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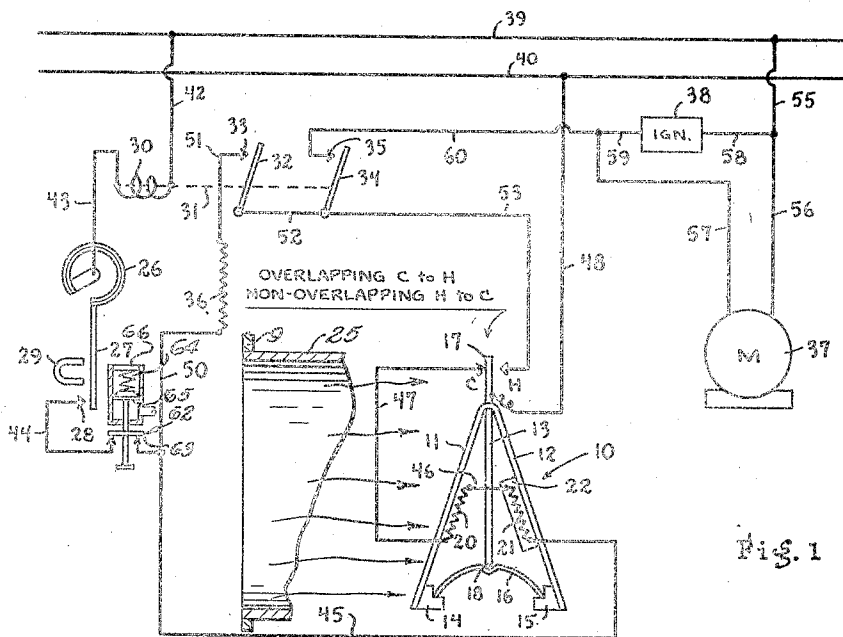
F. E. LANGE

2,355,309

AUTOMATIC BURNER CONTROL SYSTEM

Filed July 10, 1941

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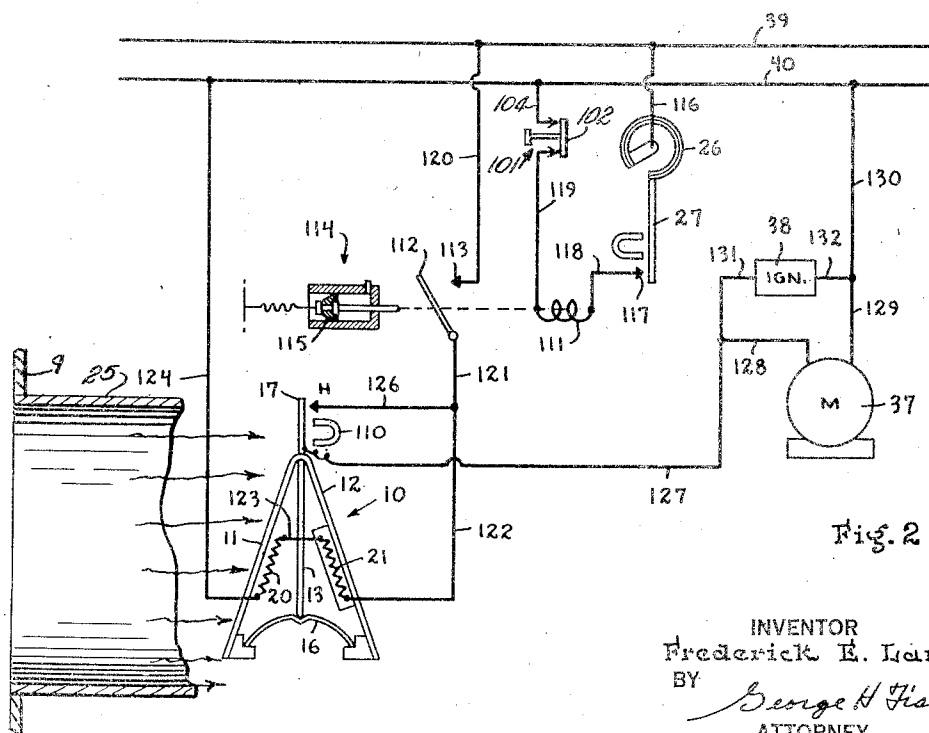


