

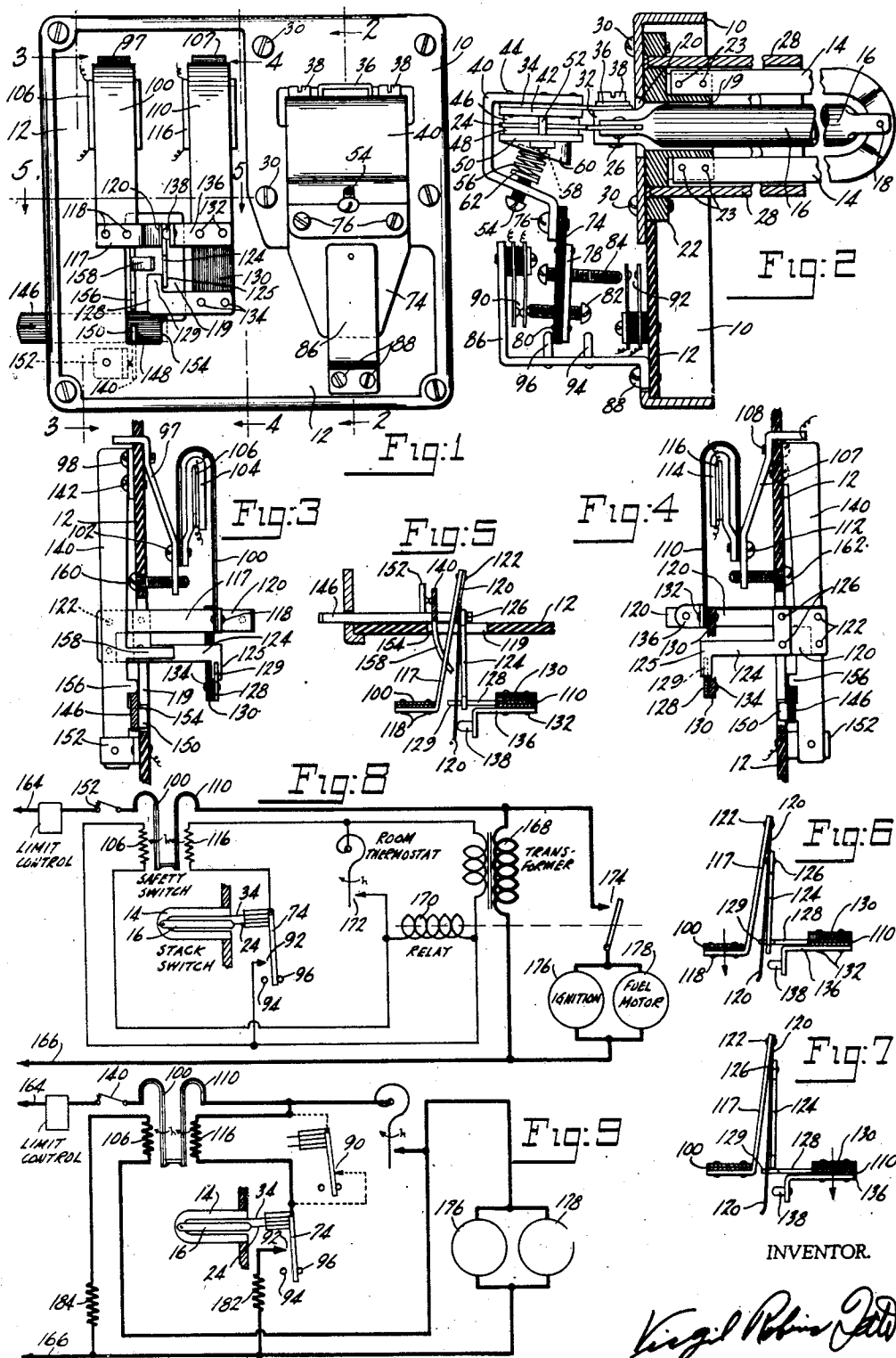
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BURNER CONTROL SYSTEM

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BURNER CONTROL SYSTEM

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This invention relates in general to control systems and more particularly to oil burner control systems.

In oil burner control systems it is customary to provide some means which will, in case of ignition failure or flame failure, shut the oil burner down until such means has been manually reset. Such means is generally referred to as a safety switch, and usually consists of a switch, a bi-metal actuator, and an electric heater. If the electric heater is permitted to remain energized for too long a period, the actuator opens the switch and it therefore remains open until manually reset. Such a safety switch is often referred to as a lockout switch. Usually the safety switch heater is energized upon starting the oil burner, and then after combustion has been established the heater is deenergized, by either opening the heater circuit or shunting it by providing a short circuit around the heater. The means for deenergizing the safety switch heater is usually responsive to combustion conditions. Such means is generally referred to as a combustion responsive switch or stack switch. The line voltage circuit for the oil burner motor is usually controlled by means of a relay having its coil in either another line voltage circuit, or in a low voltage circuit. The safety switch heater is usually connected in series with the motor, or in series with the relay coil, in order that the oil burner cannot operate without energizing the safety switch heater. This necessitates matching the heater to the load when a relay is not used, and additionally usually results in a bulky heater because of the relatively large starting currents. Two such burner control circuits are shown in the copending application of Justin A. Deubel, Serial No. 236,819, filed Oct. 24, 1938; and the present invention constitutes an improvement upon the burner control circuits of said copending application. It is an object of this invention, therefore, to overcome the foregoing objectional features and provide a control apparatus which has universal application.

