

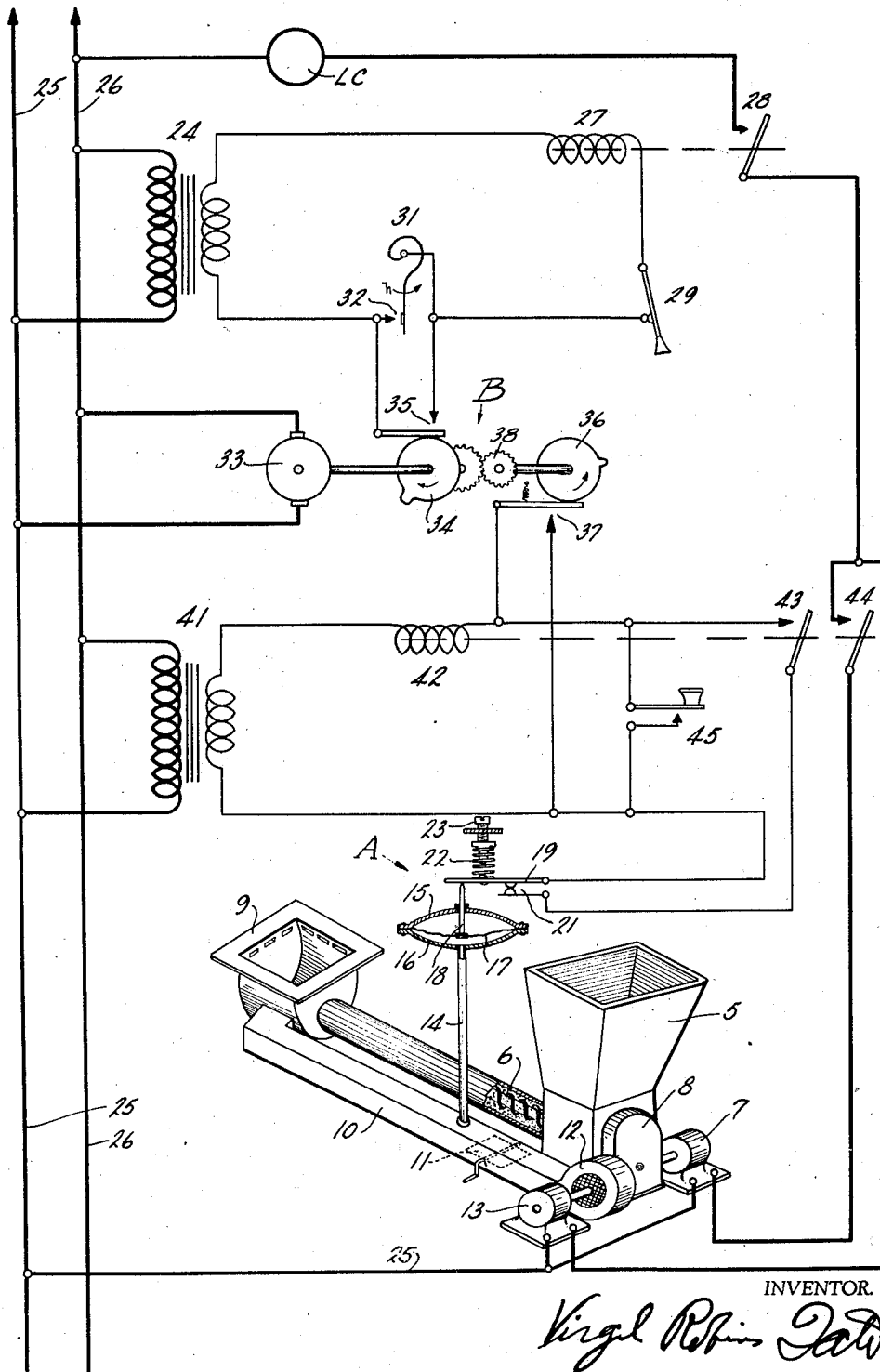
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STOKER CONTROL SYSTEM

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STOKER CONTROL SYSTEM

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This invention relates in general to control systems but more particularly to stoker control systems for heating plants, and the principal object of the invention is to provide a new and improved control system for stokers.