Fig. 2

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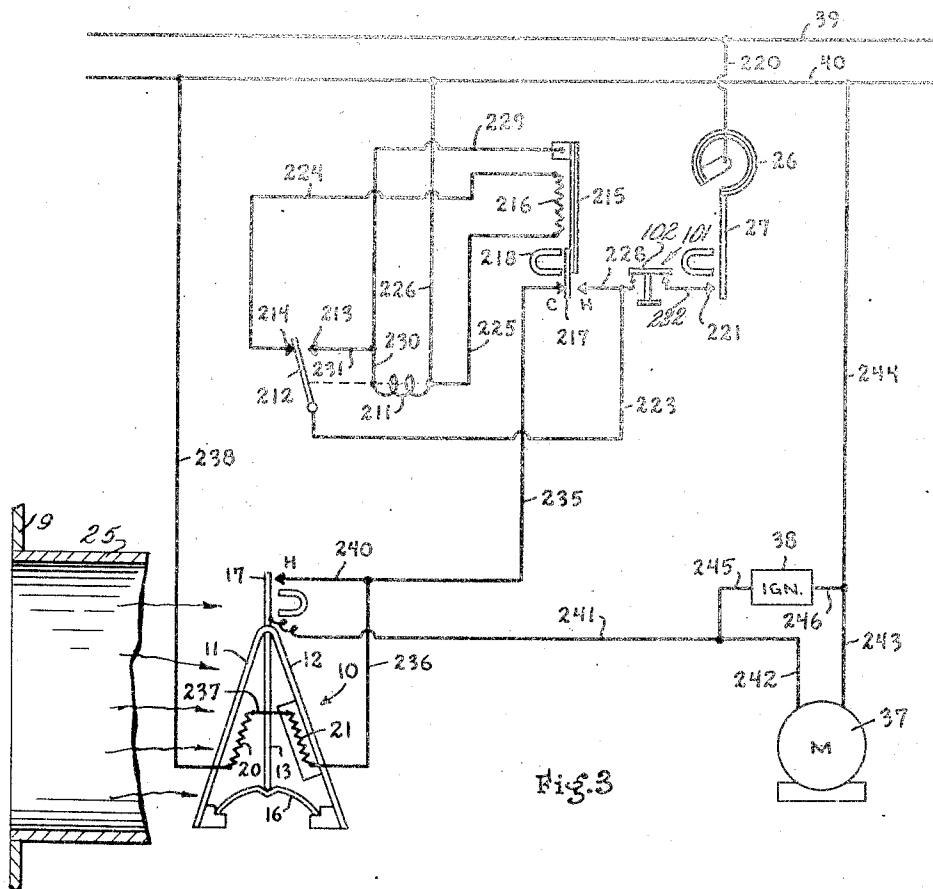
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2 Sheets-Sheet 2



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AUTOMATIC BURNER CONTROL SYSTEM

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Application July 10, 1941, Serial No. 401,736

19 Claims. (Cl. 158—28)

This invention relates generally to the automatic control of electrical devices for delivering fuel to a burner, and more specifically to burner motor control systems in which provision is made for locking out the burner motor upon failure of combustion in such a manner that a manual operation is necessary in order to reenergize the burner motor.

For the most part, prior art systems have accomplished this through the use of two separate devices, one a heat sensitive device for detecting the presence or absence of combustion, and the second, a safety switch in the form of an electrically heated, thermally operated time switch which deenergizes and locks out the burner motor in the event that its heater is not deenergized first by said combustion responsive device in response to the establishment of combustion.

One of the principal objects of the present invention is to combine the functions of the combustion responsive device and safety switch into one instrument.

Another object is to provide a fluid fuel burner system with a thermal device which is electrically heated in response to a demand for burner operation for energizing the burner motor, and is then heated directly by the heat of combustion to maintain burner operation. Still another object is to utilize this same thermal device for deenergizing the burner motor and locking it out in the event that combustion is not established, or upon a subsequent failure of combustion.

A further object of the invention is to provide the above system with a means to interpose a predetermined minimum time delay between successive energizations of the burner motor.

These and other objects will be readily apparent as the following specification is read in the light of the accompanying drawings in which

Figure 1 shows schematically a fuel burner control system embodying the various features of my present invention,

Figure 2 is a schematic showing of a modification of my invention, and

Figure 3 shows schematically a third form of my invention.

Referring now to Figure 1, the reference numeral 10 indicates an elongated expansible metal ribbon formed of two legs 11 and 12. The metal ribbon 10 is stretched across a tensioning member 13 and the two extremities of the ribbon are connected to the supporting members 14 and 15. A spring 16 carries the lower end of the tensioning member 13 and exerts a force upwardly so that this member 13 applies a tension to the

ribbon 10. The upper end of the member 13 is in the form of a contact arm 17 which is adapted to move between a cold contact C and a hot contact H.

The device is so adjusted that expansion of one of the two legs with respect to the other will cause a movement of the contact arm 17 by reason of the fact that the tensioning member 13 will rotate about the point 18 at which it is supported by the bowed spring 16. For example, if the leg 11 were heated to a temperature above that of the leg 12 then the leg 11 would expand and cause the tensioning member 13 to rotate in a clockwise direction about the point 18 and the contact arm 17 would thereupon move toward the right as seen in Figure 1.

The device 10 is so adjusted that when the two legs 11 and 12 are at the same temperature, the contact arm 17 will be in engagement with the cold contact C, and when the leg 11 is heated to a temperature above that of leg 12, the resultant expansion of leg 11 causes the contact arm 17 to move over into engagement with the contact H.

It will be appreciated that the operation of the switches C and H is entirely independent of the actual temperature of the two legs 11 and 12. The operation of these switches depends only upon a differential in temperature existing between these two legs.