The primary object of this invention is to provide new and improved control systems for controlling the operation of automatic fuel burners and more particularly oil burners.

Another object of this invention is to provide a new and improved safety switch arrangement which will avoid the necessity of deenergizing the safety switch heater after combustion is established.

Another object of this invention is to provide an improved oil burner control circuit which will

give safe operation without having to connect the safety switch heater in series with either the motor or any circuit controlling the motor.

Another object of this invention is to provide an automatic means for checking the stack switch operation which will totally deenergize the system if the stack switch does not function properly.

Other objects and advantages reside in certain novel features of construction, circuit arrangement, and operation of the various parts and elements which will be hereinafter more fully described in the specification, 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, and in which;

Fig. 1 shows a front elevation of the safety switch and stack switch;

Fig. 2 is a cross sectional view of the stack elements taken along the line 2—2 of Fig. 1;

Fig. 3 is a left side view of the latch mechanism of the lockout device taken along the line 3—3 of Fig. 1;

Fig. 4 is a right side view of the latch mechanism taken along the line 4—4 of Fig. 1;

Fig. 5 is a top view of the latch mechanism in its normal engaged position taken along the line 5—5 of Fig. 1;

Fig. 6 is a fragmentary portion of the lockout mechanism showing the switch latch released in one direction;

Fig. 7 is a fragmentary portion of the lockout mechanism showing the switch latch released in the opposite direction;

Fig. 8 is a schematic circuit diagram of one form of the improved control system utilizing a relay; while

Fig. 9 is a schematic circuit diagram of another form of the improved control system in which relays are not used, and discloses two preferred alternative methods of operating the safety switch from the stack switch.

The drawing discloses a preferred embodiment of the invention for the purpose of explaining and describing the invention. In the specific form shown in Fig. 1, a flanged metal base 10 is provided, having a panel of insulating material 12 fastened thereto by screws as shown, for supporting the various elements and parts of the control mechanism. A combustion responsive means is provided such as a thermal device having a plurality of elements. One of said elements comprises a relatively high expansive channel member 14 formed into a U-shape, and

a second element 16 comprising a relatively low expansive tubular member rigidly fastened by the rivet 18 at one of its ends to the channel member 14 at the bend of the U. The other end of the low expansive element 16 is slotted and flattened, and is arranged to protrude through an opening 19 in a support plate 22 and an additional opening 20 in the base 10. The open ends of the U-shaped channel member 14 are suitably fastened to the support plate 22 by rivets 23 as shown. A slip friction means which includes a connector link shown in the drawing as a spring blade 24 made of hard, smooth, corrosion resisting material such as stainless steel, is secured to the protruding end of the low expansive element 16 by means of a rivet 26. Staked to the support plate 22 at one end as shown, is a support tube 28. The support plate 22 is fastened rigidly to the base 10 by means of screws 30. Hinge supports 32, cast integral with the support plate 22, protrude through the base 10 to receive a hinge means shown in the drawing as U-shaped steel spring hinge 34. The open ends of the U of the spring hinge 34 are clamped between a hinge clamp 36 and the hinge supports 32 by screws 38 which pass thru the two former members and thread into the latter. The base portion of the U-shaped spring hinge 34 is clamped between a movable member such as an actuating arm 40 and a friction block bracket or clamping plate 42 by means of rivets 44. The slip friction means also includes two additional elements. One of these elements comprises a block 46 made of friction material such as carbon which is inserted in a cavity or recess in the friction block bracket 42. The other of these elements comprises a second block 48 made of friction material such as carbon, which is inserted in a cavity or recess formed in a friction block support member 50, said support being free to move along a pair of guide pins 52 fastened to the actuating arm 40. The spring blade 24 is clamped between the friction blocks 46 and 48 close to the spring hinge 34, to form the short arm of a lever system so that the relative motion of the thermal elements 14 and 16 will be amplified at the end of the actuating arm 40. The clamping effort upon the friction blocks is applied by an adjustable means such as a screw 54 threaded through the actuating arm 40, through a compression spring 56 which is arranged at such an angle that its horizontal component of force is always sufficient to cause the friction block support 50 to bear against but one side of the guide pins 52. One end of the compression spring 56 extends into a recess 58 formed in a protruding portion 60 on the friction block support 50, and the other end carries a cup-shaped insert 62 which in turn receives the end of the adjusting screw 54. An insulating plate member 74 is fastened to the actuating arm 40 by screws 76 and serves to further amplify the relative motion of the thermal elements 14 and 16. It carries a plate 78 which is fastened to it by rivets 80. Two switch actuating screws 82 and 84 are threaded into the plate 78. A switch bracket 86 is fastened to the panel 12 by screws 88.