In stoker control systems it is customary to provide a motor to feed fuel and combustion air to a furnace fire bed and to control the motor by a room thermostat located in the space being heated so as to maintain the space at a comfortable temperature. It is also customary to provide an interval timer for periodically operating the motor independent of the room thermostat in order to prevent the fire from becoming extinguished during long stand-by intervals such as may be encountered in mild weather when the thermostat does not call for heat over long periods of time. In the operation of such a system it is difficult to maintain a substantially uniform thickness of fuel bed consistent with the demands of heat by the system. This is due to the simultaneous operation of feeding fuel and supplying combustion air to the fire bed at always substantially the same rate. The volume of air cannot be effectively proportioned to the amount of coal fed to the fire and the result usually is that the fuel bed either becomes too thick, smothering or choking the fire which eventually becomes extinguished; or alternately the fuel bed becomes too thin resulting in the formation of "blow-holes" in the fire bed through which the combustion air rushes unrestrained and the fire gradually burns itself out. These difficulties are further aggravated when the character of the fuel varies, when caking occurs, or the formation of slag is such as to close the retort tuyères.

It is one of the important objects of the invention to provide a control system for a stoker in which the fuel and combustion air fed to the fire are substantially automatically proportioned in accordance with the demand for heat by the system.

A further object is to provide a stoker control system which is adapted to continuously maintain the fuel bed upon the retort at substantially a predetermined thickness in order to render the stoker operation efficient at all times regardless of the heating requirements under all conditions.

A further object is to provide an arrangement for a stoker in which the fuel feeding means is operated and controlled independent of the combustion air supply means, thereby enabling these devices to more efficiently perform the required

function of maintaining a constant depth of fuel on the fire bed.

Another object of the invention is to provide a control system in which the fuel feeding motor is controlled in accordance with predetermined static pressure conditions existing in the air duct through which the combustion air is fed to the stoker retort. This predetermined static pressure is predicated upon the fuel bed reaching a particular depth in the retort.

A further object is to provide a system embodying a circuit arrangement in which the high voltage operating circuits for the fuel and air blower motors are electrically disassociated from the low voltage devices which are adapted to control them, whereby the possibility of false operation or circuit "feed-back" is avoided, and a positive and reliable operation of the stoker is assured.

An additional object is to provide an arrangement whereby the static air pressure in the air duct caused by the accumulation of fuel upon and within the fire bed, controls the operation of the fuel feed motor in such a manner as to assure a predetermined fixed depth of fire bed, regardless of the varying demands for heat upon the heating plant.

The foregoing and other objects and advantages reside in certain novel features of construction, operation, arrangement and cooperation of the various parts and elements of the system which will be hereinafter more fully described and particularly pointed out in the appended claims, and of which a preferred embodiment is illustrated in the accompanying sheet of drawings forming a part thereof.

Referring to the drawing; a conventional type of stoker mechanism for a furnace is diagrammatically illustrated. It comprises essentially a coal hopper 5 from which coal is fed by means of a screw 6 operated by an electric motor 7 through the medium of suitable gearing 8. The coal is fed into a burner or retort 9 inside of the furnace. The burner or retort may be of any suitable construction providing a chamber for the fuel bed for receiving the coal from the feed screw and having a series of tuyères or ports therein for the admission of combustion air. An air conduit or duct 10 extends from the retort 9 and is provided with a manually operated damper control 11 therein. A blower or fan 12 operated by an electric motor 13 is arranged to provide forced combustion air to the retort 9 through the air duct 10.

Arranged upon the air duct 10 and connected

thereto by a suitable air passage or air pipe 14 is a pressure responsive device such as the static or back pressure responsive switch generally designated as "A." This pressure switch may be of any well known type or construction and, for example, comprises upper and lower walls 15 and 16 secured together to form a chamber. Within the chamber there is arranged a flexible diaphragm 17, one side of which is accessible to the static or back air pressure within the air duct 10 which passes thereto through the pipe 14. Secured to the diaphragm 17 and extending upward through the top wall 15 of the chamber is a stem or plunger 18. Plunger 18 is adapted to engage the lower side of a lever 19 and actuate the same as the air pressure within the chamber and below the diaphragm 17 is increased, and the diaphragm is pushed upward. Lever 19 is adapted when operated to open a set of contacts 21 when the static or back pressure reaches a predetermined pressure value. In order to adjust the particular value at which the pressure responsive device actuates the contacts 21, an adjusting means is provided which comprises a compression spring 22 bearing against the top of the lever 19 at any desired compression depending on the adjustment of an adjusting screw 23.

