle 28. Dipper 48 is pivoted to a chute 51 which discharges pellets from the mill which are picked up by the dipper 48. When it is desired to clear the mill of its charge of pellets, it is merely necessary to rotate the handle 28 in such a manner that the dipper 48 contacts the inner walls of the mill under which condition the dipper will ultimately dip all the pellets from the mill and discharge them through chute 51 to the exterior of the mill. This chute 51 is attached to the inner wall 27 of the mill by an angle iron 37 as illustrated in FIGURE 2.

Angle iron 40 is similar to angle iron 36.

In normal operation, the mill emptying dipper 48 is rotated by means of handle 28 into the position illustrated by the dotted or broken lines in FIGURE 2 so that the dipper will not remove all of the carbon black pellets from the mill.

Since the dippers 25 remove carbon black from the bed of carbon black 46 when the mill is rotated in a clockwise direction when looking in the direction of the arrowed line 2—2, then upon rotation of the mill in the opposite direction, scoops 25 will not pick up pellets from the bed. Thus, according to this invention, I provide apparatus for stopping the rotation of the mill in case of failure of the pellet removal conveyor and then rotating the mill in the opposite direction under which condition the mill still rotates but the pellets will not be removed from the mill. In this manner, the shell or walls of the mill will not be overheated because they are being rotated and heat will be evenly distributed over the entire surface of the mill. When the mill is rotated in this opposite direction to its normal direction of rotation and when wet material to be dried is still continuously introduced into the mill, considerable time can elapse before the mill becomes filled to a level or to a point at which the pellets will flow from the mill through an annular space 72 just outside pipe 13. In this manner, the mill serves as a surge container until such time that the furnace can be cooled sufficiently so as not to damage the mill in case its rotation is terminated.

The actual method of operation of this invention involves the following steps. Upon failure of the conveyor 32, valve 19 in fuel pipe 18 is closed which closing shuts off fuel to the burners 39. At the same time electrical power to motor 61 is interrupted and the rotation of the mill is stopped. After delay of a few seconds a reversing swtich is operated so as to reverse the polarity of the current to the motor 61. Also, after the elapse of an additional several seconds of time, a bypass circuit to electric motor 61 is closed thereby providing electromotive force of the opposite polarity to motor 61 and under this condition the motor operates in the reverse direction. In this manner, the mill 12 operates in the reverse direction thereby not discharging dried material from the outlet end thereof.

FIGURE 3 illustrates an arrangement of electrical wiring and switches, etc., illustrating one means of carrying out the operations just mentioned.

In FIGURE 3, wires 33 conduct electromotive force from a source, not shown, to operate electrical motor 23 which in turn operates the conveyor 32 and several solenoids and time delay relays of this invention. Wires 35 conduct electromotive force from a source, not shown, for operation of the motor 61 for rotation of the mill.

A transformer 38 is provided for adjustment of voltage of the current taken from two wires of the three wire circuit 33. The secondary terminals of transformer 38 are connected with lead wires 41 for passage of transformed current to several apparatus parts. From lead wires 41 current is passed to a solenoid 53 which retains a latch pivoted at 43 to support 44 against the bias of a tension spring 47. Latch 42 retains a lever 50 in an elevated position in such a manner as to hold the normally closed valve 19 in an open position. A tension spring 54 biases the valve 19 closed at such a time a spring 47 releases the lever 50. Lever 50 is pivoted at 52 to a support 49. The normally closed valve 19 is the valve in the fuel pipe 18 which delivers fuel to the furnace 11.

The outer leads of the circuit 35 lead to the center terminals of a double pole-double throw reversing switch 62. Said terminals being identified by reference numeral 63. In the position illustrated in FIGURE 3, switch 62 makes contact from terminal 63 by way of lead wires 64 and 64*a* to the motor 61. When the switch 62 is in the position illustrated by the broken lines then the reverse-lead wires 65 and 65*a* lead to the terminals of the motor 61 thereby reversing polarity thereto. A relay 73 is actuated by current from the secondary leads 41 from the transformer. Reference numeral 56 identifies a heater coil 56 so constructed as to provide heat for actuation of a bimetallic thermocouple type apparatus. When heater coil 56 is hot, the bimetallic element 57 assumes a well rounded position as illustrated in FIGURE 3. This bimetallic element is attached to a rod or lever 58 which in turn is attached to the double pole-double throw switch 62. When the current to the heater coil 56 is interrupted the coil and the bimetallic element 57 cool thereby tending to straighten the bimetallic element which straightening moves rod 58 thereby throwing switch 62 to reverse the polarity of current to the motor 61.

A switch 67 is a normally open switch and is positioned in one of the leads to the motor 61. This switch 67 is a normally open switch and is biased open by a spring 68 supported by a support 69. A solenoid 55 retains switch 67 closed against the bias of spring 68 as long as current is passing through leads 41 and to the solenoid 55. When current ceases to flow through wires 33, solenoid 55 is deenergized and switch 67 opens under the influence of spring 68 thereby interrupting the flow of current from source 35 to the motor 61 thereby stopping rotation of the drying mill 12.

A bypass wire 70 is attached to the lead wire to motor 61 around switch 67. This bypass wire 70 contains a normally open switch 66. Switch 66 is operated by a relay 74 which is in general similar to relay 73. Relay 74 comprises a heater coil 59 receiving current from lead wires 41. Upon cooling of the heater coil 59, a bimetallic element 60 tends to straighten out thereby moving lever 76 and closing switch 66.