Fastened to the switch bracket 86 is a pair of "cold" spring contacts 90 operated by the screw 82. Fastened to the panel 12 is a pair of "hot" spring contacts 92 operated by the screw 84. A "hot" stop pin 94 and a "cold" stop pin 96 are fastened to the switch bracket 86. After the arm 40 engages the stops 94 and 96 the blade 24 slides between the friction blocks 46—48. By this ar-

angement the contacts are operated upon changes in temperature independent of actual temperature. Further details of the construction and operation of the thermal elements and slip friction mechanism may be had by referring to a copending application of William Christiansen, Serial No. 236,818 and filed October 24, 1938.

A description of the safety switch device, a further important mechanism in the control system, will now be given in detail.

A first actuator bracket 97 (see Fig. 3) is fastened rigidly to the panel 12 at one end by a screw 98. A first thermal actuator 100, shown as a U-shaped piece of bimetal, is fastened on the free end of the bracket 97 by a pair of screws 102 passing thru the bracket and the bimetal into a first heater block 104 which is bent into a U-shape and arranged within the actuator 100. A first heater 106 is clamped in the U-bend of block 104 and serves to motivate the first actuator 100. The heater block 104 serves to securely hold the heater 106 and to additionally control the rate of movement of the first actuator 100. A second actuator bracket 107 (see Fig. 4) is fastened rigidly to the panel 12 at one end by a screw 108. A second actuator 110 shown as a U-shaped piece of bimetal, arranged in compensative relation to the first bimetal actuator 100, is fastened on the free end of the bracket 107 by a pair of screws 112 passing thru the bracket and the bimetal into a second heater block 114 bent into a U-shape and arranged within the bimetal 110. A second heater 116 is clamped within the block 114 and serves to motivate the second actuator 110. This heater block 114 serves to securely hold the heater and to additionally control the rate of movement of the second actuator 110.

A latch mechanism having two release positions is arranged to cooperate with the first and second actuators 100 and 110, and is shown to consist of a plurality of elements. A latch bracket 117 is fastened at one of its ends to the first actuator 100 by rivets 118, and is bent back to pass rearwardly through an opening 119 cut in the panel 12. A latch spring 120 is fastened to the free end of the latch bracket 117 by rivets 122, and is arranged to pass forwardly thru the opening 119 in the panel 12. Adjacent the fastening point of the latch spring 120, one end of a latch member shown as an L-shaped member 124 with a latch 125 is fastened to the latch spring 120 by rivets 126 and extends forwardly thru the panel opening 119 along with the latch spring 120. A release member shown as an L-shaped member 128 with a trigger 129 is fastened to the free end of the second actuator 110 and is arranged to be perpendicular to and normally in engagement with the latch 125. The release member 128 is insulated from the second actuator 110 by an insulating member 130 which is fastened to the second actuator by rivets 132, and to the release member by rivets 134. A contact bracket shown as an L-shaped bracket 136 is additionally fastened to the second actuator by the rivets 132. A latch contact 138 which engages the latch spring 120 is fastened to the contact bracket 136.

A reset mechanism is provided to manually reset the latch member 124 to its normal position after it has been released. This mechanism is shown to comprise a resilient resetting member 140 rigidly fastened to the panel 12 at one end by the screw 98 and an additional screw 142; a sliding bar member 146 passing thru the base for

manually operating the resetting member 140 and having a notch 148 cut in it for engaging a projection 150 formed on the resetting member 140; and a combination stop and switch member 152 fastened to the panel 12 against which the resetting member 140 normally rests and completes circuit connection therethru. Projection 150 on the resetting member 140 extends thru an opening 119 in the panel 12 and also serves to limit the motion of the resetting member 140 under action of the bar 146 by engaging the edge of the panel opening 154. Additional projections 156 and 158 are also provided on the resetting member 140 to respectively loosely hold the sliding bar member 146 in place and to engage the latch member 124 when it is reset.

An adjusting screw 160 passing thru the panel 12 and threaded into the first actuator bracket 97 serves to adjust the relative position of the first actuator 100 with respect to the second actuator 110 and hence adjust the setting or calibration of the safety switch by adjusting the latch 125 with respect to the position of the trigger 129. A second adjusting screw 162 passing thru the panel 12 and threaded into the second actuator bracket 107 serves as an additional adjustment for the latch 125.

The safety switch is so arranged that a circuit path is provided thru it extending from the wire attached to the stop member 152, thru the resetting member 140, the screw 98 holding the resetting member 140, the first actuator bracket 97, first actuator 100, the latch bracket 117, the latch spring 120, the contact 138, the contact bracket 136, the second actuator 110, and finally thru the second actuator bracket 107 to a wire attached thereto. When the safety switch is opened or locked out the circuit thru it is interrupted at the contact 138 by the latch spring 120.