A step-down transformer 24 is provided, having its primary winding connected directly across a set of high voltage line conductors 25 and 26 for feeding current to the system. The conductor 25 is the "ground" side of the line while conductor 26 is the "hot" side. The low voltage secondary of transformer 24 is connected to a relay winding 27 which is adapted to close its contacts 28 when energized and complete a high voltage circuit to the blower motor 13. A manually operated switch 29 is also connected in the low voltage relay circuit. A physical condition responsive means, which may be a pressure responsive device but is preferably a device responsive to space temperature, such as a room thermostat 31, is connected in series with the relay winding 27 and the secondary of the transformer 24 through its contacts 32. The usual high limit control L.C. for guarding against excessive furnace temperatures is included in the "hot" line 26 in series with the contacts 28, or in any other location where it can disable the system when operated.

An interval timer is provided in the system such as the timer indicated generally at "B," comprising an electric synchronous motor 33 connected across the line conductors 25 and 26 for continuous operation. The motor 33 is adapted to control the operation of a pair of cams at predetermined periodical intervals. One of the cams 34 is provided with an abutment arranged to actuate or close a pair of cam contacts 35 in parallel with the contacts 32 of the room thermostat 31 so as to energize relay winding 27 independent of the thermostat. The cam 34 is arranged to close the contacts 35, preferably for a time interval of about three minutes during each hour, the remaining 57 minutes of the rotation of the cam permitting the contacts 35 to be opened. The second cam 36 on the interval timer is arranged with an abutment to periodically close cam contacts 37. This cam 36 is provided with suitable multiplying gearing 38 whereby a ratio of rotation of approximately 10 to 1 is provided between cams 34 and 36. Cam 36 is arranged to close contacts 37 for a time interval of preferably one minute and to permit them to open for a time interval of five minutes.

A second step-down transformer 41 is provided which has its primary winding connected across the line conductors 25 and 26 and one side of its secondary winding to the winding of a second relay 42. Relay 42 is provided with a set of contacts 43 extending in series with the relay winding 42 and the pressure responsive contacts 21. The arrangement is such that when contacts 43 are closed, the relay is locked energized through the contacts 21 of the pressure switch and under control thereof. A second set of contacts 44 is controlled by relay 42 for closing the high voltage operating circuit for the fuel feeding motor 7 of the stoker. A manually operated push button 45 is arranged in the circuit of relay 42 to energize the same independent of the cam contacts 37. The cam contacts 37 are adapted when closed to energize the relay winding 42.

It will be noted that the operating circuits for the fuel motor 7 and the blower motor 13 are all connected to the high voltage line circuit 25 and 26 whereas the controlling devices such as the relays, cam contacts, etc. for operating the motors are all connected in isolated independent low voltage circuits. This arrangement insures that the relatively heavy motor loads will not adversely affect the operation of the necessarily delicate associated controlling devices. It will be seen that the arrangement of the system precludes the possibility of "feed-back" and resultant false operation. The controlling contacts 28 and 44 break the "hot" line 26 for the motors while the "ground" line 25 is connected directly to the other side of the motors.

Operation

In the operation of the system assume that in the ordinary sequence of events the interval timer rotates the cam 36 to a position in which its abutment closes the contacts 37. This closure occurs, as has been stated, for a time interval of one minute out of each six minutes of operation. The closure of cam contacts 37 completes the energizing circuit of relay 42 through the secondary of transformer 41. Relay 42 upon operating closes a locking circuit for itself through its contacts 43 in series with the pressure switch contacts 21 and independent of the cam contacts 37. Relay 42 therefor remains held in its energized condition after the cam contacts 37 are opened or for an indefinite interval of time, bridging the interval between the time of each operation of the cam contacts 37 and until the pressure switch contacts 21 open. The energization of relay 42, however, is subject to the condition of the pressure switch "A" and as soon as its switch contacts 21 are opened, the relay is deenergized, provided of course the cam contacts 37 are not closed at the time. Contacts 44, when relay 42 is energized, prepares the high voltage operating circuit of the fuel feeding motor 7. It is seen that the relay 42 can be initially energized only when the cam contacts 37 close and may then thereafter be held energized through its locking contacts 43 after cam contacts 37 open. The relay is deenergized, however, only when the pressure switch contacts 21 open. From the foregoing it is seen that after an interval of time which cannot exceed five minutes after the deenergization of relay 42 the fuel motor 7 is prepared for operation. This operation will occur when the condition of the fuel bed is such that additional fuel is required to be fed to the fire bed, as will be pointed out.