The overall operation of the apparatus illustrated in FIGURE 3 is as follows. Upon failure of the source of current from lead wires 33, or in case of mechanical failure of conveyor 32 under which condition current from wires 33 can be manually or automatically interrupted. Upon interruption of current in wires 33 current ceases to flow through lead wires 41, solenoid 53 becomes deenergized thereby allowing valve 19 in the fuel line 18 to close thereby shutting off fuel to the burner under the

dryer. At the same time solenoid 55 becomes deenergized thereby allowing switch 67 to open under the influence of spring 68 thereby terminating rotation of the mill 12. Since it takes a few seconds for such a mill to stop rotation once its power is turned off relay 73 is a time delay operating relay. The time delay is occasioned by the time required for cooling of the heating coil 56 and of the bimetallic element 57. Thus, upon cooling of the heating coil 56 and bimetallic element 57, the bimetallic element by way of rod 58 reverses the reversing switch 62. Then the second relay 74, which is also a time delay relay, closes switch 66 thereby allowing current to flow to the motor 61 but the polarity thereto is reversed and the motor 61 operates in the reverse direction.

It is intended that the relay 73 operate with a less time lag than the relay 74 so that the polarity to the motor 61 will be reversed before switch 66 is closed.

Thus, when this apparatus operates as herinabove explained upon failure of the operation of the conveyor 32, dryer mill 12 ceases to rotate thereby eliminating further discharge of pellets to the conveyor so that the inlet end of the conveyor is not overloaded and pellets do not spill on the ground. Also, the fires are turned out under the dryer mill 12. Then, after a few seconds' delay the polarity of the current to the motor 61 is reversed after which the circuit thereto is again closed and the mill operates in the reverse direction and under this condition pellets also are not discharged from the dryer mill. As mentioned hereinabove, the mill can operate in this reverse direction for a period of time and when so operating serves as a surge so that the wet pellet inlet apparatus feeding wet pellets to the wet pellet inlet means need not be closed down. In many instances, it is only a matter of seconds or a relatively few minutes until the conveyor 32 is placed again into operation. And under such conditions the dryer mill is immediately placed back into normal operation.

The placing of the dryer mill back into normal operation upon restoration of electromotive force to the lead wires 33 is as follows. Upon flow of electric current to leads 41, solenoid 53 is energized to move latch 42 against the bias of spring 47. Lever 50 is set manually with respect to latch 42 and at that time the fires under the dryer are relit. Solenoid 55 is energized thereby closing switch 67 and returning the double pull double throw switch 62 to its original position and also opening switch 66. These latter two operations are occasioned by the rapid heating of the heater coil 56 and 59 upon restoration of the current thereto. Thus, in this manner the dryer is put back into normal operation.

The opening of valve 19 upon restoration of current to solenoid 53 and to the apparatus in general is not preferred because it is not desired to open the valve regulating the flow of fuel through line 18 until an operator is ready to light the burners.

While certain embodiments of the invention have been described for illustrative purposes, the invention obviously is not limited thereto.

I claim:

1. In an apparatus for drying moist, granular material, having a rotatable, horizontally disposed, tubular member, heat resistant walls partially enclosing said tubular member, the ends of said tubular member extending beyond opposite walls, a fuel burner positioned to direct heat into a space within the enclosing walls for heating said tubular member, a conduit having a normally closed motor valve therein for passage of fuel to said burner, an electrically power operated conveyor for removal of dried granular material from the outlet end of said tubular

member and means introducing moist granular material into the inlet end of said tubular member, the improvement comprising, in combination, a reversible electric motor operatively connected with said tubular member for rotating same, scoops facing only the normal direction of rotation of said tubular member in the outlet end of said tubular member for discharge of dried granular material, a hopper positioned for receiving dried granular material from said scoops and directing same to said conveyor, a first circuit leading electrical energy to said power operated conveyor, a second circuit for passage of electrical energy to said reversible motor, a reversing switch in said second circuit, a first normally open switch in said second circuit, a bypass lead communicating said second circuit on opposite sides of said first normally open switch, a second normally closed switch in said bypass lead, first and second means communicating said first circuit with said first and second normally open switch, respectively, for closing same, and a third means communicating said first circuit with said reversing switch for operating same, and a fourth means maintaining said motor valve open, whereby upon failure of said first source of power said conveyor ceases operation, said first and second means become deenergized thereby allowing said first switch to open and said second switch to close, said third means becomes deenergized thereby reversing said reversing switch thereby reversing rotation of said tubular member and eliminating discharge of dried granular material to said conveyor while said means introducing moist granular material into said tubular member continues to introduce moist granular material into said tubular member and said fourth means becomes deenergized thereby allowing said motor valve to close.

2. In the apparatus of claim 1 wherein said second and third means are time delay means.

3. In the apparatus of claim 1 wherein said first and fourth means are solenoids.

4. In an apparatus for drying moist, granular material having a rotatable, horizontally disposed, tubular shell, and heat resistant walls partially enclosing said tubular shell, means for supplying heat to said tubular shell, means for introducing moist granular material into the inlet end thereof, the improvement comprising a reversible motor operatively connected with said shell for rotating same, means for conveying dried material from the outlet end of said shell, discharge means extending from within said shell through the outlet end thereof to said means for conveying, the end of said discharge means in said shell having a dried material inlet opening only facing the normal direction of rotation of said shell for inlet of dried material into said discharge means, means connected with said conveying means and said reversible motor for reversing said motor in response to failure of said conveying means thereby reversing rotation of said tubular shell and terminating entry of dried material into said opening of said discharge means.

5. In the apparatus of claim 4, further means in operative communication with said means for conveying and with said means for supplying heat rendering inoperative said means for supplying heat upon failure of said means for conveying.

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