An electric heater 20 is mounted on the leg 11 for the purpose of heating the same. Electric heater 21 is mounted upon the leg 12 for the same purpose. The heater 21 however is provided with a suitable lagging 22 so that the heat developed by the heater 21 will be delayed in reaching the leg 12 whereas the heat from the electric heater 20 will be immediately transmitted to leg 11. The result of this arrangement is that when the two heaters 20 and 21 are simultaneously energized the leg 11 will heat more rapidly than the leg 12, but after a predetermined time interval these legs will reach the same temperature. The effect on the contact arm 17 is that upon energization of the two heaters 20 and 21, the leg 11 will first be heated to a temperature above that of leg 12 and the arm 17 will first be rotated toward the right as seen in Figure 1, and then as the two legs reach the same temperature contact arm 17 will rotate toward the left and return to its original position.

The contacts C and H and the contact arm 17 are shown diagrammatically. Actually this switching arrangement operates to close a circuit from the contact arm 17 to the hot contact H before the circuit is broken between the cold

contact C and the contact arm 17. Thus as the contact arm 17 moves toward the right as seen in Figure 1, the control of these circuits overlap. As the contact arm 17 moves toward the left it will first break the circuit between the hot contact H and the contact arm 17 and later make the circuit between the cold contact C and the contact arm 17. To state it differently, the hot contact is always actuated before the cold contact so that it makes first on movement of the arm 17 to the right and breaks first on movement of this arm to the left. This switch function is well known in the prior art and there are a great many patented devices for accomplishing it. Further description thereof is therefore believed unnecessary.

The furnace wall 9 is provided with an opening in which a tube 25 is located. This tube, only a portion of which is shown in the drawings, serves to direct radiant heat from the flame produced by the burner onto the leg 11 of the thermal device 10 whereby this leg may be heated during the period that combustion is present within the furnace. The leg 12 is protected so that radiant heat from the furnace cannot strike it, and therefore during the period that combustion is present within the furnace the leg 11 will be maintained at a higher temperature than the leg 12, and the contact arm 17 will therefore remain in engagement with the hot contact H. This will be true regardless of the energization of the two electric heaters 20 and 21.

Located in the room, or other region where the temperature is to be controlled, is a thermostat in the form of a bimetal coil 26. This coil is fixed at one end and at the other end carries a contact blade 27 which on a decrease in temperature is moved by the coil 26 into engagement with the stationary contact 28. A permanent magnet 29 may be provided for the purpose of assuring positive action between the blade 27 and the contact 28.

A relay winding 30 is adapted when energized to attract its armature, indicated by the dotted line 31, which simultaneously moves the contact arm 32 into engagement with the stationary contact 33 and the contact arm 34 into engagement with the stationary contact 35. A relatively high resistance 36 is located in series with the contact 33 for a purpose to be later described.

The reference numeral 37 indicates an electrical device for controlling the flow of fuel to the burner and an electrical ignition device for the fuel is indicated at 38. Obviously any other type of ignition means may be substituted therefor, such as a constantly burning gas pilot flame, for example. For the purpose of this description, the system will be referred to as an oil burner control system, and therefore the electrical device 37 will be the conventional type of oil burner motor. The electrical energy for operating the system is supplied by means of the two line wires 39 and 40.

A manually operated switch is provided for de-energizing the heater for a predetermined period of time. This switch comprises a push button actuated switch plate 63 associated with a dash-pot 62. The dash-pot 62 includes a cylinder 64 in which a piston 65 operates. A spring 66 serves to bias the piston in switch closing direction. The dash-pot 62 is of any conventional type in which the movement in one direction only is impeded. Thus, the operator is able to quickly open the switch by moving the switch plate 63 away from the switch contacts. After the switch is

thus opened, the switch is slowly returned to closed position by a spring 66 under the control of dash-pot 62.

Operation

The system has been shown in its satisfied position in which the thermostat 26 has separated the contact blade 27 from the contact 28. The burner motor 37 is deenergized as well as the two electrical heaters 20 and 21 and the thermal device 10 is therefore in its cold position at which time the contact arm 17 engages the cold contact C and is disengaged from the hot contact H. This is because the two legs 11 and 12 of the thermal device 10 have reached the same temperature, there being no heat applied to them by the heaters or by the furnace combustion chamber.

Due to the fact that the burner motor 37 is deenergized, the temperature in the space in which the thermostat 26 is located will begin to fall, and when it reaches a predetermined value the thermostat 26 will cause the contact blade 27 to engage the stationary contact 28. This will establish a circuit from line wire 39 through conductor 42, relay winding 30, conductor 43, thermostat 26, contact blade 27, stationary contact 28, conductor 44, switch plate 63, conductor 45, electric heater 21, conductor 46, electric heater 20, conductor 47, cold contact C, contact arm 17 and conductor 48 back to the other line wire 40. The above circuit results in the simultaneous energization of the two electric heaters 20 and 21, with the result that the leg 11 will be immediately heated to a temperature above that of the leg 12. This will cause a rotation of the tensioning member 13 and the contact arm 17 will then close a circuit with the hot contact H. It will be noted that the relay winding 30 was energized at the same time as the two electric heaters 20 and 21 with the result that the two arms 32 and 34 will move into engagement with the contacts 33 and 35 respectively. No new circuits are established by the energization of the relay, but when contact arm 17 engages the hot contact H a circuit is set up in parallel with the two electric heaters 20 and 21. This circuit extends from the conductor 44 through switch plate 63, conductor 50, resistance 36, conductor 51, contact 33, switch arm 32, conductor 52, conductor 53, hot contact H, and contact arm 17 to conductor 48. The relatively high electrical resistance 36, which is now in parallel with the electric heaters 20 and 21, prevents these heaters from being deenergized.