In the further operation of the system, assume now, for example, that it has been operating satisfactorily for some time and that all conditions are such that the system is functioning to maintain the temperature of the space within which the room thermostat 31 is located, at a comfortable value. Under these conditions and during mild weather when there is little call for heat, the room thermostat would operate relatively infrequently. However, the interval timer 33, operating continuously, would function to maintain the fire alive. This is accomplished by the hour cam 34 which functions to close cam contact 35 for a time period of approximately three minutes in each hour. The relay winding 27 is thereby energized resulting in the closing of its contacts 28. A high voltage circuit is thereby completed from the hot line conductor 26 through the blower motor 13 to the ground line conductor 25. The blower 12 operates and forces air through the air duct 10 into the retort 9 and through the fuel bed thereon. If there is a sufficient amount of coal upon or within the retort, which may be the case immediately after an operation of the fuel motor 7, the back pressure within the air duct is equal to a certain amount due to the resistance of the fuel bed. This pressure appears within the pressure responsive device A and the diaphragm 17 is forced upward to open contacts 21. If, however, the fuel bed is not of the required depth, the restriction to the passage of air through the fuel bed would be nominal and the pressure within the air duct 10 would not be sufficient to cause deflection of diaphragm 17 to open contacts 21. The foregoing operations of the blower cannot, however, endure very long since the cam 36 is effective each five minutes or may be effective at the same time as cam 34 to cause fuel to be fed to the fire bed, as will be pointed out.

In the event that the relay 42 is locked energized at the time the cam contacts 35 are closed or the room thermostat 31 is calling for heat, which will always be the case under normal operation, a circuit is closed for the fuel motor 7, through the relay contacts 44 and the relay contacts 28, and the screw 6 feeds fuel to the fire bed at the same time the blower 12 is forcing combustion air to the same. As this fuel continues to build up within the retort 9, the static or back pressure within the air duct 10 gradually increases due to the increase in resistance to the forced air caused by the accumulation of fuel. At the predetermined pressure value to which the adjusting spring 22 has been adjusted, the movement of the diaphragm 17 causes an opening of the contacts 21. This results in the deenergization of relay 42 which thereupon opens its contacts 44 and causes a stoppage of the fuel motor 7. The blower, however, continues to run. At contacts 43 the locking circuit for relay 42 is opened and the relay 42 can only energize again when the cam contacts 37 close in five minutes, but the relay cannot remain energized unless contacts 21 are reestablished. The cam contacts 35 open at the expiration of three minutes and unless the thermostat is calling for heat, deenergize relay 27 to disconnect the high voltage operating circuit extending through relay contacts 28.

From the foregoing it is seen that the interval timer sets up a starting and running circuit for the fuel motor whereas the pressure responsive switch A disrupts the running circuit for the fuel motor when the proper depth of fuel bed has been reached. Should the room thermostat 31 continue to call for heat for a longer time than

the cam contacts 35 are closed, the blower motor 13 would continue to operate until the bed of fuel has been reduced or burned down to the required depth and the static pressure reduced to permit the pressure switch contacts 21 to close. If the room thermostat is still calling for heat at this time, the closing of pressure switch contacts 21 would allow relay 42 to operate (if it is in a position to do so) and feed fuel to the fire bed. This fuel feed would continue until sufficient resistance is again built up to cause opening of contacts 21. In this manner the fuel feed to the burner is automatically regulated to the rate of burning of the fuel. The volume of air delivered to the burner controls the amount of fuel burned, and the operation of the pressure responsive device A determines the amount of fuel fed to regulate the depth of the fuel bed. By adjusting the screw 23 and thereby the force of the spring 22 against the effort of the diaphragm, the setting is readily made for the maximum static pressure at which the fuel feed mechanism is permitted to operate. Adjustment to increase the static pressure results in a thicker fuel bed, and adjustment to decrease the pressure will result in a thinner fuel bed.

As the air from the blower 12 enters the retort 9 and flows through the tuyère passages, it encounters more or less resistance, depending upon the depth of the fuel bed through which the air must travel. Assume now that as the system is operated, there is a thin fuel bed within the burner. The resistance to air flow is then very low and the static or back pressure created in the air duct 10 will be correspondingly low and therefor insufficient to actuate the pressure diaphragm 17. The contacts 21 therefor remain closed and the fuel motor continues to feed fuel. As the supply of fuel to the burner increases, the resistance to the air increases and eventually the static or back pressure will become sufficient to actuate the diaphragm 17 and open contacts 21 causing the deenergization of relay 42 and the stopping of stoker motor 7.

The air duct damper 11 may be set for any desired volume of air supply for the burner and if it is set wide open it permits maximum capacity. Under these conditions the fuel bed is set to be relatively thick at all times and the adjustment of the diaphragm pressure spring 22 is correspondingly set so that the static or back pressure will operate the diaphragm only when the maximum amount of fuel has been fed to the fuel bed. A setting for a relatively thinner fuel bed is made when the damper 11 is adjusted for a smaller amount of air.