Now referring particularly to the control system shown in Fig. 8. Alternating current is fed over the line conductors 164 and 166 thru the limit control and passes thru the circuit of the safety switch previously described, to a stepdown transformer 168. A relay 170 and the first heater 106 associated with the first actuator 100 are energized in parallel from the low voltage secondary of the transformer 168 by means of the room thermostat contacts 172. The relay contacts 174 control an ignition means 176 and a fuel motor 178 wired in parallel therewith, by connecting them to the lines 164 and 166 thru the limit control and the safety switch. The second heater 116 associated with the second bimetal 110 is energized directly from the secondary winding of the transformer 168 thru the stack switch hot contacts 92.

Assume now that the control is mounted in the stack of an oil burning furnace and that all the elements are in their normal inactive positions. When the room thermostat calls for heat in response to a drop in the room temperature, the relay 170 and the heater 106 are energized over the circuit described. In response to the heat generated by the first heater 106, the first actuator 100 slowly warps its free end away from the panel 12. The relay 170 closes its contacts 174 and energizes the ignition means 176 and the fuel motor 178 thru the circuit described. As a result combustion conditions are normally obtained and the temperature of the stack rises effecting relative motion between the thermal elements 14 and

16. This motion is transmitted to the actuating arm 40 thru the slip friction connection 24—46—48 and causes closure of the hot contacts 92, which effect the energization of the second heater 116 thru the circuit pointed out. In response to the heat generated by the second heater 116 the second actuator 110 slowly warps its free end away from the panel 12 closely following the first actuator 100. Thus the latch 125 and the trigger 129 remain engaged and consequently the circuit thru the safety switch is maintained. Upon reaching their ultimate positions the two actuators resume approximately the same relative positions they had when cold and remain so related during the entire ensuing normal operation of the fuel burning means. When the stack temperature reaches a sufficiently high temperature the actuating arm engages the hot stop 94. Then upon additional stack temperature rise the slip friction mechanism is brought into operation. The spring blade 24 slides between the carbon blocks 46 and 48 and allows the thermal elements to move independent of the actuating arm.

If combustion is not established, however, as a result of the energization of the fuel burning means, the second heater 116 is not energized because the actuating arm 74, under these conditions, is not motivated and the stack contacts 92 remain open. As a result the free end of the first actuator 100 moves away from the base alone and the latch 125 fastened to it slides on the trigger 129. After some period of time, depending upon the calibration or setting of the latch 125 with respect to the trigger 129, the relative motion between the two actuators 103 and 110 becomes sufficient to cause the latch 125 to be released by the trigger 129. Upon being released the latch member 124 is snapped over to the lockout position shown in Fig. 6 in response to the biasing action of the latch spring 120. The circuit thru the safety switch is thereby opened at contact 138, and the fuel burning means is consequently shut down until the safety switch is manually reset. The safety switch is usually calibrated or set to lockout in a definite predetermined time under this condition of operation. Other things being equal, the safety switch timing under other conditions of operation is hence dependent upon this setting. The relative safety switch timings under various conditions of operation, however, can be modified by changing the physical dimensions of the engaging portions 125 and 129 of the latch and release members 124 and 128.

Assume now that the control device and the fuel burning means have functioned normally in response to the thermostat's call for heat and have reached their normal running positions. When sufficient heat has been generated to satisfy the thermostat, thermostat contacts 172 open deenergizing the first heater 106 and the relay 170 but not the second heater 116. The relay 170 opens the relay contacts 174 and shuts down the fuel burning means 176—178. After a short time combustion ceases and the stack temperature drops effecting an initial relative movement of the thermal elements which in turn initiates movement of the actuating arm 40 in the cold direction. When the temperature of the thermal device drops a predetermined amount, the hot contacts 92 open and the second heater 116 is deenergized before sufficient relative motion has occurred between the first

and second actuators to release the latch member 124 and to consequently open the safety switch. Ultimately all the elements cool to their cold positions and remain inactive until the thermostat again calls for heat.

As another condition of operation, assume again that the control device and the fuel burning means have functioned normally in response to the room thermostat's call for heat and have reached their ultimate normal running positions. Now assume that combustion ceases for some reason. The resulting stack temperature drop will immediately effect the thermal device 14-16 and initiate motion of the actuating arm 40 in the cold direction. After the stack temperature drops a predetermined amount the contacts 92 open deenergizing the second heater 116, and causing the second actuator 110 to move toward its cold position. The relative distance between the energized first actuator and the cooling deenergized second actuator increases until finally the trigger 129 releases the latch 125 and the safety switch opens as shown in Fig. 6. The safety switch deenergizes the system upon opening and shuts it down so that it cannot be restarted until the safety switch is manually reset.

To reset the safety switch the sliding bar member 146 is pushed inward toward the base. This motion is transmitted to the resetting member 140 by means of the notch 148 on the sliding member 146 and the engaging projecting member 150 on the reset member 140. As the movement of the sliding member progresses the lower end of the resetting member 140 moves away from the combination stop and switch member 152, and the projecting member 158 engages and moves the latch member 124 against the effort of the latch spring 120 so that the latch 125 assumes a position in back of the trigger 129 on the releasing member 128. The separation of the resetting member 140 from its stop 152 disables the burner system until the bar 146 is restored by the tension of member 140. This prevents the operation of fuel burning system while the safety switch elements 120 and 138 are normally held in engagement and hence out of control of the actuators 100 and 110.