When the contact arm 17 engages the hot contact H an energizing circuit for the burner motor and ignition device is also established from supply line 39 through conductor 55, then through one circuit comprising conductor 56, burner motor 37 and conductor 57 and through a parallel circuit comprising conductor 58, electrical ignition device 38 and conductor 59. From the junction of the conductors 57 and 59 the circuit continues through conductor 60, contact 35, switch arm 34, conductor 53, hot contact H, contact arm 17 and conductor 48 back to the other line wire 40.

Let it be assumed first that for some reason the energization of the burner motor 37 and ignition device 38 does not result in the combustion of fuel at the burner. There will therefore be no flame and hence no radiant heat will impinge upon the leg 11 of the thermal device 10. A predetermined time after the switch arm 17 has been moved into engagement with the hot contact H (usually about 90 seconds) the lagged heater 21 will cause the leg 12 to come up to about the same

temperature as the leg 11 at which time the contact arm 17 will disengage the hot contact H which will result in the deenergization of the burner motor and ignition device. Preferably the resistance values of the heaters 20 and 21 are so chosen that upon energization the leg 11 will be expanded sufficiently to close the hot switch H but insufficient to open the cold switch C. In this way the heaters will remain continuously energized during the trial ignition period. As the thermostat 26 is still calling for heat, the heaters 20 and 21 will remain energized, thereby effectively locking the system in a condition where the burner motor cannot be reenergized until manual intervention occurs. This manual intervention consists of opening the manual switch 63. The delayed reclosure of the switch due to the action of dash-pot 62 is sufficient to allow both legs 11 and 12 to cool down to such an extent that upon reenergization of these two heaters 20 and 21, the leg 11 will be heated to a value above that of leg 12 causing the contact 17 to again engage the hot contact H to reenergize the burner motor 37.

Let it be assumed now that the two electric heaters 20 and 21 have been energized and the contact arm 17 has engaged the hot contact H and energized the burner motor 37 and the electric ignition device 38 and that as a result combustion has been established in the combustion chamber of the furnace. Radiant heat from the flame produced will now impinge directly upon the leg 11 and keep this leg at a temperature above that of the leg 12 even though at this time the electric heaters 20 and 21 remain energized. As a matter of fact the effect of the radiant heat on the leg 11 is such that the expansion of this leg is increased to such an extent that the arm 17 disengages the cold contact C and deenergizes the two electric heaters 20 and 21. Therefore at this time the hot contact H remains closed due directly to the effect of the radiant heat from the flame on the thermal device 10. This is the running condition of the system.

In the event of a flame failure the leg 11 will cool and contract and the arm 17 will immediately open the hot contact H and deenergize the burner motor. After a predetermined interval of time the two legs will reach the same temperature and the cold contact C will be closed, thereby reestablishing the original energizing circuit through the two heaters 20 and 21 and the system will again attempt to start. If the difficulty has been corrected and combustion is established, the system will attain its running condition as before. Otherwise it will lock itself out as described above.

A power failure will deenergize the burner motor and the thermal device 10 will open the hot contact H. The system cannot restart until contact arm 17 recloses cold contact C at which time the system will go through its normal starting function. The delayed closure of the cold contact C following the failure of combustion for any purpose interposes a predetermined minimum time delay between successive burner energizations in order to give the combustion chamber a chance to scavenge properly.

SYSTEM OF FIGURE 2

The system disclosed in Figure 2 is somewhat different from that disclosed in Figure 1 in that in Figure 2 the contact arm 17 closes a hot contact H, the same as in Figure 1, but there is no cold contact C in this modification. The thermal device 10 is an exact duplicate of the thermal de-

vice 10 of Figure 1 and is provided with the same fast heater 20 and lagged heater 21. In this modification, the contact arm 17 may be provided with a permanent magnet 110 in order to assure a positive contact action between the contact arm 17 and hot contact H.

The relay winding 111 in this case, when energized, moves a contact arm 112 into engagement with the stationary contact 113. This movement is retarded by means of a dash-pot indicated generally at 114 and similar to the dash-pot 62 of Figure 1. The dash-pot 114 is provided with a piston 115 which retards the movement of the contact 112 to closed position upon the energization of the winding 111 but which permits the immediate operation of the contact arm 112 and contact 113 upon the deenergization of the winding 111. Such devices are well known commercially and no further description is believed necessary.

The reference numeral 101 indicates a manually operable switch having a switch plate 102 for breaking the circuit.