It is usual in the operation of stokers that occasionally the top of the burning fuel bed cokes over to form a substantially non-porous layer. Should this occur, obviously the resistance to the air flow through the fuel bed would become quite high and the contacts 21 would be opened regardless of the thickness of the fuel bed.

Therefore, under these conditions, if the fuel bed were dependent upon the action of the contacts 21 alone, fuel feed would be prevented by this action although fuel were actually required. To alleviate this difficulty the cam 36, by closing the contacts 37, causes fuel to be fed into the retort one minute out of every six, regardless of other conditions, so long as the blower 13 is operating. This action serves to break up the "coked" layer and provide normal air flow through the fuel bed.

The normally closed switch 29 in the circuit

of relay 27 enables the stoker to be completely shut down as during the summer months or when repairs and inspections are necessary. The push button switch 45 enables the system to be tested for operation at any time without the necessity of waiting the five minutes required for the cam contacts 37 to close.

If desired, a single transformer may be used for supplying low voltage current to the two relays instead of two separate transformers as illustrated.

While there has been illustrated and described a single embodiment of the invention, it is to be understood that this arrangement is merely selected for the purpose of illustration and that various changes in the arrangement may be made without departing from the spirit of the invention or the scope of the subjoined claims.

What is claimed is:

1. In a control system for a stoker having a retort, fuel feeding means, air feeding means, a fuel feed electric motor for the fuel feeding means and an air feed electric motor for the air feeding means, the combination of, a first relay arranged to control both motors, said relay when in a first position placing both the fuel feeding means and the air feeding means out of operation and when in a second position placing the air feeding means in operation and permitting operation of the fuel feeding means, a low voltage operating circuit for the first relay, a switching device responsive to the demand for heat for opening and closing said low voltage operating circuit, a first time controlled switch for closing said operating circuit independently of said switching device at predetermined intervals, a second relay arranged to control the fuel feed motor for stopping and starting the fuel feeding means while permitting continuous operation of the air feeding means, said second relay having a main switch and a holding switch, the main switch controlling the fuel feed motor, a low voltage pull-in circuit for said second relay, a second time controlled switch arranged to be closed periodically at intervals more frequent than the first time controlled switch, said second time controlled switch being interposed in said pull-in circuit for causing said second relay to pull in at predetermined intervals, a holding circuit for maintaining said second relay pulled in independently of said pull-in circuit, said holding circuit extending through said holding switch of the second relay, a pressure responsive switch responsive to the pressure of the air supplied to the retort and arranged to be closed

when the air pressure is below a predetermined value and to be open when the air pressure is above said value, said pressure responsive switch being interposed in said holding circuit to maintain said second relay pulled in until the air pressure rises above said predetermined value, whereby said fuel feeding means is operated at predetermined intervals of time for periods of variable duration, the duration of said periods varying with the thickness of the fuel bed.

2. In a control system for a stoker having a retort, fuel feeding means, air feeding means, a fuel feed electric motor for the fuel feeding means and an air feed electric motor for the air feeding means, the combination of, a first relay arranged to control both motors, said relay when in a first position placing both the fuel feeding means and the air feeding means out of operation and when in a second position placing the air feeding means in operation and permitting operation of the fuel feeding means, a low voltage operating circuit for the first relay, a switching device responsive to the demand for heat for opening and closing said low voltage operating circuit, a second relay arranged to control the fuel feed motor for stopping and starting the fuel feeding means while permitting continuous operation of the air feeding means, said second relay having a main switch and a holding switch, the main switch controlling the fuel feed motor, a low voltage pull-in circuit for said second relay, a time controlled switch arranged to be closed periodically at intervals, said time controlled switch being interposed in said pull-in circuit for causing said second relay to pull in at predetermined intervals, a holding circuit for maintaining said second relay pulled in independently of said pull-in circuit, said holding circuit extending through said holding switch of the second relay, a pressure responsive switch responsive to the pressure of the air supplied to the retort and connected to said second relay, said pressure responsive switch assuming a first position when the air pressure is below a predetermined value for maintaining the second relay pulled in through said holding switch, while assuming a second position in which it causes deenergization of the second relay irrespective of said holding switch when the air pressure rises above a predetermined value, whereby the fuel feeding means is operated at predetermined intervals of time for periods of variable duration, the duration of said periods varying with the thickness of the fuel bed.

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