The foregoing description of the operation of the device has assumed the control mechanism to operate perfectly. Under these conditions, when the safety switch operates to lockout the system, it locks out in the manner shown in Fig. 6. If an essential element of the control device fails, however, the mechanism also locks out the system. Under these conditions the safety switch may lock out as shown in Fig. 7.

Now assume again that the control device and the fuel burning means have functioned normally in response to the thermostat operation and have reached their normal running conditions. Assume that the thermostat opens its contacts 172 at this time and combustion ceases. Further assume, because of failure in the mechanism, the actuating arm 40 fails to move from its hot position. The first actuator 100, being deenergized by the thermostat, slowly cools toward its cold position, but the second actuator 110, being independently energized by the hot contacts 92, remains in its hot position. After a short lapse of time the relative distance between the two actuators, due to the motion of the first actuator, exceeds a certain value corresponding to the safety switch setting, and the trigger 129 releases the latch 125 causing the safety switch

to trip as shown in Fig. 7. The system is thereby rendered inoperative until the second actuator cools and the safety switch can be manually reset. After being manually reset the system will continue to lockout after every burner operation until the actuating arm is again made to operate satisfactorily. From the foregoing explanation it may be seen that the control system checks the operation of the stack switch in both the hot and cold directions and shuts down the entire system if the stack switch does not go thru its complete cycle of operation for every cycle of operation of the fuel burning means.

Now assume again that the control device and the fuel burning means have functioned normally in response to the operation of the thermostat and have reached normal running conditions. Now, if either the first or the second actuator heaters 106 or 116 become deenergized because of a failure of either of the heaters, or for any other reason, the switch will lockout as shown in either Figs. 6 or 7 depending upon which of the two heaters became deenergized. One of the actuators remains energized in its hot position while the other cools. Eventually the relative distance between the two exceeds the safety switch setting and the switch trips. If the first actuator heater 106 becomes deenergized, the latch 125 will be released by dropping off one side of the trigger 129 releasing the latch member 124 and opening the switch as shown in Fig. 7. If the second actuator heater becomes deenergized, the latch 125 will be released by dropping off the other side of the trigger 129 releasing the latch member 124 and opening the switch as shown in Fig. 6. Also, if either the first or second heater 106 or 116 fail or become inoperative during the time the system is not in operation, the safety switch will proceed to a safety lockout on the subsequent operation in response to the thermostat action. Since the two actuator heaters have separate energizing circuits, although one of the heaters fails, the other will be energized upon normal operation of the burner and will serve to shut the system down by locking out the safety switch as shown in either Fig. 6 or Fig. 7, depending upon which heater fails to function. The limit control, as is well known, serves to shut down the system if excessive temperature, pressure, etc., conditions are reached and to automatically start up the system again when normal conditions are reestablished.

Fig. 9 shows two alternative methods of utilizing the control elements in the system when a low voltage relay is not used. With the mechanism shown in solid lines, the control operates in identically the same manner as described for Fig. 8 except that in this case the thermostat controls the load directly rather than thru a relay, and the first and second heaters 106 and 116 are energized from the line conductors 164 and 166 thru the first and second voltage dropping or ballast resistors 184 and 182 respectively. The first and second voltage dropping resistors 184 and 182 are provided merely to simplify the construction of the heaters 106 and 116. The control could be built so as to energize the heaters 106 and 116 directly from the line if the design of the heaters were changed.

The dotted lines show an alternative position for the stack switch in the circuit and illustrates an alternative way of energizing the second heater 116 from the stack switch. In this case the closed cold stack switch contacts 90 are used

instead of the closed hot contacts 92. Here the stack switch serves as a shunt for the heater rather than a series switch in the heater circuit. When the stack switch elements are cold the heater 116 is shunted and line voltage appears across the ballast resistor 182. When the stack switch elements are heated so as to hold the stack switch contacts 90 open, the heater 116 is energized in series with the ballast resistor 182 and part of the line voltage appears across each resistor. In this case the second ballast resistor 182 is essential. With this method of operation the second actuator is energized and de-energized at exactly the same time in the control cycle as it would be if it were controlled by the closed hot contacts 92. The functional operation of the system illustrated in Fig. 9 is identical with that of the system illustrated in Fig. 8.

An important feature of the invention concerns the method of energizing the first and second actuator heaters 106 and 116 by totally independent circuits not in any way dependent upon the energization of the fuel burning means. This method of energizing the actuators of the safety switch obviates the need for series connection of the heaters 106 and 116 in the motor circuit or in a motor control circuit, and is herein distinguished from such prior control circuits by defining the heater circuits of the present invention as being "independent" of the energization of the fuel burning means. This "independent" characteristic of the safety switch actuators, in combination with the two-way acting safety switch affords a means for checking the action of the thermal device and additionally checking the function of either heater without resorting to a series heater with all of its inherent incumbrances and non-universal application as pointed out in the introduction.