Operation

Upon a call for heat by the thermostat 26, a circuit is established from the line wire 39 through conductor 116, thermostat 26, contact blade 27, stationary contact 117, conductor 118, relay winding 111, conductor 119, switch plate 102, and conductor 104 back to the other line wire 40. This circuit energizes the relay winding 111, and after a predetermined interval of time, determined by the timing of the dash-pot 114, the contact arm 112 engages the stationary contact 113. This establishes the following circuit: from line wire 39 through conductor 120, stationary contact 113, contact arm 112, conductors 121 and 122, lagged heater 21, conductor 123, fast heater 20 and conductor 124 back to the other line wire 40. The establishment of this circuit results in the heater 20 heating the leg 11 to a temperature above that of leg 12 so that the contact arm 17 will engage the hot contact H. The closure of this contact establishes a circuit from line wire 39 through conductor 120, contact 113, contact arm 112, conductors 121 and 126, contact H, contact arm 17, conductors 127 and 128, burner motor 37 and conductor 129—130 back to the other line wire 40. Conductors 131 and 132 connect the electrical ignition device 38 in parallel with the burner motor 37.

If combustion is not established at this time the legs 11 and 12 of the thermal device 10 will soon reach the same temperature and the arm 17 will therefore disengage the hot contact H and the burner motor will be locked in deenergized position in the same manner as in Figure 1. In order to reset the system for operation at this time, it is only necessary to momentarily deenergize the winding 111 by opening switch 101. This will immediately open the switch 112—113 and the dash-pot 114 is designed to interpose a sufficient delay in the closing of this switch to permit the two legs 11 and 12 to cool sufficiently. Upon reenergization of the heaters 20 and 21 the arm 17 will reenergize the burner motor and ignition device by closing against the hot contact H.

If combustion is successfully established the leg 11 will be maintained in engagement with the hot contact H due to the radiant heat from the combustion chamber 25. In this modification the two heaters 20 and 21 will remain energized but

the effect of the radiant heat on the leg 11 is sufficient to maintain the hot contact closed.

On a momentary power failure the switch 112-113 will be immediately opened and the dash-pot 114 will insure a proper delay in the reclosing of the circuit.

SYSTEM OF FIGURE 3

The modification disclosed in Figure 3 is the same as that disclosed in Figure 2 except that a thermal time delay means has been substituted for the dash-pot 114 of Figure 2. In this modification, the relay winding 211 when energized moves the contact arm 212 into engagement with the stationary contact 213 and when deenergized the contact arm 212 engages contact 214. The time delay is provided by means of a bimetal thermostat 215 which is heated by means of an electrical heater 216. The thermostat 215 carries a movable contact 217 which in the cold position of the thermostat engages contact C and in its hot position engages contact H. A permanent magnet 218 is provided for causing the contact to move with a snap action between contacts C and H.

The thermal device 10 and its switch action are exactly the same as in Figure 2 and will not be described again. Similarly, the manual switch 101 is the same as in Figure 2.

Operation

On a call for heat by the thermostat 26, a circuit is established from line wire 39 through conductor 220, thermostat 26, contact blade 27, contact 221, conductor 222, switch plate 102, conductor 223, contact arm 212, contact 214, conductor 224, electric heater 216 and conductors 225 and 226 back to the other line wire 40. This results in the heating of the bimetal 215, and when it attains a predetermined temperature it will snap the movable contact 217 from engagement with the cold contact C to engagement with the hot contact H. This will establish a circuit from the line wire 39 through conductor 220, thermostat 26, contact blade 27, contact 221, conductor 222, switch plate 102, conductor 223, contact H, movable contact 217, bimetal 215, conductors 229 and 230, relay winding 211 and conductor 226 back to the other line wire 40. Upon energization of the relay winding 211, the relay arm 212 will separate from contact 214 and engage contact 213. This breaks the circuit through the heater 216 of the bimetal 215 and sets up a holding circuit for the relay winding 211 which is independent of the hot contact H. This holding circuit may be traced from line wire 39, conductor 220, thermostat 26, contact blade 27, contact 221, conductor 222, switch plate 102, conductor 223, relay arm 212, contact 213, conductors 231 and 230, relay winding 211 and conductor 226 back to the other line wire 40. After a predetermined time interval the bimetal 215 will cool sufficiently to snap the contact 217 out of engagement with the contact H and into engagement with the contact C. This results in the establishment of an energizing circuit for the two heaters 20 and 21 for the two legs 11 and 12 respectively of the thermal device 10. This circuit extends from the line wire 39 through conductor 220, thermostat 26, contact blade 27, contact 221, conductor 222, switch plate 102, conductor 223, relay arm 212, contact 213, conductors 231 and 229, bimetal 215, contact 217, contact C, conductors 235 and 236, lagged heater 21, conductor 237, fast heater 20 and conductor 238 back to the

other line wire 40. As described above, the energization of these heaters will result in the movement of the contact arm 17 into engagement with contact H whereby the burner motor 37 and ignition device 38 will be energized by the circuit extending from the conductor 235, through conductor 240, contact H, contact arm 17, conductors 241 and 242, burner motor 37 and conductors 243 and 244 to line wire 40. The conductors 245 and 246 connect the ignition device 38 in parallel with the burner motor 37.