While a specific embodiment of the invention has been disclosed and described, it will be apparent that many changes or modifications in the specific details of the elements can be made without departing from the spirit of the invention, and it is therefore desired that the invention be limited only by the scope of the appended claims.

What is claimed is:

1. A burner control system comprising means for burning fuel, a manually reset safety switch for controlling the fuel burning means, an automatic means for additionally controlling the fuel burning means, an actuator for the safety switch, a motivating heater for the actuator, said heater being energized independently of the energization of the fuel burning means by direct connection across a source of power by the automatic means, a second actuator for the safety switch responsive to combustion conditions, and a latch for the safety switch having two releasing positions operated by the first and second actuators whereby relative motion between the two actuators in either direction greater than a predetermined amount will open the safety switch.

2. A burner control system comprising means for burning fuel, a source of power, a safety switch for controlling the fuel burning means, an automatic means for additionally controlling the fuel burning means, an actuator for opening the safety switch, a motivating heater for the actuator, said heater being energized independently of the energization of the fuel burning means by direct connection across a source of power by the automatic means, a combustion responsive means, a second actuator for preventing the

opening of the safety switch and under predetermined conditions for opening the safety switch, and a second motivating heater for the second actuator, said second heater being energized by direct connection across the source of power by said combustion responsive means independently of the energization of the fuel burning means, whereby a check is provided upon the operativeness of both of said heaters in each burner operation.

3. A burner control system comprising means for burning fuel, a safety switch for controlling the fuel burning means, a relay for additionally controlling the fuel burning means, an actuator for the safety switch, a motivating heater for the actuator, said heater connected in parallel with the relay, a second actuator for the safety switch operated after the establishment of combustion, and a latch for the safety switch having two releasing positions whereby a difference in action between the first and second actuators in either direction greater than a predetermined amount will open the safety switch.

4. A burner control system comprising means for burning fuel, a manually reset safety switch for controlling the fuel burning means, an actuator for the safety switch, a motivating heater for the actuator, said heater being energized in parallel with the fuel burning means, a second actuator for the safety switch, a second motivating heater for the second actuator, said second heater being energized after the establishment of combustion, and a latch for the safety switch having two releasing positions whereby a difference in action between the first and second actuators in either direction greater than a predetermined amount will open the safety switch.

5. A burner control system comprising means for feeding fuel to a burner, means for energizing the fuel feeding means, a manually reset safety switch for controlling the operation of the fuel feeding means, an actuator independently energized during the entire operation of the fuel feeding means for opening the safety switch after a predetermined time if combustion does not take place, and means responsive to combustion conditions for opening the safety switch after combustion takes place if said actuator is not energized, said actuator and combustion responsive means arranged to neutralize each other for normally keeping the safety switch closed.

6. A burner control system comprising means for feeding fuel to a burner, means for energizing the fuel feeding means, a manually reset safety switch for controlling the operation of the fuel feeding means, a time delay actuator for opening the safety switch and independently energized during the entire operation of the fuel feeding means, and a second time delay actuator for opening the safety switch energized upon the establishment of combustion, said safety switch arranged to open if either actuator is energized alone but to remain closed if both actuators are energized.

7. A burner control system comprising means for feeding fuel to the burner, a manually reset safety switch for controlling the operation of the fuel feeding means, a time delay actuator for opening the safety switch, automatic means for simultaneously and independently energizing the fuel feeding means and the time delay actuator, a second time delay actuator for opening the safety switch, and combustion responsive means for energizing the second actuator, said safety

switch arranged to remain closed if both actuators are energized.

8. A burner control system comprising means for burning fuel, a safety switch for controlling said system, a time delay actuator for the safety switch, a motivating heater for the actuator, a second actuator for the safety switch responsive to combustion conditions, automatic means for controlling said fuel burning means and said heater, and means whereby said system is rendered inoperative by said safety switch after a time delay in the event that either one of said actuators is ineffective while the other is effective.

9. A safety switch for a controller comprising a pair of actuators, latching means having two releasing positions fastened to one of said actuators including a spring biased latch member, releasing means fastened to the other actuator including a release member arranged to engage said latch member under certain conditions of operation by the actuators and to release said latch member under different conditions of operation, and switching means held open by said latch member in its released position.

10. A safety switch for a controller comprising a pair of U-shaped bimetal actuators, a heater for each of the actuators, said actuators arranged to compensate each other for temperatures other than those caused by the heaters, calibrating adjusting means associated with each actuator, latching means having two releasing positions fastened to one of said actuators including a spring biased latch member, releasing means fastened to the other actuator including a release member arranged to engage said latch member under certain conditions of operation by the actuators and to release said latch member under different conditions of operation, switching means held open by said latch member in its released position, and means for resetting the latch member and closing said switching means.

11. A burner control system comprising a fuel burning means, a switch for controlling the fuel burning means, a pair of movable actuators having hot and cold positions, one of said actuators being energized concurrently with the fuel burning means and being continually energized during the total time of energization of said fuel burning means, latching means operated by the actuators, said switch operated by said latching means, said latching means holding said switch closed when both actuators are either in their hot or cold positions but opening said switch when one or the other of the actuators is in its hot position while the other is in its cold position.

12. A safety switch of the class described comprising a pair of bimetal actuators of generally U-shaped configuration and thermally insulated from each other, a heater for each of the actuators, a heater block for each of the heaters for controlling the rate of temperature rise of the actuators, latching means having forward and backward releasing positions fastened to one of said actuators, releasing means for said latching means fastened to the other actuator whereby relative motion between the two actuators in either a forward or backward direction of over a predetermined amount releases said latching means, said actuators arranged to compensate each other for ambient temperature changes, and switching means held open by said latching means in its released position.

13. A burner control apparatus comprising a

combustion responsive means, an actuating arm, a slip friction mechanism for imparting motion of the combustion responsive means to the actuating arm, contacts opened and closed by the actuating arm, a safety switch, a first actuator for the safety switch, a heater for the first actuator controlled by external automatic means, a second actuator for the safety switch, a heater for the second actuator controlled by said contacts, and latching means for said safety switch controlled by said actuators, said latching means being constructed and arranged so that a difference in action between said actuators in either direction greater than a predetermined amount will cause opening of the safety switch.

14. In a burner control apparatus, a base, a pair of thermal actuators supported at one end from the base and having their other ends free to move, an electric heater for each of the thermal actuators for actuating the same, a latch member actuated by the movable end of one of the thermal actuators, a release member having two release positions and actuated by the movable end of the other thermal actuator, biasing means for normally holding said latch member and said release member in latching engagement, means for energizing one of the electric heaters to release the latch member from the release member in one of its two releasing positions by the movement of the associated thermal actuator, means for energizing the other electric heater to release the release member in the other of its two release positions by movement of the associated thermal actuator, the energizing of both of said electric heaters being effective to maintain the latch member in latching engagement with the release member, and cooperating contact means operated upon release of said latch member.

15. In a burner control apparatus, a burner, means for starting and stopping the burner, a base, a pair of thermal actuators supported on one end of the base and having their other ends free to move, an electric heater for each thermal actuator supported thereon for actuating the same, one of said heaters energized during the entire operation of the burner, a latch member having first and second releasing positions secured to the movable end of one of the thermal actuators, a release member secured to the movable end of the other thermal actuator, said members having a latching engagement with each other, biasing means normally holding both said members in latching engagement, means for separately energizing the other electric heater, said releasing member releasing the latch member in its first releasing position in case one of the heaters is energized alone for a time period and releasing the latch member in its second releasing position in case the other heater is energized alone for a time period, but maintaining the members latched in case both heaters are energized within a time period after the burner starts or in case both heaters are de-energized within a time period after the burner stops, said members arranged to prevent burner operation in their unlatched position, and manual means for relatching said members after they have been unlatched.

16. In a burner control apparatus of the class described, a pair of thermal actuators supported on one end and having their other ends arranged free to move in two directions, a latch member carried on the free end of the first one of the thermal actuators, a release member carried on

the free end of the second thermal actuator, means for normally biasing said members in latching engagement with each other, an electric heater for each thermal actuator for operating the same to move their free ends in the same direction, the thermal actuators moving their free ends in the other direction when cooling, the independent movement of said first thermal actuator in either direction releasing its latch member from engagement with the release member, the independent movement of the second actuator in either direction releasing the release member from engagement with the latch member, the contemporaneous movement of both thermal actuators in the same direction maintaining the latch and release members in engagement with each other, and contact means actuated by the unlatching of the members.

17. In a burner control apparatus of the class described, a pair of thermal actuators supported at one end and arranged free to move their other ends in two directions, a latch member, a release member supported on the movable end of one of the thermal actuators, a biasing spring supporting the latch member on the movable end of the other thermal actuator, said biasing spring normally holding said latch and said release members in latching engagement, an electric heater for each thermal actuator for operating the same to move its free end in one direction, the thermal actuators moving their free ends in the opposite direction when cooling, the latching engaging surfaces of the members being of such an area as to require either thermal actuator to move in either direction in accordance with a predetermined time interval to unlatch the members, the relative movement of the first thermal actuator in either direction with respect to the second thermal actuator effecting an unlatching movement of the latch member from the release member, and the relative movement of the second thermal actuator in either direction with respect to the first thermal actuator effecting the unlatching movement of the release member from the latch member, the contemporaneous movement of both thermal actuators in the same direction maintaining the latch and release members in engagement with each other, and a set of contacts actuated by the unlatching of the members.

18. A burner control system comprising a fuel burning means, a safety switch for controlling the fuel burning means, a pair of movable actuators for the safety switch, and latching means for the safety switch operated by the actuators and having two released positions, said latching means arranged to operate the safety switch only after the relative movement in either direction between the two actuators exceeds a predetermined amount.