If combustion is not established the system is locked out the same as in the other two modifications, whereas if combustion is established the radiant heat from the combustion chamber 25 heats the leg 11 and maintains the hot contact H closed.

On a power failure or upon satisfaction of the thermostat 26, the relay winding 211 will be deenergized and the contact arm 212 will separate from contact 213 and engage the contact 214. This results in the deenergization of the two heaters 20 and 21 and also of the burner motor 37 and ignition device 38. The two heaters 20 and 21 cannot now be reenergized until the heater 216 is reenergized to cause the bimetal 215 to move the contact 217 into engagement with contact H which energizes the relay 211 and breaks the circuit to the heater 216 and until the bimetal 215 subsequently cools and causes the contact 217 to separate from contact H and engage the contact C. This time delay gives the two legs 11 and 12 of the thermal device sufficient time to cool so that upon reenergization of the two heaters 20 and 21 the contact arm 17 will again be moved into engagement with the contact H.

In order to manually reset this system for operation following a lock out due to failure of combustion, it is necessary only that the circuit to the relay winding 211 be momentarily broken. This may be accomplished by momentarily opening switch 101.

It will therefore be seen that I have provided an improved fuel burner control system in which the functions of the safety switch and the combustion responsive thermostat have been combined into one instrument which is my thermal device 10. This thermal device 10 acts to deenergize and lock out the burner motor in the event of an original failure of ignition and also directly detects the establishment of combustion to maintain burner operation in the event that combustion is established before the system is locked out. The three modifications have been disclosed merely for the purposes of illustration, and as many additional modifications falling within the scope of this invention will occur to those who are skilled in the art I intend to be limited only by the appended claims.

I claim as my invention:

1. An automatic fuel burner control system comprising in combination, an electrical device for controlling the flow of fuel to said burner, means for igniting said fuel, control means for said device including a thermal means having two heat sensitive portions which, when they are both at substantially the same temperature, cause said control means to assume a predetermined position in which said electrical device is deenergized, means operated in response to a demand for burner operation for heating one of said portions rapidly and the other portion slowly whereby said control means is moved in one direction to energize said electrical device for a predetermined period of time and then return to its

original position, and means for additionally heating said one portion upon the establishment of combustion to prevent the control means from returning to its original position.

2. An automatic fuel burner control system comprising in combination, an electrical device for controlling the flow of fuel to said burner, means for igniting said fuel, control means for said device including a thermal means having two heat sensitive portions which, when they are both at substantially the same temperature, cause said control means to assume a predetermined position in which said electrical device is deenergized, means operated in response to a demand for burner operation for heating one of said portions rapidly and the other portion slowly whereby said control means is moved in one direction to energize said electrical device for a predetermined period of time and then returns to its original position, said one portion being so located as to respond to the heat of combustion and prevent the return of said control means to its original position if combustion is established first.

3. An automatic fuel burner control system comprising in combination, an electrical device for controlling the flow of fuel to said burner, means for igniting said fuel, control means for said device including a thermal means having two heat sensitive portions which, when they are both at substantially the same temperature, cause said control means to assume a predetermined position in which said electrical device is deenergized, means operated in response to a demand for burner operation for heating one of said portions rapidly and the other portion slowly whereby said control means is moved in one direction to energize said electrical device for a predetermined period of time and then returns to its original position, said one portion being so located as to respond to the heat of combustion and prevent the return of said control means to its original position if combustion is established first, said one portion causing the return of said control means to its original position upon a subsequent failure of combustion, and means interposing a delay between successive energizations of said electrical device.

4. An automatic fuel burner control system comprising in combination, an electrical device for controlling the flow of fuel to said burner, means for igniting said fuel, control means for said device including a thermal means having two heat sensitive portions which, when they are both at substantially the same temperature, cause said control means to assume a predetermined position in which said electrical device is deenergized, means operated in response to a demand for burner operation for heating one of said portions rapidly and the other portion slowly whereby said control means is moved in one direction to energize said electrical device for a predetermined period of time and then returns to its original position, means for additionally heating said one portion upon the establishment of combustion to prevent the control means from returning to its original position, and means for manually deenergizing said heating means in the event of a failure of combustion whereby the system is reset for another starting attempt.

5. An automatic fuel burner control system comprising in combination, an electrical device controlling the flow of fuel to said burner, means for igniting the fuel, a cold switch, a hot switch, thermal means having two heat sensitive por-

tions, said thermal means closing said cold switch when both of said portions are at substantially the same temperature and closing said hot switch when one of said portions is heated above the other, a quick acting electrical heater for said one portion, a slow acting electrical heater for said other portion, a main switch, a circuit for said heaters including said main switch and cold switch, a circuit for said electrical device including said hot switch, and means additionally heating said one portion upon the establishment of combustion.

6. An automatic fuel burner control system comprising in combination, an electrical device controlling the flow of fuel to said burner, means for igniting the fuel, a cold switch, a hot switch, thermal means having two heat sensitive portions, said thermal means closing said cold switch when both of said portions are at substantially the same temperature and closing said hot switch when one of said portions is heated above the other, a quick acting electrical heater for said one portion, a slow acting electrical heater for said other portion, a main switch, a circuit for said heaters including said main switch and cold switch, a circuit for said electrical device including said hot switch, said one portion being so located as to respond to combustion in a manner to keep said hot switch closed.