19. A burner control system comprising fuel burning means, a safety switch for controlling the fuel burning means, a pair of movable actuators having hot and cold positions, one of said actuators energized concurrently with the fuel feeding means and the other actuator energized responsive to combustion conditions, latching means for the safety switch operated by the actuators, said latching means holding said safety switch closed when both actuators are in their hot or cold positions but opening said safety switch when either of the actuators is in its hot position while the other is in its cold position.

20. An oil burner system comprising means for burning fuel, a safety switch for controlling the

fuel burning means, a pair of movable actuators for controlling the safety switch, latching means operated by said actuators for opening the safety switch when released, said latching means comprising members, one moved by each actuator and having slidable engaging surfaces which cooperate with each other to remain engaged so long as both actuators move in unison in the same direction but to disengage after relative motion between the actuators exceeds a predetermined amount in either direction.

21. A burner control system comprising a fuel burner, means for feeding fuel to the burner, a safety switch having open and closed positions for controlling the fuel feeding means, first time delay means for opening the safety switch effective so long as the fuel feeding means is energized, second means for opening the safety switch effective so long as fuel is being burned, said first and second means cooperating to restrain said safety switch in the closed position if both first and second means are contemporaneously effective and operable to release said safety switch for opening movement when either of said first or second means is ineffective while the other is effective.

22. A safety switch controller comprising a pair of actuators, latching means fastened to one of said actuators, releasing means for said latching means fastened to the other actuator and having two released positions whereby relative motion between the two actuators in either direction of movement releases said latching means, and switching means held open by said latching means in either of its released positions.

23. A control system for a fuel burning means, the combination of, a switch for controlling the fuel burning means, means including latching means for causing said switch to remain in a predetermined position, a first thermal actuator, a second thermal actuator, said first and second thermal actuators being mechanically associated with and causing release of said latching means upon a predetermined difference in action in either direction between said thermal actuators, a heating means for the first thermal actuator, and means for controlling said heating means and causing heating of said second thermal actuator.

24. A burner control system comprising means for burning fuel, switching means for controlling said fuel burning means, a first thermal actuator, a second thermal actuator, mechanical means actuated in accordance with differences in action between said actuators and acting upon a predetermined difference in action in either direction between said thermal actuators to actuate said switching means in a single electrical manner, heating means for the first thermal actuator, and means for controlling said heating means and causing heating of said second thermal actuator.

25. A controller of the class described comprising, a first thermal actuator, a first heating means for the first thermal actuator, a second thermal actuator exposed to the same ambient temperature as the first thermal actuator for compensating the controller for changes in ambient temperature, a second heating means for the second thermal actuator, a control device, and mechanical means actuated by a predetermined difference in action in either direction between said thermal actuators for actuating said control device in a single manner.

26. A control system for a power consuming device, the combination of, a switch for controlling the power consuming device, means including latching means for causing said switch to remain in a predetermined position, and means for releasing said latching means comprising a first actuator and a second actuator, said actuators being mechanically associated with and releasing said latching means upon a predetermined difference in action thereof in one direction and also releasing said latching means upon a predetermined difference in action between the actuators in the opposite direction.

27. A control system for a fuel burner, the combination of, a safety switch, a first thermal element, a second thermal element, means actuated by a predetermined difference in action in either direction between said thermal elements for operating said safety switch, a power circuit for said burner and including said safety switch, a responsive device for opening and closing said power circuit for thereby starting and stopping the burner, first heating means for the first thermal element, a second heating means for the second thermal element, said heating means being connected in parallel with respect to each other and with respect to said burner, both of said heating means being controlled by the responsive device, and a combustion responsive switching means interposed in circuit with one only of said heating means, said last mentioned switch closing upon presence of combustion.

28. In a control system for a burner, the combination of, switching means for controlling the burner, a thermostatic element for actuating said switching means, electric heating means for said thermostatic element and energized during the entire operation of the burner, a second element for controlling said switching means and having electric operating means therefor, combustion responsive means for energizing said electric op-

erating means upon presence of combustion, said elements and switching means being arranged to prevent continued operation of the burner if either the electric heating means or the electric operating means is energized alone, but to maintain the burner in operation if both the electric heating means and the electric operating means are energized.

29. In a control system for an electric motor driven fuel burner, the combination of, a switch for controlling the burner, a first thermostatic element for actuating said switch, said first thermostatic element being arranged to open said switch upon movement of said first thermostatic element in either direction, electric heating means for said first thermostatic element for causing movement of said first thermostatic element in one direction, a second thermostatic element for cooperating with said first thermostatic element in controlling said switch, said second thermostatic element having electric heating means therefor and movable under the influence of the same, said second thermostatic element in one position preventing movement of the switch to open position due to movement of the first thermostatic element in said one direction and in another position permitting movement of the switch to open position upon movement of the first thermostatic element in said one direction, means including control means responsive to the demand for heat from the burner for energizing the electric heating means of the first thermostatic element upon demand for heat, and combustion responsive switching means actuated upon presence of combustion for controlling the electric heating means of the second thermostatic element in a manner preventing opening of the switch by movement of the first thermostatic element in said one direction.

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