7. An automatic fuel burner control system comprising in combination, an electrical device controlling the flow of fuel to said burner, means for igniting the fuel, a cold switch, a hot switch, thermal means having two heat sensitive portions, said thermal means closing said cold switch when both of said portions are at substantially the same temperature and closing said hot switch when one of said portions is heated above the other, a quick acting electrical heater for said one portion, a slow acting electrical heater for said other portion, a main switch, a circuit for said heaters including said main switch and cold switch, a circuit for said electrical device including said hot switch, said hot switch closing before the cold switch opens on movement of said thermal means in one direction and opening before said cold switch closes on movement of said thermal means in the opposite direction, said one portion being so located as to respond to combustion in a manner to keep said hot switch closed.

8. An automatic fuel burner control system comprising in combination, an electrical device controlling the flow of fuel to said burner, means for igniting the fuel, a cold switch, a hot switch, thermal means having two heat sensitive portions, said thermal means closing said cold switch when both of said portions are at substantially the same temperature and closing said hot switch when one of said portions is heated above the other, a quick acting electrical heater for said one portion, a slow acting electrical heater for said other portion, a main switch, a relay winding, a first circuit including said main switch, relay winding, both electrical heaters, and said cold switch, a switch closed by said relay winding, a circuit for said electrical device including said relay switch and hot switch, and means providing for the additional heating of said one portion upon the establishment of combustion.

9. An automatic fuel burner control system comprising in combination, an electrical device controlling the flow of fuel to said burner, means for igniting the fuel, a cold switch, a hot switch, thermal means having two heat sensitive por-

tions, said thermal means closing said cold switch when both of said portions are at substantially the same temperature and closing said hot switch when one of said portions is heated above the other, a quick acting electrical heater for said one portion, a slow acting electrical heater for said other portion, a main switch, a relay winding, a first circuit including said main switch, relay winding, both electrical heaters, and said cold switch, a switch closed by said relay winding, a circuit for said electrical device including said relay switch and hot switch, means providing for the additional heating of said one portion upon the establishment of combustion, and means interposing a delay before the cold switch is closed following the extinguishment of the burner whereby a predetermined minimum time interval must elapse between successive energizations of said electrical device.

10. An automatic fuel burner control system comprising in combination, an electrical device controlling the flow of fuel to said burner, means for igniting the fuel, a cold switch, a hot switch, thermal means having two heat sensitive portions, said thermal means closing said cold switch when both of said portions are at substantially the same temperature and closing said hot switch when one of said portions is heated above the other, a quick acting electrical heater for said one portion, a slow acting electrical heater for said other portion, a main switch, a relay winding, a first circuit including said main switch, relay winding, both electrical heaters, and said cold switch, a switch closed by said relay winding, a circuit for said electrical device including said relay switch and hot switch, a second switch closed by said relay winding, a holding circuit for said relay winding including said main switch, second switch, and hot switch, and means providing for the additional heating of said one portion upon the establishment of combustion for maintaining said hot switch closed as long as combustion exists.

11. An automatic fuel burner control system comprising in combination, an electrical device controlling the flow of fuel to said burner, means for igniting the fuel, a cold switch, a hot switch, thermal means having two heat sensitive portions, said thermal means closing said cold switch when both of said portions are at substantially the same temperature and closing said hot switch when one of said portions is heated above the other, a quick acting electrical heater for said one portion, a slow acting electrical heater for said other portion, a main switch, a relay winding, a first circuit including said main switch, relay winding, both electrical heaters, and said cold switch, a switch closed by said relay winding, a circuit for said electrical device including said relay switch and hot switch, a second switch closed by said relay, a shunt circuit around said two heaters, said shunt circuit including said main switch, said second switch, and said hot switch, a resistance element in said shunt circuit to prevent the short circuiting of said electrical heaters when both of said hot and cold switches are closed, and means providing for the additional heating of said one portion upon the establishment of combustion for maintaining said hot switch closed as long as combustion exists.

12. An automatic fuel burner control system comprising in combination, an electrical device controlling the flow of fuel to the burner, means for igniting the fuel, a hot switch, thermal means having two heat sensitive portions, said thermal

means opening said hot switch when both of said portions are at substantially the same temperature and closing said hot switch when one of said portions is heated up above the other, a quick acting electrical heater for said one portion and a slow acting electrical heater for said other portion, circuit closing means operating in response to a demand for burner operation for closing a circuit through said two electrical heaters, a circuit for said electrical device including said hot switch, means providing for the additional heating of said one portion upon the establishment of combustion whereby said thermal means maintains said hot switch closed, and means for breaking the circuit to said electrical device when the demand for burner operation ceases.

13. An automatic fuel burner control system comprising in combination, an electrical device controlling the flow of fuel to the burner, means for igniting the fuel, a hot switch, thermal means having two heat sensitive portions, said thermal means opening said hot switch when both of said portions are at substantially the same temperature and closing said hot switch when one of said portions is heated up above the other, a quick acting electrical heater for said one portion and a slow acting electrical heater for said other portion, circuit closing means operating in response to a demand for burner operation for closing a circuit through said two electrical heaters, a circuit for said electrical device including said hot switch, and said circuit closing means, means providing for the additional heating of said one portion upon the establishment of combustion whereby said thermal means maintains said hot switch closed, and means retarding the action of said circuit closing means for interposing a predetermined time delay between successive energizations of said electrical device.

14. An automatic fuel burner control system comprising in combination, an electrical device controlling the flow of fuel to the burner, means for igniting the fuel, a hot switch, thermal means having two heat sensitive portions, said thermal means opening said hot switch when both of said portions are at substantially the same temperature and closing said hot switch when one of said portions is heated up above the other, a quick acting electrical heater for said one portion and a slow acting electrical heater for said other portion, a main switch, a relay winding for closing said main switch, means delaying the closure of said main switch following the energization of said winding but permitting said switch to open immediately upon deenergization of said winding, means for energizing said winding in response to a demand for burner operation, a circuit for said two electrical heaters including said main switch, a circuit for said electrical device including said main switch and said hot switch, and means providing for the additional heating of said one portion upon the establishment of combustion whereby said thermal means maintains said hot switch closed.

15. An automatic fuel burner control system comprising in combination, an electrical device controlling the flow of fuel to the burner, means for igniting the fuel, a hot switch, thermal means having two heat sensitive portions, said thermal means opening said hot switch when both of said portions are at substantially the same temperature and closing said hot switch when one of said portions is heated up above the other, a quick acting electrical heater for said one portion and a slow acting electrical heater for said other por-

tion, a main switch, a relay winding for closing said main switch, means delaying the closure of said main switch following the energization of said winding but permitting said switch to open immediately upon deenergization of said winding, means for energizing said winding in response to a demand for burner operation, a circuit for said two electric heaters including said main switch, a circuit for said electrical device including said main switch and said hot switch, means providing for the additional heating of said one portion upon the establishment of combustion whereby said thermal means maintains said hot switch closed, and a manual switch in circuit with said relay winding for reconditioning the system for operation following a failure of combustion during a demand for burner operation.

16. In a burner control device, a ribbon of a material expansible with temperature, a pivoted switch actuating arm, means for placing said ribbon under tension with an intermediate point thereof engaging said switch actuating arm so that said switch actuating member assumes a position dependent upon the relative expansion of the two portions of the ribbon on opposite sides of said intermediate point, an electrical heater for heating one portion of said ribbon sufficiently to tend to cause movement of said switch actuating arm in one direction away from a predetermined position, means for heating the other portion in response to the establishment of combustion to cause said switch actuating arm to remain in said predetermined position, and a burner control switch associated with said switch actuating arm and held in closed position when said switch actuating arm is in said predetermined position.

17. In a burner control device, a ribbon of a material expansible with temperature, a pivoted switch actuating arm, means for placing said ribbon under tension with an intermediate point thereof engaging said switch actuating arm so that said switch actuating member assumes a position dependent upon the relative expansion of the two portions of the ribbon on opposite sides of said intermediate point, an electrical heater for heating one portion of said ribbon sufficiently to tend to cause movement of said switch actuating arm in one direction away from a predetermined position, means for heating the other portion in response to the establishment of combustion to cause said switch actuating arm to remain in said predetermined position, a burner control switch associated with said switch actuating arm and held in closed position when

said switch actuating arm is in said predetermined position, and relay means for controlling the energization of said heater, said relay means being operative a predetermined period of time after energization thereof to cause energization of said electric heater and operative upon deenergization thereof to cause immediate deenergization of said heater.

18. In a burner control device, a pair of expansible temperature responsive elements acting in opposition to each other, a switch actuating member associated with said elements and moved in one direction or another by said elements depending upon the relative temperatures of the two elements, a quick acting electrical heater associated with a first of said elements to cause movement of said switch actuating member in one direction from a normal cold position to a predetermined position, a slow acting electrical heater connected in series with said quick acting heater and associated with the other of said elements to cause movement of said switch actuating member in the opposite direction away from said predetermined position, means for additionally heating said first element in response to the establishment of combustion to cause said switch actuating member to remain in said predetermined position despite the action of said slow acting heater, and a burner control switch held in closed position when said switch actuating member is in said predetermined position.

19. An automatic fuel burner control system comprising in combination, an electrical device for feeding fuel to said burner, means for igniting the fuel, a control switch for said electrical device, an actuator for said switch, a continuous ribbon member of thermally extensible mono-metallic material, said ribbon member having two portions each adapted to be heated, means including said actuator for operatively connecting the mid-portion of said ribbon to said switch to maintain said switch in either a first position in which operation of said burner is permitted or a second position depending upon the relative lengths of said two portions as affected by their relative temperatures, electrical means associated with said member for heating one of said portions so as to tend to cause said member to move said switch from said first to said second position, and means for subjecting the other of said portions of said member to the heat of combustion of said burner to cause it to be heated so that said member maintains said switch in said first position despite said electrical heating means.

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